School of Management

Development and Evaluation of a Sustainable e-Learning Framework for Higher Education Institutions in Malaysia

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Declaration

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgement has been made.

This thesis contains no material, which has been accepted for the award for any other degree or diploma in any university.

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Date:

Abstract

This thesis presents a report of a research which focused on the development and evaluation of a sustainable e-learning framework (SeLF) for higher education institutions in Malaysia. The aims of this research were: (1) to ascertain the characteristics of a sustainable e-learning framework for the higher education sector in Malaysia; (2) to identify stakeholders' perspectives and expectations of the characteristics of sustainable e-learning; and, (3) to ascertain if the new sustainable e-learning framework would assist the Malaysian higher education stakeholders to become more sustainable. In order to achieve the aims of this research, a mixed-methods approach was considered to be the most appropriate. Data were collected from respondents in a survey conducted among Malaysian university academics and students which comprised 108 academic staff and 207 students. Additionally, expert interviews were conducted with seven local and international experts to evaluate the usability of SeLF.

In the context of sustainable development, this thesis has responded to numerous calls made in several United Nations global key events such as the 2005 World Summit (United Nations 2005), The Future We Want 2012 (United Nations 2012), and the United Nations Summit for the Adoption of the Post-2015 Development (President of United Nations General Assembly 2015). Recently, with the global awareness on environmental and human equality issues, awareness on higher education issues related to sustainable education, learning process and quality has also been on the rise. Therefore, the higher education institution needs to consider sustainable development as a learning process and the institution’s commitment (Copernicus Alliance 2015) to enable higher education to genuinely contribute to sustainable development. With more attention being directed towards existing e-learning scholars, this study developed and evaluated an e-learning framework that would provide guidelines for higher education to contribute towards sustainability in education.

This research artefact was drawn from two separate, but associated, literatures related to sustainable development and e-learning. Literature relating to sustainable development was explored through the theoretical lens of e-learning and education

while e-learning was studied through the theoretical lens of sustainability. In order to achieve these research aims and objectives, a mixed-method approach was considered the most appropriate. This research sought to close the research gap in the literatures, indicating the lack of practical evidence of existing e-learning frameworks which had been identified to be a contributing factor to sustainable development and the strengthening of the Triple Bottom Line (TBL), that is, the people, the economy, and the environment. This thesis argued that the proposed SeLF would assist the higher education transformation towards sustainability in education rather than a limited focus on education for sustainable development. Furthermore, through this research, this thesis has also contributed to existing debates on sustainability and e-learning with the inclusion of the higher education sector's contribution towards sustainable development.

The quantitative and the qualitative data analyses from the survey have confirmed the presence of e-learning in Malaysian higher education institutions and sustainable innovation components in SeLF. Based on the evaluation of theoretical and empirical studies, this thesis has provided the much-needed answers in response to sustainable e-learning, with the main interest directed towards the characteristics of a sustainable e-learning framework and how the framework would assist the higher education to contribute towards sustainability in education. The empirical studies have provided evidence of assessment and acknowledgement of the need for a sustainable e-learning framework which was validated by experts in e-learning, education, and sustainable development. The thorough discussions presented in this thesis have highlighted the elements of SeLF and how SeLF would be able to contribute to the three TBL dimensions of sustainability while supporting higher education transformation towards sustainable development. This thesis defines sustainable e-learning as online education solution that performs sustainable practices in education to promote education equity (society), income equity (economy), and low carbon future (environment) while meeting the learners' present and future needs. It is anticipated that the outcomes of this thesis could assist higher education to successfully address the depreciation of sustainability in e-learning in the higher education sector and provide directions for new and future research in this field.

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Related Thesis Publications

Journal Articles

- Sofiadin, Aidrina Mohamed. 2014. "Sustainable Development, E-Learning and Web 3.0: A Descriptive Literature Review." *Journal of Information, Communication and Ethics in Society* 12 (3): 157-176.
- Sofiadin, Aidrina Mohamed. 2015. "Students' Perspectives towards Sustainable E-Learning in Malaysia" *Australian Journal of Basic and Applied Sciences* 9 (9): 14-17.

Conference Publications

- Sofiadin, Aidrina Mohamed, and Tomayess Issa. 2012. "An Initial E-Learning 3.0 Framework for Higher Education Universities in Malaysia." In *IADIS International Conference on Internet Technologies & Society 2012*, *Perth, Australia*.
- Sofiadin, Aidrina binti Mohamed. 2013. "Development and Evaluation of a Sustainable E-Learning Framework for Higher Education Institutions in Malaysia." In *International Conference on Sustainability, Technology and Education 2013, Kuala Lumpur, Malaysia*, edited by Theodora Issa, Tomayess Issa, Nurfadhlina Mohd Sharef and Pedro Isaias, 63-70. IADIS Press.

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Glossary of Key Abbreviations

AMS	-	Assessment Management System
CBT	-	Computer Based Training
CD	-	Compact Disc
CFA	-	Confirmatory Factor Analysis
CMS	-	Content Management System
CRM	-	Customer Relationship Management
DSR	-	Design Science Research
EEIO	-	Environmental Extended Input-Output
EFA	-	Exploratory Factor Analysis
ESD	-	Education for Sustainable Development
GBI	-	Green Building Index
GCI	-	Green Campus Initiative
GSHP	-	Ground Source Heat Pump
GTC	-	Green Technology Council
GVSU	-	Grand Valley State University
HCI	-	Human Computer Interaction
ICT	-	Information and Communication Technology
IIEP	-	International Institute for Educational Planning
IPTEACES	-	Involvement, Preparation, Transmission, Exemplification, Application, Connection, Evaluation, and Simulation
ISP	-	Internet Service Provider
KMO	-	Kaiser-Meyer-Olkin
LAN	-	Local Area Network
LMS	-	Learning Management System
MGBC	-	Malaysia Green Building Confederation
MMLS	-	Multimedia Learning System
MMU	-	Multimedia University
MOE	-	Malaysia Ministry of Education
MyVLE	-	My Virtual Learning Environment
NGTP	-	National Green Technology Policy
NSDS	-	National Sustainable Development Strategies
OECD	-	Organization for Economic Co-operation and Development
OLT	-	Online Live Tutorial
OMES	-	Online Marks Entry System
OUM	-	Open University Malaysia
PCA	-	Principal Components Analysis
SCORM	-	Shareable Courseware Object Reference Model
SeLF	-	Sustainable e-Learning Framework
SLAAS	-	Sustainable School Environment Awards
SPSS	-	Statistical Package for the Social Sciences

TBL	-	Triple Bottom Line
TEL	-	Technology Enhanced Learning
TLA	-	Teaching, Learning, and Assessment
UCSI	-	University College Sedaya International
UiTM	-	University Technology Mara
UKM	-	University Kebangsaan Malaysia
UM	-	University of Malaya
UMP	-	Universiti Malaysia Pahang
UNESCO	-	United Nations Educational, Scientific, and Cultural Organization
UNITAR	-	University Tun Abdul Razak
USM	-	Universiti Sains Malaysia
UTM	-	University Technology Malaysia
VLE	-	Virtual Learning Environment
VOISS	-	Virtual Online Instructional Support System
WWW	-	World Wide Web

Glossary of Definitions

Term	***Definition***
E-learning	Online education that delivers learning environment to anyone, at any place and anytime through an innovative approach.
Sustainability	Long term innovation process that intends to benefit the society, economy, and environment.
Sustainable e-learning	Online education solution that performs sustainable practices to promote education equity (society), income equity (economy), and low carbon future (environment) while meeting the learners' present and future needs
Sustainable e-learning in societal context	Sustainable e-learning that ensures quality education equity, educational achievement, and knowledgeable and innovative individuals while promoting a lifelong learning and sustainable development concept.
Sustainable e-learning in economical context	E-learning that aims to improve tertiary learning attainment, knowledge-intensive employment, and quality of life through a sustainable online education solution.
Sustainable e-learning in environmental context	E-learning that focuses on sustainable production and consumption through sustainable e-learning that promotes eco-friendly e-learning principles and technological development as part of the action on climate change and its impact, to meet the needs of present and future generations.
Sustainable Development	Development that focuses on meeting the present and future needs.

CHAPTER 1

INTRODUCTION

1.1 Introduction

Technologies are constantly and dramatically changing as they evolve to improve communication, collaboration, interaction, performance, and productivity for business and individuals locally and globally. New technology has also become a part of higher education practice in developing communication skills and sharing knowledge amongst individuals and institutions (Sofiadin and Issa 2012). Here, e-learning or online learning systems are areas where technology plays a key role in most universities. E-learning refers to a learning environment where students carry out their learning activities using online tools and resources (Kanninen 2008).

Sustainability is becoming a common phenomenon in e-learning, mainly addressing the ongoing learning needs of stakeholders and the communities that they serve. Since e-learning has the ability to contribute to lifelong learning, it needs to reach a level of sustainability to ensure its own lifelong use. In order for e-learning to become a lifelong and on-going practice, it must generally foster trust and continuing learner satisfaction (Filip 2011). In this work, we use the term ‘sustainable e-learning’ to express sustainability practice in e-learning concepts that intend to assist higher education institutions to meet their present and future students’ needs.

In Malaysia's education sector, there are several sustainable development initiatives geared towards sustainable education. These are organised by universities and include, among others, the Green Campus Initiative (GCI), Integrated Approaches to Sustainable Development Practice, and the Recycle Project. Despite these initiatives, there is no consideration of sustainability in e-learning in the Malaysian Plan - neither the Ninth from 2006-2010 nor the Tenth from 2011-2015. Rather, the focus was on ensuring a balance between developmental and environmental needs (Abdullah 2006) on improving the standard and sustainability of the quality of life. Regarding sustainability, the focus is on sustainability principles applied to economic development to ensure that the environment and natural resources are preserved, as well as the National Climate Change Policy and the National Green Technology Policy being implemented as a move towards a low-carbon economy and to attain sustainable development (Razak 2010). According to Razak (2010), Malaysia aims to become a developed country by the year 2020. One of the National Missions is to enhance Malaysia's capacity for knowledge, creativity, and innovation and develop a 'first class mentality' by providing an innovative environment that comprises e-learning. Many universities (public and private) have established their own e-learning system by offering Internet-based degree programmes and delivering online learning materials. In addition, many workshops, seminars, and conferences are organised to promote knowledge sharing, information exchange, and collaboration.

1.2 The Importance of Sustainable Development and E-learning

Sustainable development involves technological, organisational, and social changes (Sahid, Endut and Peng 2011). Sustainability is intended to support long-term innovation processes while benefiting the people, economy, and environment (Weaver et al. 2000); these three 'pillars of sustainability' constitute what is known as the 'triple bottom line'. Based on the triple bottom line, decisions on sustainable development influence all three aspects of sustainability, which are people, environment, and economy (Manitoba Department of Education and Training 2000). Sustainable people require an agreement between communities and nature. A sustainable environment is one in which natural resources are protected and restored. A sustainable economy relies on decisions, policies, and practices that allow access to resources and opportunities to support economic production while improving social and environmental well-being. Thus, a sustainable economy, sustainable people, and sustainable environment can be promoted by a sustainable e-learning practice.

E-learning is well-known as online education that provides flexibility, accessibility, scalability, easy update, low cost of content delivery, and collaborative learning to learners (Ali 2004). E-learning is a strategic tool that allows institutions to compete in a global higher education market by providing technology that facilitates fast, flexible, and economical learning (Kesim 2012). Meanwhile, sustainable e-learning has become a normative practice in catering for the needs of the present and future (Robertson 2008). One of the characteristics of sustainable e-learning is its support of reusable or transferable e-learning content. This allows advanced searches for existing content that can be reused and shared. Sustainable e-learning content can be delivered through various media such as smart mobiles and tablets. It consists of three domains which are resource management, educational attainment, and professional development and innovation (Stepanyan, Littlejohn and Margaryan 2013). The resource management domain focuses on e-learning costs. Educational attainment is concerned with assessing student success and development. The professional development and innovation domain focuses on continual improvement and adaptation to environmental changes. More discussion on sustainable e-learning can be found in Chapter 3.

1.3 Purpose of this Research

Instead of focusing on education for sustainable development, this research focused on developing sustainability in education through an e-learning framework. This research was undertaken to support sustainable e-learning development by creating a sustainable e-learning framework comprising e-learning and e-teaching principles, technology, application, and environment. The triple bottom line components - society, economy, and environment - were used to guide and inform the processes by which higher education institutions can achieve sustainable e-learning. The components of the framework are evaluated by applying the triple bottom line as a driver of sustainable e-learning, supporting continuous, self-directed e-learning and providing new and meaningful resources to support e-learning in Malaysia.

Most universities have integrated e-learning in their education programmes. Although some universities have claimed a successful e-learning implementation, others have raised several issues regarding e-learning. These include poor information fluency (Aman 2010), lack of pedagogical strategies (Sridharan, Deng and Corbitt 2010), lack of students' computer skills (Musa and Othman 2012), technology as a learning motivator (Sridharan, Deng and Corbitt 2010), or poor interface design and consistency (Pagram and Pagram 2006). Nevertheless, many researchers have addressed the importance of sustainability in e-learning including positive change of mindset regarding sustainability, cost effectiveness, and reusable e-learning resources. Hence, embracing sustainable e-learning improves e-learning and overcomes e-learning issues. However, researchers have not addressed the elements of a Sustainable e-Learning Framework that integrates the Triple Bottom Line (TBL) assessment.

The proposed framework recommends a fundamental structure for the e-learning system. Therefore, existing e-learning frameworks are analysed in Chapter 2 and synthesised in Chapter 4 in order to address framework components including: the management of e-learning administration, community, content, information quality, implementation and evaluation, training, and learning activity. The analysis indicated that most of the current e-learning frameworks do not consider sustainability; rather, they address the major concerns of the stakeholders, teachers, learners, and trainers to provide e-learning guidelines and components for the implementation of an e-learning system. This is also reflected in the Malaysia E-learning Evaluation Framework (Yunus and Salim 2011) and the Malaysia Public Sector E-learning Implementation Framework (EPSA (E-Pembelajaran Sektor Awam) 2011). Thus, none of these frameworks are concerned with developing e-learning.

This research addressed a gap in the literature by developing a sustainable e-learning framework for higher education institutions in Malaysia. It is anticipated that it could contribute in achieving the goal of sustainable development in the Malaysian education sector and improve education equity among Malaysians located in both rural and urban areas. Thus, the aim of this thesis was to develop a Sustainable e-Learning Framework in order to improve the current e-learning practice so that it becomes more sustainable in a manner that benefits society, the economy, and the environment.

1.4 E-learning Opportunities

Practitioners and researchers are still in the process of discussing and agreeing upon a common e-learning definition, even as learning technologies are rapidly evolving (Lowenthal and Wilson 2010). There are also different educational settings with varying interpretations of what is meant by e-learning. However, for the purposes of this thesis, the researcher defined e-learning in an educational context as "*An innovative approach for delivering well-designed, learner-centred, interactive, and facilitated learning environment to anyone, anyplace, anytime by utilising the attributes and resources of various digital technologies along with other forms of learning materials suited for an open, flexible, and distributed learning environment*" (Khan 2005). The researcher further considered a core e-learning contribution towards the idea of lifelong learning; "E-learning provides students the flexibility to learn at their own pace at any stage in the lifespan – thereby fostering positive attitudes about the value of lifelong learning" (CCL (Canadian Council on Learning) 2009).

E-learning can offer benefits, flexibility, and can be more affordable compared to traditional learning modes. E-learning provides a wider range of learning materials from various knowledge databases, while traditional learning is limited to textbooks and notes provided by the instructor. For example, e-learning content can be tagged for advanced search ability (Sural 2010) while traditional learning allows students to listen to lecturers (FSU (Florida State University) 2011) and obtain notes such as PowerPoint slides and textbook references. The e-learning content is stored in a central database repository such as a database warehouse where the user can control data and transform them into meaningful and personalised information by means of data mining. The e-learning design process adopts an iterative process of use, feedback, redesign, and reuse. The virtual space of a course enables users to read, repurpose and improve the e-learning resources from year to year. A 'learning loop' of feedback allows the design quality to be improved steadily over time rather than having to recreate everything from scratch (Robert and Goodyear 2010).

1.5 E-learning Problems

There is no doubt that most higher education institutions have experienced e-learning issues and challenges such as poor awareness of e-learning, limitations of Internet connection and bandwidth, digital divide, and lack of information fluency (Aman 2010; Arabasz, Judith and Fawcett 2003; Ali 2004; Pagram and Pagram 2006). Hussain (2004) suggested that the lack of strategic planning and adequate funds are two of the reasons why e-learning is unsuccessful. Moreover, the quality issue has become part of the e-learning problem in the context of e-learning content, human-computer interaction, and teaching and learning activities. Ali (2004) indicated that the reasons for the poor quality of e-learning content are the lack of funds and inadequate expertise. Ossiannilsson (2012) suggested that benchmarking for e-learning improvement and enhancement is necessary to identify the strengths and weaknesses and provide institutions with better insight and best practices. Ossiannilsson (2012) also stressed that e-learning stakeholders need to make a commitment to change in order to successfully implement new practices. In addition, Guskey (2002) pointed out that changes in users' practices, beliefs, behaviours, and teaching and learning outcomes can be affected by obtaining feedback from students and providing follow-up information about new practices, support to overcome difficulties associated with changes, and pressure to motivate changes. From the financial perspective, adequate funding to ensure the continuity of e-learning initiatives seemed to be an obstacle to sustainable e-learning (Gunn 2011). Moreover, the great waste of energy and human resources due to the termination of an e-learning initiative has led to non-sustainable e-learning. However, there is a tendency to sustain e-learning practices by encouraging user commitment towards new e-learning practice, which should consider teaching, learning, and technology aspects that characterise a broad range of e-learning systems. Therefore, a solution for these challenging e-learning issues is needed.

1.6 Research Questions and Objectives

This research aims to develop and evaluate the Sustainable e-Learning Framework (SeLF) for higher education institutions in Malaysia. SeLF is for teachers, developers, and university management as it offers an efficient and effective mode of managing e-learning sustainability. Therefore, the core elements required for a sustainable e-learning approach are identified and evaluated in order to develop a framework showing how the elements are meant to be used, integrated, and combined with each other.

RESEARCH QUESTIONS

In order to develop the new Sustainable e-Learning Framework for higher education, this research addressed the following research questions:

1. What are the characteristics of a Sustainable e-Learning Framework for the higher education sector in Malaysia?
2. What are the stakeholders' perspectives and expectations of the characteristics of sustainable e-learning?
3. How can the new Sustainable e-Learning Framework assist the Malaysian higher education stakeholders to become more sustainable?

1.7 Significance of the Study

The aim of the Sustainable e-Learning Framework developed in this research is to produce an evidence-based approach for the implementation and management of sustainable e-Learning practices, resources, and infrastructure in Malaysia's universities and to assist Malaysia in achieving sustainable development. It is intended that the new Sustainable e-Learning Framework could help Malaysian educational institutions to develop a sustained e-learning system that increases the benefits and quality of e-learning while reducing the cost of e-learning infrastructure and environmental impact of e-learning in general.

In 1998, the University of Malaya (Government University) launched the first Learning Management System (LMS). Today, the University of Malaya uses an open source platform called Moodle (Embi 2011) as it is cheaper than Blackboard, a commonly used commercial platform. Later in 1999, three universities started to implement Moodle; they were the Multimedia University, Universiti Tun Abdul Razak, and International Medical University, followed by another 20 public universities in 2000 (Asirvatham et al. 2003). Today, most of the higher education institutions in Malaysia develop their own e-learning platform or customise an open source e-learning system (Embi 2011). There is a big push forward to online education. There are many studies on education for sustainable development among the education sector (United Nations General Assembly 2002; Bhasin et al. 2003; McCormick et al. 2005; Leacock 2006; Robertson 2008; Doherty and Cooper 2007; Razak 2009; Makrakis 2011; Lambrechts et al. 2013; Manteaw 2012; Foo 2013; Verhulst and Lambrechts 2015; Bacelar-Nicolau et al. 2015; Beynaghi et al. 2016; Berzosa, Bernaldo and Fernández-Sanchez 2017). Sustainable development initiatives such as the Green Campus Initiative (GCI), Recycle Project, and Integrated Approaches to Sustainable Development Practice have been adopted by some Malaysian universities. Therefore, the practical significance of this research is to support these future e-learning applications and sustainable e-learning. This research intends to assist the institutions to improve their contribution to sustainable development goals through the development of a Sustainable e-Learning Framework. The framework focuses on sustainability in education through e-learning initiatives rather than education for sustainable development. Furthermore, to improve Malaysia's education and protect the population and natural resources, this research could help Malaysia to create and sustain teaching and learning in a society where technology is rapidly changing.

In terms of past research, little work has been conducted on e-learning with respect to sustainability. Moreover, there is no theoretical framework for e-learning sustainability using the TBL value approach. Therefore, this research is intended to assist researchers and scholars in the Information Technology/Systems and education sectors to improve their current and future teaching and learning methods by using the latest technology and to raise awareness of sustainability by implementing a Sustainable e-Learning Framework for higher education. It is envisaged that the development of a Sustainable e-Learning Framework for tertiary education institutions could assist Malaysia to become a country with an expert-driven economy (Malaysia Ministry of Education 2012) and encourage Malaysia and other developing countries to become more innovative, especially in regards to e-learning.

1.8 Research Methodology

A mixed-methods (qualitative and quantitative) approach was employed to assess the new Sustainable e-Learning Framework with various stakeholders (i.e., academic staff and students) from higher education institutions.

The research included five phases to achieve the research objectives. The first phase comprised a review of relevant literature in order to develop the initial Sustainable e-Learning Framework. After a synthesis of the literature review was completed, surveys were developed, conducted, and analysed. The third phase involved consolidating the findings from survey questionnaires and developing the Sustainable e-Learning Framework based on findings from the previous phases. In the next phase, preparation was made for the interviews with experts, and then the interviews were conducted, the interview data were analysed, and findings were identified. In the last phase, SeLF was finalised based on findings from the expert interviews, which are discussed in Chapter 8.

This research sought participation from e-learning stakeholders such as students and academic staff, and as they could be the end-users of an e-learning system they were given the opportunity to share their knowledge and ideas to support the framework.

The stakeholders who participated in this research are from a Malaysian government university and a private university that reflects a subgroup of the Malaysian educational system to enrich the sample size of the survey, and interviews with experts were conducted in order to evaluate the framework. Based on the literature review (Asirvatham et al. 2003; Kamarulzaman, Madun and Ghani 2011; Hashim, Ahmad and Abdullah 2010; Huey, Foong and Mat 2007; Puteh 2007; Embi 2011; Malaysia Qualifications Agency 2011), several criteria were applied to identify suitable Malaysian universities for the purpose of assessing the new Sustainable e-Learning Framework. The criteria were: type of university, year of establishment, ranking, and percentage of courses offered online. It was important to select universities that have made a significant effort to establish sustainable development, as they play an exemplary role for other Malaysian universities. However, the participants chosen for the expert interviews were from Australia, the Netherlands, and Malaysia. These participants were recruited in order to obtain different perspectives on SeLF evaluation based on different cultures and backgrounds.

Via the survey questionnaire, the academic staff and students had the opportunity to share their knowledge and ideas to support the framework. To reduce the margin of error, it was decided that the sample size would be between 300 and 400 (Sekaran and Bougie 2009). Surveys were analysed using the Statistical Package for the Social Sciences (SPSS) software for the quantitative data and manual coding of the qualitative data. After analysing the survey results, a Sustainable e-Learning Framework research artifact was developed and evaluated by means of interviews with experts. Seven interviews were conducted to acquire experts’ perspectives and evaluations of the new Sustainable e-Learning Framework. The data from the expert interviews were analysed using a manual coding method. The outcomes of these interviews with experts assisted the researcher to improve and develop the new Sustainable e-Learning Framework to produce a final version. Further details on research methodology are discussed in Chapter 3.

1.9 Ethical Issues and Data Storage

The Curtin University Human Research Ethics Committee approved this research (approval no: RDBS-62-15). Participants were informed of the purpose and aims of this research. Participants were informed that their participation was voluntary and they had the right to withdraw partially or completely from the research process at any time. A participant information sheet was distributed to the participants in order to obtain their consent. Participants were assured that any published material would maintain their anonymity and that of their organisations.

The research data will be stored for a minimum of seven years. The data will be securely stored on a shared network drive. The original data will be retained by the university and a copy of the data may be retained by the researcher. Upon completion, the researcher will work with central Records and Information Management to find a suitable long-term storage location. Upon its return to Curtin University, all digital data will be transferred to Curtin's shared network drive according to the Curtin University guidelines. Data under analysis will be stored on a local drive of principal or co-investigator computer, which is password-protected on absence.

1.10 Definition of Sustainable e-Learning and Sustainable E-Learning Framework

In this thesis, we use the term 'sustainable e-learning' to express sustainability practice in e-learning concepts that intends to assist higher education institutions to meet their present and future students' needs. This thesis defines sustainable e-learning as an online education solution that performs sustainable practices in education to promote education equity (society), income equity (economy), and low carbon future (environment) while meeting the learners' present and future needs. SeLF is a Sustainable e-Learning Framework that focuses on e-learning principles, technologies, application, and all aspects that benefit the Triple Bottom Line: society, economy, and environment.

1.11 Outline of the Thesis

This chapter has provided background for e-learning in higher education. In higher education, e-learning can provide an online service that delivers education resources, provides online assessments and training, promotes user integration, and motivates the learner. This chapter also briefly described the importance of sustainable development, e-learning and sustainable e-learning, which were taken into consideration by the researcher when developing the new Sustainable e-Learning Framework for higher education institutions in Malaysia.

The literature review presented in Chapter 2 identifies gaps in the literature that this thesis was intended to address. The broad argument presented in Chapter 2 is the difficulty of defining the concepts of sustainable e-learning in a higher education context, particularly in a developing country such as Malaysia. The third chapter outlines the research methods and design, introduces the Information System research paradigm, provides reasons for adopting the mixed-methods approach and the design science research approach, presents the ethical considerations and the overall research process. The data analysis methods used in surveys and expert interviews are also described in Chapter 3. Chapter 4 presents the initial Sustainable e-Learning Framework (SeLF) that was developed based on a synthesis of the literature review. Chapter 5 serves to outline the survey results and data analysis of both quantitative and qualitative data. Chapter 6 discusses the data analysis and results for the expert interviews where experts evaluated SeLF to identify the utility and usability of the research artefact. Chapter 7 demonstrates the research artefact (SeLF) that was developed based on the findings from the survey. This chapter explains the research artefact that was used for evaluation in the interviews with experts. Chapter 8 discusses the research findings. This chapter also draws conclusions from the findings and discusses the research significance and reasons for the adoption of SeLF in higher education intuitions. This thesis concludes with a discussion on the outcomes of the expert interviews and the importance of the newly-developed SeLF for higher education institutions.

1.12 Summary

This chapter has discussed the extant research on e-learning and its relationship to sustainable development, which has motivated this research. The framework that is an outcome of this research is comprised of elements that can improve e-learning sustainability. E-learning issues and opportunities were discussed as important aspects of developing sustainable e-learning. The rest of this chapter presented the research questions, discussed the research significance, and described the research methodology. Chapter 2 discusses the review of literature pertaining to sustainability, e-learning, and e-learning frameworks.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the literature on sustainability, e-learning, and e-learning frameworks. The literature on sustainability is mainly concerned with sustainable development, supportable technology innovation, the Triple Bottom Line (TBL), green alternatives as a sustainability approach, sustainable education, and e-learning. On the other hand, the review of literature on e-learning discusses the foundation, components, and implementation of e-learning in the context of the higher education sector. The review of the literature on existing e-learning frameworks examines the e-learning frameworks that were developed over the last two decades and identifies the research gaps in the related research. Together with the literature on sustainability, e-learning, and existing e-learning frameworks, a draft of a Sustainable e-Learning Framework was developed as an outcome of the literature review synthesis. This framework is further developed in later chapters as an outcome of this research.

2.1 Introduction of Sustainability

The terms “sustainability” and “sustainable development” have become popular in global policy (OECD 2001) and research such as that conducted by the International Sustainable Development Research Society (ISDRS). Sustainability is defined as the support of long-term innovation processes while benefiting the three pillars of the Triple Bottom Line: society, economy, and the planet (Weaver et al. 2000). What is meant by sustainability can depend on the area or context of where it will be applied (Brown et al. 1987). In the context of online education, sustainability can refer to the policies and practices that improve the quality of an online educational programme in a manner that is financially worthwhile (Meyer, Bruwelheide and Poulin 2006). Inspired by this concept, this research aims to develop a framework that intends to improve e-learning quality and e-learning investment and promote sustainable practice that benefits the people, economy, and environment. The concept of sustainability has been a human concern and has received widespread attention in terms of its global impact on people, the economy, and the environment.

The sustainable development ideas were discussed in Our Common Future that was published in the Brundtland Report in 1987. The report acknowledged the strategies and challenges of sustainable development by focusing on initiatives that benefit the Triple Bottom Line. The most well-known definition of sustainable development is from the Brundtland Commission; “Sustainable development is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland 1987). Sustainable development strategies are intended to build a sustainable society, sustainable environment, and sustainable economy. Sustainable society refers to a society that meets the needs of the present and future generations. Furthermore, it refers to the individual opportunity to make one’s own choices within a well-balanced society (Kerk and Manuel 2008). A sustainable environment is one where the environmental impacts of development are minimised and the natural resources are protected and restored (Siemens 2004). A sustainable economy comprises decisions, policies, and practices that allow access to resources and opportunities to minimise environmental impact. In addition, a sustainable economy takes into consideration the supply and demand that meet justifiable resource consumption and societal needs (Lorek and Spangenberg 2014). Sustainable consumption is needed to achieve a sustainable economy. The best practice in the promotion of sustainable consumption can be achieved through education and its institutions (United Nations General Assembly 2002). In the past, there have been various United Nations conferences on sustainable development such as the United Nations Conference on Environment and the Development (1992), a World Summit (2005), Rio +20 (2012), and the United Nations Summit Post in 2015. With respect to the Brundtland Report and the reports from these United Nations conferences, it is important to achieve a sustainable society, a sustainable environment, and a sustainable economy and to ensure a balanced connection between them.

In the education context, a document called “The Future We Want” indicates the importance of providing full access to quality education at all levels to achieve sustainable development and human development (United Nations 2012). Also, it is essential to improve education access by strengthening the education infrastructure and investment to improve the quality of education in developing countries. The United Nations 2015 Global Sustainable Development report indicates that strategies in an education context involve ensuring equitable education and the availability of life-long learning for all (President of United Nations General Assembly 2015). The report indicates that technology can assist in the evolution of sustainable consumption. The exploitation of resources, the direction of investments, behavioural change, the orientation of technological development, and institutional change can occur by realising that sustainable development is the process of change to meet human needs and inspirations. Thus, sustainable technologies and sustainable education have become increasingly important, given their role in promoting awareness, knowledge, and innovation in terms of sustainable development. Therefore, appropriate guidelines for sustainable technologies and sustainable education are required to assist countries to adopt sustainable development strategies such as the National Sustainable Development Strategies (NSDS). Hence, the aim of this thesis is to assist countries to provide education equity and life-long learning for all.

'Sustaining' is about supporting continuity, nourishing, and acknowledgment (Gundogan and Eby 2012). To achieve true sustainability, comparable reductions in emissions, resource use, and waste generation are needed (Vergragt and Brown 2007) as part of sustainability goals. Branden (2012) added that a process is considered sustainable if it meets the present basic needs without compromising the future needs, and does not threaten the environment. Thus, business stakeholders in various economic and social sectors have taken sustainability measures into consideration in their plans and actions in order to prevent harm to the environment while achieving the sustainable development goals. So, to achieve sustainable development goals when providing education equity and life-long learning through sustainable e-learning approach, the need for a sustainable e-learning framework is indicated.

2.1.1 The Triple Bottom Line

The Triple Bottom Line captures the sustainability agenda promoted by Elkington in 1994, and consists of three sustainability dimensions or 'pillars', as they have become known. These dimensions are the environment, economy, and society (Elkington 2004, 1998). The TBL seeks to strike a balance between environmental pressure, social justice, and economic growth, which represent sustainable development as an essential vision (Kamp 2006).

According to the Business and Higher Education Round Table (BHERT 2000), the first step to embrace the TBL concept is to acknowledge that sustainable development does not mean that the profit goals need to be discarded while focusing on the long-term protection of natural resources.

From a business perspective, TBL evaluates the performance of a business and its impact on the environment (Dao, Langella and Carbo 2011) along with the societal and economic considerations. Training development and continuous improvement of the TBL will ensure the strategic alignment of a supply chain. The term ‘TBL reporting’ refers to the relationship between an organisation's economic, social, and environmental dimensions of its process, products, and services (BHERT 2000). Clear methodologies and indicators are needed to understand and measure organisations' TBL impact. In order to develop clear directions and thinking when establishing a TBL, its implementation and evaluation, a great deal of time, effort, and resources are required (BHERT 2000). According to Casey, Cawthorne, DeLong, Herold, and Lim (2014) , organisations need to embrace the TBL and not just the financial ‘bottom line’ if they are to achieve sustainability. Triple Bottom Line accounting offers such an approach by introducing a measurement method that considers environmental, economic, and community dimensions.

A TBL approach can be generalised to higher education institutions (Saadatian et al. 2012). Guiding principles that integrate the TBL have been adopted by the Grand Valley State University (GVSU) Sustainable Community Development Initiative in 2004, which led the university to formally implement the sustainability initiative in GVSU (GVSU (Grand Valley State University) 2010). Campus TBL focuses on the contribution to the community’s viability and affluence via economic prosperity, social responsibility, and environment- and ecology-friendly practices (Brown 2009). In the University of Minnesota, for instance, the university focuses on developing campus and community engagement with sustainable development via educational programmes, sustainability networks, and initiatives (Bhasin et al. 2003).

TBL becomes part of the performance model for evaluations of where the public participates with democratic values (Ajiake 2015). Ajiake added that TBL should form a picture that categorises social and environmental indicators that are aligned with the economic indicators. TBL and sustainability enable a report to be produced on stakeholders' planning efforts regarding cost savings, environmental protection, and social benefits contribution (Liner, DeMonsabert and Morley 2012). A development is considered sustainable if it includes all three TBL components (Saadatian et al. 2011). For that reason, TBL deserves specific attention, especially when developing sustainable initiatives such as e-learning that could affect society, technology, the economy, and the environment. In this regard, TBL is seen as the solution that addresses the research gaps. Due to the importance of TBL in measuring an organisational sustainability performance, this research integrates the TBL approach in the development of a sustainable e-learning framework.

2.1.2 Sustainability in Higher Education Institutions

Sustainability in education has developed along two broad streams which are sustainability of education and education for sustainability (Stepanyan, Littlejohn and Margaryan 2013). Sustainability of education is the execution of sustainable practice in education development, management, and innovation (Davies and West-Burnham 2003). Sustainability in education through e-learning development has the potential to help universities to achieve sustainable development through the online learning process, education development, sustainable policies, management, and innovation. Conversely, education for sustainability aims to provide a sustainable environment through education solutions (Bourn and Shiel 2009). Education for Sustainable Development (ESD) should provide innovative, attractive, supportive learning and teaching approaches, and facilitate lifelong learning that improves learning skills (Barth et al. 2014). This thesis focused on sustainability of education rather than development of education for sustainable development.

Sustainability of education

Environmental impacts caused by a variety of university operations have led to the importance of finding sustainable alternatives to reduce a university's environmental footprint. Efficient use of energy and materials, cost savings, minimised environmental impact, reduction of greenhouse gas emission, reduction of water and solid wastes, acknowledgement of environmental awareness, and increased green innovation are the goals that the university community needs to achieve (Geng et al. 2013). Thus, a shift towards ‘green’ practices in higher education institutions is a sustainable development effort required by all universities.

Throughout the world, universities are embracing green initiatives. These green alternatives include consumption-based carbon footprints, Environmental Extended Input-Output (EEIO), renewable energy sources, reduced energy consumption, Ground Source Heat Pump (GSHP), Annual Environmental Report, green policies such as IS0 14001, indicator systems that evaluate green project performance, stakeholders’ roles in the green education process, and innovative models for establishing a green culture within universities (Geng et al. 2013). An innovative model for establishing a green university includes three main components: principles, goal, and activities. The principles are intended to reduce, reuse, and recycle for economic feasibility and environmental protection. The activities include research, education, waste, water, and energy (Geng et al. 2013). The goal is to improve the overall eco-efficiency of the university. Similarly, these sustainable initiatives have been adopted by the business world. In order to develop a sustainable society, higher education needs to develop important skills for sustainable development such as responsibility, emotional intelligence, system orientation, future orientation, personal involvement, and action skills among students (Lambrechts et al. 2013).

Based on Shenyang University in China, which has made efforts to green their campus, a green university should have a low carbon campus, water efficiency, green solid-waste management, green research, and green education. A low carbon campus is one that utilises renewable energy and implements energy-saving measures. Water efficiency involves the minimisation of water wastage. Solid-waste management involves infrastructure, a demonstration project, and regulations. The centre for green research in the University of Northern British Columbia considers sustainability research as a way to designate the human relationship with the environment in multiple dimensions, which aim to improve social and environmental well-being (UNBC(University of Northern British Columbia) 2016). Thus, the university implements recycling and recovery programmes such as the recycling of lab plastics, which is managed by the sustainability department (Columbia). 2016).

Education for sustainability

In the late 1990s, the awareness of sustainable development in education was initiated by a group of educators from the Urban Planning Department in Bazok, Iran (Dimitrova 2014). Education is an important tool for achieving sustainable development (McKeown et al. 2006). Universities deliver education on sustainable development and green education by including them in their curriculum-specific courses related to these issues. Green education focuses on providing green courses and engaging in international collaboration (Geng et al. 2013). Sustainable education or green education refers to Education for Sustainable Education (ESD), which is a learning process that is inspired by sustainability principles to improve sustainable human development, lifelong learning, and education quality (UNESCO 2015). There is a strong demand in the industry for trained human resources, requiring new courses and training programmes. Therefore, to meet the needs of the industry, universities should offer sustainable education to develop graduates who understand sustainable development. For instance, Bulgarian universities in Southeastern Europe delivered sustainable development modules which integrate sustainability in professional fields that are concerned about environmental issues (Dimitrova 2014) in order to produce sustainability-aware graduates.

The aims of ESD are to enable communication among ESD's stakeholders, improve teaching and learning quality in ESD, assist countries to achieve the Millennium Development Goals via ESD alternatives, and provide new opportunities to integrate ESD into education (Little and Green 2009). ESD provides more knowledge of interdisciplinary and problem-based approaches to ensure a sustainable future. Many universities are willing to deliver sustainable education programmes that include environmental protection and climatic research, particularly in the domain of physical sciences. As an integral part of sustainable alternatives, universities should consider e-learning as a means of delivering those sustainable education programmes and embracing the green research and practices. The University of British Columbia has defined green research as a programme that reduces the research footprint on the environment. Sustainable education can be achieved by providing students and teachers with the knowledge, skills, and insights regarding sustainability challenges and innovations (McCormick et al. 2005). The output of sustainable education may include wider environmental and sustainability knowledge, improved communication skills, engagement in environmental curriculum activities, and enhanced green computer usage. Sustainable education should encourage students to include sustainable development in their thinking regarding technology design and innovation (Kamp 2006). As such, pedagogical logic focuses on general restructuring that connects educational philosophies with appropriate teaching and learning processes. However, a sustainable pedagogical logic aims to develop knowledge to identify sustainable development goals by connecting teaching and learning processes with social, ecological and economic practices (Manteaw 2012). Sustainable development modules comprise aspects such as module positioning in the curriculum, module status, module's structure and content, educational results assessment, integration with other related modules, teaching methods, and a teaching team (Dimitrova 2014).

The challenges of sustainable education and a complex learning environment are influenced by various factors. Awareness and well-considered efforts are required across cultures to develop sustainable and meaningful learning processes (Manteaw 2012). Therefore, to achieve this, there needs to be a revision of sustainable development goals and the implementation of suitable educational philosophies and pedagogies (Manteaw 2012). However, higher education faces a great challenge in changing universities' curricula so that they include sustainability (Sterling and Thomas 2006), as educators should revise the curricula to emphasise sustainable elements in teaching rather than develop additional materials (Holdsworth et al. 2006). Information and Communications Technology (ICT) courses need to be carefully designed and updated with latest technologies. ICT concepts need to be taught to ensure that students understand the basics of ICT (Chin and Chang 2009). ICT curricula must include skills and knowledge to produce graduates who can meet the demands of the industry. The lack of thinking and motivation at academic and administrative levels make it difficult to transition to sustainable education (Dimitrova 2014). Overall, the challenges faced by universities include inadequate commitment to and operational support for the development of sustainable education.

Environmental education focuses on supporting an ecologically sustainable environment by raising awareness, acquiring new ideas, knowledge, insight, perspectives, and implementing formal and informal sustainable processes. The values of environmental education state that it must include participation, lifelong learning, holistic appreciation and connection, practical application, and agree with social and economic goals (Commonwealth 2000).

Therefore, to achieve a sustainable future, expertise and vision regarding sustainable development need to be delivered to future educators, policy makers, and community and business leaders (Filho, Manolas and Pace 2009). In addition, technology education for sustainability, environmental education, and education for sustainable development need to be encouraged among the aforementioned stakeholders.

Sustainable e-learning

The 21st century is the age of digital literacy. Distance learning has become a cyberised system that makes use of online learning. Callan and Bowman (2010) were of the view that educators need to discover effective teaching methods for the digital native to avoid possible harm and respond to both current and future demands and expectations (Callan and Bowman 2010). Callan and Bowman (2010) added that, in order to move towards sustainable e-learning, strategy, senior leadership, business case, resourcing, champions, people support, technology support, and individual commitment are required.

Sustainable e-learning has become normative in catering for the needs of the present and future (Robertson 2008) to support lifelong learning. According to Stepanyan, Littlejohn, and Margaryan (2013), sustainable e-learning consists of three domains: resource management, educational attainment, and professional development and innovation. The resource management domain focuses on e-learning costs; educational attainment concentrates on assessing student success and development; and the professional development and innovation domain focuses on continual improvement and adaptation to environmental changes. Institutional strategies to achieve sustainable e-learning may include giving support to natural resources (learners, facilitators, and content), awareness of possible harms caused by technology, and prevention of waste (Gundogan and Eby 2012). One of the characteristics of sustainable e-learning is its support of reusable or transferable e-learning contents. This allows advanced searches for existing content that can be reused and shared. The energy component is added to other e-learning components of institutional strategies aimed at achieving sustainable e-learning. Sustainable e-learning content can be delivered through various media such as smart mobiles and tablets. Moreover, Littlejohn (2003) also agreed that sustainable e-learning refers to the adoption of technology that offers cost savings while maintaining the quality of teaching. Additionally, Gundogan and Eby (2012) stated that sustainable e-learning materials must be updatable, renewable, and readily available (Gundogan and Eby 2012).

The inputs of e-learning include context, learner needs, goals, characteristics, the local learning environment, interaction, collaboration, and feedback. Therefore, active learning, effective learning, and innovative products can be defined as outputs in terms of sustainability (Gundogan and Eby 2012). Thus, sustainable e-learning can be achieved through active, innovative, and effective learning. This means that in adopting up-to-date technologies such as cloud computing to support effective learning, resources management is essential to develop a sustainable e-learning system (Sridharan, Deng and Corbitt 2010). A generation of new theories, however, could be possible only with the collaboration between technology awareness, learning outcomes, resources, and professional development.

There are various scholars of learning ecosystems which involve a learning and teaching community, materials and content, principles and methods, systems and processes, and management of learning resources (Sridharan, Deng and Corbitt 2010). Materials and content refer to learning resources such as video, audio, and text. The principles and methods concern the use of suitable pedagogical strategies. Systems and processes refer to the Internet, multimedia, and semantic Web that support e-learning by implementing pedagogical strategies. These two components are important for developing e-learning that is viable. A good understanding of e-learning ecosystems and their barriers could assist e-learning stakeholders to develop a sustainable e-learning environment. Moreover, according to Gunn (2011), the conditions of sustainable e-learning initiatives are that the learning design and the system using ICT have been developed and implemented within a course study, potentially proven to be adopted or possibly adapted for future development, and the maintenance is independent.

E-learning methods can contribute to the development of lifelong learning skills. E-learning techniques and the facilities to access teaching and learning resources remotely have led to continuous learning opportunities, even when someone has completed formal studies. Lifelong learning can be achieved through e-learning initiatives that allow learners to learn throughout their lives, regardless of their location, age, or occupation (Holley 2002). In the context of lifelong learning, e-learning has been used as part of ESD (Azeiteiro, Bacelar-Nicolau and Caetano 2015). E-learning also needs to foster users' trust and satisfaction to ensure a lifelong engagement (Filip 2011).

Furthermore, integrating ESD through e-learning can be very advantageous for students during their studies and later in their career through on-going professional development (Azeiteiro, Bacelar-Nicolau and Caetano 2015). Therefore, to support sustainable e-learning, transforming Web-based content to learner-centred interactive e-learning that supports technologies and learning resources is important and must be effectively implemented (Sridharan, Deng and Corbitt 2010), and should be considered as part of a good e-learning pedagogy. This means that a successful e-learning pedagogy involves the successful implementation of learner-centred interactive e-learning that adopts learning resources and the latest technologies.

Some researchers have identified the critical success factors and strategy for sustainable e-learning. Gunn (2011) indicated that the critical success factors of sustainable e-learning include: getting the right team of academicians and developers which reflects the pedagogy and research; acquiring the passion and commitment of the champion to raise the level of awareness on sustainability and e-learning; ease of e-learning usage and access; and institutional funding support (Gunn 2011). However, Gunn (2011) added that a sustainable e-learning strategy is essential, one which involves staff support to improve teaching practice, resources that are created by academics and students, staff development, sharing and reuse of contents and activities, and time management of additional work imposed on academics. In order to implement these strategies, Guskey (2002) indicated that changes in current practices need to be identified since changes may lead to risk-related failures. Gunn (2011) also pointed out that the ability to sense the environmental impact and modify systems to meet continuously changing requirements that lead to e-learning success is required. Therefore, there is a need for guidelines on how e-learning stakeholders could be able to reconfigure e-learning to meet specific learning purposes while considering the environmental, societal, and economic factors.

There is a need to investigate how e-learning contributes to the three dimensions of sustainable development (society, economy, and environment) in order to develop an e-learning system that is cost-saving, preserves raw materials, increases competition and innovation, meets stakeholders' needs and expectations, is less time consuming, re-skills and retains employees, reduces carbon emission and energy, and acquires profit, new opportunities and skills (Issa and Isaias 2013). Thus, the relationship between e-learning and sustainability needs to be clear to identify the e-learning impact towards the TBL. In this research, sustainable e-learning is seen as sustainability for education rather than education for sustainability due to the development of the sustainable e-learning framework that intends to perform sustainable practice in e-learning development, strategy, and innovation.

Sustainable development in Malaysia

Developing countries should enhance the progress made, overcome any weakness and try to achieve progress by focusing more on quality issues and consistency of achievement. Some developing countries have been implementing sustainable development initiatives, and some are more advanced in sustainability practices than the developed countries. For example, honoured on the "Rights of Nature" by Ecuador and the Plurinational State of Bolivia were those developing countries that first implemented sustainable development initiatives before the developed countries (United Nations 2013). The evolution of developing countries in terms of sustainable and equitable consumption will provide a guideline for developing countries when pursuing their human development goals in a more environmentally sustainable way (United Nations 2013)

In Malaysia, the Ninth Malaysia Plan 2006-2010 was established to ensure a balance between developmental and environmental needs (Abdullah 2006). Thrust four in the Tenth Malaysia Plan 2011-2015 is focused on improving the standard and sustainability of the quality of life, which this research supports by promoting sustainable e-learning practices. In response to the Eleventh Malaysia Plan 2016-2020 (Razak 2015), this research may assist Malaysia to develop knowledgeable and innovative individuals, improve education equity, improve the quality of life as part of the continuous effort to fulfil the Tenth Malaysia Plan, and reduce the carbon footprint through sustainable e-learning.

In addition, the National Climate Change Policy and the National Green Technology Policy were implemented in a move towards a low-carbon economy and to attain sustainable development (Razak 2010). This demonstrates a commitment to sustainability principles that will be applied to economic development with the goal of ensuring that the environment and natural resources are preserved.

Several green policies such as the National Energy Policy 1979, National Depletion Policy 1980, Four Fuel Diversification Policy 1981, Fifth Fuel Policy 2000, National Biofuel Policy, and National Green Technology Policy have been introduced to encourage sustainable development in Malaysia (Chua and Oh 2011). Overall, these policies focus on promoting renewable energy and energy efficiency while minimising the negative impacts on the environment of energy production, transportation, transformation, and consumption. In respect to this, these policies have encouraged universities in Malaysia to consider renewable energy and energy efficiency in their operations. This improves Malaysia's green technology capability and capacity, which will in turn promote its economic growth. Since energy is linked with the e-learning capacity to deliver online teaching and learning activities, universities should consider appropriate technologies to support those activities. Technologies such as communication technologies and course management technologies (Ibezim 2013) must be considered to sustain e-learning, improve energy saving, and reduce carbon emissions.

Sustainable development efforts assist Malaysian institutions and enterprises to prevent environmental pollution and reduce energy waste. It benefits society in terms of expenditure, conserves diminishing non-renewable fuels, preserves the environment, and improves foreign reserves.

Sustainability of education in Malaysia

Several of Malaysia's universities have taken initiatives for sustainable development. These include the Green Campus Initiative (GCI), Integrated Approaches to

Sustainable Development Practice, and the Recycle Project. GCI has been implemented at the University College Sedaya International (UCSI) that evaluates the university's carbon footprint (Hooi, Hassan and Jami 2011). The Green Campus Initiative (GCI) promotes a bicycle-friendly campus as an environmentally friendly form of transportation around campus, as it can save money and time and produces no air and noise pollution (Wong et al. 2007). USM integrates a sustainability platform as part of its vision of a sustainable tomorrow by promoting equity, accessibility, availability, affordability, and quality values. A Centre for Global Sustainability Studies was established to coordinate sustainability efforts on USM's campus (Razak 2009). Moreover, Universiti Putra Malaysia (UPM) has commercialised green technology innovations by establishing a Centre of Excellence, where the collaborative areas associate with the National Green Technology Policy direction (Foo 2013). Universiti Malaysia Pahang (UMP) focuses on developing a group of engineers to develop green technology through a student exchange (UMP(Universiti Malaysia Pahang) 2009). The Greenway in Malaysia's universities provides a continuous shaded canopy along pedestrian paths to encourage walking and cycling around campus (Bahari and Said 2008). Integrated Approaches to Sustainable Development Practice links with top problem solvers together with graduate students via Web technology. The Recycle Project implements measures such as providing recycle bins in the university and encouraging students to save electricity (Saadatian et al. 2012).

Malaysia's practice towards sustainable education

Malaysia aims to become a developed country by the year 2020. One of the National Missions is to enhance Malaysia's capacity for knowledge, creativity, and innovation and develop a 'first class mentality' to improve the education system by providing an innovative environment that comprises e-learning. Most universities (public and private) have established their own e-learning system by offering Internet-based degree programmes and delivering online learning materials. In addition, many workshops, seminars, and conferences are organised to promote knowledge sharing, information exchange, and collaboration. Research on green campus and sustainability in construction has been conducted by various Malaysian universities such as Universiti Sains Malaysia (USM), Universiti Teknologi Mara (UiTM), and Universiti Kebangsaan Malaysia(UKM) (Foo 2013). Conferences and symposiums have also been conducted by these universities (Holcim 2006) in order to raise awareness and improve knowledge of sustainable development. According to Azeiteiro, Bacelar-Nicolau, and Caetano (2014) , the effectiveness of Education of Sustainable Education should be assessed by formal e-learning programmes with respect to the quality of education and pedagogy, student satisfaction, motivation, and behaviour. They added that the integration of ESD in an e-learning system can lead to a sustainable societal contribution. Also, delivering ESD resources through e-learning is able to create equal opportunities to learn ESD (Pretorius 2004). Alternatively, in traditional learning methods, most universities offer ESD on campus as part of their curricula to promote the practice of sustainability among students. In secondary education, a programme called Sustainable School Environment Award (SLAAS) was introduced and managed by the Ministry of Education Malaysia, Department of Environment, and Universiti Kebangsaan Malaysia (UKM). The SLAAS programme provides a structured and ongoing approach to environmental awareness among students and teachers (Khalil et al. 2011; Mahat and Idrus 2016). Thus, e-learning that has the ability to deliver ESD effectiveness needs to be measured.

In order to promote green awareness through Malaysia's education system, green courses and Greentition Awards Programme were introduced. Green courses are included in the national education syllabus overseen by the Ministry of Education and Ministry of Higher Education. The Greentition Awards Programme fosters green technology awareness and reinforcement through schools and universities (Chua and Oh 2011). Sustainability provisions have to be an essential element of the design and delivery policies to provide the best e-learning solutions to meet the needs of current and future learners (Gundogan and Eby 2012). Therefore, sustainable education and green awareness can be promoted through green courses, knowledge sharing, information exchange, and collaboration.

2.2 Introduction to e-Learning

E-learning has been evolving in the business, education, training, and military sectors since 1960 (Fernandez-Manjon et al. 2007). The term 'e-learning' was first used in 1999 at a Computer Based Training (CBT) system seminar in Los Angeles (Sudirman, Sloria and Apriani 2011). In higher education, e-learning is a means of delivering formal education or training online. Formal education in e-learning is led by a trained academic or instructors that meet certain standards (Willems 2008). E-learning requires designing and implementing a sequence of strategies in order to provide online resources that create, transfer, and consolidate knowledge among individuals (Pérez-Montoro 2011) and a collaborating group of learners, experts, and academics. Moreover, e-learning can deliver affordable and quality learning to students. Even though e-learning may require a lot of investment for setup and development, in the long term, it can be cost-efficient and cost-effective. According to Rumble (1997), a system is cost-efficient if the cost of the system output is less than the cost of the system input. Cost effectiveness refers to the least costly of the alternatives to achieve the same objectives (Thomas and Martin 1997).

E-learning can include learning activities in a virtual learning environment, which allow users to use various learning tools (such as communication technologies and course content management) via the Internet (Kanninen 2008). The changes and demands of technology together with learners' needs have led e-learning to become a complementary approach to traditional education methods. E-learning is a unique system where the learners and their needs are real, but the teaching and learning take place in a virtual environment. According to Kesim (2012) , e-learning is also a strategic tool enabling institutions to compete in a global higher education market by providing technology that facilitates fast, flexible, and economical learning. However, there can be challenges associated with both developing and implementing e-learning. To overcome these challenges, a thorough understanding of the e-learning background, its components, and their relationships is needed in order for these strategic benefits to be fully realised (Mutula 2002; Arabasz, Judith and Fawcett 2003; Ali 2004; Aczel, Peake and Hardy 2008; Andersson 2008; Aman 2010; Embi 2011).

2.2.1 E-learning versus traditional learning

Based on a case study by Darbyshire and Sandy (2012), e-learning is considered more effective than traditional learning methods with respect to cost-effectiveness and flexibility in delivering courses that meet students' needs. E-learning is a learning process that occurs in a virtual environment while traditional learning occurs in a physical environment (Singh, Yusoff and Oo 2009). Extensive and rapid technological developments have brought advantageous changes to teaching design and implementation (McPhee and Soderstrom 2012). E-learning brings various benefits to its stakeholders as it provides flexible class work that can be scheduled based on personal preferences, minimum transportation cost and time, a choice of learning materials that are appropriate for the learner’s level of knowledge and interest, and allow learning to take place anywhere anytime via the Internet (Ozuorcun and Tabak 2012). In this regard, e-learning technologies have changed lecturers’ roles and responsibilities in higher education.

Several studies have compared e-learning to traditional learning. According to Ni (2013), observation of classes (online and face-to-face) at the California State University indicated that both the online and face-to-face learning modes are not the same based on an assessment of the students' level of persistence and interaction. Her findings indicate that e-learning enhances the quality of participation by encouraging instructors to develop online discussion modules. These findings also support a study by Smith and Hardaker (2000) , which investigated how online settings encourage in-depth discussion. McLaren (2004) also pointed out that there is significant difference in student performance between online and face-to-face learning modes.

In 2014, Kemp and Grieve (2014) conducted a study that involved undergraduate students at an Australian university. The study aimed to discover students' attitudes to online learning and the traditional classroom based on their test performance. The findings show that, overall, students prefer the face-to-face classroom rather than online learning. This is because students believe that the face-to-face classroom provides more engagement with the social environment of a physical classroom setting, with immediate feedback from instructors and peers. However, some students prefer online learning due to convenience, wider contributions, and online discussions that promote more response, as there were no time constraints.

Recently, Gutierrez (2016) stated that e-learning can be distinguished from traditional e-learning in terms of social interaction, learning the location, instructional materials, instructor focused versus learner focused, and learning time. Gutierrez (2016) indicated that online interaction via forums, emails, and discussion boards generates more discussion and student participation than the traditional classroom. Regarding location, e-learning allows students to learn anywhere, while the classroom has limited or specific locations such as a university or school. The implication for sustainability is that students are not required to travel to a specific place in order to learn. However, instructional e-learning materials should be clear and as brief as possible since the instructor is unable to deliver the materials verbally as occurs in the traditional classroom. This statement is supported by McConnell (2000) who indicated that e-learning has less sense of instructional control while traditional learning requires a sense of leadership from the instructor. However, Clark and Meyer (2008) argued that the use of visual modalities for verbal materials such as conversational tone and pedagogical agents are required for an effective technique to promote better learning through e-learning. In regard to instructor-focused versus learner-focused learning, e-learning allows students to review course material; however, in a traditional learning environment, the learner is responsible for paying attention to what is being presented by the instructors. In response to McConnell (2000), learners can ignore their instructor through e-learning but not in traditional learning where they should focus on what the instructors are teaching. There are studies on students' preference between e-learning and traditional learning based on surveys (Fortune, Spielman and Pangelinan 2011; Paechter, Maier and Macher 2010). According to Fortune, Spielman, and Pangeligan (2011), 77% of students prefer e-learning and 17.9% student prefer traditional learning. Paechter, Maier, and Macher (2010) found that cost benefit relation to effort and learning was assured by e-learning components such as course design. This may lead to sustainability aspects in terms of cost-effectiveness. They added that students prefer a traditional learning method if they are required to demonstrate or apply their knowledge and skills (Paechter, Maier and Macher 2010). Some students prefer e-learning due to its convenience, the benefits of self-directed learning, or because they have full-time jobs. On the other hand, some students believe that traditional learning provides a better learning experience, on-campus classes, and better communication.

These studies indicate that e-learning motivates learners to develop self-knowledge, self-confidence, and responsibility for their learning. Even though e-learning is more flexible compared to traditional learning (Titthasiri 2013), it has disadvantages that include cultural issues, variations in students' ICT skills, limited social interaction, and technical limitations. E-learning can limit students' social interaction as it is difficult to establish learner relationships with other students and teachers. It seems that some students think that e-learning is less engaging and effective compared to traditional learning (Price, Richardson and Jelfs 2007). In order to use e-learning effectively, Ozuorcun and Tabak (2012) suggested that teachers and students require basic computer skills and a computer with a high-speed Internet connection. Therefore, there is a need to provide enough training and technical support to improve e-learning effectiveness in delivering educational resources and improve students' learning outcomes.

In order to take advantage of the benefits offered by both online learning and traditional learning, a 'blended learning' approach can be implemented. Based on a field study by Martinez-Caro and Campuzano-Bolarin (2011) on student satisfaction with course delivery, blended learning produces greater student satisfaction than traditional learning methods as evidenced by improved class attendance, better motivation, and closer collaboration. Blended learning models that combine traditional learning and online learning are commonly used in universities. Graham, Allen, and Ure (2005) have shown that the reasons for implementing blended learning are that it improves pedagogy, and the technology increases access to learning and the effectiveness of the teaching. However, the disadvantages of blended learning are quite similar to those of e-learning: it requires learning technology; not everyone has the same ICT skills; and the setup and maintenance of the technology are costly (Pappas 2015). Since student assessment involves both traditional classroom teaching and performance, and online learning and discussion, blended learning makes the evaluation of students' learning more difficult (Chen and Lu 2013).

Bates and Poole (2003) stated that the e-learning continuum consists of five elements which are face-to-face classroom teaching, classroom aids (technology-enhanced face-to-face classroom), mixed mode (face-to-face and online), distributed learning, and distance education. Face-to-face classroom teaching involves traditional teaching methods. Classroom aids include electronic technologies used to present some or all of a course. However, in a study by the Organisation for Economic Co-operation and Development (OECD) in 2004, Bates and Poole's (2003) 'classroom aids' were subdivided into 'Web supplemented' (such as course outline, online learning notes, and email) and 'Web development' (such as Web design, content management systems, and databases) categories. Mixed-mode delivery, also known as blended learning, is the electronic approach that combines face-to-face and online interaction that is integrated with the curriculum. Distributed learning and distance education allow the learning process to take place at home or in the workplace.

2.2.2 Components of e-Learning

Learning management system

A Learning Management System (LMS) provides pedagogical tools for content creation, communication, assessment, and administration (Kats 2010). It is an efficient way to track how students access and open the digital notes, recordings, interactive media, and other learning resources; interact with peers and learning facilitators; and undertake online assignments. An LMS provides a means to test students to see whether knowledge transfer is really occurring through e-learning. Assessment in distance education or e-learning offers online tests that are automatically managed by computer programmes, and online submissions (Bailey 1998) through LMS. LMS can eliminate the limitation of traditional learning which requires students' participation at the same time and location (Pinantoan 2014). Salmon (2000) claims that lecturers will move towards traditional assessment alternatives as they become more comfortable in the e-learning environment.

An LMS can be an expensive system initially. There are different types of e-learning platforms, namely: open-source, developed-in-house, and commercial platforms. Open-source LMS is less expensive than commercial LMS. The use of open-source as an e-learning platform and the open access to the developed online content are necessary to ensure sustainability (Kloos, Pardo, Organero, et al. 2007), and ensures education equity where everyone can access education resources. According to Young and Pasian (2016), the open source platform allows institutions to customise e-learning to meet certain learning objectives and outcomes. However, with a commercial LMS such as Blackboard, e-learning users need to be able to embrace any changes (such as changes of Web layout and additional tools) that are made in Blackboard. Thus, if these changes lead to risk failure of e-learning initiatives instead of improvement, it may lead to an unsupportable LMS as a result. A secure LMS protects private learning resources. Today, an LMS provides interactivity, simulation, and multimedia that make the learning more effective and interesting. For instance, Siemens uses the LMS Virtual.Lab suite for its engineers as they learn to develop accurate simulation models, simulate mechanical design performance, identify weak spots of a model, and explore and access various design alternatives (Siemens 2016). Most LMSs measure an individual's competency level via skill-assessment tests and then guides the user to the most appropriate course(s) to address any skill shortcomings.

Furthermore, the emergence of social media like Facebook has enabled teachers to create learner interaction spaces that use social media groups in online spaces that students are already using for social purposes (Wang et al. 2012). This means that such social network features can overcome some of the LMS limitations by providing a cheaper or free, and easily maintained system. Universities utilise LMS and social media platforms because both technologies encourage file sharing, collaboration, peer-to-peer interaction and discussion among students and instructors (Gray, Annabell and Kennedy 2010; Veletsianos and Navarrete 2012). However, Hrastinski and Aghaee (2012) argued that social media can lead to learning misunderstanding, reduce creative thinking skills, and minimise learning collaboration. This argument was supported by Davies, Chase, Good, and Spencer (2010) who indicated that social media such as Facebook is a waste of time since students can be distracted by Facebook content that is irrelevant to learning (Gafni and Deri 2012). This argument was also supported by Madge, Meek, Wellens, and Hooley (2009) who pointed out that students do not prefer to have formal learning discussions through Facebook; hence, they do not prefer to use social media for learning purposes. Based on these arguments, Salmon, Rossb, Pechenkinac, and Chase (2015) suggested that student performance on social media needs to be considered and should be viewed as an additional feature of LMS rather than a substitute for LMS. They also revealed that learning could be improved through social media such as Facebook and Twitter based on online surveys and interviews.

Content management system

A Content Management System (CMS) is a database that provides access to digital content such as files that contains text, image, graphics, music, and video. A CMS can be used to manage digital assets and enables the convenient and flexible management of learning resources (Pérez-Montoro 2011). A CMS can be used by lecturers, instructors, or those involved in the management of the content development process. Furthermore, CMS allows academic staff to create course Websites where e-learning materials can be uploaded in a variety of formats such as .pdf, .docx, or .pptx

(Ninoriya, Chawan and Meshram 2011). CMS can efficiently support e-learning by offering discussion board features whereby teachers require their students to undertake the course-related learning activities, and monitor them (Ninoriya, Chawan and Meshram 2011). This could increase the use of e-learning collaboration tools, hence, making them a supportable e-learning initiative. Moreover, to support sustainable e-learning, CMS should allow reusability of content to create economies of scale and provide access to high quality educational resources.

Assessment management system

An Assessment Management System (AMS) enables course instructors to manage all assessment tasks such as quizzes or tests. Assessment refers to the measurement of academic success as well as knowledge and understanding. AMS functions measure student knowledge and track student progress. Such assessments are known as 'e-assessment' given that instructors can upload, edit, and delete the assessment. The student can also download the assessments. The e-assessment tool provides flexibility and a user-friendly interface to assist instructors to deliver and manage their students' assessment (Al-Smadi, Guetl and Helic 2009). Through an AMS, students can also receive a detailed breakdown of scores or the results of assessment tasks such as quizzes. Data storage is primarily on a Local Area Network (LAN) or on a secure World Wide Web (WWW) server. The assessments and results are stored in the programme's database.

Monitoring system for e-Learning

Monitoring and tracking students' behaviour regarding the use of e-learning can help the lecturer to identify the level of student interest in learning material. By knowing how the student has assimilated the learning content, how s/he has reacted to it and the period of time spent on the learning object, could help an instructor to determine whether the content adequately caters for student needs. This type of system monitors students-content interaction and their reaction to various tasks proposed by a lecturer for a specific learning activity. Chen (2016) added that monitoring in e-learning involves observation of student interactions. Efficient monitoring systems together with dynamic intervention by the instructor are able to provide teaching support and improve students' engagement in learning activities (Chen 2016). Examples of LMS data on indicators of engagement are click count (indicator of student participation) and grade (indication academic achievement) (Beer, Clark and Jones 2010). Based on an evaluation index system, Yan, Shang, and Liu (2011) discovered that it is important to monitor the service status of a website in order to improve the course quality and utilisation of education resources. They also added that the monitoring processes can be optimised by adjusting the response time to produce accurate results, ensuring that the monitoring list is according to the statistical data, and determining the rate of monitoring (Yan, Shang and Liu 2011). Martin and Ndoye (2016) also pointed out that formative assessment monitors students learning, while summative assessment is able to determine learning effectiveness.

Virtual Learning Environment

A Virtual Learning Environment (VLE) provides a single integrated system that consists of a Web content management feature for designing and creating e-learning courses, storing e-learning content, providing hyperlinks between online digital resources, and actively conducting and monitoring the learning process. VLE offers some of the LMS and CMS functionalities. In 2005, VLE usage has increased to 95% of all institutions' adoption of VLE in the United Kingdom based on a survey (Browne, Jenkins and Walker 2005). According to BBC Active (2010), most higher education institutions have at least one VLE for greater learning flexibility. Some have bought this from service providers or obtained it for free through the use of open-source solutions. VLE allows instructors to develop Web-based multimedia resources without having programming language skills (Cheng and Yen 1998), while students have the ability to access information and asynchronous postings (McPhee and Soderstrom 2012). VLE best practice distinguishes content authoring from design and delivery (Ferrer and Alfonso 2011) so it could be easier to manage. According to Sneha and Nagaraja (2013), VLE plays an essential role in articulating and managing the learning experience. Conversely, Barajas and Owen (2000) discovered that some students wish to avoid VLE due to their lack of ICT skills and their inability to buy equipment. They also discovered that teachers who lack the ICT skills to facilitate learning through VLE seem to avoid using VLE.

Quality of e-learning

Quality in education takes into account the stakeholders' opinions and thoughts (Casanova, Moreira and Costa 2011)within an organisation in order to meet stakeholders' goals and needs (Pawlowski 2007). In e-learning, quality refers to ICT's ability to support all activities, products, and services (Pawlowski 2007). This often consists of measuring the utilisation of learning resources by students and their participation and engagement with peers and learning facilitators using collaborative learning tools.

With respect to Barbera's (2004) view on Technology Enhanced Learning (TEL) evaluation that considers different dimensions of teaching and learning process, Casanova, Moreira, and Costa (2011) suggested five dimensions that evaluate TEL. These are: stakeholders' expectations and perceptions, teaching, learning, assessment strategies, learning environment and resources competences, and logistic and support. The stakeholders' expectations and perceptions concern an improvement of academic success, motivation, participation and satisfaction, as the expectations and perceptions relate to communication skills, entrepreneurial competences, pedagogical competences, scientific capabilities, self-regulation competences, and technological capabilities. The dimension of teaching and learning strategies focuses on accuracy, diversity, and effectiveness of teaching and learning strategies. In addition, this dimension aims to respect the ethical principles, foster active learning, and strategies suitable for an online learning environment. As for the learning environment and resources dimension, it concentrates mainly on the accessibility of the learning environment and compliance with standards. The logistics and support dimension focus on the institutional recognition and regulation, and adequacy of administrative resources, human resources, pedagogical support, scientific resources, technical resources, and support. Furthermore, a few key issues need to be considered such as standards, review, process, and improvement (Ellis et al. 2007) to ensure e-learning quality (Doherty and Cooper 2007).

Ten pedagogic principles for e-learning

Anderson and McCormick (2005) stated ten pedagogic principles necessary for e-learning success. The first principle is that e-learning should be aligned with the curriculum and should have clear objectives (at an appropriate level and form of a specification). It should consider the relevance of content covered, the appropriateness of student activities, and the nature of the assessment. Robertson (2008) expanded on this, noting that this principle supports sustainable e-learning when the pedagogy meets the present and future needs of students. The quality of teaching and learning models and the innovation of curriculum development need to be evaluated (Hellstén and Reid 2009) so that the pedagogy is aligned with the curriculum to ensure that e-learning delivers the right curriculum to meet the learning objectives.

The second principle is inclusion (Anderson and McCormick 2005). The pedagogy should support inclusive practice in terms of different types and range of achievement (including special needs), physical disabilities that can be particularly supported by e-learning, different social and ethnic groups, and gender, which could help to avoid gender inequity.

The third principle is learner engagement (Anderson and McCormick 2005). The pedagogy should engage and motivate learners. It improves the class atmosphere for learning and makes it a good experience for teachers and learners alike. In order to provide quality learning, sustained reasoning and learner engagement with knowledge production practices need to be developed (Wankel and Blessinger 2013). Wankel and Blessinger (2013) added that learner engagement should have a 'worthwhile' educational aim, and not just be used to occupy or entertain learners, although it might employ 'game-like' approaches to learning. Students who are engaged with their learning experience with sustainability agendas are likely to be equipped with knowledge and skills that contribute to sustainability (CSU (Charles Stuart University) 2016). This engagement must not produce adverse emotional reactions such as loss of interest that are likely to reduce motivation to learn in general, or to use ICT.

The fourth principle pertains to the use of innovative approaches (Anderson and McCormick 2005). It should be evident why learning technologies are being used, rather than a non-technological approach that achieves the same end just as effectively. Digital forms should be used where they bring an innovative approach that cannot be achieved in any other way. Learning tools such as animated graphics, games, online groups, and simulation can be used to enhance the learning through ICT advancements

(Tomei 2013). The design and implementation of the digital material or environment may also be innovative.

The fifth principle is effective learning (Anderson and McCormick 2005). This principle can be demonstrated in a variety of ways. Anderson and McCormick (2005) indicate that effective learning can be demonstrated by providing a range of approaches that will allow the learner to choose one that suits his/her learning goals, or that can be personalised to his/her learning needs. Also, Anderson and McCormick (2005) pointed out that effective learning should also include empirical evidence of effective outcomes of the pedagogic approach (including the digital material). Finally, effective learning can occur by providing authentic learning opportunities that enable a student to explore multiple perspectives on a topic (Sadler-Smith 1996). In response to sustainability, Education for Sustainable Development (ESD) helps to engage students effectively and innovatively with sustainability, sustainable development, and ESD provision (McEwen 2007; McKeown et al. 2006; Mahat and Idrus 2016). In higher education, ESD can be accessed through educational programmes provided by universities (Azeiteiro, Bacelar-Nicolau and Caetano 2015). This means that effective learning involves personalised learning, learning outcomes, learning success components, and authentic learning.

The sixth principal is formative assessment. This may be achieved in a number of ways which include providing rapid feedback, peer assessment, and self-assessment (Anderson and McCormick 2005). Formative assessment, for example, can enable teachers to identify the students’ strengths and weaknesses in order to better guide future learning (Devedzic 2006). In addition, feedback on formative assessment allows students to understand criteria or standards of performance when undertaking assessment tasks in future. Formative assessment also is seen as the heart of sustainable assessment that focuses on students' interest (Singh and Terry 2008) to manage assessment and inspire their learning outcomes.

The seventh principle is the summative assessment. Summative assessment is known as outcome-based qualification profiles (Khan 2001). Summative assessment involves grading students on their overall achievement and can be used to guide the selection of further learning pathways. It must be valid and reliable, comprehensible by teachers, learners and parents, able to deal with a range of achievement levels, and not have an adverse emotional impact on the learner (Anderson and McCormick 2005). Furthermore, summative assessment needs to consider its impact on student learning in order to support sustainability since it has limited learning objectives (Boud 2000). Although not all e-learning will include formative assessment, most e-learning systems provide a summative assessment.

The eighth principle is coherence, consistency, and transparency (Anderson and McCormick 2005). The pedagogy must be internally coherent and consistent so that the objectives, content, student activities and assessment are aligned. It must be open and accessible in its design. The student should be very clear about what is required of him/her. High level of consistency of self-assessment, peer assessment, and teacher assessment may be affected by different educational levels, assessment rubrics, or assessment environments (Chatti et al. 2010). This implies that all the components of e-learning should be aligned, and the intention should be transparent.

The ninth principle is ease of use (Anderson and McCormick 2005). As well as being transparent in its intention, e-learning should be transparent in its ease of use by being open and accessible, being intuitive and not requiring guidance on use, providing appropriate guidance for the learner or the teacher. E-learning should not require extensive training or instructions that are not themselves part of the educational aims of the e-learning, and appropriate assumptions about the ICT skills of users should be considered with the provision of straightforward guidance (Sural 2010). Furthermore, page layout, design, and navigation of e-learning need to be consistent to support the learning process (Robert and Goodyear 2010). Therefore, it is important for e-learning to be user-friendly to encourage the learner to access and use it, which could support sustainable e-learning by increasing the adoption rates of e-learning.

The tenth principle is cost-effectiveness. Technology solutions need to be justifiable, affordable, and the costs sustainable (Anderson and McCormick 2005). Learning technology is not a cheap option for enhancing educational opportunity, broadening choice, and raising standards. Training on the use of technology needs to be made available to teachers and students to ensure the effectiveness of e-learning (Sural 2010). Thus, this leads to inconsistency in the literature regarding e-learning as being cost-effective. The research has found that huge investments are required to establish e-learning which requires the purchase of technology and training. Considering the economic aspect of TBL, the investment needs to be justified in terms of cost benefits and savings through economies of scale, or in terms of affordance of pedagogic opportunities and enrichment, or in meeting educational needs and goals, which are not achievable in other ways.

2.2.3 E-learning in Malaysia

Today, Malaysia has become an export-driven economy motivated by high technology and industries. Malaysia aims to become a developed country by the year 2020. One of the National Missions is to enhance Malaysia's capacity for knowledge, creativity, and innovation and develop a 'first class mentality' (Abdullah 2006). Therefore, in order to become a developed country through education, the education system needs to be thoroughly overhauled by providing an environment conducive to the implementation of an innovative system such as e-learning.

In response to the ten pedagogic principles of e-learning success as discussed earlier, the Malaysia e-learning guidelines produced by the Ministry of Education Malaysia (MOE) has considered all the pedagogic principles, except for the cost-effectiveness aspect, as shown in Table 2.1 below.

Table 2.1: Malaysia E-learning guidelines 2014 responds to the 10 pedagogy principles for e-learning success

The 10 Pedagogy Principles (Anderson and McCormick 2005)	**Malaysia e-learning guidelines (Ministry of Education Malaysia 2014)**
E-learning matched to the curriculum	E-learning should offer appropriate curriculum and understand curriculum requirements.
Inclusive practice	E-learning pedagogy should offer inclusive practice that covers a range of achievement potential.
Learner engagement	E-learning should ensure full engagement with e-learning practices among students and lecturers.
Innovative approach	Conduct research for innovative e-learning practices and identify why learning technologies are used.
Effective learning	Conduct survey and use rubrics to measure e-learning effectiveness.

Formative assessment	The provision of formative assessment or learning practice. Feedback should be answering students' questions and focus on learning goals.
Summative assessment	The e-learning course needs to be aligned with summative and formative assessments. Also, e-learning needs to ensure that students achieve the desired learning objectives.
Coherence, consistency, and transparency	Pedagogy must be internally coherent and consistent with learning objectives, content, learning activities and assessment. Transparency refers to the openness and accessibility of pedagogy.
Ease of use	Easy-to-perform learning tasks and easy navigation of e-learning system.
Cost effectiveness	Cost effectiveness is not considered in the e-learning guidelines.

Since the Malaysia E-learning guidelines 2014 do not include the cost-effective aspects, there is a need to develop a guideline or a framework that considers cost-effectiveness as this aspect could lead to e-learning success and sustainability.

Malaysia's development of e-learning

In Malaysia, e-learning is not a new trend, having been introduced many decades ago. E-learning is used in smart schools, colleges, universities, and libraries. Based on a report on e-learning trends and status in Malaysia by Embi (2011) , 65% of lecturers use content delivery such as course management, assessments, and tracking, which is the highest LMS components used by lecturers, while most students use assessment (55%), email (54%), and course management (53%) as the most beneficial LMS components to their learning. Most activities on the net involve obtaining information, social networking, education, and leisure. In 1970, the University of Science Malaysia (USM) introduced the first distance-learning programme, known as the 'off-campus programme', although final year students needed to be on campus to complete their three-year programme (Alhabshi 2005). In 1972, the pre e-learning development was started when the Malaysian Ministry of Education set up the Educational Technology Division (Asirvatham, Kaur and Abas 2005).

In 1998, the first Learning Management System (LMS) for higher education was launched by the University of Malaya (UM), which provides online courses for their students (Asirvatham, Kaur and Abas 2005). A year later, several private universities established their own e-learning system by offering Internet-based degree programmes and delivering online learning materials (Asirvatham, Kaur and Abas 2005). In addition, many workshops, seminars, and conferences were organised to promote knowledge sharing, information exchange, and collaboration.

Malaysia Education Blueprint 2013-2025

The Malaysia Education Blueprint 2013-2025 (Malaysia Ministry of Education 2012), established three phases, or waves, to help Malaysia to become a developed country through education. The first wave (2013-2015) was intended to enhance the foundation by providing network infrastructure and learning platforms, delivering new ICT devices to schools and universities, ensuring all teachers and ministry officials became ICT literate, shifting towards more user-created content, and integrating data management. The second wave (2015-2020) will introduce ICT innovations by exploring best practices for the education system and achieving critical mass in ICT devices. The third wave (2021-2025) will maintain innovative and system-wide usage by defining ICT literacy for teachers and ensuring that ICT is fully embedded in the education pedagogy and curriculum.

In response to the 2005 World Summit, The Future We Want 2012, and Sustainable Development goals 2015, the Malaysia Education Blueprint 2013-2025 has considered some of the goals for education and higher education. These goals include achieving education equality, adopting effective ICT usage to improve learning outcomes, promoting sustainable practices in universities, and providing lifelong learning opportunities for all.

Benefits of e-learning in Malaysia

E-learning could bring many benefits to higher education institutions in Malaysia such as flexibility, accessibility, scalability, easy update, low cost of delivering content, and collaborative learning (Ali 2004). In addition, it is anticipated that students could develop good thinking skills, leadership skills, knowledge, ethics, bilingual proficiency, and national identity (Malaysia Ministry of Education 2012). These benefits provide students with richer learning experiences and could enable them to access the learning material at any time, place, and on any device. Instructors can easily update and deliver contents to a small or large number of students at low cost.

Challenges of e-learning in Malaysia

Based on a study of the trend of e-learning implementation in Malaysia's higher education institutions, Hussain (2004) argued that an e-learning project will not be successful if there is a lack of strategic planning and adequate funding. Poor awareness and low adoption rate by those who prefer traditional learning methods can lead to difficulty in engaging the learners online. The limitations of Internet connections can create frustration among learners when downloading activities, or when there is system failure. In addition, the poor interactivity of e-learning content can lead to a moderate impact on the learners. From a professional development perspective, changes in users' practices, beliefs, behaviours, and teaching and learning outcomes (Guskey 2002), have become a challenge for e-learning sustainability. Guskey suggested that the identification of change, regular feedback on students' learning outcomes, and continuous support are required to sustain e-learning.

E-learning practices among Malaysian universities

In order to compete in the educational market, some universities in Malaysia such as Universiti Kebangsaan Malaysia (public university) and Universiti Teknologi Malaysia (private university) produced mission and vision statements that support e-learning (Puteh 2007) (see Figure 2.1 below). The researcher found that these mission and vision statements indicate the intention of both universities to develop a sustainable society that is ethical and knowledgeable. However, there is no mention in the statements of how the universities will support a sustainable economy and environment. Regarding e-learning, both universities embrace technology and education to develop quality graduates. The commitment of Malaysian universities to e-learning has ensured that e-learning has become a well-established feature of the higher education sector in Malaysia. Based on research on the trends of e-learning implementation, Al-rahmi, Othman, and Yusuf (2015) identified that there are five e-learning trends: e-learning policy, e-learning governance, LMS, e-learning training, and e-learning integration into teaching and learning. Figure 2.1 below shows the mission and vision statements for Universiti Kebangsaan Malaysia (UKM) and Universiti Teknology Malaysia (UTM). These vision statements can help each university's community to understand the university's aims and how to achieve them.

University	Vision	Mission
UKM	To be the leading university that pioneers innovations in creating a dynamic, knowledgeable, and ethical society.	To be the premier university that affirms and promotes the value of the Malay language while globalising knowledge within the framework of the national culture.
UTM	To be a world-class centre of academic and technological excellence through creativity.	To lead in the development of creative human resource and technology in line with the aspirations of the nation.

Figure 2.1: Mission and vision statements for UKM and UTM (Puteh 2007)

UNITAR's experience with e-learning has become well known among Malaysia's educators since 1996 when the university became known as Malaysia's first 'Virtual University' (Hussain 2004). The UNITAR e-learning model consists of six components: CD-based teaching courseware, face-to-face tutorials, virtual library, Virtual Online Instructional Support System (VOISS) which is a bespoke system, Customer Relationship Management (CRM) that assists students with their technical issues 24/7, and Online Live Tutorial (OLT) that uses voice-over Internet Service Provider (ISP) technology to provide real-time communication with students (Alhabshi 2005). UNITAR offers both online learning and off-campus learning options to students. Hence, UNITAR is using a hybrid learning or blended learning mode that combines three different approaches, which are: resource-based learning, collaborative learning, and computer-based training. The hybrid learning approach uses the VIOSS, which was designed to assist the learning process (Puteh and Hussin 2007). Both synchronous online tutorials and face-to-face tutorials are used. According to Puteh and Hussin, synchronous online tutorials involve OLT and face-to-face meeting where the face-to-face tutorials are conducted at the UNITAR regional campuses. UNITAR has chosen e-learning to deliver education because it does not require a huge campus, the financial capital can be reduced, there is no restriction on enrolment that offers scalability, it provides a more convenient study environment, and encourages online social interactions between students and staff (Alhabshi 2005). Nevertheless, even UNITAR recognised that they faced several issues such as difficulty in achieving a reasonable balance between commercial and academic objectives, few IT savvy students, students do not fully utilise the teaching CDs, lecturers prefer conventional delivery modes, and the academic activities are not always aligned with commercial objectives (Alhabshi and Hakim 2006).

Multimedia University (MMU) offers three types of educational delivery: an on-campus programme, an e-learning on-campus programme, and a distance education programme (Hussin and Salleh 2008). On-campus programmes deliver education to on-campus undergraduate and postgraduate students. The e-learning on-campus programme provides education access through video conferencing (Puteh and Hussin 2007). The distance education programme was designed for part-time students as it is conducted off-campus (Puteh and Hussin 2007). Most of MMU's students are enrolled in on-campus programmes at the Malacca and Cyberjaya campuses. In 2000, MMU developed an Instructional Designers (ID) department responsible for connecting content experts with IT experts when developing their own LMS (Raja Hussain 2002) known as the Multimedia Learning System (MMLS). MMU stresses the importance of IT and multimedia learning and training through MMLS (Hussin and Salleh 2008), which is a multifaceted system that helps to manage courses content, provides communication tools, facilitates asynchronous communication, online testing, online grading, and monitors students' learning activities. It is also divided into architecture and content components (Puteh and Hussin 2007). The MMLS architecture includes an intelligent agent that records and analyses a student's learning pattern. Also, MMLS follows the international standard called Shareable Courseware Object Reference Model (SCORM) (Adni and Hussain 2009) to deliver various learning objects for different courses (Nordin and Lajis 2010).

Open University Malaysia (OUM) focuses on distance learning and implements a Web-based system by using IT in a variety of modes. Compared with UNITAR and MMU, OUM has the highest number of students that are engaged with the e-learning environment (Hussin and Salleh 2008). Currently, OUM has successfully run online education courses through its open and distance learning programme (Hussin and Salleh 2008). OUM has received several awards for its e-learning achievements, such as the ‘Excellence in Education Management – Provision of Continuous Education' award from the Technology Business Review, ‘Excellence for Distance Education Materials – Learning Skills for Open and Distance Learning Award' from the Commonwealth of Learning, and ‘E-learning Recognition' from the Eszterhazy Karoly College. OUM has adopted a blended approach whereby the students meet face-to-face with their teacher three or five times for 150 minutes each semester, and the remaining teaching-learning hours are conducted online. OUM delivers its e-learning through an in-house development platform called My Virtual Learning Environment (MyVLE) (Embi 2011). MyLMS comprises application packages for the user and it is very user-friendly. MyLMS provides facilities such as myUniversity, myCourse, myCommunity, myProfile, myLibrary, myMail, and my Online Marks Entry System (OMES), that help to make myLMS an excellent system. OUM's components and major applications of LMS include communication, student involvement, administration, course delivery, and content development (Embi 2011). The President/Vice Chancellor of OUM, Professor Anuwar Ali stated that there is a number of important fundamentals that account for OUM’s successful e-learning implementation, namely: a pedagogical model, effective policies, e-learning funding, ‘humanware’, infrastructure, and ‘infostructure’ (Ali 2008). The pedagogical model includes formulated blended learning pedagogies that provide an environment conducive to learning, and that can be tailored to various learning styles and a variety of media. Effective policies ensure that there are sufficient facilities and resources to provide a positive e-learning environment. Funding refers to an adequate budget to support the necessary purchase of hardware, software, services, and human resources. ‘Humanware’ refers to having the necessary talent among technical staff, programmers, Web designers, instructional designers, and graphic designers that are able to assist with the ICT ‘infostructure’ and development of e-learning solutions (Ali 2008). Infrastructure refers to facilities that support e-learning environments such as computer laboratories and the hotspot for wireless Internet access. The term ‘infostructure’ refers to information assets that organised, managed, and maintained hardware, software, networks, infrastructure, information, and applications (Alhabshi 2005). The success of OUM’S e-learning system can be attributed to several factors. These key success factors include the introduction of a course on Learning Skills for Open and Distance Learners, uploading assignment questions online, availability of online students' profile, financial records, and academic records, providing a reliable and learner-friendly learning management system, ensuring that OUM's tutors are available online to support and monitor forum discussions, ensuring constant availability of Internet connection, and having an experienced technical team to manage OUM's infrastructure and ‘infostructure’. In OUM, meeting the learner's expectations and requirements regarding learning materials is a starting point for ensuring the quality of e-learning. Learner’s expectations and requirements include having a user-friendly system, being provided with materials relevant to students’ studies that are easy to understand, balanced in terms of media usage, well researched and current with up-to-date information to enhance students’ knowledge and skills that leads to learner engagement and meets the objectives of the academic programme.

Three main factors were identified that contribute to the lack of a Malaysian virtual university like OUM, UNITAR, and MMU that deliver education through an Internet connection. These include inadequate IT infrastructure and bandwidth necessary to support a virtual university(Salleh 2008), lack of extensive experience with e-learning (Alhabshi and Hakim 2006), lack of student familiarity with virtual education (Puteh and Hussin 2007), and the emerging e-learning environment driving students to change their learning styles.

2.3 E-learning Frameworks

A number of e-learning frameworks have been developed during the last two decades. These include the E-learning and Pedagogical Innovation Strategic framework (Salmon 2005), Quality framework (Moore 2005), UNITAR e-learning model (Alhabshi 2005), E-Learning Success Model (Holsapple and Lee-Post 2006), E-learning Evaluation Model (Yunus and Salim 2011), Theoretical Framework (Georgouli, Skalkidis and Guerreiro 2008), Pedagogical Framework (Granic, Mifsud and Cukusic 2009), Information Quality Framework for e-Learning System (Alkhattabi, Neagu and Cullen 2010), The Global E-learning Framework (Khan 2010), Quality framework(Casanova, Moreira and Costa 2011), A conceptual framework for e-learning quality (Ossiannilsson and Landgren 2011), Malaysian E-learning implementation framework (EPSA (E-Pembelajaran Sektor Awam) 2011), Theoretical Framework for blended learning for adults (Fang, Chow and Soo 2012), E-learning Evaluation Framework (Yunus and Salim 2011), Involvement, Preparation, Transmission, Exemplification, Application, Connection, Evaluation, and Simulation (IPTEACES) e-learning framework (Isaias and Pena 2014), and E-learning Theoretical Framework (Aparicio, Bacao and Oliveira 2016). The e-learning frameworks presented in this chapter were identified based on key terms such as 'e-learning framework', 'sustainable e-learning framework', and 'online education framework', which were used throughout the search of online databases and library collections.

2.3.1 The Development of e-Learning Frameworks

Researchers have been developing different frameworks over the last few decades due to changes in technology, pedagogy, and students' needs. The evolution and application of new technology, and the changing learning and teaching requirements, have been investigated and identified. Many new research areas have emerged such as open education. Particularly important areas for this thesis were e-learning and e-teaching principles, technology, application, and sustainable development within higher education practice. Figure 2.2 below gives a clear visualisation of the evolution of e-learning framework in education practice between 2005 and 2016. After searching online databases and library collections, the researcher identified other existing frameworks related to e-learning practice in education. Frameworks that were published in journal papers, books, or conferences papers were the targeted sources.

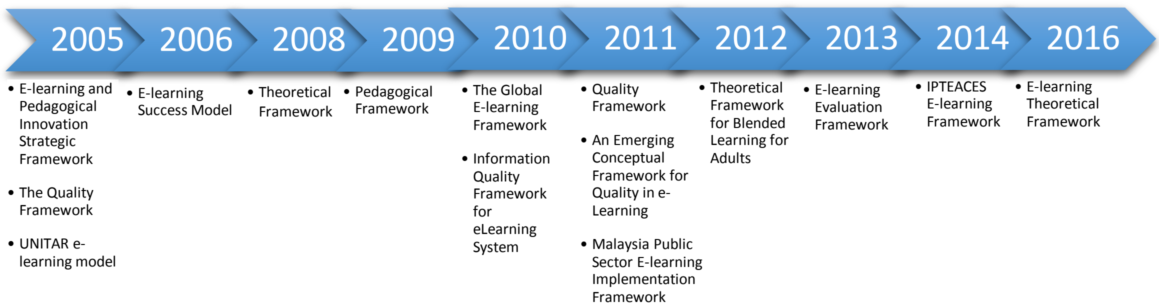


Figure 2.2: Timeline of e-learning frameworks in the education sector (2005-2016)

In 2005, the e-learning and pedagogical innovation strategic framework was developed by Gilly Salmon and included components such as mission, market, objectives, technology, and pedagogy. In order to meet current and new practices, Salmon included four quadrants as shown in Figure 2.3 below.

Technology and Pedagogy			
Existing	New		
Quadrant 1	**Quadrant 2**		
VLEs and e-libraries for: Increased student number flexibility, blend, accessibility, quality, efficiency	Mobile and wireless learning for any time, any place, combinations and blends	Existing	Market Mission Objectives
Quadrant 3	**Quadrant 4**		
Countries, objectives, levels of education and markets not addressed previously using VLE and e-library resources	Scan environment, Research, Explore emerging technologies and applications for innovation	New	

Figure 2.3: The E-learning and Pedagogical Innovation Strategic Framework (Salmon 2005)

Quadrant 1 outlines the minimum baseline for providing suitable e-learning to students through existing virtual learning environments and online libraries. Quadrants 1 and 2 provide suggestions on establishing a university's main strengths in teaching with new technology. Quadrant 2 addresses the increasing availability of new learning and mobile technologies. In this quadrant, pedagogies require more exploration and the evaluation of feedback, and research can be done to discover and create an appropriate e-learning pedagogy. Quadrant 3 addresses the various and new learning and teaching disciplines, missions, and markets using existing core expertise and technologies. The use of learning objects in this quadrant will support the management and sharing of both pedagogical and content knowledge to broaden the new learning and teaching missions. This quadrant is intended to ensure that students are given equal service and learning experiences. Lastly, Quadrant 4 denotes a further improvement through peripheral technologies, new products, markets, and missions. It requires each university to constantly discover new technology innovations and market environments, and create innovative projects using peripheral technologies. In summary, Quadrants 1, 2, and 3 represent the arrangement of the university's current main capabilities through innovation growth. The consideration of new and existing technology, pedagogy, market, objectives, and missions are significant to improve e-learning innovation, which could benefit the e-learning stakeholders and investment. The framework provides a suitable platform for discussions on the development of an e-learning strategy in higher education institutions.

In the same year, in response to the development of quality and evaluation as crucial aspects of educational institutions, the Quality Framework was developed by Moore (2005) that consists of five pillars, namely: learning, cost effectiveness, access, and satisfaction among faculty and student. The framework provides continuous measurement of the five pillars in order to improve users' networks, practices, achievement, and development. This framework does not focus only on faculty and students; it also considers the IT staff such as programmers, Web designers, and instructional designers so as to improve e-learning quality. Unlike Salmon's E-learning and Pedagogical Innovation Strategic Framework (2005), Moore's framework focuses on the quality of e-learning rather than on discovering existing and new technology, application, market, and objectives.

In Malaysia, based on a paper produced by the former founding president of Universiti Tun Abdul Razak (UNITAR), the university has developed its own e-learning model that comprises CD-based teaching courseware, face-to-face tutorials, virtual library development, own Learning Management System (LMS), Customer Relationship Management (CRM), and Online Tutorial (OLT) (Alhabshi 2005). Every component of the model could help to support successful e-learning, however, the CD-based teaching courseware may not be an effective approach in today's learning activities due to online and open-access e-learning resources. Training and support enabling stakeholders to cope with the rapid changes in Information and Communications Technology (ICT) need to be offered in order to sustain the university's e-learning system.

From the Information Systems perspective, Holsapple and Lee-Post (2006) conducted a research that attempted to understand e-learning success factors based on the definition, evaluation, and promotion of e-learning. The E-learning Success Model comprised six dimensions: system quality, information quality, service quality, use, user satisfaction, and net benefits, which occur in three stages, namely, system design, system delivery, and system outcome (Holsapple and Lee-Post 2006). Based on survey results and findings, e-learning success can be defined, accessed, and promoted in these dimensions by measuring each of the six dimensions through students' feedback. Nevertheless, the framework should consider system planning as one of the stages to support the definition and measurement of e-learning success. Moreover, the professional development of academic staff (Guskey 2002) should be considered to support information quality, service quality, system use, and improve the learners' satisfaction.

In light of the research progress and the emergence of e-learning, Georgouli, Skalkidis, and Guerreiro (2008) proposed the Theoretical Framework, which consists of guidelines for designing an e-learning instructional model for Web-enhanced courses, called e-course. It is based on the blended learning model, complementing face-to-face interaction with online delivery methods. This framework consists of four major components: administration, content, activities, and community. The administration component consists of tools that collect essential statistics and provide reports for course evaluation. The other three components address the pedagogical issues. According to Khan (2000) , teachers need to recognise the activities that support student learning, and contribute to the framework. Based on a survey, students who accessed e-learning are more interested in the collection of e-learning tools such as forums, chats, and wiki.

In 2009, the Pedagogical Framework (Granic, Mifsud and Cukusic 2009) was designed, implemented, and validated by a Europe-wide network of experts from the education sector. As shown in Figure 2.4, it consists of five components, which are the pedagogical framework context, the pedagogical approach, assessment techniques, current pedagogical practices and national specifics, and teacher training.

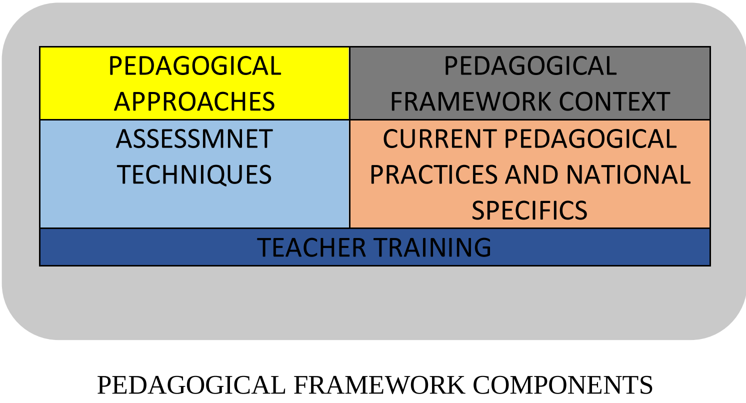


Figure 2.4: "Components of the Pedagogical Framework" (Granic, Mifsud and Cukusic 2009)

The Pedagogical Framework components refers to the overall perspective and it comprises learners' empowerment, affordance of mobile devices, and awareness of the need to understand traditional practice. Pedagogical approaches in the framework promote active learning that includes ideas on knowledge attainment, learning activities management, and the importance of the social element in the collaborative and individual settings. Assessment training includes consideration of four types of assessment. These are computer-based assessment, self-assessment, peer-assessment, and tutor-assessment. In order to develop a common pedagogical framework, the specific requirements and standards established by the government were taken into consideration. Government curricula and school educational policy plans, current pedagogical practices, technical structure, and future users were considered. Based on Granic, Mifsud, and Cukusic, the framework was intended to be an operational tool for e-learning which reflected and implemented the educational practices. Additionally, training techniques for building a learning community were designed.

Based on a study on e-learning critical issues and course design, a Global E-learning Framework was developed by Khan that has been adopted by most institutions (Khan 2010). The framework has seven components: institutional, management, technological, pedagogical, ethic, interface design, resources support, and evaluation. Institutional dimension of e-learning focuses on issues on administrative and academic affairs, and student services. The e-learning management refers to the learning environment and maintenance of information delivery. The technological component focuses on technology infrastructures such as issues regarding infrastructure planning, software, and hardware. Meanwhile, pedagogical refers to teaching and learning practices, which consider issues related to content analysis, goal analysis, design method, and learning strategies. The ethical component refers to social, political and cultural influences, and legal issues. Interface design focuses on content design, Web design, navigation, accessibility, and usability. The resource support aims to promote meaningful learning through online support and resources. In order to develop a meaningful and supportive learning environment, Khan suggested e-learning designers should understand issues of each component. All of these components constitute a significant ingredient of e-learning implementation, however, this framework should consider factors such as users' behaviour, acceptance, and satisfaction.

Alkhattabi, Neagu, and Cullen (2010) added improvements to the existing e-learning quality frameworks, especially the Data Quality Framework from 1996. The Information Quality Framework for e-Learning System contains the crucial quality dimensions of e-learning. The extended framework is based on Wang and Strong's Data Quality Framework of 1996, which initially included four quality dimensions. Based on the questionnaires and factor analysis of the collected data, the new proposed framework comprises three quality factors and 19 quality dimensions. The framework was based on a cross-section survey conducted among teachers and students involved in e-learning.

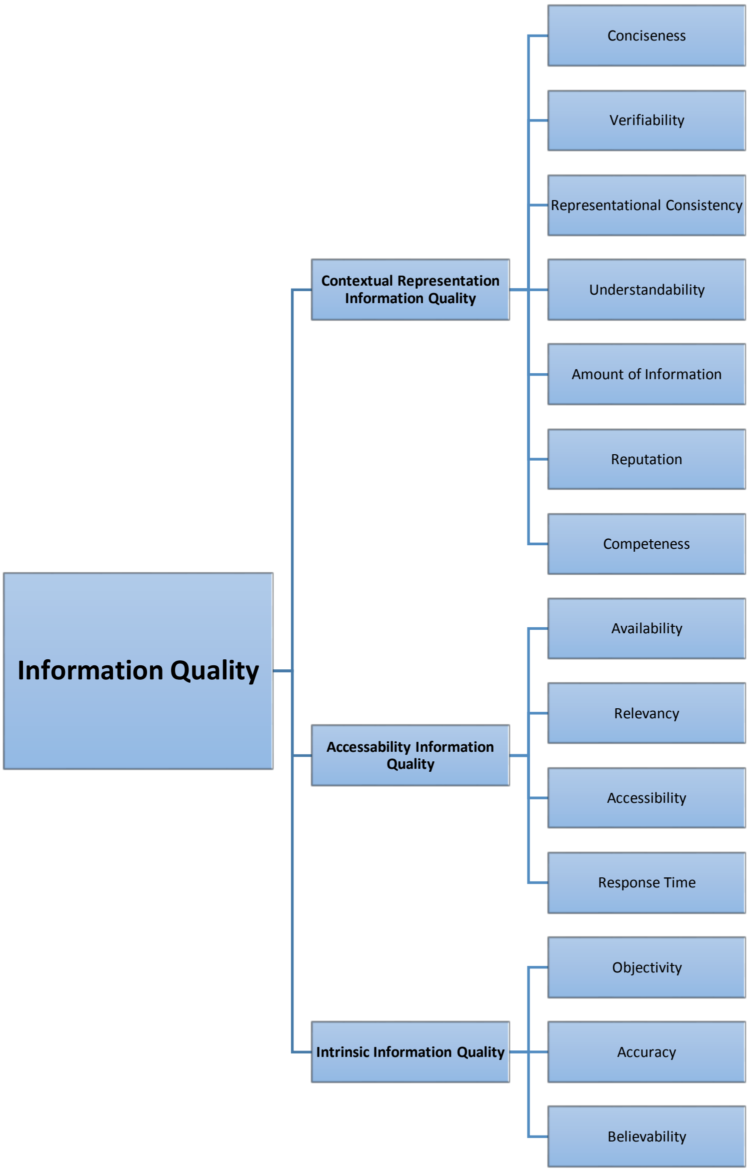


Figure 2.5: "Proposed Information Quality Framework for e-Learning System" (Alkhattabi, Neagu and Cullen 2010)

Figure 2.5 above shows the proposed framework based on survey findings by Alkhattabi, Neagu, and Cullen (2010), which includes three quality dimensions: intrinsic information quality, contextual information quality, and accessibility information quality. In addition, it has 14 quality dimensions: conciseness, verifiability, understandability, amount of information, reputation, completeness, accuracy, believability, objectivity, relevancy, representational consistency, accessibility, availability, and response time. The previous framework comprises three quality factors: contextual information quality, representational information quality, and accessibility information quality, and 19 quality dimensions which are accuracy, believability, consistency, objectivity, reputation, the appropriate amount of data, completeness, relevancy, timeliness, value-added, verifiability, concise representation, ease of understanding, interpretability, representational consistency, accessibility, access security, availability, and response time.

Unlike the e-learning quality frameworks (Moore 2005) described earlier, the quality framework produced by Casanova, Moreira, and Costa (2011) provides guidelines for best practice and quality standards for stakeholders. The framework is intended to deliver a method that develops the quality of Technology Enhanced Learning (TEL). The framework aims to monitor and evaluate TEL practice in order to improve its quality. The framework was developed based on interviews and a literature review. A 'Framework of Reference' refers to the development of an object from two analytical outcomes. The design process of the framework leads to the development of references, analyses, defines evaluation dimensions, and justifies the selected standards. The framework has five dimensions: expectations and perceptions, competencies, learning environment and learning resources, Teaching, Learning and Assessment (TLA) strategies and practices, and logistics and support. Expectations and perceptions relate to stakeholders' expectations and perceptions of TEL practices. Competencies are the capabilities required by the participants in teaching and learning activities. Learning environment and learning resources refer to the quality and design of the learning environment. TLA strategies and practices refer to teachers and students' strategies on TEL practices. Logistics and support relate to the logistics and equipment required for TEL practice and university's support.

The Emerging Conceptual Framework for Quality in e-Learning is based on a complex and holistic view of e-learning quality (Ossiannilsson and Landgren 2011), as shown in Figure 2.6 below. The measures of products, services, and management were established with a specific focus on accessibility, flexibility, and interactiveness. It also comprises four principles of excellence which are personalisation, accessibility, flexibility, and interactiveness. Participation and productivity were included as these are important for e-learning quality. Transparency is the third e-learning success factor.

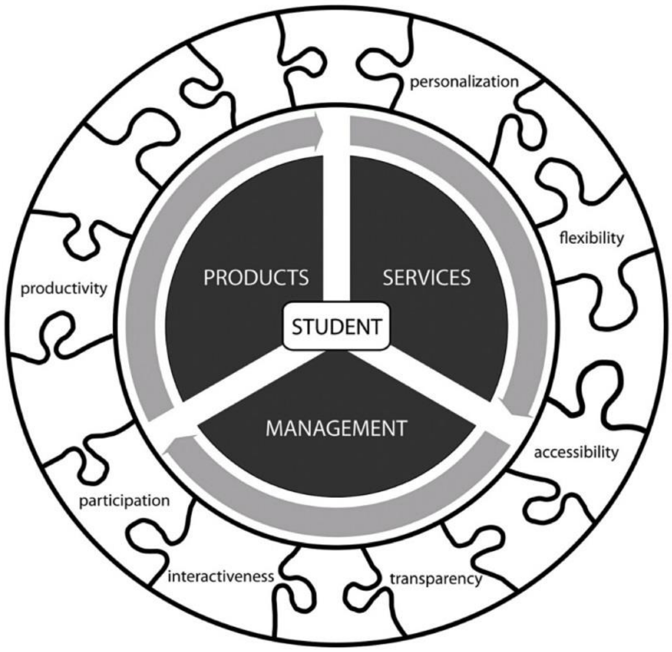


Figure 2.6: “Emerging conceptual framework for quality in e-learning” (Ossiannilsson and Landgren 2011)

Unlike the earlier frameworks presented in this chapter, this framework considers eco-sustainability as a fundamental feature of today's global perspectives and importance to society in the 21st century. However, this framework considers eco-sustainability, which benefits the environment; it does not give equal consideration to other dimensions of sustainability. There is a need to consider sustainability in the context of a broader sustainability framework like the Triple Bottom Line. Therefore, a sustainable e-learning framework is required that includes these extra dimensions of sustainability.

In 2011, the Malaysia Public Sector E-learning Implementation Framework was developed by Malaysian Public Sector E-Learning (EPSA). This implementation framework for the Malaysian public sector includes strategic alignment, content sourcing, content repository, delivery, learning administration, and operation and administration (EPSA (E-Pembelajaran Sektor Awam) 2011). These components play an important role in e-learning implementation. Content is important, but the developers play a key role in ensuring content repository and sourcing readiness. However, the framework does not consider the private sector. Also, the framework needs to consider the technology required to deliver common learning content and learning administration.

Unlike the previous framework which focuses only on e-learning, the Theoretical Framework for Blended Learning for Adults (Fang, Chow and Soo 2012) utilises a systematic learning motivation via continuous feedback and self-directed learning. This framework (see Figure 2.7) was proposed by SIM University in Singapore, which was included in this literature review as it integrates e-learning in its teaching method. In order to sustain learning, continuous feedback was given through a combination of intrinsic motivations such as reading interest, and extrinsic motivations such as money and high grades. This framework also includes content interaction, learning collaboration, and tutor facilitation. According to Fang, Chow, and Soo (2012), the learning content should not be restricted to only one of the educational domains, namely, cognitive, psychomotor, and affective, if it is to provide meaningful practical interactions. Learning collaboration offers group sharing to develop new ideas and patterns of knowledge. It also promotes long-term communities of practices. Finally, tutor facilitation ensures every learner’s finest performance and communication by motivating, creating communications, providing timely feedback, regulating discussion, and building learning communities.

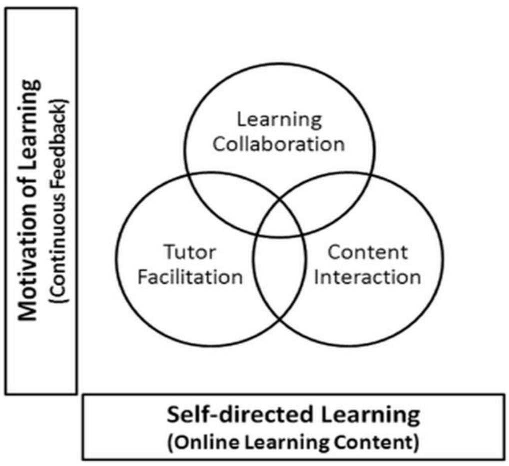


Figure 2.7: “Theoretical Framework for blended learning for adults” (Fang, Chow and Soo 2012)

Fang, Chow, and Soo (2012) added that the strengths of the framework instruments are the quantitative and qualitative data from surveys, interviews, and LMS statistics.

The research aimed to: 1) determine whether a discussion forum helps the learner to prepare for face-to-face, individual, and collaborative presentations; 2) identify the effect of a blended framework of self-directed learning and peer collaboration on the adult learner; and 3) determine the effectiveness of a discussion board in supporting peer learning.

In response to the Malaysia Public Sector E-learning Implementation Framework mentioned earlier, the E-learning Evaluation Framework was developed by Yunus and Salim in 2008. They believed that some e-learning research has focused on technical rather than pedagogical issues. Thus, the framework considers four dimensions: individual, learning, content, and the learner-instructor dimensions that were developed based on a quantitative survey, qualitative interviews, and case studies conducted by Yunus and Salim (2013). The research participants were all public sector civil servants involved in e-learning. The evaluation criteria for the individual dimension focused on the learner's motivation, attitude, and learning style. The learning dimension aims at the theory-objective-learning outcome and knowledge transfer. The e-learning content, interactivity, structure design, interface design, multimedia design, and instruction and support, focus on the content dimension. Lastly, the Learner-Instructor dimension concerns the instructors' and students' responses and interactions. However, this framework was developed based on the public sector only and did not consider the private sector.

The IPTEACES framework represents involvement, preparation, transmission, exemplification, application, connection, evaluation, and simulation (Isaias and Pena 2014). The framework aims to improve learning concepts. Thus, the framework was developed based on the mixed-methods collection of data through online survey, formal feedback, and informal feedback from students in Australian and Portuguese higher education institutions. The online survey focuses on exploring the students' attitudes to Information Systems or Website Planning and Development unit programme, assessment, and lecturers' feedback. Also, the data collection aims to determine students' skills related to Human Computer Interaction (HCI) and usability after completing the units. The involvement relates to the strategy used to engage students with a real business situation. Preparation involves the programme and its objectives, and subject contextualisation and activation of existing knowledge.

Transmission involves the acquisition of the learning content, systematisation and formative assessment. Furthermore, the exemplification and demonstration focus on the real cases or situations, guided exemplification to provide learning guidance, and a complex situation that motivates students to seek advice from an expert. Moreover, application and transfer focus on motivating students to apply what they have learned. Connection focuses on asynchronous mentoring, collaboration, and tools. Evaluation concentrates on student achievements on the learning objectives. Finally, simulation exam refers to the face-to-face exam that needs to be passed by the students.

In 2016, the E-learning Theoretical Framework that is based on three principle dimensions - user, technology, and services - was developed by Aparicio, Bacao, and Oliveira (2016). An in-depth literature review was conducted for each dimension. Therefore, it is clear that all the three principle dimensions were measured in the existing e-learning frameworks. With respect to these dimensions, this framework focuses on the stakeholders' interaction with e-learning system (user), identifies technological specifications that are compatible with any technological artifacts (technology), and operationalises instructional strategies and several pedagogical models (system). Aparicio, Bacao, and Oliveira added that the framework intends to guide e-learning studies.

Based on a report by Docebo (2014) , the global market for e-learning reached $51.5 billion in 2016. The highest rate of e-learning growth is in Asia at 17.3%, while Eastern Europe is 16.9%, Africa is 15.2%, Latin America is 14.6%, and Middle East is 9%. In response to this report, there is a need to develop an e-learning framework that enhances the existing frameworks in order to meet the higher demands and expectations of e-learning in the future.

2.3.2 Similar Components of Current e-Learning Frameworks

Overall, these frameworks attempt to improve e-learning in terms of e-learning administration, community, content, information quality, implementation, evaluation, training, and activity components, which can be used in any institutions due to its general e-learning features. However, these frameworks might be adopted by institutions based on the institutions' particular strategies to achieve their mission. Similarities among these existing frameworks include consideration of pedagogies, technology, training, and strategy. Recognising this similarity, there is a need to address these aspects that might generate good theories resulting in better e-learning practices.

Firstly, pedagogies were the major focus of most of the existing frameworks such as the E-learning and Pedagogical Innovation Strategic Framework (Salmon 2005), Pedagogical Framework (Granic, Mifsud and Cukusic 2009), Quality Framework for Technology Enhanced Learning (Georgouli, Skalkidis and Guerreiro 2008), Information Quality Framework (Alkhattabi, Neagu and Cullen 2010), Framework for Evaluating Blended Learning (Fang, Chow and Soo 2012), IPTEACES E-learning Framework (Isaias and Pena 2014), E-learning Evaluation Model (Yunus and Salim 2011), Quality Framework (Moore 2005), and the Global E-learning Framework (Khan 2010). However, not all of these e-learning frameworks embrace the ten pedagogic principles of e-learning success to support e-learning viability, which were discussed earlier in this chapter. Most of these frameworks satisfy the pedagogic principles that address curriculum expectations, inclusion, learner engagement, innovative approach, effective learning, formative assessment, summative assessment, consistency and transparency, ease of use, and cost-effectiveness. In this regard, there are gaps in these e-learning frameworks in terms of adopting all of the ten pedagogic principles. Therefore, there is a need to develop a framework that comprises all the pedagogic principles to support e-learning success.

Table 2.2: The existing frameworks' reflection of the ten pedagogic principles

Pedagogic principles	Framework	Year
E-learning matched to the curriculum	Theoretical Framework for blended learning for adults	2012
	UNITAR e-learning model	2005
	Pedagogical Framework	2009
	The Global E-learning Framework	2010
	E-learning Evaluation Framework	2013
Inclusive practice	Pedagogical Framework	2009
	IPTEACES E-learning Framework	2014
Learner engagement	Theoretical Framework for blended learning for adults	2012
	IPTEACES E-learning Framework	2014
Innovative approach	E-learning and Pedagogical Innovation Strategic Framework	2005
	UNITAR e-learning model	2005
	The Global E-learning Framework	2010
	Quality Framework	2011
	E-learning Theoretical Framework	2016
Effective learning	Theoretical Framework for blended learning for adults	2012
	Quality Framework	2005
Formative assessment	Theoretical Framework for blended learning for adults	2012
	Pedagogical Framework	2009
	Theoretical Framework	2008
	The Global E-learning Framework	2010
	Quality Framework	2011
	E-learning Evaluation Framework	2013
Summative assessment	Theoretical Framework for blended learning for adults	2012
	Pedagogical Framework	2009
	Theoretical Framework	2008
	The Global E-learning Framework	2010
	Quality Framework	2011
	E-learning Evaluation Framework	2013
	IPTEACES E-learning Framework	2014
Coherence, consistency, transparency	E-learning Success Model	2006
	Information Quality Framework for eLearning System	2010
	Conceptual Framework for Quality in e-Learning	2011
Ease of use	E-learning Success Model	2006
	Conceptual Framework for Quality in e-Learning	2011
Cost-effectiveness	Quality Framework	2005

As shown in Table 2.2 above, most of these frameworks such as The Quality Framework for Technology Enhanced Learning (Georgouli, Skalkidis and Guerreiro 2008), Information Quality Framework (Alkhattabi, Neagu and Cullen 2010), Conceptual Framework for E-learning Quality (Ossiannilsson and Landgren 2011), Quality Framework (Moore 2005), and E-learning Success Model (Holsapple and Lee-Post 2006) focused on the quality of e-learning. Based on a review of the literature pertaining to the quality of e-learning, which was discussed in the previous chapter, e-learning quality focuses on meeting e-learning stakeholder needs and includes products and services (Pawlowski 2007). Thus, these e-learning frameworks addressed quality e-learning by integrating components that assist e-learning in meeting the e-learning stakeholders' needs. These e-learning quality frameworks considered users' expectations, teaching and learning strategies, learning environment and resources, logistic and support, accessibility, intrinsic motivation, flexibility, interactiveness, personalisation, productivity, affordability, and system design, to improve the quality of e-learning. Therefore, e-learning quality can be categorised in e-learning and e-teaching principle, technology, application, and sustainable development aspects.

The relationship between technology and e-learning cannot be separated since e-learning depends on the technology to support online education. Several existing frameworks considered technology as a framework component. The E-learning and Pedagogical Innovation Strategic Framework (Salmon 2005), A Conceptual Framework for E-learning Quality (Ossiannilsson and Landgren 2011), Quality Framework (Moore 2005), Implementation Framework (EPSA (E-Pembelajaran Sektor Awam) 2011), Global E-learning Framework (Khan 2010), and E-learning Theoretical Framework (Aparicio, Bacao and Oliveira 2016), are those frameworks that integrate technology components such as accessibility, flexibility, affordability, content sourcing and repository, interactiveness, personalisation, and productivity. This means that technology is an essential component of e-learning that should be considered in an e-learning framework.

Training needs to be considered to ensure e-learning effectiveness (Sural 2010). Gupta, Bostrom, and Huber (2010) indicated that there has been a significant use and increase of training in technology-mediated activities. The effectiveness of training depends on the training design and methods (Gupta, Bostrom and Huber 2010). Furthermore, student satisfaction with the training can be evaluated through the user's feedback (Gupta, Bostrom and Huber 2010). Such a holistic view of training trends in e-learning, some of the existing e-learning frameworks such as Quality Framework for Technology Enhanced Learning (Georgouli, Skalkidis and Guerreiro 2008), Information Quality Framework (Alkhattabi, Neagu and Cullen 2010), E-learning Evaluation Model (Yunus and Salim 2011), Quality Framework (Moore 2005), and The E-learning Success Model (Holsapple and Lee-Post 2006) have addressed the training component that takes into account student support, pre-training, training and learning process, and post-training. Therefore, training that supports the use of e-learning and develops necessary skills and motivation, is vital for e-learning effectiveness.

To a lesser extent, a component that was considered in several previous e-learning frameworks is the strategic component. Frameworks such as the E-learning and Pedagogical Innovation Strategic Framework (Salmon 2005), E-learning Evaluation Model (Yunus and Salim 2011), and Global E-learning Framework (Khan 2010), integrated strategic components such as management, marketing, ethics, and evaluation. However, only the Pedagogical Framework (Granic, Mifsud and Cukusic 2009) considered developing a systematic strategy for change (Rosenberg 2001) to monitor e-learning adoption. E-learning needs a clear strategy that addresses the value that each e-learning programme needs to deliver (Ismail 2001). Hall and LeCavalier (2000) indicated that the most promising e-learning strategy is the evaluation of job performance. According to McGraw (2001) , e-learning strategy should at least address the e-learning vision in meeting business needs, principles, policies, course design, individual learner profiles support, and a standard-driven technical architecture. In the light of e-learning strategy, a framework that addresses e-learning strategy is necessary to outline the objectives of certain e-learning components so that each component can perform effectively in the context of a given institutional strategy.

From sustainable perspectives, sustainability approaches such as change management, cost-effectiveness, reusability, and accessibility were identified within the existing frameworks, as shown in Table 2.3 below.

Table 2.3: Sustainability approach of existing e-learning frameworks.

E-learning framework	Year	Change Management	Cost-effective	Reusability	Accessibility
E-learning and Pedagogical Innovation Strategic Framework	2005	✓			
Quality Framework	2005	✓	✓		✓
UNITAR e-learning model	2005				
E-learning Success Model	2006				
Theoretical Framework	2008				✓
Pedagogical Framework	2009	✓	✓	✓	✓
Global E-learning Framework	2010				✓
Information Quality Framework for eLearning System	2010				
Quality Framework	2011				✓
Conceptual Framework for Quality in e-Learning	2011				✓
Malaysia Public Sector E-learning Implementation Framework	2011				
Theoretical Framework for Blended Learning for Adults	2012				✓
E-learning Evaluation Framework	2013				
IPTEACES E-learning Framework	2014	✓			✓
E-learning Theoretical Framework	2016				

Change management refers to a sustainable change in technology (Moore 2005), pedagogy (Salmon 2005; Isaias and Pena 2014), culture change and teachers' role and belief (Granic, Mifsud and Cukusic 2009), and changes in learning outcomes (Gupta, Bostrom and Huber 2010). Referring to Guskey (2002), this change should be focused on the area of teachers' attitudes and beliefs and student learning outcomes, as this could lead to significant and sustained educational improvement. Littlejohn (2003) agreed that sustainable e-learning offers cost-saving benefits through technology while maintaining the quality of teaching. Additionally, Thomas and Martin (1997) considered cost-effectiveness and selection as the least costly of the alternatives that address the same objectives.

Referring to the existing e-learning frameworks, the cost-effectiveness aspect related to affordability and low cost (Granic, Mifsud and Cukusic 2009; Moore 2005; Salmon 2005). It seems that the Pedagogical Framework (Granic, Mifsud and Cukusic 2009) promotes reuse of courses and their metadata. Most of the frameworks considered accessibility to online learning resources (Isaias and Pena 2014; Moore 2005; Alkhattabi, Neagu and Cullen 2010; Georgouli, Skalkidis and Guerreiro 2008; Fang, Chow and Soo 2012; Ossiannilsson and Landgren 2011), tacit and explicit knowledge (Granic, Mifsud and Cukusic 2009), assessments, and learning environments(Casanova, Moreira and Costa 2011). In an emerging conceptual framework for quality in e-learning developed by Ossiannilsson and Landgren (2011), eco-sustainability has been addressed as part of e-learning accessibility. Even though there are nine e-learning frameworks that consider sustainability, only two of them clearly state sustainability in terms of eco-sustainability (Ossiannilsson and Landgren 2011) and cost-effectiveness (Moore 2005).

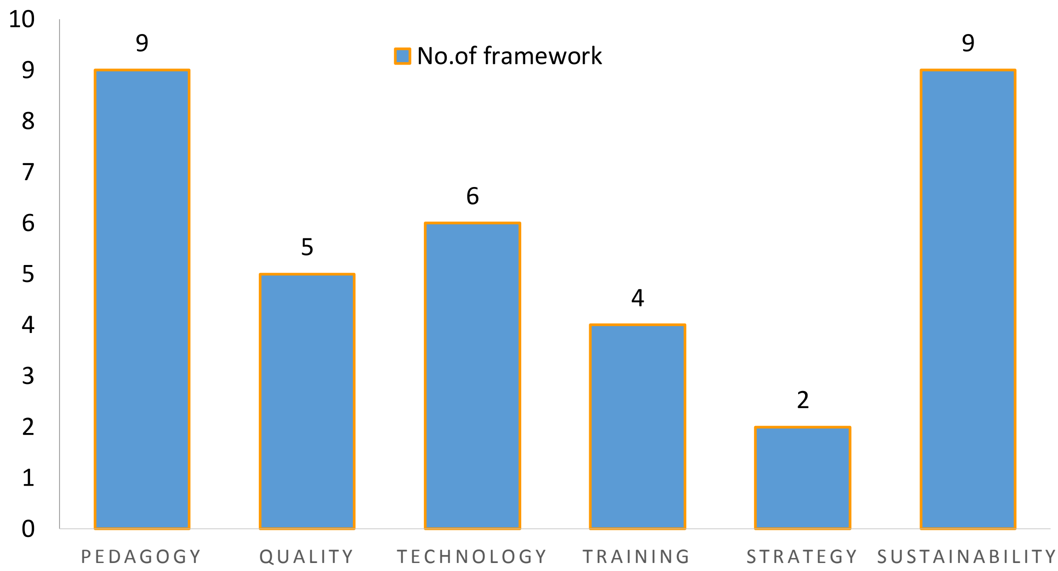


Figure 2.8: E-learning studies of the existing e-learning frameworks

Table 2.4: Relationship between existing e-learning frameworks and e-learning studies

E-learning framework	**Year**	**Pedagogy**	**Quality**	**Technology**	**Training**	**Strategy**	**Sustainability**
E-learning and Pedagogical Innovation Strategic Framework	2005	✓		✓		✓	✓
The Quality Framework	2005	✓	✓	✓	✓		✓
UNITAR e-learning model	2005	✓			✓		
E-learning Success Model	2006		✓	✓			
Theoretical Framework	2008				✓		✓
Pedagogical Framework	2009	✓			✓		✓
The Global E-learning Framework	2010	✓		✓			
Information Quality Framework for eLearning System	2010		✓	✓			✓
Quality Framework	2011	✓	✓				✓
Conceptual Framework for Quality in e-Learning	2011		✓				✓
Malaysia Public Sector E-learning Implementation Framework	2011						
Theoretical Framework for Blended Learning for Adults	2012	✓					✓
E-learning Evaluation Framework	2013	✓					
IPTEACES E-learning Framework	2014	✓				✓	✓
E-learning Theoretical Framework	2016			✓			

Figure 2.8 above gives an overview of the number of e-learning frameworks and their attributes that were discussed in this chapter. Table 2.4 outlines the frameworks that are related to e-learning studies. The key terms of e-learning studies were derived based on explicit and implicit components of the frameworks. The identified frameworks were categorised according to these key terms in order to identify and find similarities between them. Figure 2.8 illustrates the categorisation. Based on the identified similarities of e-learning components between the e-learning frameworks, a new e-learning framework should consider the pedagogy principles, e-learning strategy, e-learning quality, technology, training, and sustainability aspects to provide a holistic approach to e-learning development.

2.3.3 Limitations of Existing Frameworks

By noting their similarities and studying the characteristics of e-learning frameworks worldwide and in Malaysia, it was evident that these frameworks have either a limited focus on limited implicit aspects of sustainability or none at all. Therefore, a new framework was needed in order to address the shortcomings of the current e-learning frameworks and to take into account the principles of sustainability and the TBL concept, which includes e-learning measures in terms of the environmental, societal, and financial 'bottom line'. This framework should include guidelines and recommendations regarding key technologies, application, and teaching and learning practices that can be used, integrated, and combined to provide a sustainable e-learning system in Malaysia.

Even though the existing framework provides accessibility, change management, reusability of learning resources, and cost-effectiveness, the concept of TBL needs to be integrated into e-learning to measure the three sustainability dimensions: people, economy, and the environment. It is evident that TBL is the key to developing an e-learning system that strikes a balance between society, the economy, and the environment. In response to Dao, Langella, and Carbo (2011) on the reasons for using TBL in the business world, the integration of TBL in e-learning helps to evaluate e-learning performance and its impact on the environment.

Based on the literature review, terms such as reuse resources, change strategy, cost saving, user support, and funds were incorporated, to define and describe sustainable e-learning. These terms were used to categorise sustainability as shown in Figure 2.8 above. However, the existing frameworks focus more on cost saving rather than other sustainability terms (see Table 2.5 below). Moreover, none of these frameworks explicitly includes sustainability except for those of Moore and Ossiannilsson and Landgren. None of these frameworks integrates TBL. Reuse of online learning resources (Littlejohn and Shum 2003; Gundogan and Eby 2012), professional development (Guskey 2002; Stepanyan, Littlejohn and Margaryan 2013), open access to online resources (Stansfield et al. 2009), cost saving (Stepanyan, Littlejohn and Margaryan 2013; Callan and Bowman 2010), and change strategy (Rosenberg 2001; Granic, Mifsud and Cukusic 2009), should be highlighted to promote sustainable e-learning.

Table 2.5: Sustainability terms in extant e-learning literature

Sustainability terms	**Author/Year**
Reuse resource	❖ Littlejohn & Shum 2003 ❖ Gundogan & Eby 2012
Change strategy	❖ Guskey 2002 ❖ Stepanyan, Littlejohn, & Margaryan 2013 ❖ Roserberg 2001 ❖ Granic & Mifsud 2009 ❖ Callan & Bowman 2010
Cost savings	❖ Stepanyan, Littlejohn, & Margaryan 2013 ❖ Callan & Bowman 2010
Accessibility	❖ Stansfield, Connolly, Cartelli, Jimoyiannis, Magalhaes, & Maillet 2009
User support	❖ Callan & Bowman 2010 ❖ Gunn 2011
Funds	❖ Gunn 2011

Based on Table 2.4 which shows the similarities between existing e-learning frameworks, Table 2.6 was produced. The components of existing e-learning frameworks were categorised according to four key elements, which are e-Teaching and e-Learning Principles, Technology, Application, and Sustainable Development.

Table 2.6 below presents the categorisation of e-learning studies based on the four key elements.

Table 2.6: Classification of components of existing e-learning frameworks according to the four key components

Key element	**Components of existing e-learning framework**	**Framework**	**Year**
E-Teaching & E-learning Principles	Pedagogy	E-learning and Pedagogical Innovation Strategic Framework	2005
		The Global E-learning Framework	2010
		IPTEACES E-learning Framework	2014
		Theoretical Framework for Blended Learning for Adults	2012
	Evaluation	Malaysia Public Sector E-learning Implementation Framework	2011
		E-learning Evaluation Framework	2013
		Quality Framework	2011
	Training	UNITAR e-learning model	2005
		Pedagogical Framework	2009
		Theoretical Framework	2008
	Strategy; - New and existing pedagogy	E-learning and Pedagogical Innovation Strategic Framework	2005
	- Student engagement	IPTEACES E-learning Framework	2014
	Quality; - Information	Information Quality Framework for e-Learning System	2010
	- Learning	The Quality Framework	2005
Technology	Technology infrastructure	The Global E-learning Framework	2010
	Compatibility	E-learning Theoretical Framework	2016
	New & existing technology	E-learning and Pedagogical Innovation Strategic Framework	2005
	Accessibility	The Quality Framework	2005
		Information Quality Framework for e-Learning System	2010
	System quality	E-Learning Success Model	2006
Application	Productivity	Conceptual framework for e-learning quality	2011
	Personalisation	Conceptual framework for e-learning quality	2011
	Service quality	E-Learning Success Model	2006
	Quality design	Quality framework	2011
Sustainable Development	Affordability	The Quality Framework	2005
	Sustainability change	The Quality Framework	2005
	Eco-sustainability	A conceptual framework for e-learning quality	2011

Table 2.7: Existing e-learning frameworks components

E-learning framework	Year	E-Teaching and E-learning Principles	Technology	Application	Sustainability
E-learning and Pedagogical Innovation Strategic Framework	2005	✓	✓		
Quality Framework	2005	✓	✓		✓
UNITAR e-learning model	2005		✓		
E-learning Success Model	2006		✓		
Theoretical Framework	2008	✓			
Pedagogical Framework	2009	✓			
Global E-learning Framework	2010	✓	✓		
Information Quality Framework for eLearning System	2010	✓	✓		
Quality Framework	2011	✓			✓
Conceptual Framework for Quality in e-Learning	2011		✓	✓	
Malaysia Public Sector E-learning Implementation Framework	2011	✓		✓	
Theoretical Framework for Blended Learning for Adults	2012	✓			
E-learning Evaluation Framework	2013	✓			

IPTEACES E-learning Framework	2014	✓			
E-learning Theoretical Framework	2016	✓			

In order to identify the limitation(s) of the existing e-learning frameworks, Table 2.7 shows the components that are included or omitted in each framework. The components are: E-Teaching and E-learning Principles, Technology, and Sustainable Development. The E-teaching and E-Principles comprise e-learning pedagogy, user motivations, user development, e-learning resources, training, and e-learning strategy. On the other hand, technology focuses on mobile technology, course management technology, database, connectivity, and networking. The application includes personalisation, administration service, communication tools, and productivity. Sustainability comprises cost-effectiveness, reusability, accessibility, participation, and change management. The table provides a holistic view of the e-learning frameworks, indicating their similarities and differences, and also shows the frameworks that have no or limited adoption of sustainability.

2.3.4 Existing e-Learning Frameworks through the Lens of Sustainability Dimensions

In order to get a better view of how existing e-learning frameworks contribute to sustainable development, each framework was analysed based on whether it took into consideration the three dimensions of sustainability: people, the economy, and the environment. Table 2.8 shows the contribution to sustainability of each e-learning framework. Since e-learning focuses on delivering quality education and training to students, all of the existing frameworks benefit people such as students and teachers. In terms of the economy, only four frameworks consider financial aspects such as cost effectiveness, which is, however, implicit in the framework. Yet, only one framework considers the environmental aspect by incorporating eco-sustainability. Therefore, a balance between the three pillars of sustainability – or TBL – needs to be established to improve sustainable e-learning, which this research's framework (SeLF) aims to achieve.

Table 2.8: Existing e-learning frameworks through a sustainability lens

E-learning framework	Year	Sustainability dimensions/ TBL		
		People	Economy	Environment
E-learning and Pedagogical Innovation Strategic Framework	2005	✓	✓	
Quality Framework	2005	✓	✓	
UNITAR e-learning model	2005	✓		
E-learning Success Model	2006	✓		
Theoretical Framework	2008	✓		
Pedagogical Framework	2009	✓	✓	
Global E-learning Framework	2010	✓		
Information Quality Framework for eLearning System	2010	✓		
Quality Framework	2011	✓		
Conceptual Framework for Quality in e-Learning	2011	✓		✓
Malaysia Public Sector E-learning Implementation Framework	2011	✓		
Theoretical Framework for Blended Learning for Adults	2012	✓		
E-learning Evaluation Framework	2013	✓		
IPTEACES E-learning Framework	2014	✓	✓	
E-learning Theoretical Framework	2016	✓		

Referring to Table 2.8 above, it seems that all of the e-learning frameworks address only the people aspect since e-learning aims to deliver learning to students through online technology. A few of the e-learning frameworks consider the economic aspects such as cost and funds in the development of e-learning systems. In respect to the environment, only one e-learning framework addresses environmental concerns through eco-sustainability. Most of the frameworks consider the learning environment but not environmental concerns. In this regard, there is a need to develop an e-learning framework that takes all three dimensions of sustainability into consideration. The integration of the TBL in e-learning systems seems to be the solution.

2.4 Summary

This chapter discussed the background of sustainability, e-learning, and existing e-learning frameworks. This section is divided into three sub-sections, each of which provides a summary of the literature pertaining to sustainability, e-learning, and existing e-learning frameworks.

2.4.1 Summary of Sustainability

The review of literature on sustainability highlighted the sustainable development measures that have been implemented across the nations in various contexts, but especially in education. The use of green technology is one of the most common initiatives taken by organisations to achieve sustainable development goals. In higher education, green practices such as green campus, carbon footprint assessments and reports, and sustainable education have been adopted by universities across the world. The background of sustainable e-learning was presented in this chapter since this issue is the main focus of this research. Table 2.9 below presents an overview of the research gaps based on the review of literature on sustainable development.

Table 2.9: Overview of the research gap

Author/ Year	Topic area	Relevant text from article	Research gap
United Nations (2013)	Sustainable Development challenges	✚ Challenges exist in all three dimensions of sustainable development: poverty, income inequality, unsustainable consumption and production patterns. ✚ Education could have a positive impact on human development and economic activity.	Gap identified on how sustainable development challenges such as providing education equity can be overcome via e-learning.
United Nations (1992)	Sustainable Development strategies	National Sustainable Development Strategies (NSDS) aims to develop and build harmonisation between social, economic, and environmental factors.	Gaps identified: • How e-learning can benefit all three dimensions of sustainable development • e-learning policy
Elkington (1994)	The Triple Bottom Line	✚ TBL refers to the three dimensions of sustainability namely: economy, society, and environment.	TBL was identified as a solution to the following identified gaps: • e-learning ability to contribute to sustainable development • e-learning ability to increase institution's profit while ensuring long-term environment protection and social benefits
BHERT (2000)		✚ TBL concept is to acknowledge sustainable development that focuses on the long-term protection of natural resources without disregard for profit goals.	
Shahid et al. (2011)	Sustainable and green technology	✚ Technology education can play an important role in establishing ESD within formal online education. ✚ Green research and green education programmes.	Gaps were identified using the following criteria: • Communication technology • Course management technology • Green servers for e-learning platform
Adombent et al. (2013)	Sustainable education	Learning for sustainable consumption in higher education through learning facility to design learning setting.	Gap identified was the potential of e-learning to stimulate learning processes in ESD context.
Gunn (2011)	Sustainable e-learning	✚ Fostering sustainable change in funds, learning outcomes, and teaching staff availability.	Gaps identified were: • The impact of change; benefits, importance, and measures. • The relationship between technology, resources (human, natural, e-learning), professional development, and learning outcomes.
Guskey (2002)		✚ Implications for teachers' professional development involve identifying the change, receiving feedback on students' learning, and providing subsequent support to facilitate change.	

In summary, the literature review analysis found that there is a gap between sustainable strategies, initiatives, and education. The ability of e-learning can be seen to improve education equity through low-cost education and distance education. The researcher identified that an e-learning policy should include sustainability principles. In the context of ESD, the researcher recognised the importance of stimulating learning processes in ESD, and the technology features (such as communication technology, course management technology, and green servers) required when establishing online ESD. The impact of sustainability change was identified to determine the short-term and long-term benefits of such change. Also, the researcher ascertained the importance of understanding the relationship between e-learning resources, technology, professional development, and learning outcomes. The researcher also concluded that e-learning can support sustainable education and practice through teaching and learning principles and technology. Moreover, the Triple Bottom Line can be applied to address these gaps as it enables e-learning to increase an institution’s profits, ensure long-term environment protection and social benefits, and contribute to sustainable development.

2.4.2 Summary of e-Learning

The review of the literature pertaining to e-learning indicated the importance of e-learning in providing equal access to quality online education, which is one of the sustainable development goals. In addition, this literature review also highlighted the development of e-learning through Web evolution that offers features to support e-learning, and the importance of applying the ten pedagogies principles of e-learning as a means of improving e-learning effectiveness. Furthermore, this chapter focused on understanding the development of e-learning among Malaysian universities, and the initiatives taken by them to improve current e-learning practice. This chapter identified the drivers of successful e-learning and the issues experienced by the institutions. Based on the literature review, there is a need to develop an e-learning framework or a guideline that takes into consideration the e-learning components and the ten principles of pedagogy, and which provides alternatives to meet the sustainable development goals. The review of the literature on e-learning examined these success factors of current e-learning practice to support sustainable e-learning.

2.4.3 Summary of Existing e-Learning Frameworks

Overall, the review of literature on existing e-learning frameworks indicated that the majority of these e-learning frameworks are intended to manage e-learning research not only in Malaysia but worldwide. The literature review in this thesis was conducted in order to examine the present characteristics of these e-learning frameworks and to determine those that are missing. This chapter also discussed the implications of some of these existing frameworks on sustainability such as accessibility, change management, reusability of learning resources, and cost-effectiveness, which helped the researcher to identify the gaps of sustainable e-learning and unsustainable e-learning. Therefore, to improve sustainable e-learning, this chapter highlighted the TBL concept as a solution for e-learning sustainability to measure its performance in terms of society, the economy, and environment bottom line. Recognising TBL in e-learning might generate suitable theories that differentiate sustainable e-learning from unsustainable e-learning. Next, Chapter 3 discusses the research methods, followed by Chapter 4 which discusses the initial e-Learning Framework (SeLF) that was developed based on the synthesis of the literature review.

RESEARCH METHODS

3.1 Introduction

This chapter discusses the approach used in this research, outlines the research paradigm, research design and research methods, and summarises the research approach. The discussion focuses on the theoretical paradigms used and why they were used in this research. The research design is described, as are the exploratory design approach and the Design Science Research (DSR) process employed in this research. The research methods are explained, including participant sampling, data collection and data reliability for the exploration of data produced by a survey and interviews with experts.

3.2 Information System Research Paradigm

The research process is influenced by the researcher's theoretical framework, which is sometimes referred to as the research paradigm (Mertens 2005) that encompasses the knowledge derived from the research and the methods of interpretation (Mackenzie and Knipe 2006). The paradigm definition includes three elements that consider the nature, methodology, and validity of the research that will lead to new knowledge (MacNaughton 2001). Therefore, the research paradigm chosen at the beginning of a research project provides the foundation for the subsequent selection of the methodology, methods, and research design (Mackenzie and Knipe 2006). It is important that a researcher identifies a particular research paradigm (Doyle, Brady and Byrne 2009) because it could influence the research questions and research methodology (Morgan 2007). This research was conducted using a mixed-methods approach using a DSR approach to evaluate and refine the principal research artefact.

There are six key characteristics of DSR (Weber 2012). The first characteristic of DSR (Simon 1996) involves both developing new solutions to current problems and matching current solutions to new problems. Second, DSR reflects Information System design theory components and the development of a conceptual framework(Walls, Widmeyer and Sawy 1992). Third, DSR considers processes or products (Walls, Widmeyer and Sawy 1992) that focus on development and evaluation of the IT artefact. Next, DSR evaluation (Hevner et al. 2004) can be conducted in a technical, interpretive, or positivistic manner. The developmental characteristic (Gregg, Kulkarni and Vinze 2001) of DSR strongly emphasises the development and evaluation of technology based on a developmental paradigm. Finally, the theory-building characteristic leads to a multi-methodological approach in addressing research objectives in a manner that integrates theory building and system development.

There are a number of theoretical paradigms: positivist, constructivist, interpretivist, transformative, emancipatory, critical, pragmatic, and de-constructivist (Mackenzie and Knipe 2006). The mixed-methods approach used in this research employed a constructivist paradigm.

The constructivist paradigm investigates participants' perspectives regarding the context of the research. It does not start with a theory. Instead, it develops a theory or outlines meanings (Creswell 2003). It relies on qualitative data or a mixed-methods approach that involves the use of both quantitative and qualitative data (Mackenzie and Knipe 2006). The data collection tools for a constructivist paradigm are interviews, observations, document reviews, and visual data analysis.

In order to respond to the second research question, which investigates stakeholder perspectives and expectations regarding sustainable e-learning characteristics, a constructivist paradigm was used to facilitate the sharing of participant perspectives and expectations about sustainable e-learning characteristics. As a result, this research will consider as much as possible the participants' views regarding the characteristics of SeLF.

3.3 Information System Research Methods and Design

3.3.1 Design Science Research

Design Science Research (DSR) was adopted to ensure that this research develops solutions and makes a theoretical contribution that addresses a real-world problem (Weber 2012). DSR was adopted because it is a rigorous means of developing and evaluating Information Technology artefacts (Simon 1996). For this research, the principal research artefact being evaluated is the Sustainable e-Learning Framework (SeLF).

Even though there are many exceptional DSR processes (Hevner *et al*., 2004; Purao, 2002; Gregg *et al*., 2001; March & Smith, 1995; Nunamaker *et al*., 1991; Kuechler & Vaishnavi, 2008), the DSR cycles process shown in Figure 3.1 was adopted for this research, with an output focus on the principal research artefact (Hevner 2007). It involves three cycles: the Relevance Cycle, the Design Cycle, and the Rigor Cycle (Hevner 2007).

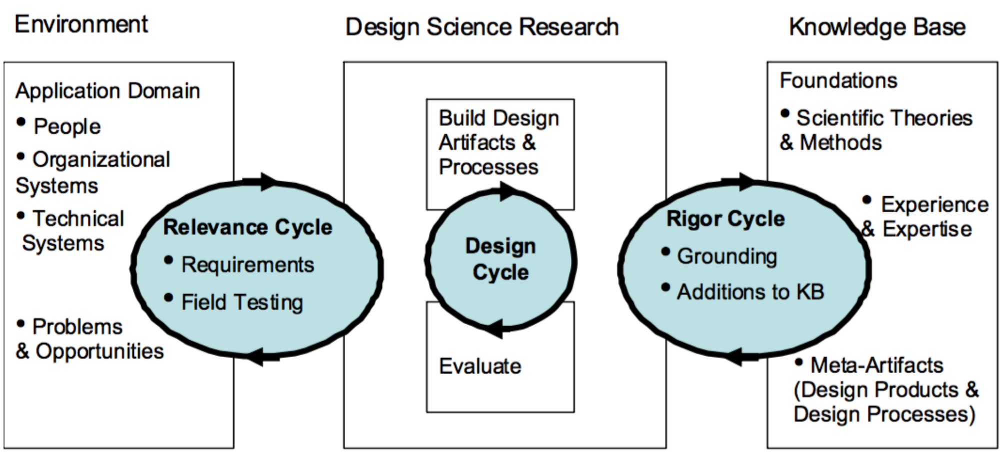


Figure 3.1: The Design Science Research cycles diagram (Hevner, 2007)

The inputs for the Relevance Cycle were derived from the contextual research environment and related to research opportunities and problems. This cycle also introduced the SeLF into the research environment to determine whether additional refinements were needed.

The Design Cycle was used to enhance SeLF through iterative evaluation and development. In DSR, the efforts expended on the development and evaluation processes need to be balanced and strongly based on research relevance and rigor.

The Rigor Cycle provided existing knowledge such as grounded theory from the knowledge base and new knowledge derived from the research.

These cycles are interdependent in the sense that the Design Cycle depends on the Relevance Cycle to provide the context and requirements as input, and Rigor Cycle to gauge the utility of resulting artefacts alongside the methods used for development and evaluation.

Seven DSR guidelines (Hevner et al. 2004) were adopted to ensure that this research developed, improved, and evaluated IT artefacts in a rigorous manner likely to enhance the utility of the final artefact. Table 3.1 below describes the research activities based on these seven guidelines.

Table 3.1: Seven guidelines of DSR (Hevner et al. 2004)

No.	**Guideline**	**Research activity**
1	Design as an Artefact	This research focused on producing a practical artefact in the form of a framework as the research outcome.
2	Problem Relevance	A literature review was conducted in order to understand and define the problem of a specific domain, which helped to provide a comprehensive view of the possible solution. Survey was conducted to identify possible solution that may be the characteristics of the research artefact.
3	Design Evaluation	The focus here was on demonstrating the utility, value, and efficacy of the SeLF design through interviews with experts.
4	Research Contributions	The researcher ensured that the SeLF provides clear and supportable research contributions to Information Systems and Higher Education domains.
5	Research Rigor	Precise and thorough methods were applied to the SeLF development and evaluation process.
6	Design as a Search Process	Available resources were utilised to achieve the desired goals to promote the search for an effective sustainable e-learning framework.
7	Communication of Research	The research is presented effectively.

Based on the summary of the properties of an open system by Prat, Comyn-Wattiau, and Akoka (2014), the properties that comprise SeLF include interrelationship and interdependence of objects and attributes, goal-seeking, transformation process, inputs, and outputs. SeLF is characterised by the interrelationship and interdependence of objects as all the elements in SeLF are correlated with each other to achieve the desired goal (Prat, Comyn-Wattiau and Akoka 2014). The framework involves a systematic interaction intended to produce an input. Then, to achieve the desired goals, the process transforms inputs into outputs as part of the transformation process. The outputs in SeLF are defined based on an evaluation of sustainability e-learning priority, benefits, and measurement.

In DSR, the evaluation process is an essential activity for researchers to evaluate the design artefacts and design theories(Venable, Pries-Heje and Baskerville 2012). The purposes of the DSR evaluation process are to evaluate the designed artefact to determine its utility and value, the formalised knowledge of the designed artefact's utility in achieving its purpose, the designed artefact with other designed artefacts that have a similar purpose, the designed artefact to identify the side effects of its use, and the designed artefact development to identify weakness or areas of improvement (Venable, Pries-Heje and Baskerville 2012).

Several aspects and characteristics need to be evaluated in DSR. Hevner et al. (2004) indicated that the evaluation of an artefact can be based on its functionality, completeness, consistency, accuracy, performance, usability, and organisation suitability. Furthermore, there are five criteria that assess the quality of the evaluation: efficiency, effectiveness, efficacy, ethicality, and refinement (Checkland and Scholes 1990). This research evaluated the designed framework based on rigor, efficiency, and the ethics component of DSR evaluation(Venable, Pries-Heje and Baskerville 2012). Rigor focuses on designing a framework that produces a practical improvement (efficacy) and works in a real situation (effectiveness). Efficiency focuses on an evaluation that works within resource constraints such as money, time, and lower consumption. Ethics relates to minimising or eliminating risk during and after evaluation.

A comprehensive framework and a method for the DSR evaluation process were introduced by Venable, Pries-Heje, and Baskerville. The evaluation design comprises four methods: identifying evaluation purpose, goals, and requirements; establishing an evaluation strategy; identifying an appropriate evaluation process or method to use; and designing the evaluation in more detail. Based on these four methods, a four-step method was introduced that involves evaluation requirement analysis, mapping the evaluation requirement to one or more dimensions and quadrants in the DSR Evaluation Strategy Selection Framework, selecting a suitable evaluation method based on the DSR Evaluation Method Selection Framework, and designing a more detailed evaluation(Venable, Pries-Heje and Baskerville 2012).

3.3.2 Mixed-methods

A mixed-methods approach using both qualitative and quantitative techniques and procedures was employed in this research to minimise the possibility of discrepancies in the findings (Saunders, Lewis and Thornhill 2009; Tashakkori and Creswell 2007). DSR interviews and a survey were conducted to collect qualitative and quantitative data from the participants.

There are four types of mixed-methods design: Triangulation Design, Embedded Design, Explanatory Design, and Exploratory Design (Creswell 2007). The Triangulation Design is the most popular for a mixed-methods approach as it allows the researcher to compare quantitative results with qualitative findings (Creswell 2007). The Embedded Design is also a mixed-methods approach whereby qualitative elements are embedded within a quantitative scheme (Creswell 2007). The Explanatory Design is a two-phase mixed-methods approach where the qualitative data support the initial quantitative results (Creswell et al. 2003). Similarly, the Exploratory Design is also a two-phase mixed-methods approach, although the results of a qualitative method will help to develop the quantitative method (Greene, Caracelli and Graham 1989). Hence, this research used the Explanatory Design where the DSR interview data were used to complement and confirm the results of the survey.

As aforementioned, the explanatory design is a two-phase mixed-methods approach that begins with the collection and analysis of quantitative data and is followed by qualitative data collection and analysis (Creswell et al. 2003). This research began with the development of an initial framework based on the literature review. Then, the initial framework was evaluated using the mixed-methods approach. The framework evaluation began with a quantitative survey in order to ascertain whether there were any statistical significant discrepancies or unusual results affecting the initial version of the framework. These results were then interpreted by means of an in-depth qualitative analysis to identify the utility and efficacy of the research outcome. Two variants of explanatory design are the follow-up explanations model and the participant selection model (Creswell 2007). The follow-up explanations model is where the researcher initially collects and analyses quantitative data and later conducts qualitative follow-up on those findings to provide a better understanding of the quantitative data (Harrison and Reilly 2011). The participant selection model requires quantitative information to identify research participants for a follow-up qualitative study (Terry 2012). Thus, qualitative results are used to explain and support the quantitative result. This research used the follow-up explanations model (see Figure 3.2), in which qualitative data can be used to support explanations of the quantitative results. The interviews with DSR experts were intended to support the findings of the survey. The strength of survey research is to discover general trends and preferences in sustainable e-learning, and qualitative follow-up was used to address discrepancies that resulted from exclusive findings from the survey.

Figure 3.2: The Explanatory Design: Follow-up Explanations Model

The initial data collection phase began with quantitative data collection from the survey followed by data analysis. Based on the data collection, new factors were identified for follow-up. In this research, the extended version of SeLF was developed during this phase. Then, qualitative DSR interviews with experts were conducted to collect qualitative data to evaluate the utility and efficacy of SeLF. The data were then analysed and the results represented the final version of SeLF.

3.3.3 Advantages and Disadvantages

Overall, the mixed-methods approach allows researchers to adopt a combination of research approaches in order to answer their research questions (Doyle, Brady and

Byrne 2009) as it is able to reduce any gap between the quantitative and qualitative processes (Johnson and Onwuegbuzie 2004). Moreover, mixed-methods enable researchers to make stronger inferences and overcome the weaknesses of qualitative and quantitative approaches (Creswell et al. 2003). According to Creswell and Clark, a mixed-methods approach allows researchers to answer different research questions as it provides a wide range of tools to meet the research objectives (Creswell and Clark 2011). Since this research conducted a quantitative survey followed by qualitative DSR interviews, the mixed-methods approach helped to explain the acquired data (Doyle, Brady and Byrne 2009) from the survey to understand the findings. This approach allows qualitative research findings to clarify or confirm quantitative findings (Doyle, Brady and Byrne 2009). Hence, in this research, the data obtained from DSR interviews were intended to complement the findings from the survey. The adoption of the explanatory design via the follow-up explanations model made the implementation of the research process straightforward.

Even though mixed-methods research has many benefits, there are also limitations. Quantitative and qualitative research methods cannot readily be combined (Doyle, Brady and Byrne 2009). Moreover, it may be difficult for an individual researcher to implement qualitative and quantitative processes simultaneously (Johnson and Onwuegbuzie 2004). Nonetheless, it is sensible to use a pragmatic approach (Howe 1988) in order to overcome limitations and take advantage of mixed-methods. This research adopted DSR guidelines as presented in Table 3.1 and used the survey to identify relevance problems and interviews to evaluate the research artifact.

3.4 Research Design

This section discusses the research methods used in this research including participant sampling, data collection, data reliability, and data exploration.

3.4.1 Overview of the Research Method

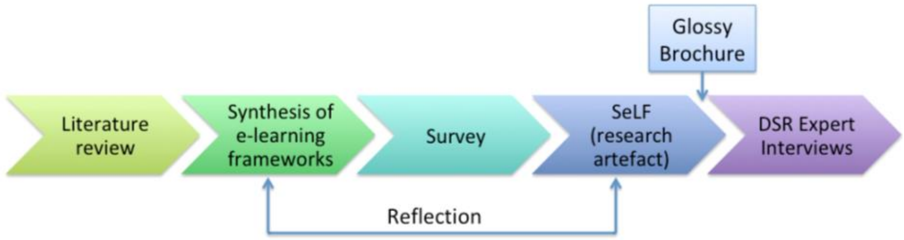


Figure 3.3: Overview of the research phases

An overview of this research is shown in Figure 3.3. This research started with a literature review that involved searching for published literature related to the research topic and theory. The literature review led to this study, which concerns the development and evaluation of a Sustainable e-Learning Framework (SeLF). Integrative reviews of findings from various studies were undertaken to draw an overall conclusion and identify research gaps. These integrative reviews involved four stages: 1) identifying and extracting articles, 2) actual coding, 3) classification 4) analysis and reporting. In the first stage, articles were searched and selected based on the research area of interest. The search strategy included identifying a key topic and searching for titles, abstracts, and keywords. In this research, keywords such as e-learning, sustainable development, sustainability, and higher education were used to conduct a search of online databases and library collections. In order to ensure the quality of the selected articles, the targeted texts were derived from journals, books, reports, government documents, and conference papers. Secondly, the literature was prepared for analysis through a filter process using coding, which comprised a two-level analysis. In the first level, articles were filtered based on topic, abstract, and keywords related to the research topic. In the second level, the articles were fully reviewed using memo and annotation to generate ideas and insights. After the filtering process using actual coding was done, the selected articles were classified according to their specific topics. As a result, four key elements were identified along with their sub-elements. Finally, an initial Sustainable e-Learning Framework was developed based on the classification.

Following the literature review, a synthesis of e-learning frameworks was developed based on articles related to e-learning, online education, sustainable development, higher education, and sustainability in e-learning. Additionally, various e-learning frameworks that had been developed and published by previous researchers were evaluated to identify their key elements, similarities, differences, and shortcomings. Findings and conclusions relating to the existing frameworks were made and used to synthesise the SeLF.

Once the synthesis of e-learning frameworks had been developed, the research methodology was applied to identify, collect, and analyse data to achieve the research objectives. The research data collection began with quantitative and qualitative data collection through a survey. The survey was intended to address these research questions: 1) what are the characteristics of a Sustainable e-Learning Framework in higher education in Malaysia? 2) What are the stakeholders' perspectives and expectations of the characteristics of sustainable e-learning? The participant sample comprised the students and academic staff from both government and private universities in Malaysia. The data were analysed using the Statistical Package for the Social Sciences (SPSS) software for the quantitative data and manual coding of qualitative data.

Based on the results of the survey, the initial SeLF that was developed from the literature review synthesis was refined using both quantitative and qualitative data. Then, a SeLF summary document was developed as a research artifact to provide guidelines to stakeholders on the practical implementation of SeLF. Experts who were subsequently interviewed evaluated the brochure.

Expert interviews were conducted as part of the DSR approach to evaluating the utility and efficacy of SeLF in real environments. The DSR interviews were intended to help achieve the research objectives and investigate the extent to which the new Sustainable e-Learning Framework would be likely to assist Malaysian higher-education stakeholders to become more sustainable. All participants were experts in one or more of the teaching and learning, e-learning, or sustainable development fields. The DSR interviews were recorded, transcribed and thematically analysed using manual coding.

The final SeLF was developed, along with the guidelines on how it could be used to improve or develop sustainable e-learning in tertiary education institutions.

3.4.2 Research Objectives and Questions

The research process started with a literature review and synthesis which led to the initial version of Sustainable e-Learning Framework (SeLF). Then, the initial SeLF was assessed using a quantitative survey to ascertain whether there were any statistical significant discrepancies, if any, and to identify unusual results. These results were then analysed, and an in-depth qualitative study was used to interpret the results. Table 3.2 below shows the research questions and data collection methods.

Table 3.2: Research questions and data collection methods

Research questions	Data collection methods
1. What are the characteristics of a Sustainable e-Learning Framework in higher education in Malaysia?	• Survey
2. What are the stakeholders' perspectives and expectations of the characteristics of sustainable e-learning?	• Survey • DSR expert interviews
3. How can the new Sustainable e-Learning Framework assist the Malaysian higher education stakeholders to become more sustainable?	• DSR expert interviews

These research data collection methods aim to answer the research questions and research objectives by identifying the characteristics of a Sustainable e-Learning Framework for Malaysia, discovering the stakeholders' attitudes and expectations regarding sustainable e-learning characteristics, and determining whether the new Sustainable e-Learning Framework could encourage the higher education stakeholders in Malaysia to become more sustainable.

3.4.3 Participant Sampling

Stakeholders from both government and private universities in Malaysia, which are representative of the Malaysian educational system, participated in this research survey. Criteria were established to identify appropriate Malaysian universities from which to recruit research participants(Asirvatham et al. 2003; Kamarulzaman, Madun and Ghani 2011; Hashim, Ahmad and Abdullah 2010; Huey, Foong and Mat 2007; Puteh 2007;

Embi 2011; Malaysia Qualifications Agency 2011). The criteria were: the type of university, year of establishment, ranking system, and percentage of courses offered online. It was deemed important to select universities that have made a significant effort to establish sustainable development as an institutional priority, as these institutions play an exemplary role in leading other Malaysian universities.

A survey was conducted to collect data from the research participants comprising students and academic staff, as they are the principal stakeholders in the education system (Chin and Chang 2009). Structured interviews were then undertaken to enrich data obtained from the survey.

Further iterative interviews were conducted as part of the evaluation and refinement of research artefacts (the DSR phase of the research). Experts in e-learning, education, online education and Information Systems were among the participants who evaluated the utility and efficacy of the framework.

3.4.3.1 Survey

The sample design is the main component of a sample survey and comprises the sampling plan and the estimation guidelines (Levy and Lemeshow 2008). The sampling plan refers to the sample selection methods, and the estimation guidelines provide guides to estimate the population values and reliability. The stratified sampling strategy was used for this research as it ensures the representation of the demographic characteristics. Participant samples are considered as non-random (Cooksey 2007).

The survey questionnaires were developed based on literature review. The literature review topics were sorted into survey question themes. Table 3.3 provides a clear view of survey questions themes and literature review topics were related. The themes were reviewed and sorted to ensure the flow of the questions is adequate to ascertain respondent’s perspectives toward the characteristics of a sustainable e-learning framework.

Table 3.3 Question themes identified in literature review

Questions theme	**Literature review topics**
Demographic	Age, gender, education level, study field.
E-learning	Accessibility, e-learning, performance, personalised learning.
Learning/Teaching	E-learning tools, usefulness of e-learning activities, e-learning contents.
Technology	Technology preferences, contents, Web development, intelligent agents, Semantic Web.
Application	Mobility, personalized learning.
Sustainable Development	Awareness, sustainable environment, sustainable education, sustainable e-learning, e-learning contents, connectivity, mobile learning, e-waste.

Table 3.4 shows an example of survey questions in sustainable development theme. These questions focus on sustainable development topic. A few types of survey questions were asked to engage respondent's interest and quality information.

Table 3.4: A screenshot of type of survey questions

<table>
<tr><th>Survey Questions</th><th>Question type</th></tr>
<tr><td>46. Please indicate your level of agreement with the statement:
"Sustainable mobility allows me to have…"
<table>
<tr><th></th><th>Strongly Disagree</th><th>Disagree</th><th>Neutral</th><th>Agree</th><th>Strongly Agree</th></tr>
<tr><td>…environment friendly services.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>…faster access.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>…open data that serve mobility.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>…personalization.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>…to save battery life.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>…a user friendly interface.</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>
</td><td>Likert scale</td></tr>
<tr><td>47. To save the environment, do you agree that using the new technology (i.e. Web 3.0) will reduce waste materials and energy consumption?
○ Yes
○ No</td><td>Yes/No</td></tr>
<tr><td>48. Give reasons for your response to Q.47.
____________________</td><td>Open-ended</td></tr>
</table>

In this research, the sample comprised students and academic staff in Malaysian higher education institutions who volunteered to participate in the survey. The main reason for selecting these particular participants is that they are part of the e-learning community (Chikh and Berkani 2010). Their inclusion afforded an opportunity for them to share their knowledge and expertise to evaluate the framework.

3.4.3.2 DSR Expert Interviews

The participants were experts in e-learning, education, online education, or information systems. This is because these groups of participants have the experience or knowledge in e-learning or online education and have the ability to use and adopt the framework in developing a sustainable e-learning in their institutions. The participants were not limited to experts from Malaysian institutions but were also from international institutions. These participants were chosen to bring to the issue a perspective different from the Malaysian one in order to maximise the utility of the framework.

3.4.4 Data collection

3.4.4.1 Survey – Quantitative and Qualitative Data

Surveys were distributed to the stakeholders (students and academic staff) from Malaysian universities to evaluate the new framework. Academic staff and students were selected because they are the end-users of an e-learning system. To reduce the margin of error, the goal was to recruit between 300 and 400 participants (Sekaran and Bougie 2009).Via the survey, participants were given the opportunity to share their knowledge and ideas about the framework development. Quantitative data were collected from closed-ended questions (i.e. multiple choice and matrix table) and qualitative data from open-ended questions (i.e. text entry). The survey instrument can be found in Appendix I.

Initially, the survey was distributed through universities' administration and faculties. Additionally, a paper-based survey was also distributed for the convenience of participants who preferred that format.

3.4.4.2 DSR Experts Interviews – Qualitative Data

The method used in this research was naturalistic evaluation(Venable, Pries-Heje and Baskerville 2012), which discovers the performance of a designed framework in its real-world setting and embraces the complications inherent in real organisations and human practice. The expert evaluation involving more than one expert for the evaluation of the framework was conducted as part of the evaluation method (Peffers et al. 2012) in order to strengthen the internal validity (Gummesson 1991).

In this research, the evaluation requirements are to 1) determine the SeLF outcome where SeLF is a purely socio-technical artefact that requires human interaction to determine its utility, and 2) ascertain the utility, effectiveness, efficiency, and ethical properties of SeLF. The evaluation goals were used to determine whether SeLF met the research objectives: to assist Malaysian higher education stakeholders to become more sustainable in their e-learning practice; to compare SeLF with existing e-learning framework practice by the stakeholders; and identify any side effects necessitating further improvement of SeLF. Then, these evaluation goals and requirements were matched to the criteria of the DSR Evaluation Strategy Selection Framework(Venable, Pries-Heje and Baskerville 2012), which derived SeLF as a naturalistic and ex ante evaluation. Given the DSR Evaluation Method Selection Framework (Venable, Pries-Heje and Baskerville 2012), the appropriate evaluation method is an interview. Finally, a comprehensive design of the evaluation was done, which comprised the design of the interview questions and process.

After refinement based on survey outcomes, the expert interviews with the experts took place for further refinement. These DSR interviews were intended to evaluate the utility and efficacy of SeLF. Each interview took less than an hour with five question themes designed to ascertain SeLF's functionality, consistency, performance, usability, and institution suitability.

3.4.5 Data Analysis

3.4.5.1 Data Analysis Process

The survey outcomes were analysed using SPSS and manual coding to determine whether the new framework met the higher education sector's needs. Before the data analysis process, data cleaning was performed to ensure the completion and usability of the survey. At the theorising stage, the characteristics of the new framework were described to ensure its relevance to Information Technology as it provides a sustainable development approach by using an e-learning system. Survey results were evaluated using SPSS software to determine whether the new framework met the user requirements and expectations based on the generated statistical summary. SPSS was chosen because it is a comprehensive system for analysing data (IBM(International Business Machines) 2012) and it enables the user to enter raw data and run descriptive statistics calculations, factor analysis, and a simple statistical summary of the statistical data (Griffith 2009). The qualitative data were evaluated by using the manual coding method. The phase outcomes were the research artifact, which is the Sustainable e-Learning Framework (SeLF).

Manual coding was also used to analyse the data from the DSR expert interviews to avoid any data misinterpretations that may lead to loss of validity (Basit 2003). However, data cleaning was performed on recording transcripts (Chapman 2005). Data cleaning identifies and eliminates errors to improve the data entry process and prevent the reoccurrence of errors. This includes checks on the format, completeness, and reasonableness of the collected data. The aim of the expert interviews was to ascertain the adequacy of the new model and its utility for stakeholders in the context of their home institutions and environments. Therefore, it was important to have some interaction between the new framework and its practical environment.

3.4.5.2 Data Analysis Tools

Survey – Factor Analysis

Factor Analysis was used to analyse the quantitative data from the surveys to reduce data to a smaller set of variables that are referred to as factors (Williams, Brown and

Onsman 2012). Exploratory Factor Analysis (EFA) was selected due to its non-theoretical application (Friel 2002). The factor analysis process was guided by the five steps of EFA. First, the data was tested through Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity, to ensure that it is suitable for factor analysis. Second, for the extraction, the Principal Component Analysis (PCA) method was selected as it is commonly used by researchers and has an automatic setting in SPSS. Third, the decision regarding the number of factors to be extracted was based on Kaiser's criteria where the Eigenvalue is greater than one (Field 2005). Then, Orthogonal Varimax was selected as the rotation method because it enriches factor interpretability by reducing the number of variables with high factor loadings (Khelifa 2009). Finally, after being extracted, the factors were interpreted and given a name or theme that represented its characteristics.

Survey –Coding using manual coding

Grounded theory is the framework most widely used by researchers for analysing qualitative data. The tools of grounded theory are theoretical sampling, coding, theoretical saturation, and comparison of constants (Bryman and Burgees 1994). Because there was a small amount of qualitative data, manual coding was used for the analysis. Coding is the most important process in grounded theory where the data are divided into component parts that are later given names or labels (Bryman and Burgees 1994). The qualitative data from the open-ended questions were analysed, coded, and named. Since this research used manual coding, three processes were conducted: data reduction, data coding, and presenting the results. The reduction process is a generalisation process whereby the data are classified (Jones 2007). In this process, the data are de-contextualised by identifying word frequency, the texts are isolated from their sources and meaning, and later they are re-contextualised by creating a meaning that represents them. As for the coding process, the documents are coded using codes which have been developed from categories. Codes are allocated to categories that represent the meaning of the data (Jones 2007). However, although researchers are often less confident regarding the naming of codes and themes, their confidence generally increases as the data analysis process continues (Liamputtong and Serry 2013). The coding is generally descriptive and repetitive at the beginning but changes as the codes are organised and assembled.

DSR expert interviews using manual coding

Manual coding was used to process the data acquired from the DSR expert interviews to determine whether the Sustainable e-Learning Framework was complete, sustainable and suitable. The qualitative data were analysed through these sequential steps: coding, creating, working, and shaping the data (Bazeley and Richards 2000). The search process used reflected the attitudes and ideas that emerged from the DSR interviews. The outcomes included institutional points of view used to develop the final Sustainable e-Learning Framework. Furthermore, the framework recommendations, guidelines, and process were created as an outcome of this research.

3.4.5.3 Data Reliability and Validity

The reliability and validity of data depend on the method used in sample selection and measurement (Levy and Lemeshow 2008). In social sciences, measuring data reliability and validity is important (Miller and Johnson 2013). There are four aspects of measuring data validity: content validity, predictive validity, concurrent validity, and construct validity (Lennon 1956). This research focused on the content validity as it measures all dimensions present in the research context (Gleason et al. 2010). There are three types of reliability measures: test-retest reliability, inter-item reliability, and inter-rater reliability (Gleason et al. 2010). In this research, inter-item reliability was used by means of a scale to measure an unobserved theory. The internal consistency is measured using Cronbach's Alpha which indicates the correlation between the items (Gleason et al. 2010). Cronbach's Alpha is a method used to measure the reliability of multiple data scales (Hair 1998). Therefore, the data reliability and validity of the quantitative survey were measured using the Cronbach's Alpha in SPSS as it is a widely used method in social science. Meanwhile, the data validity of qualitative interview was deemed absolute through data dependency reduction, while the data reliability was achieved by the data being dependable, trustworthy, and having genuine characteristics (Kirk and Miller 1986). Hence, the data reliability and validity were established to ensure their appropriateness and relevance to the research questions.

3.5 Ethical Considerations

This research was conducted with the approval of the Curtin University Human Research Ethics Committee (Approval Number RDBS-62-15). Participants were informed of the purpose and aims of this research. A participant information sheet was distributed to the participants in order to obtain their consent. The consent form for the survey is provided in Appendix I. Regarding the interviews with experts, Appendix V shows the participant information sheet and Appendix VI presents the consent form. Participants were informed that their participation was voluntary and that they had the right to withdraw partially or completely from the research process at any time. Participants were assured that all their responses would remain anonymous and strictly confidential. Published material on the research findings would maintain the anonymity of participants and their organisations.

3.6 Research Process Flow Chart

In order to ensure that this research was conducted systematically, a model of the research process flow chart was developed as depicted in Figure 3.4 below.

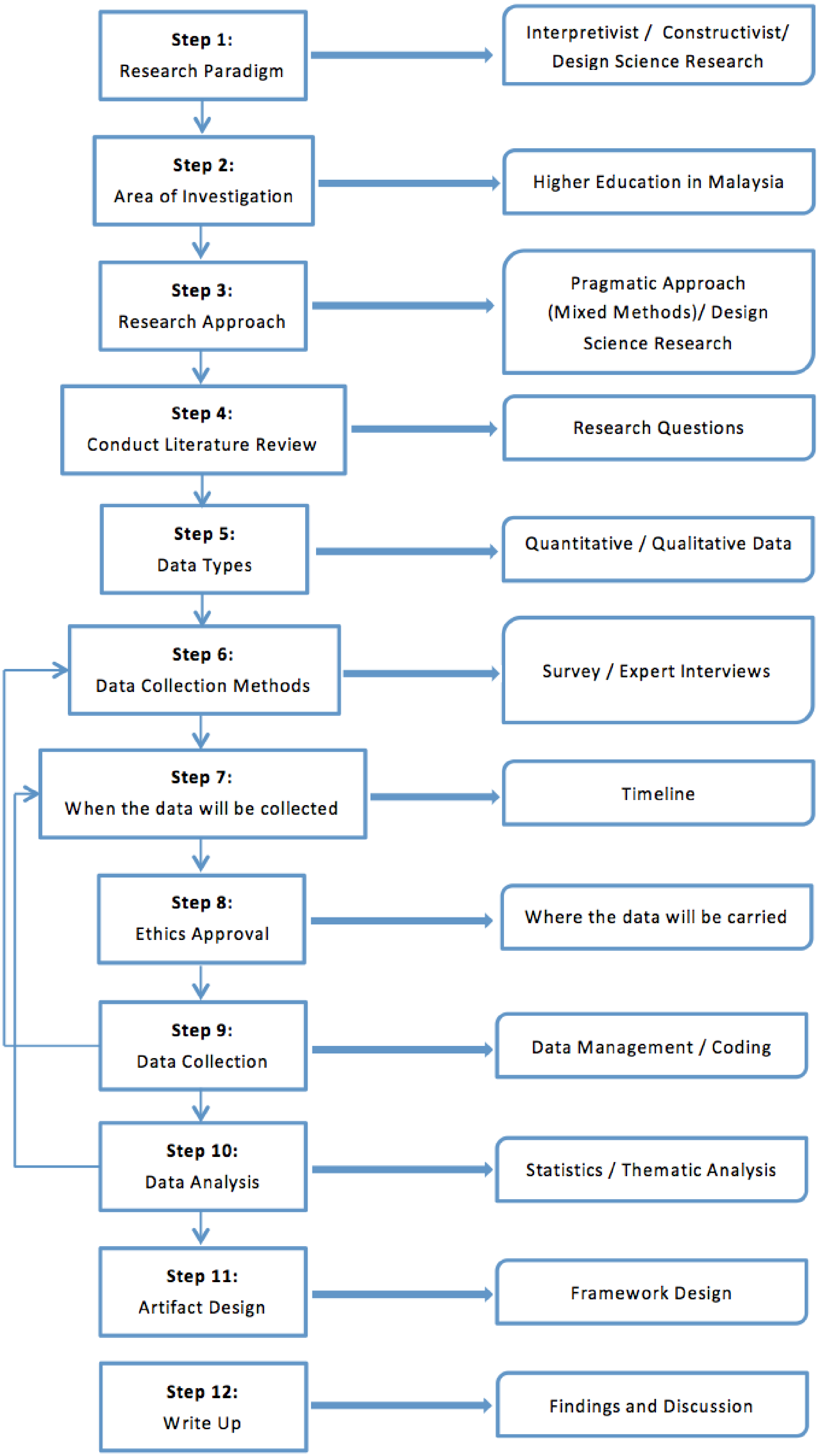


Figure 3.4: Research Method Process

3.7 Summary

This chapter began with an overview of the information system research paradigm as it provides a foundation for selecting the methodology, methods, and research design. Since the use of quantitative and qualitative study has it owns benefits and disadvantages, a thorough investigation was conducted of relevant literature on mixed-methods. Furthermore, a critical literature review related to DSR was conducted to ensure the effective implementation of DSR. This chapter then discussed the research design in terms of the research objectives, participant sampling, data collection, and data analysis. A review of the literature pertaining to the successful conducting of interviews and evaluation in DSR was done to ensure that the research objectives were achieved. Additionally, ethical considerations were discussed. This chapter concluded with the research process flow chart and provided a guideline for the data collection and analysis process for the survey and interviews with DSR experts.

CHAPTER 4

SYNTHESIS OF E-LEARNING FRAMEWORK

This chapter discusses the initial Sustainable E-learning Framework (SeLF) that was developed based on the literature reviews on sustainable development, e-learning, and existing e-learning frameworks, which were discussed in Chapter 2.

4.1 Introduction

The initial Sustainable e-Learning Framework (SeLF) was developed with the objectives of defining sustainable e-learning characteristics and overcoming the challenges of e-learning in the Malaysian higher education sector. The initial framework consists of four main dimensions: e-Teaching and e-Learning principles, technology, applications, and sustainable development. As a final point, the initial users of the new Sustainable e-Learning Framework are intended to be the higher education institutions in Malaysia.

4.2 Literature Review Approach

The components of the new e-learning framework were developed based on a review of the literature pertaining to sustainable development, e-learning, and e-learning frameworks as discussed earlier.

The literature review began with a search of online databases and library collections. To ensure the quality of the literature reviewed, articles, journals, books, government documents, reports, and conference papers were the targeted sources. Keywords such as e-learning, sustainable development, sustainability, e-learning in Malaysia, sustainable development in Malaysia, and e-learning-higher education were used.

During the literature search, the articles were filtered using coding that comprised a two-level analysis. Firstly, each article was analysed using topic, abstract, and keywords. Secondly, the articles were fully reviewed and memo and annotations were used to generate ideas and insights.

The reviewed articles were categorised according to their particular topics, which were established as e-Teaching and e-Learning Principles, Technology, Application, and Sustainable Development. These were further divided into sub-topics based on specific research foci (see Table 4.2). An initial Sustainable e-Learning Framework was then developed based on the topics and sub-topics that comprised the elements and sub-elements required to support sustainability in e-learning.

4.3 Design of Sustainable e-Learning Framework

Challenges existing in the Malaysian higher education sector (discussed in section 2.1.2) motivated this research, which was intended to develop and assess a new Sustainable e-Learning Framework. Based on the extensive literature review (Kar-tin 2005; Isaías, Miranda and Pífano 2009; Baker, Buyya and Laforenza 2002; Reynard 2010; Dhotre and Patil 2010; Wagner, Hassanein and Head 2008; Harasim 1995; Beetham and Sharpe 2007; Kanninen 2008; Blake, Riley and Hosokawa 2000; Bidarra and Cardoso 2007; Hart 2009; Soh et al. 2012; Samah, Yahaya and Ali 2011; Rego, Moreira and Garcia-Penalvo 2010; Jothi, Maraimalai and Prasad 2011; Sharma and Sharma 2009; Chiou 2011; Yang 2006; Guskey 2002; Gunn 2010; Littlejohn 2003), several criteria have been considered in the development of an innovative and future-oriented framework (see Table 4.1).

4.3.1 Elements of Initial Sustainable e-Learning Framework

A description of each key element of the initial Sustainable e-Learning Framework is presented in Table 4.1 and the sub-elements are presented in Table 4.2 below. The key elements of the initial SeLF namely, e-Teaching and e-Learning principles, technology, applications, and sustainable development, were mainly identified from the review of literature on the sustainable e-learning initiatives (Gunn 2010; Littlejohn 2003; Stepanyan, Littlejohn and Margaryan 2013; Wiles and Littlejohn 2003; Robertson 2008) and e-learning critical success factors (Selim 2007; Sridharan, Deng and Corbitt 2010; Sridharan 2011; Bhuasiri et al. 2012; Musa and Othman 2012; McGill, Klobas and Renzi 2014). In addition to these, ‘sustainable development’ was added in response to the review of literature on sustainable development, as discussed in Chapter 2. This ‘sustainable development' element also differentiates the sustainable e-learning approach from its non-sustainable counterpart.

Table 4.1: Fundamental main categories and supporting sustainability of the proposed framework.

Key Elements	Description
E-teaching and E-learning Principle	The e-learning pedagogy that meets the user's basic education needs, which can be achieved for a long time. Everyone should have full access to quality education. Sustainability curricula and quality and innovative programs should be developed.
Technology	The use of technology that reduces, recycles, and reuses energy. The technology should meet communities' needs by offering appropriate and affordable technologies. Furthermore, the technology should support the development and strength of the education infrastructure.
Application	Use of an application that supports green technology and improves learning outcomes. The application should support the human right to education and learning at all levels through the use of e-learning, enabling people to learn anytime and anywhere.
Sustainable development	Support sustainable development by providing sustainable innovation and delivering sustainable education and training. Sustainable education should be delivered through e-learning to promote Education for Sustainable Development (ESD) to develop awareness and knowledge of sustainability. Sustainability of education should promote sustainable practice in e-learning development, innovation, and strategy.

Table 4.1 above illustrates the fundamental key elements of the initial SeLF intended to support the sustainability of the proposed framework. The descriptions were based on the sustainable development goals established by the United Nations (United Nations 2012, 2005). These elements ensure that the framework can be adapted to changing environments and does not become obsolete in the near future. Furthermore, the description of each element (see Table 4.2) differentiates the sustainable e-learning from the non-sustainable e-learning approach. Since technology is constantly evolving, broader concepts like pedagogy and connecting principles are used, giving the framework the capability and flexibility to include new elements at a later stage.

Table 4.2: Elements of initial Sustainable e-Learning Framework.

Key Element	Sub-element	Characteristic	Descriptions
E-Teaching and e-Learning Principles	Teaching Principles	Curriculum	The e-learning curriculum is intended to develop skills among users. This can be done through academic activities, mentorship, assessment and feedback, systematic syllabus, skills development and practice, and peer and collaborative learning (Blake, Riley and Hosokawa 2000).
		Pedagogy	An excellent pedagogy can come from good practice, teaching and assessment methods, and personalised, collaborative, and conditional learning method (Beetham and Sharpe 2007).
	Learning	Learning Theories	There are two learning theories (Rubens, Kaplan and Okamoto 2014) which are: Pragmatism – Provides connections between the user and information. Connectivism – Distributed knowledge across a network of connections.
		Learning Models	A learning model allows large-scale data to be available. Semantic Web allows learning models to provide Web-based services and ontology-based model (Ghaleb et al. 2006) .
		Learning Environment	A physical or virtual setting that engages learners in reasoning about large resource sets. Learning Models include Immersion World, 3D Environment, 3D software and libraries, virtual community, Avatar-based world, and augmented and virtual reality (Bidarra and Cardoso 2007).
Technology	Green Technology	Consolidations	Reduce energy consumption as multiple applications are managed within a shared virtualised resource pool (Uddin and Rahman 2010).
		Energy Efficiency Algorithm	An energy efficient algorithm was designed to support a complete energy efficiency system by delivering solutions for energy saving, balancing hardware and system-based methods (Albers 2010).
		Energy Proportional	Energy proportionality states that a device should consume a small amount of energy for every system workload (Zheng and Cai 2010).

	Semantic Web	Data	Intelligent Learning (Rubens, Kaplan and Okamoto 2014) requires data such as: Metadata – description of the learning of object content to make the learning object accessible (Devedzic 2006). Linked Data – allows data to be processed directly and indirectly by machines. Data-Driven – data that lead to hypotheses and new information. Global Database – uses standards that make information readable by different systems and cross-platforms (Rego, Moreira and Garcia-Penalvo 2010).
		Ontology	Knowledge representation by defining terminology, relationships, concepts, hierarchies, and constraints (Devedzic 2006).
	Intelligent Agents	Pedagogical Agents	Enables the flow of information and content by supporting learning activities through interaction with students, teachers, and other agents (Devedzic 2006).
Applications	Mobility	Extended smart mobile technology	Distributed computing in combination with smart mobile technology could enable learners to have access anytime and anywhere and could provide intelligent solutions to Web searching, document management and organisation of content from virtually anywhere (Chiou 2011).
	Personalisation	Personal Development	Personal development of skills and knowledge through short courses and online communities (Fee 2009).
		Personal Mentor	Personal mentoring provided by ICT applications of communication, which is considered to be an effective strategy for support and development (Ensher, Heun and Blanchard 2003).
		Personal Learning Environment	A set of different applications, services and various other types of learning resources which are constructed by individuals (Samah, Yahaya and Ali 2011).
Sustainable Development	Sustainability in Education	Sustainability for education	Promote sustainable practice in education development, innovation, and management (Davies and West-Burnham 2003).
		Education for sustainability	Provide knowledge, skills, and insights regarding sustainability challenges and innovations (McCormick et al. 2005).

A framework based on a synthesis of other e-learning frameworks was developed (see Figure 4.1) which met the criteria shown in Table 4.2. This initial framework shows the key elements of a Sustainable e-Learning Framework designed to determine sustainable e-learning in the Malaysian higher education sector. The final framework includes guidelines and recommendations on how the key technology, application, and teaching and learning practices can be used, integrated, and combined to provide sustainable e-learning in Malaysia.

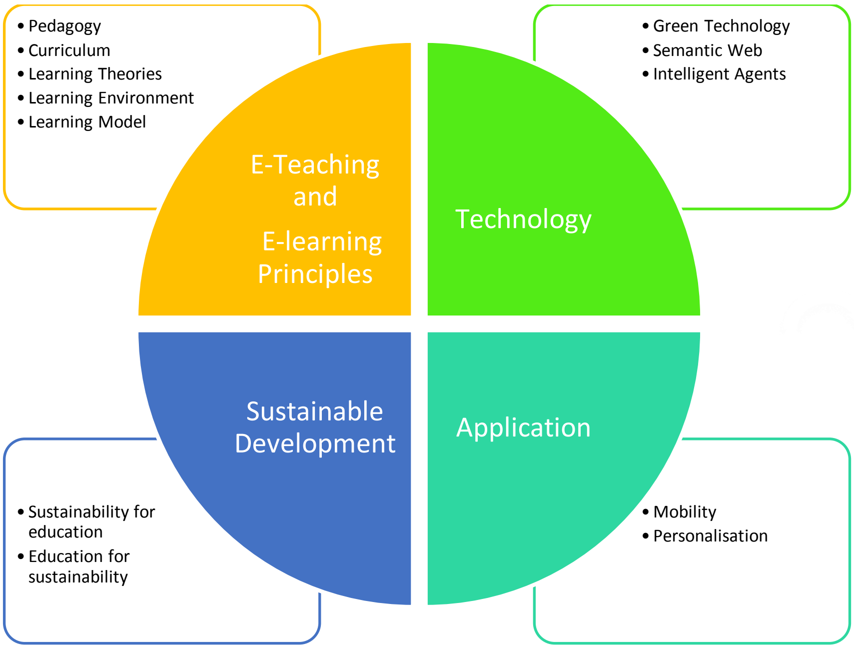


Figure 4.1: A synthesis of e-learning frameworks

These elements represent characteristics of sustainable e-learning while ensuring the quality of e-learning through efficiency and effectiveness of the e-learning principles, technology, application, and sustainability.

4.4 Benefits of SeLF

The integration of sustainability and the Triple Bottom Line (TBL) concept is intended to assist higher education institutions to evaluate their educational performance and its impact on the environment, economy, and society. Furthermore, the key elements and components of the framework are intended to act as indicators that measure the institutions' TBL impact. The measurement can be done on the impact size on how each e-learning decision or goal will affect the society, the environment, and the economy 'bottom line'. This will give the e-learning stakeholders an overview of how SeLF contributes to the Triple Bottom Line.

4.5 Significance of SeLF

Since a cohesive sustainable development educational framework at the university level is an important educational planning strategy, (Dimitrova 2014), SeLF is intended to assist universities by offering guidelines and recommendations on how key technology, application, and teaching and learning practices can be used, integrated, and combined to provide sustainable e-learning. It is anticipated that this framework could assist higher education institutions to achieve sustainable development goals on developing education equity, lifelong learning, sustainable innovation, and building resilient e-learning infrastructure and fostering e-learning innovation. For instance, the integration of curriculum (e-learning principles), intelligent agents (technology), mobility (application), and ESD (sustainable development) is able to promote education equity and lifelong learning that provide learners an equal opportunity to learn ESD based on learners' context of interest that can be accessed anywhere at any time.

However, the limitation of this version of the framework was that its various components were not verified by e-learning stakeholders, such as students and academic staff as being essential for the development of a Sustainable e-Learning Framework. Thus, a survey was conducted to gather academic staff and students' opinions regarding the characteristics of sustainable e-learning and of the elements necessary for sustainable e-learning. A research artefact was developed based on the results and findings of the surveys.

4.6 Summary

This chapter has presented the initial Sustainable E-learning Framework (SeLF) that was developed based on the literature review on sustainable development, e-learning, and existing e-learning frameworks. In order to identify the attitudes of academic staff and students towards sustainable e-learning, this initial framework was evaluated based on the key elements identified in the survey data. Quantitative data and qualitative data were analysed to clarify the characteristics of sustainable e-learning. Chapter 5 will discuss the data analysis and findings of the survey.

CHAPTER 5

DATA ANALYSIS AND RESULTS: SURVEY

5.1 Introduction

Chapter 1 introduces the research background, research objectives, research questions, and research significance. Chapter 2 presents a review of the literature relevant to sustainability, e-learning, and existing e-learning frameworks. As a result of the literature review, a synthesis of e-learning frameworks is presented and described in Chapter 4, which was based on a synthesis of e-learning frameworks. In the previous chapter, the research method used to accomplish the research objectives and answer the research questions is described. In this chapter, the analyses of data acquired from both online and paper-based surveys are presented. These data, gathered from public and private universities, were analysed using both qualitative and quantitative methods. The statistical technique and coding method used to analyse the data are described in Chapter 3. Statistical techniques such as factor analysis and data reliability were applied to the qualitative data from the survey. Manual coding was used to code the qualitative data. In addition, a description of the data and the participants' demographic profile is provided. This chapter concludes with new elements that have emerged from the survey findings that were used to refine the initial SeLF.

5.2 Survey: Academic Staff

In total, 147 academic staff from both public and private universities participated in this research. Survey questionnaires both in paper and online format were distributed to the academic staff of the universities. Initially, online questionnaires were distributed through the universities' administrative units and faculties. Paper-based questionnaires were distributed at a later stage for the convenience of participants who preferred this format.

5.2.1 Response Rate

Survey participation was voluntary and the resulting samples were considered to be non-random (Cooksey 2007) as it involved voluntary participants. A total of 58 online and 89 paper-based surveys were completed by the academic staff as shown in Table 5.1 and Table 5.2. However, the usable number was 47 online and 61 paper-based surveys only as the remaining were incomplete. Therefore, the total sample size for academic staff was 108.

Table 5.1: Academic staff response rate summary from online survey

Universities	**Surveys Completed**	**Usable Surveys**
Public Universities	21	13
Private Universities	37	34
Total	**58**	**47**

Table 5.2: Academic staff response rate summary from paper-based survey

Universities	**Total Distributed**	**Total Returned**	**Total Usable**
Public Universities	70	38	23
Private Universities	70	51	38
Total	**140**	**89**	**61**

5.2.2 Demographic Profile of Academic Staff

This section discusses the demographic profile of the academic staff who participated in this research. Although demographic data does not directly address the research questions, it helps to characterise the sample. In this survey, the sample was categorised according to six categories: public university, private university, gender, age, position, year(s) of teaching experience, and main teaching areas, as outlined in Table 5.3 below.

Table 5.3: Respondents' profile by university type for academic staff survey

	Public Universities		Private Universities		Overall	
Gender						
Female	25	(29%)	61	(71%)	86	(80%)
Male	11	(50%)	11	(50%)	22	(20%)
Age						
Under 25 years	0	(0%)	0	(0%)	0	(0%)
25 - 29	6	(35%)	11	(65%)	17	(16%)
30 - 39	16	(33%)	32	(67%)	48	(44%)
40 - 49	8	(22%)	28	(78%)	36	(33%)
50 – 59	6	(86%)	1	(14%)	7	(7%)
60 - 69	0	(0%)	0	(0%)	0	(0%)
Above 70	0	(0%)	0	(0%)	0	(0%)
Position						
Tutor	4	(44%)	5	(56%)	9	(8%)
Lecturer	17	(31%)	38	(69%)	55	(51%)
Senior Lecturer	11	(30%)	26	(70%)	37	(34%)
Head of School/ Faculty/ Department	1	(25%)	3	(75%)	4	(4%)
Dean of School/Faculty	0	(0%)	0	(0%)	0	(0%)
Other	3	(100%)	0	(0%)	3	(3%)
Year(s) of teaching experience						
0 - 9 years	19	(33%)	39	(67%)	58	(54%)
10 - 19 years	9	(26%)	26	(74%)	35	(32%)
20 - 29 years	4	(40%)	6	(60%)	10	(9%)
More than 30 years	4	(80%)	1	(20%)	5	(5%)
Main teaching areas						
Arts	3	(25%)	9	(75%)	12	(11%)
Business / Law / Finance	5	(16%)	26	(84%)	31	(27%)
Education	9	(69%)	4	(31%)	13	(11%)
Health Science	2	(18%)	9	(82%)	11	(10%)
Information Systems	4	(20%)	16	(80%)	20	(18%)
Marine Institute	0	(0%)	0	(0%)	0	(0%)
Pharmacy	3	(75%)	1	(25%)	4	(3%)
Science Engineering	5	(31%)	11	(69%)	16	(14%)
Social Work	0	(0%)	0	(0%)	0	(0%)
Other	7	(100%)	0	(0%)	7	(6%)

Table 5.3 shows the demographic profile of the academic staff from public and private universities who responded to the survey. The number of respondents from private universities was 50% greater than the number of respondents from public universities. This is because private universities were easier to approach as they were more committed to e-learning research and innovation. There were more female than male

respondents. Based on the Chi-squared test, the asymptotic significance value is 0.063, indicating that there is no significant relationship between gender and the type of university (Hole 2006). The majority of the academic staff who participated in this survey were in the range of 30-49 years of age; 51% of the academic staff were lecturers, and 34% were senior lecturers. Other positions held by the respondents were Deputy Director, Associate Professor, and trainee lecturer. Most participants had less than nine years of teaching experience (57%), which shows that the respondents were most likely new academic staff. As for the teaching area, many respondents were from the faculties of Business, Law or Finance (28.7%), followed by Information Systems (19%) and Science Engineering (15%). Some of the respondents taught in areas outside their primary discipline such as Languages, Architecture, and Skills Development such as Leadership, Applied Social Sciences, and Islamic Studies. None of the respondents taught in the areas of marine biology or social sciences.

5.2.3. Academic Staff: Quantitative Analysis

The survey was divided into five sections: e-learning, learning principles, technology, application, and sustainable development. Each section was analysed using factor analysis, data reliability, and qualitative data coding methods.

The sample size for factor analysis should be more than 100 (Hair 1998). The data cleaning process that checks the completeness and usability of the data indicated that a total of 147 participants had completed the survey. As a result, the number of valid data and usable surveys is 108. The principle component method was applied for factor extraction as it is the most commonly used method and requires no prior existing theory or model (Williams, Brown and Onsman 2012). Orthogonal rotation was applied using the Varimax method to allow variables to be correlated. It is the most common rotational method used, and it develops uncorrelated factor structures (Williams, Brown and Onsman 2012).

5.2.3.1. Descriptive Statistics

Descriptive statistics are used to manage and describe a sample's characteristics or to draw a conclusion (Fisher and Marshall 2008). Descriptive statistics are one of the data analysis methods used for the analysis of quantitative data (Creswell et al. 2003). It is essential to present descriptive statistics as they explain the measures of central tendency. The survey consisted of four sections: e-teaching principles, technology, application, and sustainable development. A five-point Likert scale was used, ranging from Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), to Strongly Agree (5). Since Likert scales are numeric hierarchically ordered categories, the level of measurement is ordinal (Fisher and Marshall 2008). Hence, measures of central tendency will be median and mode. Therefore, the measure of central tendency for each section was calculated as shown in Table 5.4 below. Additionally, Figure 5.1 shows the level of participants' agreement with the findings.

Table 5.4: Descriptive statistics for academic staff survey

Measure of central tendency	E-Teaching Principles	Technology	Application	Sustainable Development
Median	4.00	3.90	4.06	4.35
Mode	4	4	4	4

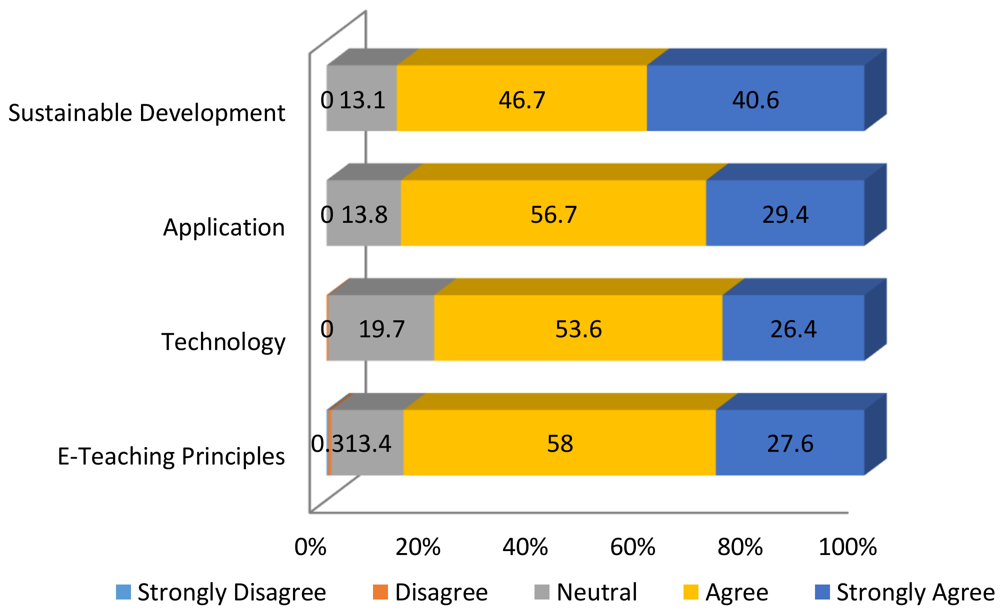


Figure 5.1: Academic staff's level of agreement with statements in each section

Figure 5.1 shows the overall level of agreement for each section, indicating that most academic staff agreed with the statements in each section (see Appendix II for the list of statements and the corresponding statistics). Fourteen (14) variables were listed in the e-teaching principles section. The variable with the highest means indicates that the use of online learning materials in teaching encourages academic staff to be IT-savvy. The mode is four, which refers to the Agree rate, which was the highest at 58%. This indicates that most of the academic staff have a positive view towards e-teaching as a system that motivates them in their teaching practices. Furthermore, this may be due to the students' requirements or financial consideration (Tynan et al. 2012) that encourages them to adopt online teaching.

There were 16 variables in the technology section. The Agree rate was the highest at 53.6%, followed by Strongly Agree at 26.4% and Neutral at 19.7%. This shows that most academic staff believed that the use of technology such as data-driven science, linked data, and big data are useful in e-learning. In addition, the academic staff agreed that Semantic Web offers them 3D visualisation and interaction, collaborative intelligent filtering, distributed computing, and extended smart mobile technology. Furthermore, the academic staff believed that using new technology can make e-learning teaching contents more useful and meaningful.

Applications that support teaching through personalised learning experiences and provide individualised content have the highest mean. This shows that the academic staff had high expectations on applications that can support student learning by providing personalised resources. The Agree rate was the highest at 56.7%, followed by Strongly Agree at 29.4% and Neutral at 13.8%. This shows that most academic staff respondents believed that personalised teaching can assist their teaching by providing individualised content, filtering search results, having a virtual personal assistant, and customising their teaching. They also believed that the applications listed in the survey such as rubric, intelligent agent, global database, data mining techniques, and automation process could help their teaching.

There are 59 variables in the sustainable development section. The mode is four, which refers to the Agree rate, which was the highest at 46.7%. This was followed by Strongly Agree at 40.6%, Neutral at 13.1%, and Disagree and Strongly Disagree at 0%, which explains the median value of 4.35. This shows that most academic staff agreed with statements regarding sustainable development. The descriptive statistics indicate that academic staff in selected Malaysian universities are aware of the benefits of sustainable development in their teaching. They are also aware of the potential benefits of sustainable development in their teaching as listed in the survey, which can be achieved through the participation of academic staff in sustainable e-learning, communications, reducing printing materials, and sustainable mobility.

Overall, most academic staff agreed with the statements regarding e-teaching principles, technology, application, and sustainable development in achieving sustainable e-learning. Further details regarding the descriptive statistics for each variable in each section are given in Appendix II.

5.2.3.2. Preliminary Analysis

Preliminary analysis checks the value of the Cronbach's Alpha to evaluate data reliability, along with the Kaiser-Meyer-Olkin Test and the Bartlett's Test of Sphericity.

Table 5.5: Preliminary analysis results for academic staff survey

Section	**Cronbach's Alpha**	**KMO**	**Bartlett's Test of Sphericity**		
			x^2	**Df**	**P**
Learning Principle	.869	.807	885.849	91	.000
Technology	.942	.915	1369.826	120	.000
Application	.866	.839	633.920	36	.000
Sustainable Development	.964	.810	6652.794	1711	.000

Based on Table 5.5 above, the findings of the preliminary analysis are:

- The Cronbach's Alpha for all items from all sections is above 0.70, indicating that it is considered 'acceptable' in most social science research (Morgan 2011).
- A Kaiser-Meyer-Olkin measure of sampling adequacy for all items from all sections indicates sufficient items for each factor as all of the KMO values are above 0.80. The highest value of KMO is 0.915 which is technology, and this degree of common variance is considered 'superb' (Hutcheson and Sofroniou 1999). Learning principle application, and sustainable development has the meritorious' (Friel 2002) degree of common variance.
- The Bartlett's Test of Sphericity is highly significant, since all variables in each section are below .001 ($p<.001$), indicating that the correlation matrix is

significant for factor analysis (Williams, Brown and Onsman 2012) and the variables are highly correlated and therefore provide a reasonable basis for factor analysis (Field 2005).

Cronbach's Alpha is a method used to measure the reliability of multiple data scales (Hair 1998). Table 5.5 above shows that items in all sections are reliable. Also, the values of KMO and the Bartlett's Test of Sphericity indicate that the data are suitable for factor analysis.

5.2.3.3. Factor Structure

Factor analysis is suitable for the analysis of this research data as the sample size is greater than 100 (Hair 1998). There are two types of factor analysis: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). This research implemented EFA as it has identified the number of factors (Mooi and Sarstedt 2011). By means of data reduction, factor analysis groups the observed variables into a smaller set referred to as factors that represent the data natural characteristics (Pett, Lackey and Sullivan 2003). The factors were extracted using Principal Components Analysis (PCA) as this method is the most commonly used (Mooi and Sarstedt 2011). Furthermore, PCA needs no existing theory or models, and is therefore recommended (Gorsuch 1983). Factor extraction was determined based on Kaiser's criterion where the Eigenvalue is greater than one (Kaiser 1960). The factor loadings and communalities calculated were based on a principal component analysis rotated by Varimax with Kaiser Normalization. The variables with factor loading values 0.70 or higher were selected and then named to reflect each variable's characteristics (Harman 1976). Subsequently, these will be added to the research artefact, SeLF.

Factor Structure: E-Teaching Principles

E-teaching principles refer to the curriculum and pedagogy of the e-learning approach. Similar to traditional learning approaches, the e-learning curriculum is intended to develop skills among users through academic activities, mentorship, assessment and feedback, systematic syllabus, skills development and practice, and peer and collaborative learning (Blake, Riley and Hosokawa 2000). On the other hand, excellent pedagogy can come from good practice in terms of teaching and assessment methods, and a personalised, collaborative, and conditional learning method (Beetham and Sharpe 2007).

In relation to the factor analysis for e-teaching principles, three factors were extracted based on their total Eigenvalues which were greater than 1. These factors were named e-learning opportunities, e-learning motivation, and e-learning strategy planning, as shown in Table 5.6 below.

Table 5.6: Factor analysis for e-learning principles based on academic staff survey

Factor name	**Total Eigenvalue**	**% of V.**	**Factor loading**	**Communality**
1. E-learning opportunities	5.236	37.399		
Using e-learning will improve teaching management.			.907	.843
Using e-learning will improve assessment management.			.856	.751
Using e-learning will improve teaching quality.			.842	.764
Using e-learning will improve online teaching delivery.			.749	.622
Using e-learning will improve user interaction.			.742	.661
2. E-learning motivation	2.672	19.084		
Using online learning materials in teaching encourages me to be IT-savvy.			.824	.693
Using online learning materials in teaching encourages me to be organised in my teaching.			.813	.708
Using online learning materials in teaching encourages me to be responsible regarding my teaching materials.			.801	.719
Using online learning materials in teaching encourages me to be innovative.			.778	.621
3. E-learning strategy planning	1.797	12.833		
E-learning develops critical thinking.			.798	.685
E-learning provides creative and innovative teaching strategies.			.798	.704
E-learning provides an effective teaching strategy.			.796	.745
E-learning allows academic staff to become more independent in their own teaching practices.			.793	.672

E-learning opportunities consist of five variables with a total Eigenvalue of 5.236. E-learning motivation comprises of four variables with a total Eigenvalue of 2.672, indicating the perception that e-learning can improve teaching through user interaction, teaching delivery, teaching management, assessment management, and teaching quality. There are also four variables for e-learning strategy planning with a total Eigenvalue of 1.797, which indicates the staff's perception that e-learning can promote creative and innovative teaching strategies together with an effective teaching strategy. Furthermore, the academic staff surveyed agreed that e-learning could encourage them to become more independent in their own teaching practices and develop critical thinking. The total Eigenvalue for these three factors is greater than 1 and is considered stable (Williams, Brown and Onsman 2012). The communalities shown in Table 5.6 represent only seven variables that exceed 0.70, with values ranging from 0.621 to 0.843.

Factor Structure: Technology

As new Web technologies become accessible in the education domain, new learning methods could be utilised. Also, technology includes the hardware that contributes to the e-learning infrastructure. Based on the factor analysis of the technology section, three factors were extracted with Eigenvalues greater than 1: new technology, Semantic Web, and database analytics, as shown in Table 5.7 below.

Table 5.7: Factor analysis for technology based on academic staff survey

Factor name	Total Eigenvalue	% of V.	Factor loading	Communality
1. New technology	8.668	54.173		
Using new technology will make e-learning teaching contents more useful and meaningful because it provides easy-to-exchange learning content.			.879	.823
Using new technology will make e-learning teaching contents more useful and meaningful because it fosters information connectivity.			.867	.859
Using new technology will make e-learning teaching contents more useful and meaningful because it encourages learning using multiple resources.			.845	.793
Using new technology will make e-learning teaching contents more useful and meaningful because it provides easier access to comprehensive information.			.833	.810
Using new technology will make e-learning teaching contents more useful and meaningful because it provides easy-to-use tools.			.833	.813
Using new technology will make e-learning teaching contents more useful and meaningful because it provides better Web browsing and communication.			.766	.766
2. Semantic Web	1.683	10.516		
Semantic Web allows me to have distributed computing.			.828	.774
Semantic Web allows me to have collaborative intelligent filtering.			.798	.775
Semantic Web allows me to have 3D visualisation and interaction.			.735	.636
Semantic Web allows me to have extended smart mobile technology.			.735	.708
3. Database analytics	1.267	7.921		
Big data			.868	.868
Linked data			.836	.836
Data-driven science			.702	.702

New technologies such as Web 2.0 and Web 3.0 comprise of six variables with a total Eigenvalue of 8.668. The highest factor loading was for the statement regarding e-learning teaching content being more useful and meaningful because new technology can offer ease of content exchange. Semantic Web comprises of four variables with a total Eigenvalue of 1.683. The third factor, data types, comprises of three variables: big data, linked data, and data-driven science with a total Eigenvalue of 1.267. The total Eigenvalue for these three factors is greater than 1, and therefore considered stable (Williams, Brown and Onsman 2012). For the communalities shown in Table 5.7, all variables exceed 0.70 except for the lowest commonality at 0.636.

Factor Structure: Application

The application refers to the features of Web technologies. E-learning tools such as video conferencing, chats, e-mail, discussion forums, wikis, blogs, and serious games support teaching applications (Romdhane 2014). Some of these tools may be part of social media tools such as blogging, microblogging, podcasting, social networks, social bookmarking, discussion forums, wikis, and virtual worlds. The benefits of these tools are that they provide learning online opportunities and access to distant specialists in teaching and professional development (Liliana 2014). Table 5.8 presents the factor structure of the application section. It shows that only two factors were extracted based on their total Eigenvalues that are greater than 1: personalised teaching and tools.

Table 5.8: Factor analysis for application based on academic staff survey

Factor name	Total Eigenvalue	% of V.	Factor loading	Communality
1. Personalised teaching	4.378	48.648		
Personalised teaching allows me to have a virtual personal mentor/assistant.			.904	.827
Personalised teaching allows me to provide interesting contents.			.877	.772
Personalised teaching allows me to filter search results.			.867	.778
Personalised teaching allows me to customise my teaching.			.841	.729
2. Tools	2.231	24.789		
Data mining techniques			.926	.867
Automation process			.898	.811
Global database			.875	.786
Intelligent Agent			.763	.673

Personalised teaching includes four variables with a total Eigenvalue of 4.378. The highest factor loading for this factor is “Personalised teaching allows me to have a virtual personal mentor/assistant". In general, the applications can offer the use of a virtual personal assistant, provide interesting contents, filter search results, and customise teaching. The second factor, tools, includes an automation process that facilitates the insertion of metadata, a global database that uses standards to ensure that information is readable to different systems and cross-platforms, and intelligent agents. The communalities shown in Table 5.8 indicate that all variables exceed 0.70, except for the lowest communality at 0.673.

Factor Structure: Sustainable Development

Sustainable e-learning has become normative in catering for the needs of the present and future (Robertson 2008). One of the characteristics of sustainable e-learning is its support of reusable or transferable e-learning contents. This enables advanced searches for existing content that can be reused and shared. There are five aspects of sustainability in e-learning practices which are the sustainability of learning platforms and learning software, sustainability of institutional responses to the use of e-learning, sustainability of e-learning materials development, sustainability of pedagogic approaches, and sustainability of teacher and trainer skills (Attwell 2004). The factor structure for the sustainable development section shows that ten factors were extracted based on their total Eigenvalues which were greater than 1. However, Table 5.9 below shows only eight factors because this analysis selected only those factor loadings that were greater than 0.70 in order to minimise information overload. The new factors are: sustainable e-learning, consistent infrastructure, sustainable e-learning activities, supportable mobility, effective browsing and connectivity, communication and interaction, efficiency, and participation.

Table 5.9: Factor analysis for sustainable development based on academic staff survey

Factor name	Total Eigenvalue	% of V.	Factor loading	Communality
1. Sustainable e-learning	18.904	32.041		
Sustainable e-learning can be achieved by providing facilities that produce low carbon emissions.			.899	.903
Sustainable e-learning can be achieved by providing facilities that consume low energy.			.879	.882
Sustainable e-learning can be achieved by providing e-learning contents that can be reused and repurposed.			.868	.839
Sustainable e-learning can be achieved by providing meaningful e-learning contents.			.828	.830
Sustainable e-learning can be achieved by providing applications that reduce environmental impact.			.822	.761
Sustainable e-learning can be achieved by providing 24/7 technical support.			.791	.794
2. Consistent infrastructure	8.498	14.404		
Sustainable e-learning can be achieved by a consistent network infrastructure.			.812	.843
Sustainable e-learning can be achieved by a consistent technology infrastructure.			.727	.757
Sustainable e-learning can be achieved by consistent hardware infrastructures.			.714	.835
3. Sustainable e-learning activities	4.148	7.030		
To support sustainable e-learning, academic staff should improve their online student assessment practices.			.761	.866
To support sustainable e-learning, academic staff should improve their online tutoring.			.723	.841
To support sustainable e-learning, academic staff should improve their online interaction.			.723	.788
4. Supportable mobility	3.123	5.294		
Sustainable mobility allows me to have a user-friendly interface.			.789	.796

Sustainable mobility allows me to save battery life.			.772	.804
Sustainable mobility allows me to have environment-friendly services.			.714	.663
Sustainable mobility allows me to have open data that serves mobility.			.704	.718
5. Effective browsing and connectivity	2.588	4.386		
Better browsing and connectivity between e-learning materials can help me reduce cost.			.780	.808
Better browsing and connectivity between e-learning materials can help me save time.			.746	.814
Better browsing and connectivity between e-learning materials can help me reduce energy consumption.			.744	.833
By switching from a cell phone network to Wi-Fi, I can save substantial energy.			.711	.773
6. Communication and interaction	1.763	2.988		
Communication and interaction among academic staff can ensure a sustainable e-learning system by establishing rapport and understanding others' roles.			.802	.729
Communication and interaction among academic staff can ensure a sustainable e-learning system by providing effective support.			.800	.801
Communication and interaction among academic staff can ensure a sustainable e-learning system by encouraging collegial sharing.			.796	.740
Communication and interaction among academic staff can ensure a sustainable e-learning system by using a common language.			.761	.725
Communication and interaction among academic staff can ensure a sustainable e-learning system through adaptability.			.756	.735
7. Efficiency	1.666	2.823		
I believe sustainable e-learning can reduce environmental impact.			.774	.807
I believe sustainable e-learning can improve and maintain the quality of education while also reduces cost.			.749	.811
I believe sustainable e-learning can reduce education costs.			.716	.826
8. Participation	1.589	2.694		
The participation of academic staff in sustainable e-learning can be improved by providing rewards for sustainable development practices.			.814	.816
The participation of academic staff in sustainable e-learning can be improved by providing training and support.			.719	.797

Green facilities contain six variables with a total Eigenvalue of 18.904. For this factor, the highest loading is for sustainable e-learning can be achieved by providing facilities with low carbon emissions (0.89). All the communalities for the variables under this factor are above 0.70, which shows that it is reliable.

The second factor is consistent infrastructure which consists of three variables with a total Eigenvalue of 8.498. It indicates that sustainable e-learning can be achieved through consistent network infrastructure, technology infrastructure, and hardware infrastructures. All the communality values are above 0.70, which shows that it is reliable.

The third factor, sustainable e-learning activities, contains three variables with a total Eigenvalue of 4.148 and all the communalities are above 0.70. It shows that the academic staff surveyed believes that online student learning engagement, online tutoring, and online interaction contribute to sustainable e-learning, and support the continuous use of e-learning and engagement with learning.

The fourth factor, sustainable mobility, consists of four variables with a total Eigenvalue of 3.123. It indicates that the academic staff believes that sustainable mobility could provide a user-friendly interface, save battery life, employ environment-friendly services, and use open data. The communalities show that all variables exceeded 0.70, except for the lowest communality at 0.663.

The fifth factor is called sustainable browsing and connectivity, which comprises of four variables with a total Eigenvalue of 2.588, and all the communalities are above 0.70. It shows that the academic staff believes that better browsing and connectivity between e-learning materials can help them reduce costs, save time, reduce energy consumption, and save substantial energy, thereby helping users to access the required information more efficiently.

The sixth factor named sustainable communication consists of five variables with a total Eigenvalue of 1.763, and all the communalities are above 0.70. It indicates that communication and interaction among the academic staff can likely ensure a sustainable e-learning system by establishing rapport and understanding others' roles, providing effective support, encouraging collegial sharing, using a common language, and adaptability.

The seventh factor is efficiency, which consists of three variables with a total Eigenvalue of 1.666, and all the communalities are above 0.70. It shows that sustainable e-learning is most likely to be cost effective as the staff perceived that it can improve or maintain the quality of education while reducing costs and environmental impact.

The eighth factor is participation, which contains two variables with a total Eigenvalue of 1.589, and all the communalities are above 0.70. It shows that the participation of the academic staff can be improved through rewards for sustainable development practices and training and support.

5.2.4. Academic Staff: Qualitative Analysis

This qualitative analysis section for academic staff had four components: e- learning principles, technology, application, and sustainable development. The data for every section was analysed using Nvivo, which is an analytics software that is used to analyse qualitative data by generating themes, concepts, and relationships between texts. In addition, before running the data in Nvivo, data cleaning was performed to correct issues such as grammatical and spelling errors.

5.2.4.1. E-Teaching Principles

Similar to the quantitative analysis, the e-teaching and teaching principles sections were combined into one category named e-learning principles. The open-ended statements for this section are "Please add other comments on the e-learning approach to teaching" and "Please add any other comments regarding the E-Learning Principles". The data for this section was divided into meaningful categories and coded as shown in Figure 5.2 below.

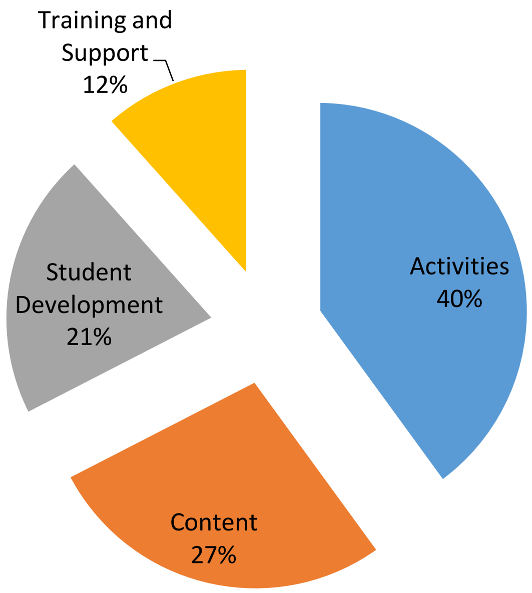


Figure 5.2: Percentage of themes for the e-Teaching section based on academic staff survey

Figure 5.2 shows the breakdown of the themes that were identified in the e-Teaching and e-Learning Principle section. Activities (40%) had the highest score. References to online assessments, group activities, and constructive feedback that improve students' skills and development were coded as ‘Activities’. The academic staff were also concerned about student learning which was affected by e-learning content, student development, and training and support. References to interactive assessment and learning contents, and updated teaching materials were coded as ‘Content’. Overall, the academic staff looked forward to sustainable e-learning capabilities as a means of improving their teaching skills and students’ learning skills through productivity tools, reliable resources, interactive learning activities, attractive learning styles, and the practical use of e-learning.

5.2.4.2. Technology

This section examines the attitudes of the academic staff towards new technology. The open question for this section is “Please add other comments about the new technology (i.e. Web 2.0, Web 3.0)”. The data was coded into meaningful categories as shown in Figure 5.3 below.

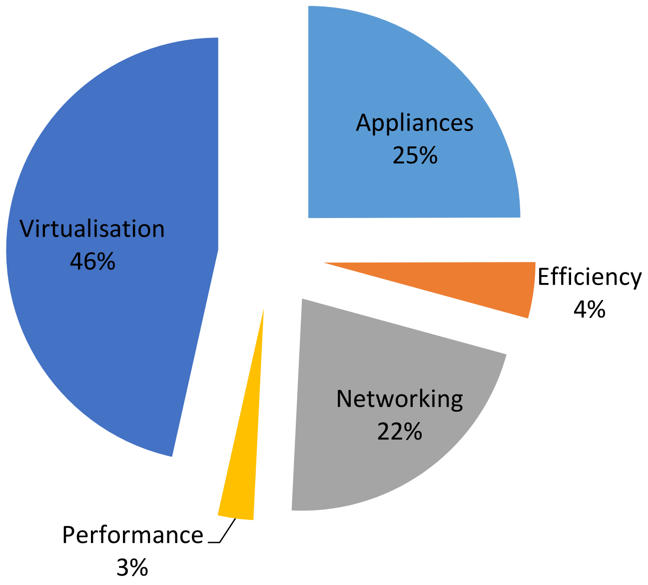


Figure 5.3: Percentage of categories for the technology section based on academic staff survey

Figure 5.2 shows the breakdown of the themes that were identified in the Technology section. The highest percentage was for Virtualisation (46%), followed by Appliances (25%) as the second highest. This indicates that the academic staff seek technology that offers more applications and a virtual environment. Virtualisation refers to 3D environments and immersive worlds that enhance student engagement and education quality. The academic staff were also concerned about Networking (22%), Efficiency (4%), and Performance (3%) which enable them to enhance their communication skills and teaching outcomes while reducing time and cost.

5.2.4.3. Application

Similar to the previous sections, data from the open-ended statement ("Please add other comments regarding the Application") in the application section of the survey were coded and organised in meaningful categories using NVIVO software. Four categories were identified as shown in Figure 5.4 below.

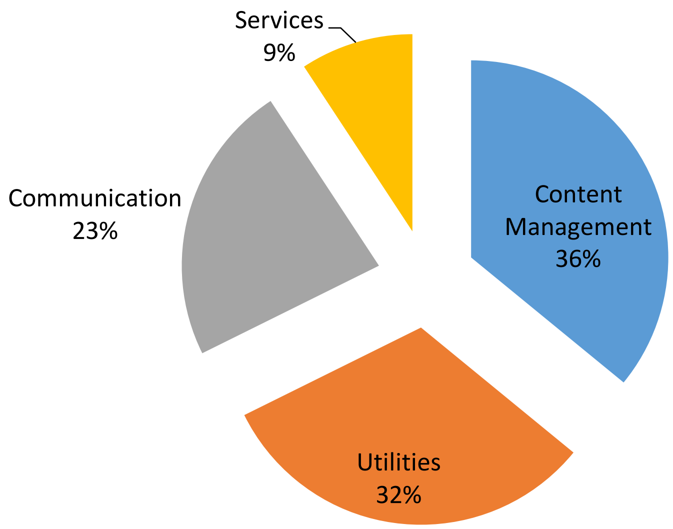


Figure 5.4: Percentage of categories for the application section based on academic staff survey

Figure 5.2 shows the breakdown of the themes that were identified in the Application section. The highest percentage is Content Management (36%), followed by Communication (23%), Utilities (32%), and Services (9%). This indicates that the academic staff prefer applications that enhance their teaching quality by assisting them to manage e-learning content teaching, such as an online word processor for content development. Furthermore, the academic staff seek communication features that offer blog tools, chat, messaging, and professional social networks that enhance user collaboration. They also required utilities such as student performance tracking tools and productivity tools, and services that allow the applications to be integrated with any device.

5.4.2.4. Sustainable Development

Qualitative data from the open-ended statement regarding technology and environment were coded and divided into meaningful categories as shown in Figure 5.5 below. The question asked academic staff to give a reason for their answers to the question "To save the environment, do you agree that using the new technology (i.e. Web 3.0) will reduce waste materials and energy consumption?"

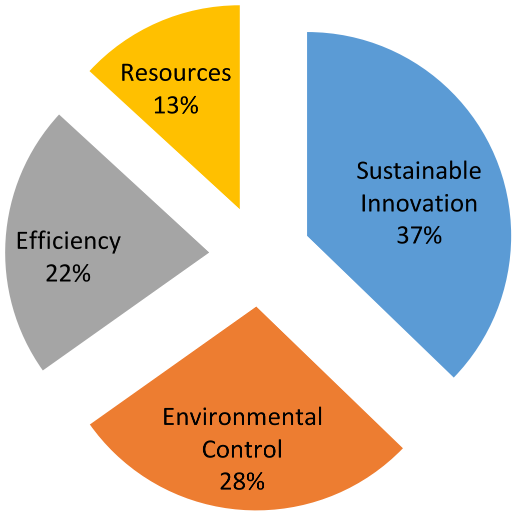


Figure 5.5: Percentage of categories for the sustainable development section based on academic staff survey

Figure 5.5 shows that Sustainable Innovation had the highest percentage at 37%; this category refers to technology that supports green technology that is easy to use, adopt and promote such as green printing, virtualisation, sustainable engineering, and sustainable design. Furthermore, the academic staff seek a technology that embraces environmental controls which produce lower carbon emissions, consume less processing power, and mitigate environmental impact. Efficiency (22%) and Resources (13%) refer to technology innovation that offers more efficient task management, energy savings, and cost effectiveness by recycling or reusing resources in the manufacturing process. This suggests that the academic staff are aware of the capabilities of technology in terms of saving the environment.

5.2.5 Summary for Academic Staff Survey

The survey was divided into five categories: demographic, e-teaching principles, technology, application, and sustainable development. The statistics show that the overall mode is 4, which indicates that most academic staff agreed with the survey statements. The highest median is 4.35 (sustainable development) and the lowest is 3.90 (technology), indicating that the academic staff agreed with or were at least neutral in respect to the survey statements. Data reliability for the quantitative data is considered acceptable where the Cronbach's Alpha is above 0.70. The Kaiser-Meyer-Olkin measure of sampling adequacy for all items in the survey indicated sufficient items as all of the KMO values are above 0.80. In addition, the Bartlett's Test of Sphericity was highly significant, as the values of variables in each section are below .001 ($p<.001$). In this research, the factor analysis and qualitative data analysis methods were most important as they identified the new factors (elements) for Sustainable e-Learning Framework. See Table 5.10 below.

Table 5.10: Summary of academic staff survey

Method	**Elements to be added to the research artefact (SeLF)**
Factor analysis	E- teaching Principles 1. E-learning opportunities 2. E-learning motivations 3. E-learning strategy planning Technology 1. New technology 2. Semantic Web 3. Database analytics Application 1. Personalised teaching 2. Tools Sustainable Development 1. Sustainable e-learning 2. Consistent Infrastructure 3. Sustainable e-learning activities 4. Supportable mobility 5. Effective browsing and connectivity 6. Communication and interaction 7. Efficiency 8. Participation

Qualitative analysis using Nvivo	<u>E-teaching Principles</u> 1. Activities 2. Contents 3. Student Development 4. Training and Support <u>Technology</u> 1. Virtualization 2. Appliances 3. Networking 4. Efficiency 5. Performance <u>Application</u> 1. Content Management 2. Utilities 3. Communication 4. Service <u>Sustainable Development</u> 1. Sustainable Innovation 2. Environmental Control 3. Efficiency 4. Resources

Table 5.10 above shows that 16 new elements were derived from the quantitative data analysis, and 17 new elements emerged from the qualitative data analysis. These new elements were considered to be included in the research artefact (SeLF).

5.3 Survey: Students

In total, 233 participants from both public and private universities participated in this research. Initially, the online questionnaires were distributed through university administration units and faculties. The deadline for filling out the questionnaires was extended due to participants' workload on academic calendar. Paper-based questionnaires were also distributed to accommodate the preferences of some students.

5.3.1. Response Rates

A total of 89 completed online and 144 paper-based completed surveys were returned as shown in Table 5.11 and Table 5.12. However, only 79 online surveys and 128 paper-based surveys were usable. Therefore, the total sample size for the survey is 207.

Table 5.11: Student response rate summary from online survey

Universities	Surveys Completed	Usable Surveys
Public Universities	38	36
Private Universities	51	43
Total	**89**	**79**

Table 5.12: Student response rate summary from paper-based survey

Universities	Total Distributed	Total Returned	Total Usable
Public Universities	100	81	68
Private Universities	100	63	60
Total	**200**	**144**	**128**

This study used SPSS as the analysis technique for quantitative data; therefore, the sample size is one of the factors that the power of statistical test relies on (Stevens 2009). Most analysts recommend that a sample size should be at least 100 cases for each subgroup in the population. Statisticians have shown that a sample size that is more than 30 will provide a mean sampling distribution that is very close to a normal distribution (Saunders, Lewis and Thornhill 2009). The survey involves voluntary participants and according to (Cooksey 2007), volunteer samples are considered as non-random.

5.3.2. Demographic Profile of Students

This section shows the demographic profile of the students who participated in both the online and paper-based surveys. The students' profiles are presented in Table 5.13 where there are six categories: public university, private university, gender, age, highest level of education, and main field of study.

Table 5.13: Respondents' profile by university type for student survey

	Public Universities	Private Universities	Overall
Gender			
Female	61%	39%	57%
Male	38%	62%	43%
Age			
17-20	39%	61%	31%
21-25	60%	40%	58%
26-30	12%	88%	8%
31-40	100%	0%	2%
Above 50	100%	0%	1%
Highest level of education			
Bachelor's Degree	59%	41%	59%
Master	50%	50%	5%
Doctorate	67%	33%	1%
Other	37%	63%	35%
Main field of study			
Arts	57%	43%	10%
Business / Law / Finance	65%	35%	39%
Education	67%	33%	4%
Health Science	4%	96%	12%
Information Systems	30%	70%	10%
Marine Institute	100%	0%	1%
Pharmacy	27%	73%	13%
Science Engineering	83%	17%	11%
Other	0%	0%	0

Table 5.13 shows that there were slightly more respondents from public universities (51%) compared to private universities (49%), as such, we can say that there is almost an equal number of respondents from each type of university. In terms of gender, the table shows that there were more female respondents than male respondents. In addition, the Chi-squared test produced an asymptotic significance value of 0.003 which indicates that there is a significant relationship between gender and type of university (Hole 2006). Most respondents were in the 20 to 25 age group. In addition, 59% of the respondents had a bachelor's degree, which means most students aged between 20 and 25 had a bachelor's degree. There were 35% who had a foundation or a diploma level qualification, and the rest hold a bachelor, master, or doctoral degree. The fields of study with the largest number of respondents were business, law, and finance (40%). Other fields of study were arts, health science, information systems, pharmacy, and science engineering. Very few of the respondents were in the education and marine studies. This is likely due to the low number of students enrolled in these fields at a small number of universities.

5.3.3. Student: Quantitative Analysis

Similar to the academic staff survey, the student survey consisted of five sections. These were: e-learning, learning principles, technology, application, and sustainable development. Each section was analysed using factor analysis and data reliability.

As mentioned previously, there were 207 completed student surveys. For factor analysis, a total sample size of 207 is considered as fair (Comrey and Lee 1992). In addition, the sample size for factor analysis should be more than 100 (Hair 1998). A total of 233 participants completed the survey, but the number of usable surveys following data cleaning was 207. Principle components analysis was used for factor extraction as it is the most commonly used method and requires no prior existing theory or model (Williams, Brown and Onsman 2012). Orthogonal rotation was applied using the Varimax method to allow the variables to correlate. It is the most common rotational method used to develop uncorrelated factor structures (Williams, Brown and Onsman 2012). Factor analysis and data reliability were applied to the quantitative data. Qualitative data analysis was conducted using manual coding.

5.3.3.1. Descriptive Statistics

Likert scales were standardised into Strongly Disagree (1), Disagree (2), Neutral (3), Agree (4), and Strongly Agree (5). Since the level of measurement of Likert scales is ordinal, the measure of central tendency will be median and mode (Fisher and Marshall 2008). Thus, the measure of central tendency for each section was calculated as shown in Table 5.14 below. In addition, Table 5.15 shows the participants' level of agreement with the findings.

Table 5.14: Descriptive statistics for student survey

Measure of central tendency	**E-Learning Principles**	**Technology**	**Application**	**Sustainable Development**
Median	4.00	3.90	4.00	5.50
Mode	4	4	4	5

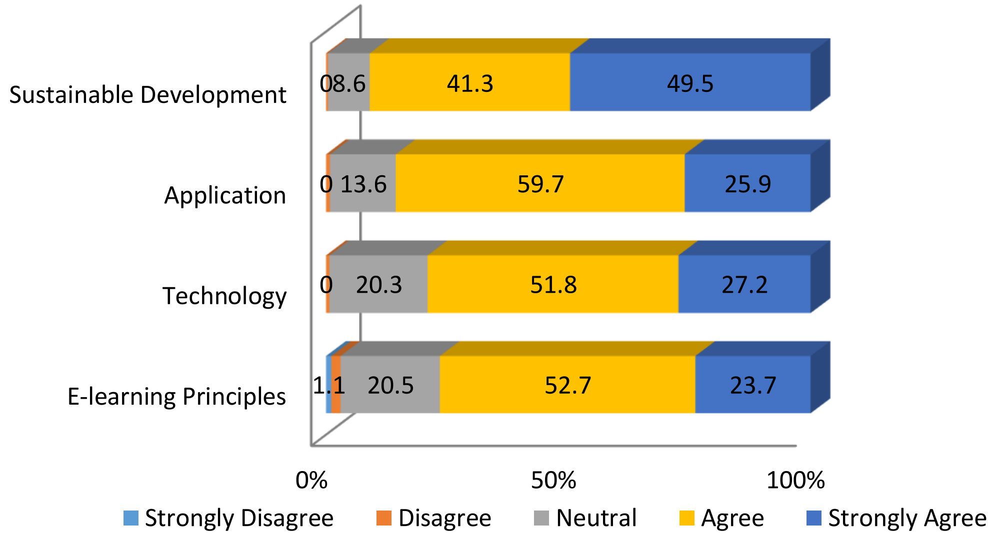


Figure 5.6: Students' level of agreement with statements in each section

There were 10 variables listed in the e-Learning principles section. Figure 5.6 shows the students' overall level of agreement with the statements in each section (see Appendix III for the list of statements and their statistics). The variable with the highest mean pertains to the "e-learning is important" statement. The median and mode value is 4 since the Agree rate was the highest at 52.7%, followed by Strongly Agree at 23.7%, Neutral at 20.5%, Disagree at1.9%, and Strongly Disagree at 1.1%. This indicates that students had a positive attitude towards e-learning as a system that provides effective learning tools to encourage students to become independent learners.

Technology that assists e-learning in providing anytime and anywhere access together with intelligent solutions to Web searching and content management had the highest mean. This shows that students had high expectations with respect to the accessibility of e-learning and intelligent assistants. The Agree rate was the highest at 51.8%, followed by Strongly Agree at 27.2% and Neutral at 20.3%, with a mode of 4. However, a median of 3.90 indicates that the students believed that e-learning could adopt technology that provides easy access to comprehensive information, information connectivity, access to multiple resources, better Web browsing and connectivity, easy-to-exchange learning content, and meaningful content.

In the application section, the statement "applications that support the student to customise their learning by obtaining interesting content" had the highest mean. This shows that students had high expectations of applications that can assist them to find contents to support their learning. Also, with a median of 4.00, this indicates that students still expected that e-learning should offer applications that can be customised and connected to their learning, instead of being overloaded with information. The mode is 4 since the Agree rate was the highest at 59.7%, followed by Strongly Agree at 25.9% and Neutral at 13.6%. This shows that most students agreed with the above statements. The lowest mean and lowest standard deviation is for the statement "Personalised learning allows me to be independent in my learning" which may be due to lack of motivation.

There are 20 variables in the sustainable development section. The Strongly Agree response was the highest at 49.7%, with a mode value of 5 and a median value of 5.5. The descriptive statistics show that students in Malaysian universities are aware of how sustainable education can be achieved and the amount of printed materials that can be reduced. They are also cognisant of the benefits of sustainable e-learning, mobile learning, and better browsing and connectivity.

5.3.3.2. Preliminary Analysis

Preliminary analysis checks the value of the Cronbach's Alpha to determine data reliability, together with the use of the Kaiser-Meyer-Olkin Test and the Bartlett's Test of Sphericity.

Table 5.15: Preliminary analysis for student survey

Section	**Cronbach's Alpha**	**KMO**	**Bartlett's Test of Sphericity**		
			x^2	**df**	**P**
Learning Principle	.813	.703	939.232	45	.000
Technology	.906	.884	1232.823	45	.000
Application	.842	.834	410.684	10	.000
Sustainable Development	.952	.918	3623.950	190	.000

Based on Table 5.15, the findings of the preliminary analysis are:

- The Cronbach's Alpha for all items from all sections is above 0.70, indicating that they are 'acceptable' in most social science research (Morgan 2011).
- A Kaiser-Meyer-Olkin measure of sampling adequacy for all items from all sections indicated sufficient items for each factor as all of the KMO values are above 0.60. The highest value of KMO is 0.918 which is for sustainable development and this degree of common variance is considered 'superb' (Hutcheson and Sofroniou 1999). Technology and application hold a 'meritorious' degree of common variance. Lastly, the lowest KMO value is 0.703 (Friel 2002) which shows that the degree of common variance for learning principles is 'middling'.
- The Bartlett's Test of Sphericity was highly significant as all variables' values in each section are below .001 ($p<.001$), which means that the correlation matrix is significant for factor analysis (Williams, Brown and Onsman 2012) and the variables are highly correlated (Field 2005) to provide a reasonable basis for factor analysis.

5.3.3.3. Factor Structure

Careful examination of the factor analysis report (Heppner, Kivlighan and Wampold 2007) led to the naming of new factors which were added to the research artefact (SeLF).

Factor Structure: E-learning Principles

For e-learning principles, three factors were extracted with a total Eigenvalue that is greater than 1: e-learning importance, e-learning risks, and e-learning opportunities as shown in Table 5.16 below.

Table 5.16: Factor analysis for e-learning principles based on student survey

Factor name	Total Eigenvalue	% of V.	Factor loading	Communality
1. E-learning importance	3.789	37.889		
E-learning is important.			.840	.787
E-learning is an effective learning tool.			.840	.798
E-learning develops students' critical thinking skills.			.772	.623
2. E-learning risks	1.756	17.560		
E-learning may lead to isolation from teacher and classroom.			.893	.811
E-learning leads to a non-social environment.			.843	.784
E-learning may impair a student's performance due to low motivation.			.778	.660
3. E-learning opportunities	1.413	14.130		
Using online learning content encourages me to be motivated.			.871	.778
Using online learning content encourages me to learn by myself.			.788	.641
Using online learning content encourages me to organise my learning activities			.748	.625

Active learning consists of three variables with a total Eigenvalue of 3.789. Isolation and motivation comprise three variables with a total Eigenvalue of 1.756. There are three variables for e-learning opportunity in self-directed learning with a total Eigenvalue of 1.413. The total Eigenvalue for these three factors are greater than 1 and they are therefore considered stable (Williams, Brown and Onsman 2012). The communalities shown in Table 5.16 show only five variables exceeding 0.70, and the lowest communality is 0.62.

Factor Structure: Technology

Two factors had Eigenvalues greater than 1: Web evolution and intelligent systems.

Table 5.17: Factor analysis for technology based on student survey

Factor name	Total Eigenvalue	% of V.	Factor loading	Communality
1. Web evolution	5.603	56.026		
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it provides information connectivity.			.851	.780
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it provides easier access to comprehensive information.			.846	.789
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it facilitates easy-to-exchange learning content.			.839	.740
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it offers better web browsing & communication.			.781	.703
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it allows one to learn from multiple resources.			.762	.687
2. Intelligent system	1.050	10.500		
E-learning systems enable me to understand the content, and also have intelligent agents that assist me in working more efficiently.			.818	.728
E-learning systems enable me to understand the content. They also run multiple software in a single system.			.745	.570

Web evolution consists of five variables with a total Eigenvalue of 5.603. The highest factor loading for this factor is "new technology makes e-learning contents more useful and meaningful because it provides information connectivity". On the other hand, virtualisation comprises two variables with a total Eigenvalue of 1.050. The total Eigenvalue for these two factors are greater than 1 and are therefore considered stable (Williams, Brown and Onsman 2012). The communalities shown in Table 5.17 indicate that only five variables exceed 0.70, and the lowest communality is 0.57.

Factor Structure: Application

Table 5.18 indicates the factor structure for the Application section. It shows that only one factor was extracted based on the total Eigenvalue that is greater than 1: Personalised learning.

Table 5.18: Factor analysis for application based on student survey

Factor name	Total Eigenvalue	% of V.	Factor loading	Communality
Personalised learning	3.082	61.642		
Personalised learning allows me to obtain interesting content.			.845	.681
Personalised learning allows me to customise my learning.			.839	.750
Personalised learning allows me to not be overloaded with information.			.799	.714
Personalised learning allows me to stay connected with my learning.			.785	.552

Personalised learning consists of four variables with a total Eigenvalue of 3.082. The highest factor loading for this factor is “Personalised learning allows me to obtain interesting contents". In general, the variables show that personalised learning can offer an effective learning experience by providing interesting content, customised learning, required information, and active learning. In the communalities shown in Table 5.18, only two variables exceed 0.70, while the lowest communality value is 0.55.

Factor Structure: Sustainable Development

The factor structure for the sustainable development section shows that only three factors were extracted based on a total Eigenvalue greater than 1: sustainable technology, sustainable mobile learning, and sustainable education.

Table 5.19: Factor analysis for sustainable development based on student survey

Factor name	Total Eigenvalue	% of V.	Factor loading	Communality
1. Sustainable technology	10.772	53.861		
The amount of printed learning content can be reduced by providing online content.			.836	.759
The amount of printed learning content can be reduced by providing online assessments.			.827	.769
The amount of printed learning content can be reduced by providing software that allows online editing and collaboration.			.807	.740
Better browsing and connectivity between e-learning content can help me save time.			.806	.801
The amount of printed learning content can be reduced by providing guidelines on how to save printing costs.			.772	.679
Better browsing and connectivity between e-learning content can help me reduce energy consumption.			.765	.595
Better browsing and connectivity between e-learning content can help me reduce cost.			.760	.744
The amount of printed learning content can be reduced by providing software that eliminates useless pages when printing.			.753	.686
The amount of printed learning content can be reduced by providing technology to improve online reading.			.748	.702
I believe sustainable e-learning can reduce the environmental impact of technology.			.736	.656
2. Sustainable mobile learning	2.012	10.060		
For sustainability, mobile learning should offer me personalisation.			.850	.746
For sustainability, mobile learning should offer me open data that serves mobility.			.792	.689
For sustainability, mobile learning should offer me a user-friendly interface.			.784	.680
3. Sustainable education	1.313	6.565		
Sustainable education can be achieved by integrating sustainability issues in the learning experience.			.858	.825
Sustainable education can be achieved by integrating the sustainable			.823	.817

development concept across education.				
Sustainable education can be achieved by articulating the benefits and limitations of being eco-literate.			.758	.762

Printing and Connectivity consists of ten variables with a total Eigenvalue of 10.772. The highest factor loading for this factor is the statement “the amount of printing learning contents can be reduced by providing online contents” (0.84). The communalities under this factor indicate that only six variables exceed 0.70, while the lowest communality value is 0.6.

Mobile learning includes three variables with a total Eigenvalue of 2.012 and one variable that has a communality value over 0.70. Finally, the third factor, sustainable education, comprises three variables with a total Eigenvalue of 1.313. All the communalities for the variables under this factor are above 0.70, which shows that it is reliable.

5.3.4. Student: Qualitative Analysis

This qualitative analysis section was divided into four sections: e-learning principles, technology, application, and sustainable development. The qualitative data for every section was analysed using manual coding. The reason for this method is because coding is a commonly used qualitative data analysis approach as it demands both data induction and deduction (Northcutt and McCoy 2004). Therefore, the patterns of the data were identified based on similarity and frequency, coded with category names, and divided into meaningful categories (Saldana 2009). In addition, data cleaning was done to remove grammatical and spelling errors.

5.3.4.1. E-learning Principles

Similar to the quantitative analysis, the e-learning section and learning principles section were combined under one category named e-learning principles in which students were asked to give their opinions. The data for this section was divided into coded and meaningful categories as shown in Figure 5.7 below.

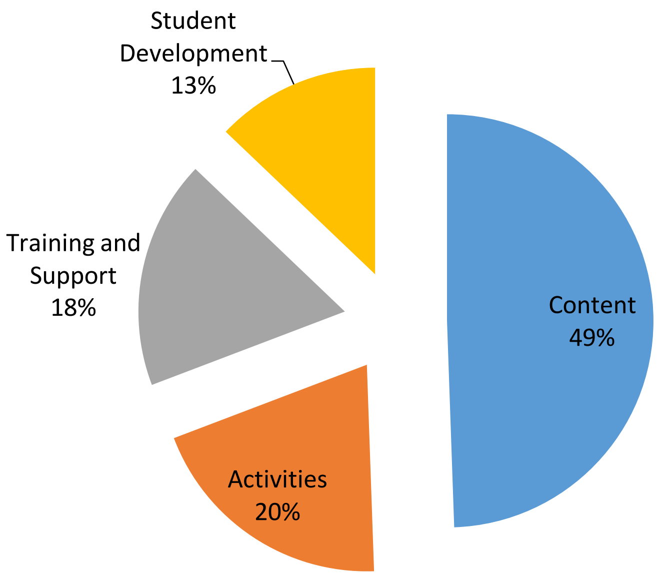


Figure 5.7: Percentage of categories for the e-learning section based on student survey

Figure 5.7 shows the percentage of categories identified in the e-learning principles section. The ‘Content’ category was identified most frequently (49%). This indicates that the students were most concerned about learning materials such as online quizzes, assessments, and learning notes. The finding indicates that contents need to be stored in a reliable database, have richer resources and are available in a variety of formats. Moreover, with responsiveness towards e-learning activities at 20%, this indicates that the students looked forward to activities that involve analytical or problem-solving approaches, teamwork discussion, and educational games. Training and support (18%) and student development (13%) seem to be necessary to ensure that e-learning is fully utilised and thus the personal and social competency of students will be developed.

5.3.4.2. Technology

In this section, students were asked to respond to an open-ended statement, which is “Please add other comments on new technology”. The data for technology section was divided into coded and meaningful categories as shown in Figure 5.8 below.

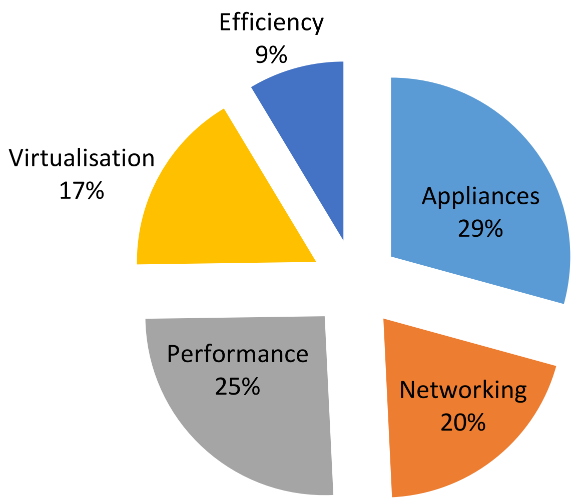


Figure 5.8: Percentage of categories for the technology section based on student survey

Figure 5.8 represents the percentage of the categories for the technology section. The highest percentage is for appliances at 29%, followed by performance (25%), networking (20%), virtualisation (17%), and efficiency (9%). This indicates that most students looked for technology that improves devices, performance, and networking that e-learning has to offer. Students look for devices such as smartphones and tablet compatibles, sustainable technology, and personal digital assistant to guide them in learning. They also wanted better e-learning performance and networking that provides faster network connections and processors that improve communication and performance. Students also believed that virtualisation such as immersive worlds, 3D animation, and avatar worlds would improve learning.

5.3.4.3. Application

Similar to previous sections, Nvivo was used in analysing the qualitative data for the question regarding the application. The data were allocated into coded and meaningful categories with category names as shown in Figure 5.9 below.

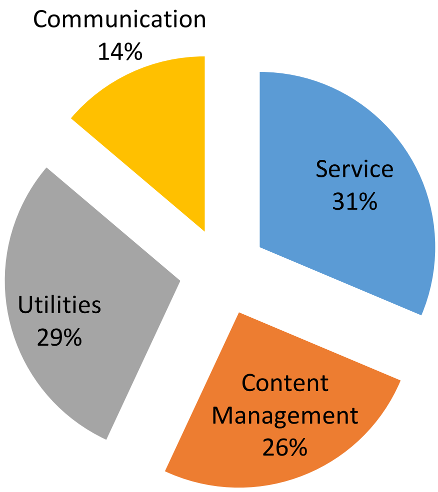


Figure 5.9: Percentage of categories for the application section based on student survey

Figure 5.9 indicates the percentage of categories in the application section. The highest percentage is Service (31%), followed by Content Management (26%), Utilities (29%), and Communication (14%). This indicates that students looked forward to applications that enhance their curriculum and pedagogy through flexible and compatible services, the use of document editor and productivity tools such as on- board spell checker, presentation tools, lecture recorder, and enhanced communication such as social network and real-time messaging.

5.3.4.4. Sustainable Development

Qualitative data from the open-ended statement from the sustainable development section were coded and divided into meaningful categories using Nvivo as shown in Figure 5.10 below. The question is about students' attitudes towards new technology and the environment.

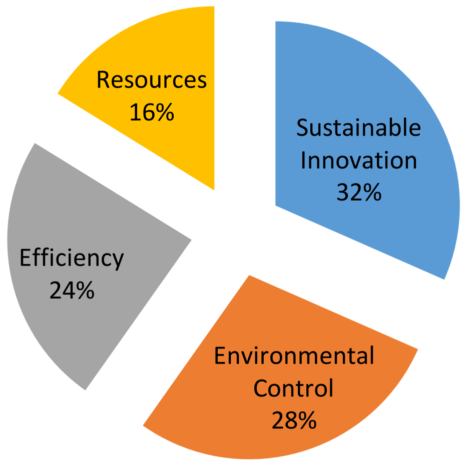


Figure 5.10: Percentage of categories for the sustainable development section based on student survey

Figure 5.10 signifies the percentage of categories for the sustainable development section. The highest percentage is for sustainable innovation (32%) that refers to green technology and sustainable and eco-friendly innovation that ensures long-term usefulness and suitability for its environment. Environmental control (28%) represents students' concern on technology innovation regarding its impact on the environment. This includes technology that produces less carbon emissions or pollution and consumes less energy. Nevertheless, students were concerned about the efficiency of a technology. It must be economical, and the resources must be reused or recycled in order to avoid waste. Overall, participants believed that technologies that help reduce carbon emissions or pollution, save energy and use recycled or reuse resources can actually reduce negative impact on the environment.

5.3.5. Summary of Students' Survey

Overall, the data analysis conducted for the student survey showed that the data reliability for the quantitative data is considered acceptable. Meanwhile, the manual coding method is a suitable method for analysing the qualitative data obtained from responses to the open-ended statement.

Table 5.20: Summary of student survey

Method	Elements to be added to the research artefact (SeLF)
Factor analysis	E- learning Principles 1. E-learning importance 2. E-learning risks 3. E-learning opportunities Technology 1. Web evolution 2. Intelligent system Application 1. Personalised learning Sustainable Development 1. Sustainable technology 2. Sustainable mobile learning 3. Sustainable education
Qualitative analysis using Nvivo	E-learning Principles 1. Contents 2. Activities 3. Training and Support 4. Student Development Technology 1. Appliances 2. Networking 3. Performance 4. Virtualisation 5. Efficiency Application 1. Service 2. Content Management 3. Utilities 4. Communication Sustainable Development 1. Sustainable Innovation 2. Environmental Control 3. Efficiency 4. Resources

Based on Table 5.20 above, there are nine new elements based on factor analysis and 17 new elements based on the qualitative analysis using NVivo for qualitative data. These new elements were considered to be included in the research artefact.

5.4 Response to Research Questions

In order to address the research questions, the surveys were divided into four sections which represent the characteristics of developing a Sustainable e-Learning Framework for Malaysia and the expectations of academic staff and students regarding the characteristics of SeLF. However, to develop the research artefact (SeLF), some elements were combined based on their shared characteristics. Therefore, only two main elements were included in the research artefact namely E-learning and E-teaching Principles and Technology.

Based on the summary of student and academic staff findings, all elements were revised and re-categorised under e-Learning and e-Teaching Principles, Technology, Application, and Environment. In addition, these elements were categorised under the context of governance, user, and e-learning components.

In relation to the first research question which is to ascertain the characteristics of developing a Sustainable e-Learning Framework for Malaysia, Table 5.21 below reveals the new elements for the research artefact based on the survey findings. These findings led to the newly identified characteristics of SeLF for Malaysian higher education institutions.

Table 5.21: New characteristics for research artefact

Section	Governance	User	E-learning component
E-teaching and E-learning Principle	• E-learning importance • E-learning risks • E-learning opportunities	• Students' development • Training and support • Motivation	• <u>E-learning resources</u> • <u>Sustainable education</u>
Application	• Mobile learning • Administration service	• Personalised learning • Social and networking • Productivity	• Content management • Course tools
Technology	• Performance • Efficiency • Mobility	• Connectivity and networking	• Information connectivity • Virtualisation • Web evolution • Intelligent system • Consistent infrastructure • Database analytics
Environment	• Sustainable consumption • Efficiency • Environmental Control	• Participation • User belief and behaviour	• Sustainable Innovation

To answer the second research question, which was intended to find out the expectation and attitudes of stakeholders towards sustainable e-learning characteristics, the identification of new characteristics (see Table 5.21) indicates the expectations and attitudes of the academic staff and students regarding the characteristics of the initial version of SeLF.

5.5 Summary

This chapter has discussed the research findings based on surveys conducted on 315 academic staff and students. Firstly, the response rates and demographic profiles of participants were presented to show the backgrounds of participants. Then, this chapter discussed the data analysis using descriptive statistics, preliminary analysis, factor analysis, and manual coding analysis.

The continuous literature review on sustainability inspired the modification of SeLF to ensure the framework contribution to sustainability. The literature review on TBL as sustainability dimensions has motivated the modifications of SeLF. The literature review on TBL has highlighted important points such as business performance and strategy plan. Thus, strategy plan has been considered as the input of SeLF and business performance that involves priorities, benefits, and measurement has been considered as an outcome. As a result, this has led to changes of SeLF objectives and practicality, and the inclusion of SeLF outcome measure Triple Bottom Line elements as drivers of the framework, and input and outcome aspects to assist the implementation of SeLF .

Survey findings as shown in Table 5.10 (summary of academic staff survey) and Table 5.20 (summary of student survey) has led to the development of new characteristics of SeLF as shown in Table 5.21 on page 143. Based on the summary of student and academic staff findings, all elements were revised and re-categorised under e-Learning and e-Teaching Principles, Technology, Application, and Environment context. In addition, these elements were categorised under the context of governance, user, and e-learning components as the new area of focus. Also, inclusion of an additional element called User belief and behavior to SeLF was considered as this element was found on both the academic staff and the student survey. The outcome of this chapter is the elements which were identified based on the findings of the survey and used to revise the initial draft of the sustainable e-learning framework. These elements indicate the characteristics of a sustainable e-learning approach.

As a conclusion, the findings addressed the first research question, which is to determine the characteristics of a Sustainable e-Learning Framework for Malaysia, and the second research question which concerns the expectation and attitudes of stakeholders towards sustainable e-learning characteristics.

CHAPTER 6

DATA ANALYSIS AND RESULTS: DSR EXPERT INTERVIEW

6.1 Introduction

Qualitative data was collected through expert interviews during which the utility and usability of the Sustainable e-Learning Framework were iteratively evaluated and refined. In order to achieve SeLF practicability in different contexts, stakeholders from various universities were invited to participate. The experts' perceptions and expectations of sustainable e-learning in the context of SeLF are presented in this chapter. In particular, the findings from the expert interviews address the second research question: 'What are the stakeholders' perspectives and expectations on the characteristics of sustainable e-learning?' and the third research question: 'How can the new Sustainable e-Learning Framework assist the Malaysian higher education stakeholders to become more sustainable?' The Design Science Research (DSR) interviews are also strengthened by the survey findings regarding the characteristics and success factors of sustainable e-learning. The participants were asked to study a research artefact (Appendix VII) to determine how the SeLF would impact sustainable practices at their own university, and to comment on their personal practices in relation to e-learning sustainability. Participants were interviewed and qualitative data were analysed using manual coding to avoid any data misinterpretations that may have led to loss of validity (Basit 2003). Chapter 3 presents the details of the data analysis process. This chapter is divided into five main sections: research artefact document, participants' profile, research method, data analysis results and discussion (emerging themes and summary of each theme), and chapter summary.

6.2 Research Artefact (SeLF) Document

Based on the findings from the survey, revisions on the Sustainable e-Learning Framework were made. New elements, components, and aspects of SeLF were described in the research artefact document (see Appendix VII). This document was distributed to the participants prior to the interviews. The participants were asked to study a research artefact document to determine how SeLF would impact sustainable practices at their own university, and to comment on their personal practices in regard to e-learning sustainability.

6.3 Participants' Profile

There were seven participants in total, divided into two rounds of interviews. The participants were experts in e-learning development, education, and sustainable development. The first round involved a member of UNESCO Learning Technologies and an expert from the Faculty of Learning Engagement Team in an Australian university. The second round of interviews involved an online coordinator of online Master of Business Administration, manager of e-Content development for e-learning and Massive Open Online Content (MOOC), a Deputy Vice-Chancellor of a university, and the Head of Social Transformation and Development for Sustainability. They were all PhD holders. Generally, participants had knowledge in education and sustainability, and e-learning experience.

Table 6.1: Experts' profiles

Round	Expert's Position	Country
1st Round of interviews	1. A member of UNESCO Learning Technologies,	• Netherlands
	2. An expert from Faculty Learning Engagement Team.	• Australia
	3. Associate Dean in Teaching and Learning.	• Australia
2nd Round of interviews	4. Online Coordinator of Online MBA	• Australia
	5. Manager of e-Content Development	• Malaysia
	6. Deputy Vice-Chancellor	• Malaysia
	7. Head of Social Transformation and Development for Sustainability	• Malaysia

The interviews elicited various experts' opinion from different countries and with different knowledge backgrounds, which enabled us to engage in experience-based discussions and receive valuable feedback especially from Australia, which is a developed country.

6.4 Research Method

Expert interviews were voluntary and undertaken with the approval of the Human Research Ethics Committee (approval no: RDBS-62-15). Unlike the survey, the interview samples were non-random since the most suitable participants were those with experience in e-learning, online education, or sustainable development.

The expert interviews consisted of five objectives as shown in Table 6.2 below. These objectives and conversation themes guided the interviews to ensure that the discussions would remain focused on the evaluation of the research artefact. Prior to the interviews, experts received the research artefact brochure (see Appendix VII) that included the framework, descriptions of the SeLF elements, the contribution of SeLF to the Triple Bottom Line, and the intended use of SeLF. DSR expert interview were trialled with research supervisors.

Before the interview, email invitations as well as the research artefact brochure were sent to experts in e-learning, education, or sustainable development areas. The participants were invited to read the brochure and consider how to apply its contents to their current practices. Prior to the DSR interview, the participants were asked to reflect on the extent that this framework might impact online learning at their home institutions. Based on the feedback from the first round of interviews, minor changes were made to the framework document to make it more concise yet still comprehensive before commencing the second round of interviews. The changes included the removal of examples of SeLF elements (see Appendix VIII). The research artefact brochure was intended to give the participants comprehensive information about the SeLF research artefact to assist them in evaluating the framework. Each interview lasted between 30 and 40 minutes.

Table 6.2: Questions asked at the interviews with experts

Objectives	**Conversation Themes**
<u>Opening</u>	1. To what extent has preparation for this interview caused you to reflect on sustainable eLearning at your institution? 2. What will be the significance or impact of changes that arise as a result of any changes that you or your institution might implement?
<u>Effectiveness of SeLF</u>	3. How will SeLF lead to learning that is more sustainable than at present? 4. How will you measure this? 5. Will you use SeLF at your institution? 6. How will you use SeLF? 7. What benefits will arise for your institution as a result of using SeLF? 8. What benefits will arise for staff at your institution as a result of using SeLF? 9. What benefits will arise for students at your institution as a result of using SeLF? 10. What benefits will arise for your local community or the nation as a result of using SeLF? 11. Will you recommend SeLF to others? Why?
<u>User knowledge</u>	12. Are you able to describe to others how sustainable e-learning is different from e-learning and learning in general?
<u>User experience</u>	13. How similar or different SeLF is compared to other frameworks you have used? How was it used? 14. Will you use SeLF differently from other frameworks that you have used? 15. What difficulties or limitations did you experience with other frameworks that can be solved by using SeLF?
<u>Closing and suggestions</u>	16. What would you change to make SeLF more relevant to you and your institution?

These interviews were essential since the experts' feedback regarding the design of the proposed framework was considered valid and useful (Cuomo and Bowen 1994; Peng, Ramaiah and Foo 2004). The main purpose of the discussions was to determine experts' attitudes towards sustainable e-learning and the SeLF framework.

Manual coding was used that included first coding, creating, working, and shaping the data (Bazeley and Richards 2000). There are five steps involved in manual coding:

i. Transcription of each interview recording
ii. Code the data (creating codes, refining codes, notes for codes)
iii. Search for themes
iv. Themes review
v. Report on findings

The recordings of the interviews were transcribed by a professional transcription service. The transcriptions were formatted in a word file with left and right columns to provide space for the codes and themes. The researcher then performed validation by reading each of the transcripts while listening to the recordings to ensure accuracy and to acquire a general sense of the data.

Throughout the reading process, the researcher coded the data by locating text segments and assigning a code to those texts (see Figure 6.1 below for an example). Codes were analysed and categorised based on the meaning of the data (Jones 2007). Many codes were identified, and these codes were refined as they have expanded and hence, the coding categories were revised. Some codes expanded due to too much data and these codes needed to be broken down into sub-codes. The rule of thumb was to ensure that the codes fit the data. Notes were also made on the ideas that emerged during the reading and analysis of the transcripts.

Code		Interview Transcription	Themes
TBL concern	P:	Yes. So we are concerned about society and the economy. I think environment is a rather new issue. Except some studies who do water management, do some atmospheric or agriculture planning, they are aware of that. But that's just one faculty.	Potential theme: TBL/ sustainability
	I:	So if you introduce this framework to your colleague does it - will it improve - benefits them?	
Ethics, tolerance, and peace components	P:	Yes. It's - for them, it's a rather new message. And it will be - will send it to the university on this area. But again, I would extend it to the more explicit ethics, tolerance and peace as well.	Ideas: improvement on SeLF
	I:	Okay. Ethics and tolerance. So do you understand between sustainability learning and e-learning itself?	
E-learning as part of innovation E-learning quality	P:	For me, e-learning is not even an essential thing. For me, e-learning is a catalytic thing, so it may speed up the process of innovation because it makes teachers think, 'What do I do if I go from the book, face to face situation, chalk board - if I go to the blackboard system,' that has the potential. But very often, the potential of e-learning is limited to what we already knew. So if teacher very keen on testing [00:38:59] management, then they will use - sorry, they will use blackboard for that lines to make it very strict, make students fairly active, very accurate. It's just not guarantee they're learning better. It's just a, kind of, feeling of safety that from managerial point of view, they are very confident	Idea: a good sense here for how sustainable e-learning different with e-learning

Figure 6.1: A screenshot of manual coding process of the transcription

The list of codes was sorted into potential themes. Figure 6.2 shows an example that was based on manual coding for the data from one of the interviews. Codes may be used to establish main themes and sub-themes, or discarded.

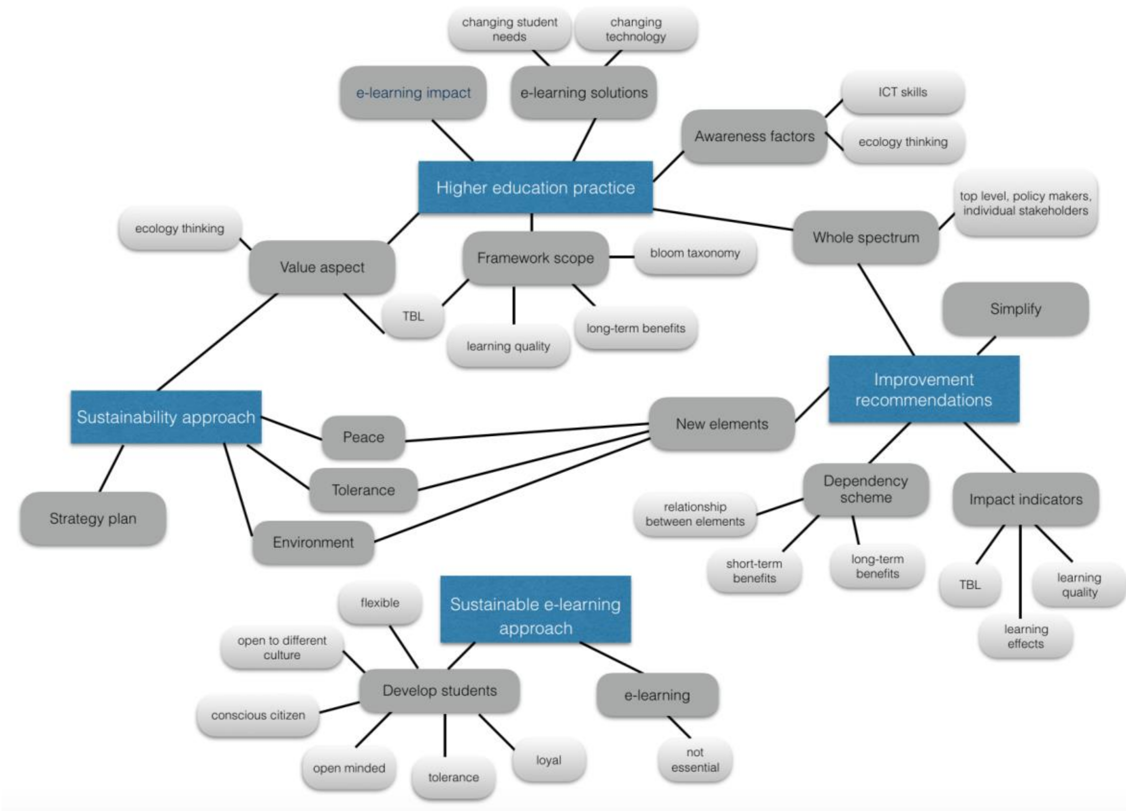


Figure 6.2: Codes identified in an interview transcript were sorted into potential themes

In order to provide a clear view of themes and codes shown in Figure 6.2, Table 6.3 was produced to list the codes under a specific theme. The themes were reviewed after the interview data and codes were reviewed to ensure the codes and data were aligned with the identified themes, and that the relationship between the themes reflected the overall meaning of the data. These codes were also used as descriptions in the findings report. As a result of the coding, four themes emerged: 1) sustainability approach, 2) sustainable e-learning approach, 3) higher education practice, and 4) continuous improvements for SeLF.

Table 6.3: List of codes that were categorised under a specific theme

Theme Number	Theme Name	Codes
1	Sustainability approach	➢ TBL (positive impact) ➢ Sustainability dimensions ➢ Economy –ROI ➢ Society – sustainable supplier, ethics, welfares ➢ Environment – impact ➢ e-learning stakeholders – benefits, ecological thinking ➢ Education equity – education for All ➢ Wider learning communities
2	Sustainable e-learning approach	➢ Cost-effectiveness ➢ Low paper consumption ➢ Sustainability values ➢ Sustainability ethics ➢ Professional learning ➢ Continuous e-learning initiatives ➢ Learning equity ➢ Learning access ➢ Develop graduates/students; • Loyal • Conscious citizens • Flexible • Global citizens • Open to assimilate different culture • Tolerant • Open-minded ➢ Sustainable resources ➢ Sustainable human resources ➢ Sustainable financial ➢ TBL

3	Higher education practices	➢ TBL – benefits ➢ Quality learning ➢ Bloom taxonomy ➢ Higher education standards ➢ Practicality – Teaching and Learning context, any context ➢ e-learning stakeholders - benefits ➢ Measure e-learning impact o Society o Economy o Environment ➢ Sustainable development goals ➢ Unsustainable initiatives factors ➢ University reputation o TBL report/measures o Sustainable consent o Ethics
4	Improvement recommendations	➢ Impact indicators –TBL ➢ Communication channels ➢ Iterative process o Continuous development o Reduce risk o Improvement ➢ Add elements o Ethics o Tolerance o Peace o Culture ➢ Complexity

6.5 Data Analysis and Results: Emerging Themes

This section presents an analysis of transcripts from the interviews. As mentioned previously, the interviews were intended to acquire experts' evaluations of the utility of the research artefact, SeLF. Each subsection includes the identified themes followed by a summary of the discussions and findings for each theme.

6.5.1 Theme 1: Sustainability Approach

The experts evaluated the impact of SeLF based on e-learning practice in their own institution. Expert 3 pointed out that SeLF does not contribute to e-learning sustainability dimensions due to its non-direct contribution to the TBL. The expert suggested that the contribution of SeLF to the TBL should be more detailed by providing examples showing how each element of the SeLF contributes to the TBL. However, other experts agreed that the use of SeLF is likely to contribute to e-learning sustainability dimensions related to society, the economy, and the environment. It was noted that most experts believed that SeLF was more likely to offer benefits to e-learning stakeholders. In regard to SeLF's contributions to the Triple Bottom Line, they expressed their belief that SeLF would have positive impacts on the societal, economic, and environmental aspects. The participants also added that SeLF encourages e-learning stakeholders to be aware of the impact of each sustainability dimension.

> *"...include in sustainability, you include a bit of side effects like the governance, the societal, economic, the ecological." – Expert 1*

> *"The economy… funding… students' value for money for their investment in their program." – Expert 2*

> *"The environment... moving and adapting their model" – Expert 2*

> *"It's going to be a big grab of all these three triple bottom line things. You can't really isolate one. You're going to have to say I think it says, we have to take the whole of that triple bottom line. And we don't do this yet and say let's formally work out what we want to cross all those three things (TBL) and translate those into how mobile learning will deliver all of that together." – Expert 4*

"So if I was the VC, I'd be going, I think we can do this and the boundaries have to be how can we take the society and economy and the environmental aspects, show some benefit to our sponsors." *– Expert 4*

"This is all about sustainability and not about other things" – Expert 5

The comments above indicate that SeLF provides a future economy direction and investment plan. SeLF considers environmental issues and therefore enables e-learning stakeholders to modify and adapt their models based on new requirements as they arise. One expert stated that the framework assists e-learning stakeholders to benefit the TBL. Most experts agreed that e-learning benefits society as it delivers education to students. One expert pointed out that SeLF promotes sustainability practices among e-learning stakeholders. An example given was that the introduction of supplier ethics could develop sustainable suppliers in the future. In consideration of economic factors, one expert was convinced that he was looking more towards the framework impacting economic factors that in turn affect sustainability. For instance, how an institution receives return on investment (ROI) from e-learning should be a consideration. Furthermore, experts pointed out that environment awareness could be delivered through education. Thus, SeLF allows e-learning stakeholders to consider ROI in all TBL dimensions. Apart from benefiting TBL, most experts indicated that SeLF will create awareness of societal, economic, and environmental concerns. The experts also mentioned environmental consequences, and societal and economic impact as part of sustainability awareness.

Expert 4 stressed that even though people recognise the TBL aspects, there is no generally accepted structure to help stakeholders explore this new area. The expert believed that SeLF is a structure that is well-positioned to fill this gap. The expert gave an example:

"In order to put a new server, we need to get a quote and check whether the server is green or not. In addition, check on how is the server going to change how much people travel. Also, check if the server makes it impractical to do from time and cost perspective". – Expert 4

To assist with these sorts of operational issues, the expert pointed out that SeLF provides a structure or a checklist to check off a range of things one at a time. Furthermore, SeLF was seen as a framework to guide measurement of the university's performance and impact on society, economy, and environment.

In response to the sustainable development goals in developing education equity (United Nations 2005, 2012; President of United Nations General Assembly 2015), the experts agreed that e-learning has the ability to provide education for all. However, some of the experts argued that it is not the responsibility of the university to provide everyone with decent qualifications. One expert added that in order to achieve sustainable development goals such as education equity, charging the right fees is necessary. The challenge of providing education for all is related to the issue of adequate funding (Gunn 2011; Delgado-Kloos et al., 2007; Grossman, 2008; McGill, Klobas, and Renzi, 2014). However, Expert 4 suggested that the institution should cooperate with the government to develop an education-for-all initiative and provide scholarships for students.

Most experts would like to use SeLF as part of a sustainability initiative in e-learning. One expert sees SeLF as a framework that could help develop technology that promotes wider learning communities, which could lead to sustainability.

> *"The wider the learning communities, the more sustainable e-learning is." – Expert 7.*

Another expert agreed to adopt SeLF if the goal is to develop sustainability in e-learning.

> *"And I would be very happy to take it (SeLF) as a forced strategy plan." - Expert 1*

Therefore, the importance of sustainable e-learning needs to be pointed out in order to promote a sustainability approach in e-learning. Nevertheless, sustainability is important to meet the future and present needs of learners (Robertson 2008), and sustainability in e-learning practices and its long-term benefits are essential to the future development of an institution (Stepanyan, Littlejohn and Margaryan 2013).

6.5.1.1 Summary of Discussion and Findings Associated with Theme 1

This section summarises the discussion and findings regarding the experts' opinions on the contribution that SeLF can make to achieve sustainable e-learning. The following is a summary of the major points:

- SeLF is intended to assist institutions to align their financial bottom line, environmental quality, and social justices to support sustainability.
- SeLF encourages institutions to evaluate their e-learning performance based on the sustainability dimensions.
- Education for all is achievable through e-learning. However, funding and support are required.
- SeLF can be viewed as a structure or guideline that assists e-learning stakeholders to contribute to the TBL.
- SeLF creates positive impacts on the Triple Bottom Line, while simultaneously developing sustainability values among e-learning stakeholders.
- Most experts agreed that SeLF could be used as a strategic plan for the development of sustainable e-learning.
- SeLF promotes sustainable practices among e-learning stakeholders by developing sustainable ethics and sustainable suppliers.

6.5.2 Theme 2: Sustainable E-learning Approach

It was noted that most experts presumed that e-learning was more likely to deliver sustainability due to its cost-effectiveness in leveraging existing technology and practical technology and tools, and lower paper consumption such as printing. The benefits of e-learning have been discussed frequently in e-learning literature, particularly the literature published over the past decade (Ali 2004; Selim 2007; Alias et al. 2012; Bourne and Moore 2003; Kar-tin 2005; Allen et al. 2010; Gulati and Srivastava 2010). However, findings from Gunn (2011), Attwell (2006), and Stepanyan, Littlejohn, and Margaryan (2013), indicated a few characteristics of sustainable e-learning that distinguish it from non-sustainable e-learning. These benefits were reflected in participant interviews in which experts talked about focus of e-learning on the development of learning objects and teaching.

"For me, e-learning is not even an essential thing. For me, e-learning is a catalytic thing, so it may speed up the process of innovation because it makes teachers think, 'What do I do if I go from the book, face to face situation, chalk board - if I go to the blackboard system that has the potential."- Expert 1

A number of experts stated that sustainable e-learning is different from e-learning itself based on sustainability values, ethics, professional learning, and continuous e-learning initiatives.

"Ethics is an essential one. It's also tolerance and peace, I would say." - Expert 1

"So, sustainability, in that sense, is both in terms of the cost – that's limited for long term. And secondly, the human resource aspect, both from our team and from the lecturing perspective." - Expert 2

According to one expert, SeLF can provide greater learning equity and access to learners with different backgrounds, financial support, and locations. The expert also believed that SeLF encourages profound thinking about the ability of e-learning to benefit higher education.

"Yes, definitely. E-learning is the opportunity to connect with learners across borders and geographical divides. It's also about access and equity because you will be able to provide higher education to people who may not be able to access it for some reasons such as they may not have the money to travel to come to the university. But instead they can use whatever resources they have to enrol in the online course."- Expert 7

"SeLF is looking at asking people to think a bit more about how or what benefits e-learning can bring to their own institution." – Expert 7

Literature has supported these findings on the sustainability aspects of e-learning. For instance, Attwell (2006) identified five aspects of sustainability in e-learning which are: sustainability of learning platforms and software, institutional responses, e-learning materials development, pedagogic approaches, and teacher and trainer skills. McGill, Klabas, and Renzi (2014) tested satisfaction of e-learning sustainability condition scores for continued and non-continued initiatives and found that these were affected by the presence or absence of ongoing financial support. Also, understanding the development and main themes of environmental, economic, and social ethics is required to develop an adequate sustainability ethics (Kibert et al. 2012). One expert mentioned that sustainability is a broad concept. This is consistent with the statement by McKenzie (2004) that sustainability is a broad multi-focal agenda and discipline that leads to definitions that are too broad to encompass all factors in any situation. The interviewees offered the following comments on sustainable e-learning:

> *"For me, sustainable is not learning for the certificates. The border of the Curtin, that's not the criteria for sustainable - for me, sustainable means the people coming from Asia, from any part of Europe, sort of, the students, that after they leave the university, then they should be as optimal as possible, conscious citizens, flexible and loyal - loyal. At least, they should be potentially global citizens, or very open to assimilate different cultures. So tolerance and open minded. And that is, I think, the real, kind of benefit that learning should bring. And I'm not sure if e-learning helps that process." - Expert 1*

> *"In the back of my mind I think along the terms of being economically sustainable, being resource sustainable, being human resource sustainable"- Expert 2*

> *"Sustainability is that you've got to have certain topics in your course, whether they're online or offline. It's not about e-learning, it's about what you do, so that's where ethics fits in and sustainability as environmental aspects, so each of our, it's content that connects us with sustainability that we currently have." – Expert 4*

> *"Sustainable e-learning – One, is to have a framework to be able to support the e-learning initiatives so that we can keep it going. Two, the e-learning objects or activities itself must be simple enough for any academicians to do on their own without having to rely on an instructional designer to design e-learning for them" – Expert 5*

Based on the various experts' opinions on e-learning and sustainable e-learning, SeLF is relevant to a sustainable e-learning approach due to the elements of the framework and the consideration given to the TBL. SeLF is relevant to e-learning practices since its elements have the potential to develop both e-learning and sustainable e-learning. The TBL aspects of the research artefact lead to sustainable practices in e-learning as TBL is concerned with the impact on people, the economy and the environment. Thus, SeLF is clearly focused on developing sustainable e-learning rather than just e-learning itself.

6.5.2.1 Summary of Discussion and Findings for Theme 2

This section discusses the findings that emerged from the experts' opinions about the relevance of SeLF in e-learning in the higher education sector. The following is a summary of the major points:

- SeLF could improve teacher's professional development through the training element to promote sustainability in e-learning.
- SeLF can be used as a guideline to ensure the continuity of e-learning initiatives and sustainability in e-learning.
- SeLF could develop a sustainable e-learning system through sustainable practices that are related to the society, the economy, and the environment.
- SeLF develops awareness on sustainability issues relating to environmental consequences, society welfare, and economic performance.
- SeLF has the ability to improve equity and access to learning.
- SeLF encourages further thinking on the ability of e-learning to establish a wider learning community that could ensure the sustainability of e-learning.

6.5.3 Theme 3: Higher Education Practices

All experts agreed that there is no e-learning framework that is similar to SeLF. Most experts agreed that SeLF integrates the variables of e-learning and sustainability such as the TBL. A variety of findings on students e-learning outcomes have been found in e-learning literature (Wan, Wang and Haggerty 2008; McPhee and Soderstrom 2012; Jenkins et al. 2011; Serwatka 2002). From the society perspective, most e-learning frameworks aim to benefit their users, especially the students. In regard to the environment, one expert talked about commercial implications being one of the factors that influence students' attitudes towards printing materials. One interviewee commented that SeLF is comprehensive as it includes measures of e-learning benefits in terms of the TBL.

> *"Well, you see, most of the models are just focussing on the quality of the learning in terms of final outputs, so I think very high in the group taxonomy. We can talk about creative skills, production, rather than e-production. We can talk about social skills like collaborative work, so in that sense, it is a limited subset of this. I think this is bigger. It's because I see it now, I'm excited. That's why I want it a little bit bigger." – Expert 1*

> *"Our e-learning framework doesn't consider sustainability in any way."– Expert 4*

> *"Yours looks into measuring the benefits of e-learning on society, economy, and environment." – Expert 5*

Based on the analysis of the interview data described above, participants were generally of the view that SeLF includes aspects of e-learning such as e-learning quality, Bloom's taxonomy, product, and learning skills. Uniquely, however, they were also of the view that SeLF is likely to lead to a sustainable approach to e-learning practices likely to benefit society, the economy, and the environment. One expert confirmed that SeLF has covered all the standards in the TEQSA higher education framework used in Australia. The higher education standards framework consists of seven dimensions: student participation and attainment, learning environment, teaching, research, institutional quality assurance, governance and accountability, and representation and information management (TEQSA(Tertiary Education Quality and Standards Agency Act) 2014).

> *"If you have a look at the standards, every one of your things here is in the standards so it's not, not that you're different, you're looking at it in a slightly different view of the world but the higher education standards are much more formal." – Expert 2*

It is evident from the experts' statements that SeLF is different from previously-developed frameworks, as it takes the TBL into consideration in the development of e-learning. The majority of the experts agreed that most e-learning frameworks are really about learning frameworks and delivering e-learning frameworks.

> *"Very different. So, for example, if you think about some aspects of the Higher Education Standards Framework, it would be ... they focus on, say, student engagement and there's many levels of this student engagement and how it plays out – student support, what do you do in your curriculum for student engagement? How do you encourage learning? What do you do for the staff to train them to understand what is student engagement, you know? But if you have a look at the framework, there are seven dimensions and each dimension is 10 pages or something."– Expert 2*

> *"So far we have only measured student acceptance and effectiveness of MOOC based on Kirkpatrick model. We have also used UTAUT2 (Unified Theory of Acceptance and Use of Technology version 2) model to measure student acceptance. Your framework looks quite comprehensive" – Expert 5*

One expert pointed out that SeLF is different from existing e-learning frameworks because it considers sustainability. Consequently, SeLF is useful for the development of e-learning especially in terms of sustainability.

> *"You say, we should take them into account and see what's the balance of the society or environment, humanity aspect. So it's a value aspect." – Expert 1*

> *"No, our e-learning framework doesn't consider sustainability in any way." - Expert 4*

They also believed that too little time is spent on sustainability considerations. Therefore, SeLF is a practical contribution to e-learning especially in ensuring sustainability because it is a comprehensive e-learning framework that includes most of the elements in the existing e-learning frameworks.

One expert opined that the framework has chosen appropriate variables for developing sustainable e-learning while another pointed out that SeLF would be useful for teaching and learning administration.

> *"That the learning and teaching process in SeLF should incorporate these elements (elements in SeLF). So, we know there are ICT skills, we know it as technology mildness, and this is kind of curricula branch, and also ecological thinking." – Expert 1*

> *"SeLF involves a lot of strategic planning. Some academic/teaching staff may argue that it is too time consuming use. SeLF may be useful for those involved in the administration of Teaching and Learning" – Expert 6*

Experts were asked whether SeLF would benefit their students, colleagues, and institution. All of them agreed that SeLF could deliver benefits to the e-learning stakeholders. One expert pointed out that the reason for adopting SeLF is to overcome issues related to current practice.

> *"Yes. It's - for them, it's a rather new message. And it will be - will send it to the university on this area. But again, I would extend it to the more explicit ethics, tolerance and peace as well."– Expert 1*

> *"I guess, for me, one of the problems that we face is being able to deliver these resources in a manner that is sustainable, i.e. not too intensive both in cost and resource – resource meaning how long it's going to take us to develop." – Expert 2*

> *"We could possibly enhance blended learning and e-learning related teaching and learning processes at the institution" – Expert 6*

Experts were asked whether they would use SeLF in their institution. Six of them expressed their interest in implementing SeLF in their institutions and measuring its actual impact on e-learning development.

> *"Yeah. I guess, for me, there's other outcomes. I certainly look at the society part as the student outcome. I look at the society part in terms of, maybe as an*

example, teaching staff being satisfied with their delivery of that unit and, consequently, how they've designed and developed and delivered that unit."- Expert 2

"Yes. I think it would be useful in that if you set these three bottom line measures, it's the measures, how you define that, you know." – Expert 4

"So, yeah, that sort of, seems like a real system." – Expert 4

"There is potential use for SeLF by my institution's Teaching & Learning Centre as we presently lead the university's move towards blended learning implementation. All categories prescribed in SeLF could potentially be applied for our activities in the Centre, except for the Environment category." – Expert 6

"However, I believe it is timely for a framework like SeLF to be introduced given the nation's targets for sustainable development, and the position of the local education sector in contributing towards these targets." – Expert 6

One expert would like to use SeLF because it measures the positive impacts of e-learning on the society, the economy, and the environment. Another expert pointed out that SeLF can be applied in any context such as the higher education, training, and vocational sectors.

Following their reading of the SeLF brochure, the experts discussed the application of a sustainable e-learning approach in their institutions. Two of the seven experts revealed that they were not aware of a 'sustainability' philosophy in their e-learning development such as course content, and also their institutions' practices overall.

"I think for my institute, it (SeLF) is a new message. I think we are not incorporate especially in the ecological thinking in the learning design and teaching design." – Expert 1

"I have not thought too much about the sustainability aspects." – Expert 2

This refers to the factors that could not sustain e-learning initiatives, and include lack of funding, low level of interest, and lack of awareness as mentioned by Gunn (2010). One expert mentioned about the pressure of being responsible to deliver e-learning for a fixed contract term, which has resulted in sustainability perspectives not taken into consideration. This is consistent with the findings of Gunn (2010) that fixed-term grants and individual pressures are the factors that lead to unsustainable e-learning initiatives.

Some of the experts believed that SeLF could benefit their institutions by improving their universities' reputation. One expert pointed out that focusing on the concerns of society, economy, and environment could enhance a university's brand or reputation. According to Thorp (2007), an institution could face consequences of unsustainable reputation caused by unsustainable practices as opposed to sustainable practices that could minimise the risk of public disappointments and boycotts. On the same note, Sridharan (2012) stated that TBL reporting is an instrument that boosts organisational credentials and develops reputation. The expert believes that sustainable e-learning delivers the university brand and its societal, economic and environmental values as part of the marketing tool. Another expert added that SeLF could develop an ethical university and thus uplift its reputation. This is consistent with the findings of Smart, Barman, and Gunasekera (2010) that a social and environmental ethics approach ensures an institution's ability to protect its reputation in the long term. They added that unethical behaviour usually leads to reputational damage.

> *"…these triple bottom lines can be outcomes, can generate a reputation or brand."- Expert 4*

> *"Develop a highly ethical university that takes care of its environment that actually contributes to everything around it." - Expert 4*

Experts also believed that the priority, benefits, and measurement of each selected elements brings benefits to the implementation process to ensure its effectiveness. By measuring the priority and benefits of e-learning initiatives, this could support the findings of Sridharan (2012) in identifying preferred technologies and learning resources that support various pedagogies for sustainable e-learning success.

6.5.3.1 Summary of Discussion and Findings for Theme 3

This section summarises the discussion and findings from the experts' viewpoints on SeLF's practicality in developing sustainable e-learning practices in the higher education sector. The following is a summary of the major points:

- SeLF has covered broad aspects of e-learning such as pedagogy and technology, which confirm that SeLF can make a practical contribution to e-learning in higher education.
- Integration of the Triple Bottom Line in e-learning development has made SeLF unique among other e-learning frameworks. In this regard, SeLF is usable to develop a sustainable e-learning that benefits the society, economy, and environment.
- SeLF has covered all the higher education standards established by the Education Quality and Standards Agency Act 2011; thus, SeLF is sensible in e-learning practice.
- SeLF can assist the education sector to contribute to sustainable development goals.
- SeLF can be implemented in many areas such as higher education, training, and the vocational sector.
- SeLF may improve e-learning and blended learning in an institution.
- SeLF comprises a variety of strategic plans for e-learning.
- All experts agreed that SeLF could benefit their students, colleagues, and institutions.
- The experts believed that a university's reputation can be improved through sustainability practices.

6.5.4 Theme 4: Continuous Improvements using SeLF

Several experts suggested that weight indicators be used to measure the impact of each SeLF element on the sustainability dimensions.

> *"The question is then: Can you give some right indicators, how much impact it has on society as a total?" – Expert 1*

One expert also suggested that communication throughout the process of using SeLF is necessary. In project management, effective communication regarding project scope, objectives, budget, outcomes, and benefits could improve business performance and project effectiveness (PMI(Project Management Institute) 2013). One expert suggested that the communication should start from the top layer (such as policy makers) to the second layer (such as senior managers), which could lead to changes in practices in schools and faculties.

> *"In negotiation, for example, you are trying to decide which benefit is more practical or which outcome is more sustainable, it needs communication and very clear understanding of what those communication channels will be."- Expert 2*

In the first iteration of the interviews, all experts commented that SeLF was a complex framework. This comment was no longer applicable after the complexity was reduced in the second iteration in response to the feedback. Firstly, the framework should include many facets to ensure it covers all e-learning and sustainability aspects. Another expert viewed the framework's contribution to TBL as 'fluffy'. In this regard, the SeLF brochure in Appendix XIII was revised to deliver a clear context and SeLF guidelines. The comments made are:

> *"It's complex and has many facets that I'm not clear how you work around. For example, if we take the first one which is 'e-learning teaching and principals', all three of these could include every one of these aspects. Multiply it out by every one of these, is very complex."- Expert 2*

> *"This table (referring to SeLF contributions in each sustainability dimension) here is too fluffy"- Expert 3*

Based on these comments, the framework brochure was simplified for the second iteration of the interview in which none of the experts believed that SeLF was complex.

Suggestions on adding variables such as ethics, tolerance, peace, and cultural in SeLF have also been informed. Some of the suggestions are:

“But again, I would extend it to the more explicit ethics, tolerance and peace as well.”- Expert 1

“So maybe sometimes you need to think about the cultural perspective that you’re going to often, I guess even in your own mind, find different arguments as to good and bad and positive and negative and whatever. Simply having assistance.”- Expert 2

One expert suggested that SeLF should be an iterative process given multiple cost-benefit scenarios requiring consideration. Another expert gave an example: if the priority is higher but the benefits are low, or an alternative has lower priority but highest benefits, some modifications need to be made to consider such an analysis. These modifications may require revision of the earlier phase such as goal definition or selection of SeLF elements which could overcome the identified limitations and provide a better alternative. The expert suggested that the TBL goal should be non-negotiable, but the elements and the priorities, benefits, and measurements should be iteratively involved. In the literature on iterative process, a number of researchers have indicated the benefits of the iterative process. For instance, Verma (2015) mentioned that the iterative approach provides the opportunity to continuously develop and improve the process. Kruchten (2000) also stated that the iterative process identifies and resolves risk during the process. One expert pointed out that the framework did not consider learning theory or learning models. However, they were considered and can be delivered through the SeLF components such as e-learning resources, student development, motivations, personalised learning, social and networking, and participation.

6.5.4.1 Summary of Discussion and Findings for Theme 4

This section summarises the discussion and findings regarding the experts’ suggestions for the improvement of SeLF. The following is a summary of the major points:

- Communication channels should be available throughout the SeLF process.
- SeLF should be developed iteratively.
- Variables such as ethics, tolerance, peace, and cultural issues should be considered.

- SeLF was found to be complicated since too many aspects were included in the framework. However, these aspects are important as they cover the broad range of e-learning and sustainability features.

6.6 Summary

The discussions on the themes, which were identified through the expert interviews appeared to confirm that SeLF contributes to the sustainability dimensions in the development of sustainable e-learning. Participants included experts with backgrounds in e-learning, teaching and learning, and sustainable development. Most experts showed a positive and welcoming attitude towards the potential of SeLF in their institutions. Experts also shared their thoughts and experiences in using and facilitating e-learning activities in their institutions. However, only one expert misunderstood the purpose of interview and SeLF document. The expert did not evaluate the use of SeLF, instead, the expert evaluatde the SeLF document as a thesis. Nevertheless, feedback from the expert has been taken into consideration and changes have been made to the document (see Appendix VIII). A summary of the key findings from experts' interviews is presented in Figure 6.3 below.

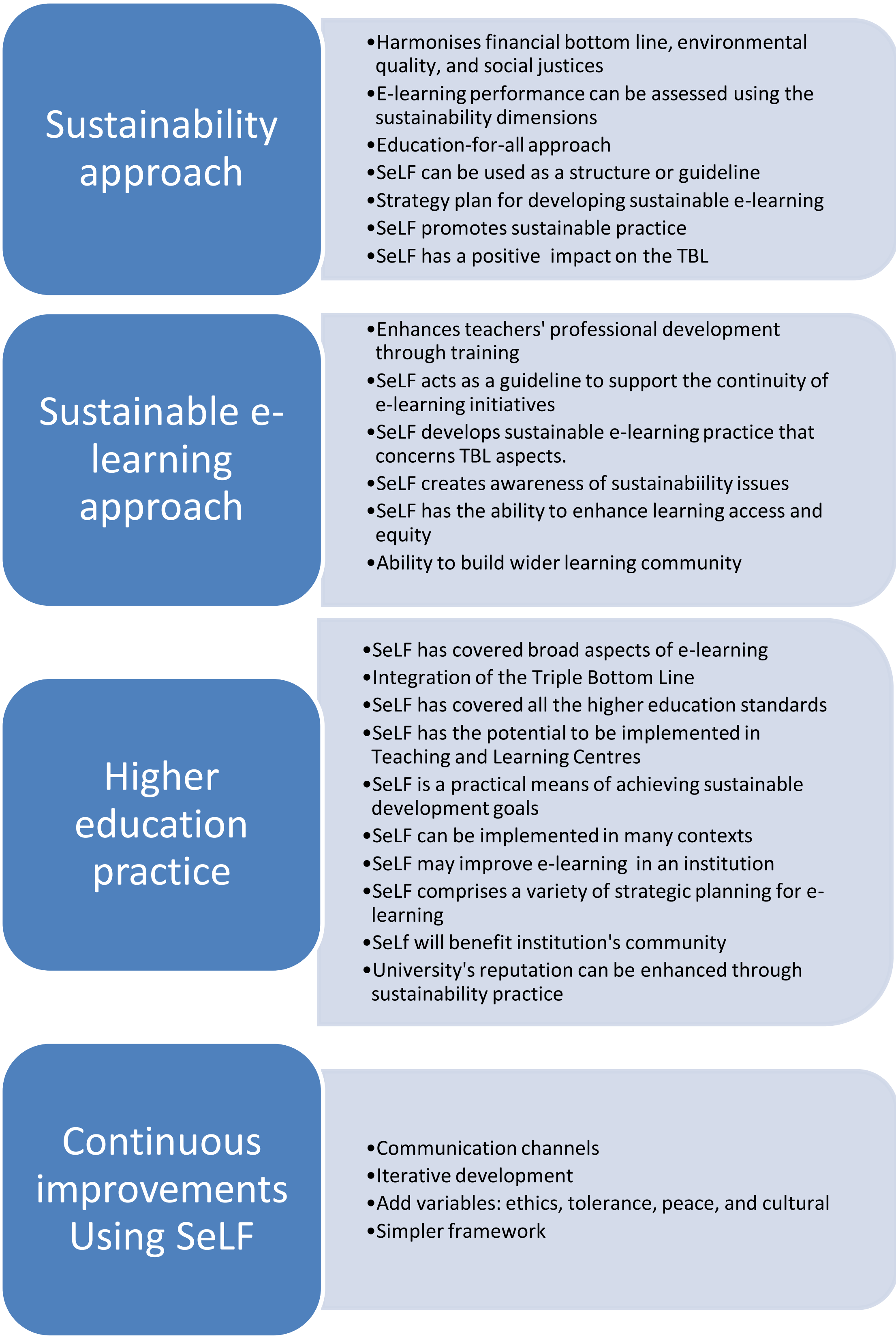


Figure 6.3: Summary of key findings from data analysis of interviews with experts

The experts offered suggestions that could improve SeLF. These suggestions were associated with practices related to project management and sustainable development. It is also important to note that the findings from the interviews addressed the second and third research questions. To conclude, this chapter reveals the experts' opinions on SeLF usage, as wells as the significance of SeLF in the development of e-learning in higher education.

CHAPTER 7

THE RESEARCH ARTEFACT: SUSTAINABLE E-LEARNING FRAMEWORK (SeLF)

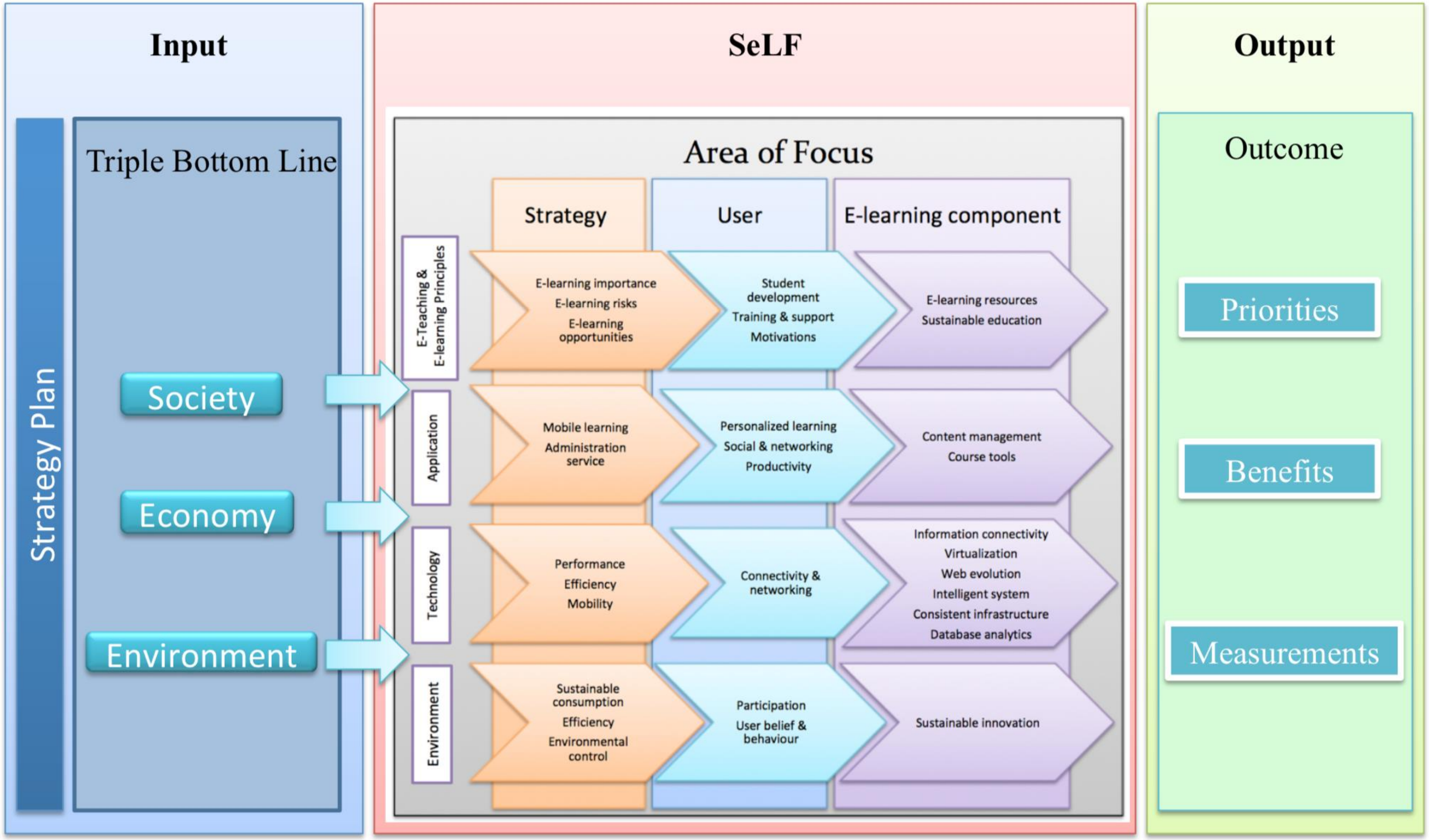
7.1 Introduction

Based on the data analysis and findings from the survey data collected, the initial SeLF was revised to enhance the significance of the framework. Amendments to the framework involved an adjustment to the area of focus, and the addition of two new elements named ‘User belief and behaviour’ and Triple Bottom Line. Input and outcome aspects were added to guide users when implementing SeLF to develop a sustainable e-learning.

7.2 Research Artefact

Based on the results obtained from the analysis of the survey data, the feedback was considered and incorporated into a revised version of the Sustainable e-Learning Framework, as shown in Figure 7.1 below.

Figure 7.1: Revised SeLF



The participants' feedback on survey led to major and minor modifications as follows:
Major modifications:

- Objectives of SeLF
- SeLF practicality
- Area of focus
- SeLF outcome measure
- Inclusion of an additional element called User belief and behaviour
- Inclusion of Triple Bottom Line elements as drivers of the framework
- Additional input and outcome aspects to assist the implementation of SeLF

Minor modifications:

- A description of the elements of the framework
- Amendments to the elements

7.2.1 Objectives of SeLF

The Sustainable e-Learning Framework delineates the characteristics of sustainable e-learning from the perspective of Malaysian higher education stakeholders. Based on the effective pedagogies presented by Husbands and Pearce (2012) , SeLF supports e-learning pedagogies that foster student learning, balanced assessment, and equity by taking into consideration their long-term learning outcomes and short-term goals.

SeLF aims to provide an e-learning system that supports continuous learning through efficient and effective learning activities. It was designed to assist Malaysian higher education stakeholders to achieve sustainability. By contributing to the achievement of sustainable goals, SeLF is aligned with formal sustainable development plans such as those established by the 2005 World Summit, The Future We Want 2012, United Nations summit for the adoption of the post-2015 development agenda, 11th Malaysia Plan 2016-2020, and the Malaysia Education Blueprint 2015-2025 (Higher Education). Hence, SeLF is a means of promoting lifelong learning, education equity, and education on sustainable development.

SeLF was designed to help Malaysian institutions achieve sustainable goals focusing on education equity, equal access to affordable and quality higher education, and increased enrolment in higher education. E-learning as a knowledge or learning resources repository has the potential to provide access to knowledge that supports lifelong learning and facilitates globalised online learning.

The main users of the SeLF framework could be the university e-learning governance committees or university executive leadership such as the Vice-Chancellor who could use SeLF to publish guide and information concerning the e-learning policy of their respective institutions. Together with the involvement of other e-learning stakeholders such as students and academic staff, DSR interviews suggested that SeLF is well-positioned to assist institutions to sustainably address the needs of learners now and in the future.

7.2.2 Processes for Applying SeLF

SeLF provides guidelines to facilitate the establishment and ongoing monitoring of sustainable e-learning policy while improving learning outcomes in a manner that benefits the economy, society, and environment. Elements and descriptions of SeLF are intended to be valuable resources enabling policy makers to differentiate between sustainable and non-sustainable e-learning initiatives. There are eight steps in the SeLF implementation process:

i) Align elements of the institutional strategic plan with e-learning goals or sustainable development goals based on a Triple Bottom Line analysis.
ii) Select the category that contributes to each e-learning or sustainable development goal.
iii) Identify the area of focus: Governance, User, or E-learning Component based on each e-learning or sustainable development goal.
iv) Select the necessary element (sub-category) that could contribute to the e-learning goal or sustainable development goal and develop or enhance it in effective ways to support the goal.
v) Prioritise the selected elements based on institutional priorities.
vi) Articulate the benefits of developing or improving the element in a manner that justifies the priority ascribed to each element.

vii) Identify metrics that can be used to measure goal attainment.

viii) Use identified metric measures to monitor short-term and long-term goals, and manage policies and resources based on the needs of today and tomorrow.

7.2.3 Application of SeLF for E-learning Development in Higher Education Institutions.

The framework is intended to develop or improve sustainability of e-learning in higher education institutions. The elements of SeLF encompass matters that a higher education institution would ordinarily be expected to address in directing and evaluating sustainability in its e-learning development, implementation and ongoing use, including the management of any associated risks. Each of the elements has a potential area of risks to be managed. These risks may impact e-learning sustainability in terms of e-learning usage, long-term usability, and availability of resources.

SeLF can be applied by a range of users from top-level policy makers to individual stakeholders: school, academic staff or students. The implementation of SeLF requires communication channels such as seminar, training, and email, which are important to ensure stakeholders' contribution, awareness, and engagement in the decision-making process. Moreover, aspects such as ethics, culture, peace, and tolerance must be taken into consideration to ensure that the application of SeLF respects the e-learning stakeholders, society, economy, and the environment.

7.2.4 Area of Focus

Based on the survey result, amendments to the area of focus were carried out in order to clarify how the SeLF components should be applied in various contexts. The previous areas of focus were students, academic staff, and general context. The three areas of focus have now shifted onto Governance, User, and E-learning components, which were categorised based on the e-learning setting. Governance relates to how the e-learning stakeholders plan the e-learning features and define e-learning goals. User refers to the e-learning stakeholders, in particular the academic staff and students. The E-learning components refer to the system or features that integrate e-learning to meet users' requirement and achieve the strategy. The decision on the revised area of focus was mainly based on the review of e-learning literature.

7.2.5 SeLF Outcome Measure

Elements contributing to the identification of goals are evaluated with respect to short-term and long-term benefits to the institution, learner, and society. The benefits should be mentioned when communicating the identified institutional priorities to the stakeholders, and to inform of the establishment of metrics that can be used to measure outcome attainment.

7.2.6 The Input: Additional Strategic Plan and the Triple Bottom Line Elements

Strategic plan: High–level definition of sustainable e-learning

This thesis defines sustainable e-learning as "*Online education that performs sustainable practices to promote education equity (society), income equity (economy), and low carbon future (environment) while meeting the learners' present and future needs".* This extends Robertson's (2008) definition, that is, *"*e-learning that has become normative in meeting the needs of the present and future" and definitions of Li, Duan, Fu, and Alford (2012) and Ibezim (2013), who have indicated the importance of identifying suitable e-learning functionalities and technology that meet students' needs.

Strategic plan: The Triple Bottom Line

Strategic planning aligns the elements of the institutional strategic plan with e-learning goals and sustainable development goals based on a Triple Bottom Line analysis. Based on the survey result, e-learning components and features should benefit people (e-learning users such as students and academic staff), the economy (cost and funds), and the environment (less air pollution, paper usage, and energy consumption). Thus, in collaboration with this survey findings and the review of literature on sustainability, TBL can promote sustainability considerations across multiple dimensions. Therefore, the TBL's components of society, economy and environment were added to drive institutions' strategy with respect to the sustainability of E-learning and E-teaching Principles, Application, Technology, and Environment.

To demonstrate how SeLF contributes to sustainable development goals, Table 7.1 and Table 7.2 represent the alignment of SeLF with sustainable development goals in both global and Malaysian contexts.

Table 7.1: SeLF contributions on Sustainable Development goals

TBL	Objectives
Society	➢ Equality ➢ Safe environment ➢ Free from fear and violence through sustainable development ➢ Sustainable Development Goal 4: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all"
Economy	➢ Participations and commitment among countries, stakeholders, and societies, which could improve country's economy ➢ Sustainable Development Goal 9: "Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation"
Environment	➢ Sustainable production and consumption to meet present and future generations' needs ➢ Eco-friendly economic, social, and technological development ➢ Sustainable Development Goal 12: "Ensure sustainable consumption and production patterns" ➢ Sustainable Development Goal 13: "Take urgent action to combat climate change and its impact"

As discussed earlier in Chapter 2, 17 sustainable goals were established by the United Nations Summit Post (President of United Nations General Assembly 2015). In this regard, SeLF was aligned with the goals and aims that relate to education, technology infrastructure, and sustainable practice. This alignment between SeLF and the

Sustainable Development Goals is intended to develop sustainability in e-learning in respect of the society, the economy, and the environment.

Table 7.2: SeLF contributions on Sustainable Development goals based on the 11th Malaysia Plan.

TBL	**Thrust 10 of 10: Malaysia Beyond 2020**
Social	- Knowledgeable and innovative individuals - Education equity
Economy	- Reduce income inequity - Increase quality of life
Environment	- A low carbon future

Definition of sustainable e-learning in societal, economical, and environmental dimensions.

Additionally, in order to provide more clear direction on how SeLF can contribute to the sustainable development goals, a definition of SeLF for each component of TBL was developed based on SeLF contributions to sustainable development goals established by the United Nations Summit 2015 (United Nations, 2015) and 11th Malaysia Plan 2016 to 2020 (Razak, 2015). Table 7.3 below presents SeLF definitions for each of the TBL's three dimensions.

Table 7.3: Definitions of SeLF in the Triple Bottom Line's components.

TBL	**SeLF Definitions**
Society	Sustainable e-learning framework aims to develop a sustainable e-learning that ensures quality education equity, educational achievement, and knowledgeable and innovative individuals while promoting lifelong learning and sustainable development concept.
Economy	Sustainable e-learning framework aims to improve educational attainment, knowledge-intensive employment, and quality of life through a sustainable online education solution.
Environment	Sustainable e-learning framework focuses on sustainable production and consumption through sustainable e-learning that promotes eco-friendly e-learning principles and technological development as part of the action on climate change and its impact, to meet present and future generations need.

These definitions provide e-learning stakeholders with a clear guideline on how SeLF elements can contribute to their e-learning development towards sustainability. This is intended to assist e-learning stakeholders to increase sustainability in e-learning by defining it in respect of the bottom line which comprises society, the environment, and the economy. Furthermore, these definitions are intended for inclusion in a strategic plan using SeLF, to guide e-learning stakeholders to select the appropriate SeLF elements and improve e-learning sustainability.

7.2.7 Modification of SeLF Elements

Additional element called User belief and behaviour

In order to improve sustainability in teaching and learning performance, the beliefs and behaviour of both academic staff and students are important when embracing changes in teaching and learning styles. This is supported by Guskey (2002), who stated that positive changes in lecturers' beliefs drive the sustainability of long-term behaviour and practices. Guskey (2002) held that staff engagement with measuring the outcome of changes to practice changes influences beliefs and hence the long-term sustainability of new teaching practices. Acceptance, participation, and interest in improvements must be achieved before implementing new strategies, pedagogies, and technologies; moreover, staff need to be engaged in measuring the impact of these changes as a means of reinforcing those beliefs and ensuring that positive changes are sustained (Guskey 2002). Guskey added that there are three areas of change: change in classroom practices, change in attitudes and beliefs, and change in the learning outcomes, which should be embraced to ensure significant and sustained educational improvement. Guskey (2002) also stated that changes involve risk, and these changes were considered in the element called E-learning risk.

Amendment on the elements

The elements comprising the synthesis of e-learning frameworks were revised based on survey outcomes to ensure that those elements sharing the same characteristics were combined into one to avoid confusion. For instance, mobile learning and sustainable mobile usage have many features in common, so these were combined in one SeLF element called Mobile learning.

The framework is interconnected such that all elements rely on other elements in order to have the capability of adapting to changes for the purpose of sustainable e-learning. As discussed in Chapter 2, sustainable change in technology (Moore, 2005), pedagogy (Salmon, 2005; Isaias and Pena, 2014), learning outcomes (Gupta, Bostrom and Huber 2010), and academic staff roles and beliefs (Granic, Mifsud and Cukusic 2009) must be considered in any e-learning strategy.

How sustainable e-learning is different from e-learning: Description on the element of the framework

Due to the amendments made to the elements of the framework and in response to the participants' feedback, explanations showing how the elements can meet the sustainable development goals were added to differentiate between sustainable elements and non-sustainable elements. See Table 7.4 for e-Learning and e-Teaching Principles, Table 7.5 for Application, Table 7.6 for Technology, and Table 7.7 for Environment.

Table 7.4: Description of elements of e-Learning and e-Teaching Principles.

Element	Description
E-learning importance	The e-learning pedagogy should engage the learner, which means it must focus on direct attention and increase participation in the most important parts without compromising instructional quality.
E-learning risks	Identify e-learning risks that include reasons for students not completing an e-learning course. Also, identify risks of implementing changes on new course tools and technology requirements (such as operating system, device).
E-learning opportunities	Finding e-learning opportunities can help e-learning to survive rapid changes in technology and students' learning needs.
Student development	Student development ensures everyone has the necessary knowledge and skills for employment and entrepreneurship while promoting sustainable development.
Training and support	Education system's capacity can be improved through the development of training programmes that assist e-learning users to overcome any difficulties in using technology for learning.
Motivation	Student motivation is important in e-learning pedagogy to ensure students' interest in the learning materials.
E-learning resource	E-learning resources should be accessible by the enrolled students to promote educational equity and increase education attainment. E-learning resources should embrace the principles of effective e-learning pedagogy and online course architecture.

Sustainable education	Sustainable education helps to promote Education for Sustainable Development; supports sustainable development by providing sustainable information and education; and improves education on climate change awareness.

The description of the elements in e-Learning and e-Teaching Principles, could enable e-learning stakeholders to understand how each element contributes to e-learning prospects, pedagogy, and curriculum. E-learning stakeholders do not need to select all the elements, but only those that are likely to contribute to the preferred e-learning pedagogy and curriculum.

Table 7.5: Description on elements for Application

Element	**Description**
Mobile learning	Mobile learning increases ICT access and significant mobilisation of e-learning resources that support human rights to education and learning at all levels, and enables people to learn anytime and anywhere.
Administration service	Availability of administration service via e-learning could help increase enrolment in higher education courses and accelerates human capital development for an advanced nation by facilitating social mobility.
Personalised learning	Personalised learning focuses on providing relevant individualised knowledge to address specific student needs. Therefore, this could create opportunities for everyone to have access to high-quality education programmes that are relevant to their learning needs and interests and promote lifelong learning.
Social and networking	Promote collaboration and social interaction between students and academicians especially the rural communities by equitably delivering education, training, knowledge, and appropriate and affordable technologies. Moreover, sustainable development and lifestyle awareness can be fostered through this element.
Productivity	Focus on the quality and quantity of students' outcome to support educational institutions in conducting sustainable development research and innovation.
Course management	Course management refers to the ability to manage quality and innovative programs where students have the opportunities to contribute in improving their courses. Students' contribution in course management could support the course quality.
Course tools	Effective course tools should be provided through e-learning to ensure everyone has literacy and numeracy that enhance the educational course outcome.

Descriptions of each element in Application are intended to provide an understanding of how each element contributes to e-learning by promoting and improving online teaching and learning activities. E-learning stakeholders are able to extend these descriptions based on their institutions' culture and e-learning styles.

Table 7.6: Description of elements for Technology.

Element	Description
Performance	Technology performance that aims to provide quality, reliable, and sustainable infrastructure that provides affordable and equitable access for everyone.
Efficiency	Continuous improvement of technology infrastructure to improve resource-use efficiency and allow greater adoption of clean and eco-friendly technologies.
Mobility	Encourage low carbon mobility to maintain green growth for sustainability and flexibility.
Connectivity and Networking	Provide and expand digital connection through broadband infrastructure nationwide that could support economic expansion, social inclusion, and growth. It involves the establishment of physical network infrastructure, information structure, platform, ICT devices and equipment that enhance online learning delivery and education access.
Information connectivity	Establish support systems such as technology, big data, data-driven science, co-operation infrastructure, and improved data monitoring systems that could promote recycling and reusing of e-learning resources, and provide relevant supplementary information.
Virtualisation	A virtual environment that supports domestic technology development, research, and innovation while promoting comprehensive and sustainable development and foster innovation.
Web evolution	Adoption of the new Web features that could help promote relevant and effective learning outcomes.
Intelligent system	Intelligent system provides learners with relevant knowledge on employment and entrepreneurship by analysing learning trends that could promote lifelong learning opportunities for all.
Consistent infrastructure	Facilitates sustainable infrastructure development through technological and training support.
Data analytics	Data analytics provides equitable opportunities for better access to quality higher education that develops knowledge, skills, ethics, and morality that are required to succeed in a competitive and changing technology, society, economy, and environment.

Since technology delivers learning online, it plays an essential role in e-learning. The description of each element in Technology allows e-learning stakeholders to understand how each element supports online learning. E-learning stakeholders only select and prioritise those elements that support e-learning performance to meet users' usage capacity.

Table 7.7: Description of elements for Environment

Element	Description
Sustainable consumption	Strengthen technological capacity to be more sustainable in consumption and production to meet the needs of present and future generations.
Efficiency	Equal access to affordable and quality higher education through affordable and time-efficient Internet access.
Environmental control	Minimise waste generation through recycling and reusing of e-learning resources.
Participation	Active participation by campus community to promote sustainable practices in institutions.
User beliefs and behaviour	Everyone intends to believe in free, equitable and quality education that could reduce gender inequality, increase effective ICT usage to improve learning outcomes, increase enrolment in higher education, and increase qualified academicians. Hence, this could lead to a change in user behaviour by adopting sustainable practices.
Sustainable innovation	Innovative ecosystem that supports university-driven research and development with significant growth for a low carbon future.

Similar to other descriptions in e-Learning and e-Teaching Principles, Application, and Technology, these descriptions intend to give e-learning stakeholders an understanding of how each element contributes to e-learning development. Whereas, the elements in Environment give e-learning stakeholders a clear notion of what and how each element contributes to e-learning environment while embracing sustainable practices.

In summary, these descriptions of SeLF elements were developed to complement the sustainable development goals established by the 2005 World Summit (United Nations 2005), The Future We Want 2012 (United Nations 2012), United Nations summit for the adoption of the post-2015 development agenda(President of United Nations General Assembly 2015), 11th Malaysia Plan 2016-2020 (Razak 2015), and Malaysia Education Blueprint 2015-2025 for Higher Education(Ministry of Education Malaysia 2014).

7.2.8 SeLF Elements Contribution to the Triple Bottom Line

This section explains how SeLF element contributes to each TBL context for E-teaching and E-learning Principles, Application, Technology, and Environment respectively. This could give e-learning stakeholders a clear view of the difference between sustainable and non-sustainable e-learning initiatives.

In e-Learning and e-Teaching Principles, SeLF intends to promote education equity, promote lifelong learning, develop e-learning that meets every learner's needs through quality education, and deliver knowledge of sustainability, which could benefit the society. SeLF could benefit the economy by developing a sustainable e-learning that reduces the cost in e-learning content development and delivery, improves e-learning Return on Investment (ROI), and improves education attainment that could lead to job equity. SeLF aims to develop a sustainable e-learning that benefits the environment through low consumption of carbon footprint and paper by practicing sustainable consumption, reuse of resources, and eco-friendly practices.

Through the Application component of SeLF, sustainable e-learning intends to provide the society a customised, quality, collaborative, and supportable education through administration service, personalised learning, social and networking, mobile learning, course tools, and course management features. These features could also benefit the economy by minimising the cost of administration, management, and acquisition of productivity tools or software. Additionally, SeLF intends to develop a sustainable e-learning that could benefit the environment by reducing paper consumption and provide course tools that empower students to become more eco-friendly.

The technology component of SeLF intends to enhance, deliver, and support online learning and teaching activities. This could benefit the society in terms of improvement on students learning, anytime and anywhere access, online collaboration, and availability of intelligent assistance in student's learning. SeLF focuses on technology use in sustainable e-learning that saves on energy costs, infrastructure modifications, hardware and software purchasing and maintenance. SeLF aims to develop sustainable e-learning that integrates technology, which could improve an institution's sustainability report on energy consumption and carbon footprint, improve resources consumption, and reduce air pollution.

Unlike non-sustainable e-learning, sustainable e-learning focuses on sustainable consumption, efficiency, environmental control, user participation, user belief, and sustainable innovation. These could benefit the society by promoting sustainable practices and lifestyle. Students could have ongoing access to a learning environment and commit to learning without having to travel to campus. Through sustainable consumption, innovation, environment and efficiency, a sustainable e-learning could benefit the economy by reducing costs on training, resources, travelling, accommodation, equipment maintenance, and renewable technologies. In addition, sustainable consumption could promote a clean energy economy and long-term economic growth. A sustainable e-learning focuses on an environment that consumes low energy and resources, and produces a low carbon footprint. SeLF considers developing environmental rights through sustainable e-learning to increase environmental awareness and enhance core values and fundamental beliefs about the environment.

7.2.9 The Outcome: Priority, Benefit, and Measurement

In response to Guskey (2002) regarding the measurement of the impact of changes and ensuring that positive changes are sustained, the three components - priority, benefit, and measurement - were added as the outcome in order to give a user a clear view of the outcome in improving current e-learning in order to become more sustainable. Priority focuses on evaluating the level of importance of the selected SeLF elements based on institutional priorities. The user can articulate the benefits of developing or improving the element in a manner that justifies the priority ascribed to each element. Elements contributing to the identification of goals are evaluated with respect to the short-term and long-term benefits to the institution, the learner, and the society. The benefits should be mentioned when communicating identified institutional priorities to stakeholders, and to inform of the establishment of metrics that can be used to measure outcome attainment. For measurement purposes, metrics should be identified which can be used to measure goal attainment. The outcomes of these measurements can be used to ascertain the achievement of short-term and long-term goals, and manage policies and resources based on the current and future needs.

7.3 Examples showing how SeLF is applied by Stakeholders

Based on the eight steps of the SeLF implementation process as outlined in Section 7.2.2, this section provides examples for a comprehensive description of how to use SeLF and examples for different university users such as the vice-chancellor, chief information officer, dean of Teaching and Learning, and lecturer.

7.3.1 Comprehensive Description of Each of the Eight Steps in the SeLF Implementation Process

Each of the SeLF's eight steps is described in detail in this section.

INPUT

I) Align elements of the institutional strategic plan with the e-learning goal or sustainable development goal based on a Triple Bottom Line analysis.

In defining a strategic plan, university leaders typically identify the current status and future aspirations regarding teaching and learning at the institution. This includes identifying the key factors that can guide an institution towards e-learning sustainability. In this case, the strategic plan example aims to improve current e-learning and becomes more sustainable through the provision of open e-learning resources.

II) Select the category that contributes to the e-learning or sustainable development goal.

To support the strategic plan, a clearly defined sustainable e-learning objective is required. Therefore, to ensure that an objective contributes to sustainability, sustainable e-learning goals should be based on the societal, environmental, and financial 'bottom line'. In this example, sustainable e-learning goals based on the societal, environmental, and financial 'bottom line' were elaborated as shown in Table 7.8 below.

Table 7.8: Example for sustainable e-learning goals based on TBL

TBL	Sustainable E-learning Goal
Social	Develop an e-learning approach that ensures equity access to quality education while promoting lifelong learning and the concept of sustainable development.
Economy	Develop an e-learning approach that improves tertiary education attainment and work-life balance through a sustainable online education solution.
Environment	Develop an e-learning approach that focuses on sustainable production and consumption that promotes eco-friendly e-learning principles and technological development as part of the action to counteract climate change and its impact, in order to meet the needs of the present and future generations.

Based on the defined sustainable e-learning goals, the appropriate SeLF category and elements that support both the strategic plan and the TBL goals are identified.

SeLF

III) Identify the area of focus: Strategy, User, or E-learning Component based on e-learning goal or sustainable development goal.

Once the strategic plan and sustainable e-learning goals have been defined, the appropriate category that supports these goals is selected. In this example, improving sustainable e-learning through accessibility involves all four SeLF categories: e-Teaching and e-Learning Principles, Application, Technology, and Environment. The reasons for selecting these categories are given below:

Table 7.9: Example of reasons for the selected categories

Category	Reason
e-Teaching and e-Learning Principles	Learning pedagogy and curriculum are the backbone of the e-learning resources.
Technology	Technology plays an important role in supporting e-learning platforms.
Environment	Since the learning resources can be accessed and viewed online, the need for paper and travel could decrease.

Upon selection of the related category, the area of focus needs to be identified based on Governance, User or E-learning component.

IV) Select the necessary element (sub-category) that could contribute to the e-learning goal or sustainable development goal and develop or enhance it in effective ways to support the goal.

The area of focus is identified based on the selected category. Subsequently, the appropriate element (sub-category) is identified and action is taken to either develop or improve the element to support the goal.

Table 7.10: Example for the selected elements contribution

Category	**Area of focus**	**Element (Subcategory)**	**Reason**
e-Teaching and e-Learning Principles	E-learning component	E-learning resource	Improves e-learning accessibility by providing open e-learning resources such as online assignments, quizzes, tests, and lecture notes.
Technology	User	Web evolution	Maximises the use and increases the availability of e-learning materials.
Environment	Governance	Efficiency	When the e-learning resources are open and accessible to all, education becomes affordable or free.

As shown in Table 7.10 above, the required elements are selected along with the reasons showing their contribution towards achieving the defined sustainable e-learning goal. In the next step, the selected elements are prioritised.

OUTCOME

V) Prioritise the selected elements based on institutional priorities.

Once the required elements have been identified and selected, they are prioritised based on the current e-learning environment and the availability of support such as funds and expertise. The selected elements were prioritised as shown in Table 7.11 below.

Table 7.11: Example on how the selected elements were prioritised

	Very Urgent	Less Urgent
Very Important	• E-learning resource • Web evolution	-
Less Important	-	• Efficiency

By allocating the elements to the above table, the user should have a clear idea of the level of importance of each element and how it can be improved or developed to achieve the sustainable e-learning goal.

VI) Articulate the benefits of developing or improving the element in a manner that justifies the priority ascribed to each element.

Once the level of importance of the selected elements has been established, the benefits of each of the element needs to be articulated. This step can be achieved as shown in Table 7.12 below.

Table 7.12: Example of the benefits of each selected element

Category	**Area of focus**	**Element (Subcategory)**	**Benefits**
e-Teaching and e-Learning Principles	E-learning component	E-learning resource	Allows students to access lecture notes and assessments and take quizzes and tests online. Enhances quality and flexibility of e-learning resources. Encourages students to apply knowledge in a broader context.
Technology	User	Web evolution	Provides platforms to support learner-centred, self-directed, peer-to-peer, and social learning approaches.
Environment	Governance	Efficiency	Offers affordable e-learning resources.

Once the benefits of each element have been expressed, the final step entails measuring the outcome.

VII) Identify metrics that can be used to measure goal attainment.

Measures can be applied to any context such as quality, efficiency, development, maintenance, innovation, cost, and profit. In this case, the measurements considered for the selected elements are as follows.

- E-learning resources

  Gauge the quality of e-learning open educational resources to ensure that they meet students' present and future needs.

- Web evolution

  Measure the flexibility and extendibility of the e-learning platforms and the ability to adapt open tools to access, reuse, develop, and share e-learning resources on the Web.

- Efficiency

  Use efficiency standards to measure the consumption of resources including computers, servers, and printers.

VIII) Use identified metrics to measure outcomes against short-term and long-term goals, and manage policies and resources based on the needs of today and tomorrow.

Once the selected elements are measured, the user should have a clearer view of the outcome of the elements in relation to short-term and/or long-term goals. Therefore, the user is in a better position to manage policies and resources to meet the required goals.

7.3.2 Hypothetical Application of SeLF: Vice-Chancellor

Table 7.13 below represents a hypothetical example showing the application of SeLF by a Vice-Chancellor.

Table 7.13: Example on overall outcomes for Vice-Chancellor

INPUT	Strategic plan:		Deliver e-learning that embraces sustainable practices to promote education equity (society), cost effectiveness and efficiency (economy), and low carbon future (environment) while meeting the students' present and future needs.
	The Triple Bottom Line	People	Promote education equity by providing equal access to e-learning resources.
		Economy	Improve the return on investment in e-learning.
		Environment	Minimise energy use and carbon footprint produced by the university's operation.
SeLF	e-Teaching and e-Learning Principles	E-learning opportunities	• Provide equal access to quality education. • Deliver flexibility to students and academicians.
		E-learning resources	• Provide quality learning resources. • Reduce cost in content development and delivery. • Promote reuse of learning resources.
		E-learning risks	• Reduce students' frustration on limited learning outcomes. • Reduce the risk of losing return on investment in e-learning.
	Application	Mobile learning	• Offer customised education content for students to be accessed on their own mobile devices. • Revolutionise education to compete effectively in the global economy.
	Technology	Efficiency	• Improve students' learning and productivity and enhance e-learning access. • Save cost through energy efficiency. • Encourage energy-efficient innovations.
		Mobility	• Provide anytime and anywhere education access to promote education equity. • Accessibility of e-learning through mobile devices such as tablet, smartphone, and laptop.
		Connectivity and networking	Widen the collaboration among students and academicians.
	Environment	Sustainable consumption	• Encourage wise use of e-learning resources. • Minimise energy usage, resource consumption, and carbon footprint.
		Environmental control	Develop sustainable practices by reducing carbon footprint.
		Sustainable innovation	Effective and efficient access to learning environment while reducing carbon footprint.
		Participation	• Increase learning collaboration among students and academicians. • Promote more job creation that increases job opportunity.

OUTCOME	Priorities	1. Develop e-learning standards that define the quality of e-learning resources. 2. Identify e-learning opportunities to enhance e-learning and identify risks to minimise the negative impact. 3. Ensure learning occurs anywhere and anytime with responsive, streamlined, powerful, and easy to use e-learning applications, accessible via mobile devices. 4. Emphasise the importance of reducing carbon emissions and use of technology and learning resources.
	Benefits	• Offer learning flexibility, and anytime and anywhere access to e-learning. • Promote lifelong learning. • Promote education equity.
	Measurements (Balanced Scorecard)	• Learning and Innovation Perspective Percentage of educational resources, total energy consumption, total carbon emission, turnover rate, number of databases, annual training hours. • Student Perspective Percentage of new students, score on assessment, number of student enrolled, employment rates (%). • Internal Process Perspective Number of successful initiatives, standard lead times, amount of work completed in a week. • Financial Perspective Increase in ROI, creating long-term value, sustainable university, revenue growth, increase in share value.

A hypothetical example of a balanced scorecard from learning and innovation, customer, internal process perspective, and financial perspectives is shown in Table 7.14, Table 7.15, Table 7.16, and Table 7.17.

Table 7.14: Balanced scorecard for Learning and Innovation Perspective (Vice-Chancellor)

Learning and Innovation Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
Promote education equity	% of access of educational resources	68%	79%	91%	• E-learning resources • Networking & connectivity	➢ Education equity ➢ Quality education
Creating a sustainable practice through sustainable innovation	Total energy consumption (kWh per annum)	20,014,512	16,555,886	13,878,212	• Energy saving programmes • Energy efficiency technology	➢ Sustainable innovation ➢ Save energy
	Total carbon emitted (tonnes per annum)	13,802	11,830	11,154	• Specialised recycling solutions • Promote reuse of e-learning resources • Install efficient server • Reduce vehicle use by providing online communication platform	➢ Minimised carbon emissions ➢ Sustainable innovation
	% of paper consumption	68%	45%	32%	• Recycle programmes • Online documents	➢ Minimise paper usage ➢ Enhance recycle activities
Employee satisfaction	Turnover rate	1%	1%	0%	• Reward programmes • Long-term incentive programmes • Champion bonus	➢ Long-term employment ➢ Reduce job poverty
Online resources to support learning	No. of databases	56	78	86	• Add more databases • E-learning resources	➢ Open online resources ➢ Lifelong learning
	No. of students	34,230	36,302	39,889	• Training programmes	➢ Lifelong learning
	No. of staff	2,321	2,891	3,007	• Internal training programmes	➢ Lifelong learning
Enabling lecturers to develop and reuse e-learning contents	Annual training hours by lecturers)	19	20	21	• Targeted development programmes	➢ Reuse of e-learning content

Table 7.15: Balanced scorecard for Customer Perspective (Vice-Chancellor)

Customer (Students) Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
New students	% of increase in new students enrolled	15%	23%	35%	• Marketing • New courses • Advertisement	➢ Education equity
Student satisfaction	Score on assessment	4 out of 10	6 out of 10	8 out of 10	• Learning analytics • Feedback on each unit/ assignment	➢ Quality education
Student demand	No. of students enrolled (e.g. MBA)				• Research on prospective students to measure their interest in specific area of study	➢ Education equity
	% of employment rates	71%	74%	77%	• Occupational trends • Current and future industry demand	➢ Job equity

Table 7.16: Balanced scorecard for Internal Process Perspective (Vice-Chancellor)

Internal Process Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
E-learning development (increase new ideas)	No. of successful initiatives	18	20	21	• Mobile learning • Web development	➢ Sustainable innovation ➢ Quality education ➢ Lifelong learning
Reduce IT support time	Standard lead times	2 hours	1 hour	<1 hour	• Working time reduction	➢ Sustainable economy
Reduce e-learning content workload	Amount of work completed in a week	34	45	66	• Training	➢ Reuse of e-learning resources

Table 7.17: Balanced scorecard for Financial Perspective (Vice-Chancellor)

Financial Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
Increase e-learning ROI	% of return on investment	42%	55%	68%	• Risk analysis	➢ Reduce the risk of loss on investment
Creating long-term value	Return on equity	13%	13%	13%	• Measure profitability of a company in relation to equity	➢ Sustainable economy ➢ Short-term and sustainable rewards
	Earnings per share increased	10-15%	13%-18%	15%-20%	• Indicator of the profitability of the company	
Sustainable university	Operating margin	8%	9%	10%	• Activity-based costing • Activity-based management • Employee leadership programme • E-learning costing	➢ Sustainable economy ➢ Long-term value ➢ Short-term and sustainable rewards ➢ Reduce financial risk ➢ Create value for shareholders
	Operating expenses	43%	43%	43%		
Revenue growth	Revenue increased	11%	11%	12%	• Activity-based costing • Activity-based management • Marketing	➢ Sustainable revenue growth
	Gross margin	47%	48%	49%	• Activity-based costing • Activity-based management • Outsourcing	
Increase share value	Share price increased above standard	12%	13%	15%	• Better education delivery • Better performance • Social responsibility • Environment accountability	➢ Improved perception on efforts towards sustainability ➢ Corporate social responsibility ➢ Environment protection

7.3.3 Hypothetical Application of SeLF: Chief Information Officer

Table 7.18 below represents a hypothetical application of SeLF used by a university Chief Information Officer.

Table 7.18: Example on overall outcomes for Chief Information Officer

INPUT	Strategic plan:		Improve sustainable consumption in e-learning infrastructure.
	The Triple Bottom Line	People	Encourage wise use of resources and develop sustainable lifestyle among university community.
		Economy	Improve sustainable innovations such as green server and building that reduce cost of IT infrastructure.
		Environment	Minimise carbon emissions and energy use through sustainable consumption.
SeLF	e-Teaching and e-Learning Principles	E-learning opportunities	• Reduce carbon emissions through sustainable innovation. • Improve resource consumption by reusing e-learning resources.
	Application	Content management	• Reduce resource consumption such as paper. • Reduce cost and time of manpower to manage content manually.
	Technology	Performance	Enhance e-learning hardware speed performance and up time maintainability while reducing energy consumption and carbon footprint.
		Efficiency	• Save energy resources used by air conditioner in machine rooms. • Used of virtualisation to minimise resources and needs to travel.
		Information connectivity	• Promote the reuse of e-learning resources such as big data and linked data. • Assist academicians and students in information search, reuse, and integration.
		Consistent infrastructure	• Avoid compatibility problems and improve communication on troubleshooting issues. • Reduce cost on infrastructures modifications.
	Environment	Sustainable consumption	Building clean energy environment by minimising energy usage, resource consumption, and carbon emissions.
		Efficiency	• Reduce costs of renewable technologies, training costs, and material costs. • Minimise energy consumption and carbon emissions.
		Sustainable innovation	• Reduce carbon footprint and energy usage. • Eliminate the need for paper. • Lifelong facility and equipment that can save cost on maintenance and repair.
OUTCOME	Priorities		1. Prioritise the need to develop performance standards regarding sustainable consumption that could limit potential damages to the environment caused by innovation. 2. Stress the importance of making choices on smarter energy innovation to reduce carbon footprint.

	Benefits	• Promote behaviour change regarding consumption choices and make it an entry point to a broader discussion on sustainable development that is related to e-learning. • Reduce energy consumption and carbon footprint by e-learning.
	Measurements (Balanced Scorecard)	• Learning and Innovation Perspective (total energy consumption, total carbon emitted, turnover rate, number of learning resources, annual training hours) • Students perspective (percentage of new students, score on training, score on course tools, number of students enrolled, percentage of tools used) • Internal Process Perspective (number of successful initiatives, percentage of paper consumption, standard lead times, amount of work completed in a week) • Financial perspective (creating long-term value, sustainable university, revenue growth, percentage of carbon tax, number of manpower, cost of modifications and maintenance)

An example of a balanced scorecard on learning and innovation perspective, customer perspective, internal process perspective, and financial perspective is shown in Table 7.19, Table 7.20, Table 7.21, and Table 7.22.

Table 7.19: Balanced scorecard for Learning and Innovation Perspective (Chief Information Officer)

Learning and Innovation Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
Creating a sustainable practice environment	Total energy consumption (kWh per annum)	20,014,512	16,555,886	13,878,212	• Energy saving programmes • Energy efficiency technology	➢ Sustainable innovation ➢ Save energy
	Total carbon emitted (tonnes per annum)	13,802	11,830	11,154	• Specialised recycling solutions • Promote reuse of e-learning resources • Install efficient server • Reduce vehicle use by providing online communication platform	➢ Minimised carbon emissions ➢ Sustainable innovation
	% of paper consumption	68%	45%	32%	• Energy saving programmes • Energy efficiency technology	➢ Minimise paper usage ➢ Enhance recycle activities
Employee satisfaction	Turnover rate	1%	1%	0%	• Reward programmes • Long-term incentive programmes • Champion bonus	➢ Supportable course tools ➢ Improve content management
Education for sustainable development	No. of learning resources	132	178	201	• Add more database • Add more e-learning resources	➢ Open online resources ➢ Lifelong learning
	No. of students	34,230	36,302	39,889	• Training programmes	➢ Lifelong learning
	No. of staff	2,321	2,891	3,007	• Internal training programmes	➢ Lifelong learning
Enabling lecturers to develop and reuse e-learning contents	Annual training hours by lecturers	19	20	21	• Targeted development programmes	➢ Reuse of e-learning content

Table 7.20: Balanced scorecard for Customer Perspective (Chief Information Officer)

Customer (Students) Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
New students	Training hours during orientation	1	1.5	2	• Orientation seminars/trainings • Advertisement	➢ Sustainable practices ➢ Education for sustainable development
Student satisfaction	Score on training	4 out of 10	6 out of 10	8 out of 10	• Learning analytics • Feedback on each training • Sustainable development projects	➢ Education for sustainable development
	Score on course tools	3 out of 10	5 out of 10	8 out of 10		➢ Supportable course tools
Student demand	No. of students enrolled in sustainable education	300	489	569	• Research on prospective students to measure their interest in specific area of study	➢ Education equity ➢ Education for sustainable development
	% of use of energy-efficient devices	25%	55%	89%	• EEnergy saving technology • RRenewable technology	➢ Reduce carbon footprint ➢ Reduce energy usage

Table 7.21: Balanced scorecard for Internal Process Perspective (Chief Information Officer)

Internal Process Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
E-learning development (increase new ideas on sustainable consumption)	No. of successful initiatives	18	20	21	• Technology efficiency (clean energy) • Information connectivity • Sustainable consumptions	➢ Sustainable innovation ➢ Sustainable consumptions ➢ Lifelong learning
Reduce resources consumption (paper)	% of paper consumption	68%	45%	32%	• Online tools • Online course management • Recycle programmes	➢ Sustainable economy ➢ Paperless technology ➢ Sustainable consumption
Reduce paper-based workload	Standard lead times	2 hours	1 hour	<1 hour	• Training • Online tools • Online document management	➢ Sustainable economy ➢ Sustainable consumption
Reduce e-learning content workload	Amount of work completed in a week	34	45	66	• Training • Quality control	➢ Reuse of e-learning resources

Table 7.22: Balanced scorecard for Financial Perspective (Chief Information Officer)

Financial Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
Creating long-term value	Return on equity	13%	13%	13%	• Measure profitability of a company in relation to equity	➢ Sustainable economy ➢ Short-term and sustainable rewards
Sustainable university	Operating margin	8%	9%	10%	• Activity-based costing • Activity-based management • Employee leadership programmes • E-learning costing	➢ Sustainable economy ➢ Long-term value ➢ Short-term and sustainable rewards ➢ Reduce financial risk ➢ Create value for shareholders
	Operating expenses	43%	43%	43%		
Revenue growth	Revenue increased	11%	11%	12%	• Activity-based costing • Activity-based management • Marketing	➢ Sustainable revenue growth
Reduce cost of manpower	No. of IT staff for e-learning development	153	128	86	• Training	➢ Improved perception on staff development ➢ Improve social well-being
Reduce carbon tax	% of carbon emitted by e-learning infrastructure (electricity)	13,802	11,830	11,154	• Clean energy technology • Renewable technology	➢ Clean energy ➢ Sustainable consumption
Reduce cost of e-learning content management system	Cost of modifications and maintenance	$83,439	$66,245	$49,891	• Reusable resources • Course creation tools • Outsourcing	➢ Reduce environment impact ➢ Social behaviour change

7.3.4 Hypothetical Application of SeLF: Dean of Teaching and Learning

The Table 7.23 below represents a hypothetical example showing the application of SeLF used by a Dean of Teaching and Learning.

Table 7.23: Example on overall outcomes for Dean of Teaching and Learning

INPUT	Strategic plan:		Develop and implement the MOOC strategy through e-learning and deliver sustainable education through e-learning.
	The Triple Bottom Line	People	• Enable full online learning. • Promote lifelong learning. • Increase awareness on sustainability issues. • Foster collaboration between academicians and students.

		Economy	• Equity access to free courses offered by the university. • Offering in-demand job opportunities for students.
		Environment	Reduce requirement to travel to campus.
SeLF	e-Teaching and e-Learning Principles	E-learning resources	Increase amount of e-learning resources such as online assessments and lecture notes.
		Sustainable education	Deliver courses that provide knowledge related to sustainable development such as climate change, poverty issues, sustainable consumption, sustainable innovation, and disaster risk reduction.
	Application	Content management	Use of Microsoft SharePoint 2016 Search and Content Management to effectively manage and reuse learning content.
		Course tools	Use of open-source tools to build a peer-grading system.
	Technology	Consistent infrastructure	Use of cloud infrastructure technologies. Server and database that are responsible for online educational resources storage and reliable in delivering needs.
		Intelligent system	Use of intelligent agents in educational environments such as Pedagogical Agents (tutor, mentor), Web Agents (working with social networking tools), and Learner's Agents to guide student's learning process and transfer specific knowledge.
	Environment	Participation	Encourage participation by academicians and students in regard to current scenarios and latest news.
OUTCOME	Priorities		1. Transformation of e-learning resources to open online educational resources to increase accessibility. 2. Consistency of the technology infrastructure to support MOOC delivery. 3. Provide suitable course tools to improve students and academician participation.
	Benefits		• Increase online enrolment and course completion. • Increase e-learning usability and accessibility.
	Measurements (Balanced scorecard)		• Learning and Innovation Perspective (number of learning resources, students, and staff, number of support system, participation percentage, annual training hours). • Student Perspective (percentage of new students enrolled, score on assessment, score on online collaboration, number of students enrolled, percentage of tools used, percentage of course completion).

		• Internal Process Perspective (number of successful initiatives, number of databases, amount of work completed in a week). • Financial Perspective (creating long-term value, sustainable university, revenue growth, number of IT staff).

A hypothetical example of a balanced scorecard from learning and innovation, customer, internal process, and financial perspectives is shown in Table 7.24, Table 7.25, Table 7.26, and Table 7.27.

Table 7.24: Balanced scorecard for Learning and Innovation Perspective (Dean of Teaching and Learning)

Learning and Innovation Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
Creating an open online resources	No. of learning resources	132	178	201	• Add more databases on online learning resources • Add Open Educational Resources (OER)	➢ Open online resources ➢ Lifelong learning ➢ Sustainable education
	No. of students	34,230	36,302	39,889	• Training programmes • Marketing	➢ Lifelong learning ➢ Sustainable education
	No. of staff	2,321	2,891	3,007	• Internal training programmes • Long-term incentive programmes	➢ Lifelong learning ➢ Sustainable education
Increase staff participation in learning	% of participation	8%	19%	45%	• Reward programmes • Long-term incentive programs • Champion bonus	➢ Supportable course tools ➢ Improve content management
Enabling lecturers to develop and reuse e-learning contents	Annual training hours by lecturers	19	20	21	• Targeted development programmes	➢ Reuse of e-learning content
Online assistance to drive staff engagement and learning	No. of support system	2	5	8	• Intelligent system • E-learning training • Course management	➢ Lifelong learning ➢ Education equity ➢ Social well-being
	No. of staff	2,321	2,891	3,007	• Recruitment process	

Table 7.25: Balanced scorecard for Customer Perspective (Dean of Teaching and Learning)

Customer (Students) Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
New students	% of increase in new students through enrolment	15%	23%	35%	• MMarketing • NNew courses • AAdvertisement	➢ Education equity
Student satisfaction	No. of score of online collaboration	3 out of 10	5 out of 10	8 out of 10	• LLearning analytics • Feedback on each assessment	➢ Education for sustainable development ➢ Supportable course tools ➢ Lifelong learning ➢ Quality education resources
	No. of score on an assessment	3 out of 10	5 out of 10	8 out of 10		
Student demand	No. of student enrolment in online course	300	489	569	• Research on prospective students to measure their interest in specific area of study	➢ Education equity ➢ Education for sustainable development
	% of course tools used	25%	55%	89%	• OOnline course tools • OOnline course management • CCollaboration points	➢ Supportable course tools ➢ Continuous e-learning initiatives
	% course completion	55%	78%	98%	• SSufficient e-leaning resources • SSupport • MMotivations	➢ Quality education ➢ Education equity

Table 7.26: Balanced scorecard for Internal Process Perspective (Dean of Teaching and Learning)

Internal Process Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
E-learning development (increase new ideas on open online course)	No. of successful initiatives	18	20	21	• Course tools • Course management • Information connectivity • Sustainable innovation • Enhance IT infrastructure	➢ Sustainable innovation ➢ Education equity ➢ Lifelong learning
Increase amount of resources	No. of databases	45	89	156	• Open online resources • Online course management • Information connectivity • Database analytics	➢ Sustainable economy ➢ Education equity ➢ Quality education resources
Reduce e-learning content workload	Amount of work completed in a week	34	45	66	• Training • Reuse resources • Information connectivity	➢ Reuse of e-learning resources ➢ Quality education ➢ Social well-being

Table 7.27: Balanced scorecard for Financial Perspective (Dean of Teaching and Learning)

Financial Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
Creating long-term value	Return on equity	13%	13%	13%	• Measure profitability of a company in relation to equity	➢ Sustainable economy ➢ Short-term and sustainable rewards
Sustainable university	Operating margin	8%	9%	10%	• Activity-based costing • Activity-based management • Employee leadership programmes • E-learning costing	➢ Sustainable economy ➢ Long-term value ➢ Short-term and sustainable rewards ➢ Reduce financial risk ➢ Create value for shareholders
	Operating expenses	43%	43%	43%		
Reduce cost of manpower	No. of IT staff for e-learning development	153	128	86	• Training • Course creation tools • Reusable resources	➢ Improved perception on staff development ➢ Improve social well-being

7.3.5 Hypothetical Application of SeLF: Lecturer

Table 7.28 below represents a hypothetical example showing the application of SeLF used by a lecturer.

Table 7.28: Example on overall outcomes for Lecturer

INPUT	Strategic plan:		Develop and deliver quality and adequate online unit materials.
	The Triple Bottom Line	People	• Availability of online learning resources. • Promote lifelong learning. • Foster collaboration between academicians and students. • Reduce time and the need to travel to obtain unit materials.
		Economy	• Equity access to online unit materials. • Save cost on printing paper-based materials.
		Environment	• Reduce the need to travel to campus. • Reduce paper usage.
SeLF	E-teaching and E-learning Principles	E-learning resources	Develop unit materials such as online assessments and lecture notes.
		Training and support	Provide adequate training for developing online resources.
		Motivation	Both academicians' and students' motivation are important in developing online resources to ensure learning materials developed by academicians meet students' needs and satisfy their interests.

	Application	Content management	Use of Microsoft SharePoint 2016 Search and Content Management to effectively manage and reuse learning content.
		Course Tools	Use of online document tools such as Google Docs, Etherpad, Microsoft Office Live, and Zoho to edit and collaborate documents in real-time.
		Productivity	Focus on the quality and quantity of online unit materials.
	Technology	Web evolution	Adoption of the new Web features such as Web 3.0 (personalised search, consolidating content) that could help promote relevant and effective learning outcomes.
		Intelligent system	Use of intelligent agents in educational environments to guide a lecturer's teaching process and development of unit materials.
	Environment	Participation	Encourage participation by academicians and students in regard to latest research and study cases.
OUTCOME	Priorities		1. Development of online unit materials. 2. Provide suitable course tools to improve the development of online resources. 3. Participation between academicians and students to develop e-learning resources that meet students' needs.
	Benefits		• Increase productivity of online resources. • Increase online enrolment of students and course completion. • Increase e-learning usability and accessibility. • Support continuous e-learning initiatives. • Provide a wide variety of e-learning resources.
	Measurements (Balanced scorecard)		• Learning and Innovation Perspective (number of learning resources, students enrolled, percentage of online material access, percentage of participation, annual training hours). • Students Perspective (percentage of new students enrolled, score on assessment, score on satisfaction on unit materials, number of students enrolled, total unit materials downloaded). • Internal Process Perspective (number of successful initiatives, number of databases, amount of work completed in a week). • Financial Perspective (amount of time for academicians to develop an online unit material).

A hypothetical example of a balanced scorecard from learning and innovation, customer, internal process, and financial perspectives is shown in Table 7.29, Table 7.30, Table 7.31, and Table 7.32.

Table 7.29: Balanced scorecard for Learning and Innovation Perspective (Lecturer)

Learning and Innovation Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
Creating online unit materials	No. of learning resources (per unit)	8	13	28	• Add more databases on online learning resources	➢ Accessible online resources ➢ Lifelong learning
	No. of students (per unit enrolled)	120	186	225	• Marketing	➢ Lifelong learning ➢ Sustainable education
Promote education equity	% of access on online materials	68%	79%	91%	• E-learning resources • Networking & connectivity	➢ Education equity ➢ Quality education
Increase academicians' participation in developing online materials	% of participation	12%	14%	21%	• Reward programmes • Long-term incentive programmes • Champion bonus	➢ Supportable course tools ➢ Improve content management
Enabling lecturers to develop and reuse e-learning contents	Annual training hours by lecturers	19	20	21	• Targeted development programmes	➢ Reuse of e-learning content

Table 7.30: Balanced scorecard for Customer Perspective (Lecturer)

Customer (Students) Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
New students	% of increase in new students through enrolment	11%	19%	26%	• New courses • Marketing	➢ Education equity
Student satisfaction	Score on satisfaction on online unit material	4 out of 10	6 out of 10	8 out of 10	• Learning analytics • Feedback on each assessment	➢ Supportable e-learning resources ➢ Lifelong learning ➢ Quality education resources
	Score on an assessment	3 out of 10	7 out of 10	9 out of 10		
Student demand	No. of students enrolled in online course	32	55	121	• Research on prospective students to measure their interest in specific unit/course.	➢ Education equity
	Total unit materials downloaded	56	101	192	• LLearning analytics • OOnline course management	➢ Supportable e-learning resources ➢ Continuous e-learning initiatives

Table 7.31: Balanced scorecard for Internal Process Perspective (Lecturer)

Internal Process Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
Increase new ideas on development of online materials	No. of successful initiatives	5	11	17	• Course tools • Course management • Information connectivity • Enhance IT infrastructure	➢ Efficiency ➢ Education equity ➢ Lifelong learning
Increase amount of resources (per unit)	No. of databases	8	13	28	• Open online resources • Online course management • Information connectivity • Database analytics	➢ Education equity ➢ Quality education resources
Reduce e-learning content workload	Amount of work completed in a week	34	45	66	• Training • Reuse resources • Information connectivity	➢ Reuse of e-learning resources ➢ Quality education ➢ Social well-being

Table 7.32: Balanced scorecard for Financial Perspective (Lecturer)

Financial Perspective						
Objectives	**Measurements**	**Targets**			**Initiatives**	**Contribution to sustainability**
		2018	**2019**	**2020**		
Reduce cost of manpower	Amount of time for academicians to develop online unit material	43	32	28	• Training • Course creation tools • Reusable resources	➢ Improve social well-being

These examples were given to show the overview of how SeLF could assist the Vice-Chancellor, the Chief Information Officer, the Dean of Teaching and Learning, or a lecturer to make decisions in developing sustainable e-learning.

7.4 Summary

In view of the above, significant improvements on the Sustainable e-Learning Framework have been made based on the findings from the survey data. It is anticipated that the framework's contribution to the Triple Bottom Line could help institutions become more sustainable. SeLF provides a guideline to facilitate the establishment and ongoing monitoring of sustainable e-learning policy while improving learning outcomes in a manner that benefits the economy, society, and environment. The elements and descriptions of SeLF are intended to be valuable resources enabling policy makers to differentiate between sustainable and non-sustainable e-learning initiatives. Moreover, the elements of this framework can shift the attitudes and behaviours of e-learning users towards more sustainable practices.

Chapter 8

DISCUSSION AND CONCLUSION

8.1 Introduction

This research examined sustainable e-learning, an area which is currently under-studied, with the aim of developing the Sustainable e-Learning Framework. In order to achieve the aims and objectives of the present research, the researcher employed an explanatory mixed-methods approach. The thesis supports the contemporary debate on sustainable development and e-learning, and through the present research, it attempts to close the gap identified in the literature as discussed in Chapter 2. The gap identified was the lack of a framework supporting sustainability in e-learning to achieve sustainable development goals and e-learning success. The concept of the Triple Bottom Line (TBL) was proposed as the solution to develop sustainable e-learning in a manner that would benefit the society, the economy, and the environment. As discussed in Chapter 4, a synthesis of e-learning frameworks was developed. Then, a research artefact was developed based on data analysis and findings of the survey and expert interviews, which have been presented and discussed in Chapter 7. Recommendations for the improvements of SeLF were made by a number of experts who had experience in e-learning and knowledge on sustainable development. In this chapter, a summary of key findings related to the research questions will be made. This will be followed by discussions of the key findings in response to the research questions and the significant impact of SeLF.

8.2 Summary of the Thesis

This thesis has described research leading to a unique framework, with the indication that it will contribute to the planning, implementation, and measurement of sustainable e-learning. To develop the new Sustainable e-Learning Framework for higher education, which has later become known as SeLF, three research objectives were set:

1. To ascertain the characteristics of developing a Sustainable e-Learning Framework for higher education in Malaysia;

2. To find out the stakeholders' perspectives and expectations of the characteristics of sustainable e-learning; and,
3. To ascertain if the new Sustainable e-Learning Framework would assist Malaysian higher education stakeholders to become more sustainable.

Chapter 1 has identified the main research objectives for the research entitled “Development and Evaluation of a Sustainable E-learning Framework for Higher Education Institutions in Malaysia”. The chapter has outlined the research purpose, research questions, significance of the study, research methods, and ethical issues.

Chapter 2 has presented a review of the literature related to sustainable development, e-learning, and existing e-learning frameworks. The first section of this chapter has concentrated on sustainability, the Triple Bottom Line (TBL) in higher education, and sustainable e-learning. The discussions in the second section have continued with e-learning in terms of its features and components, which include e-learning quality and the ten pedagogic principles for e-learning. In addition, this section has also discussed e-learning development in Malaysia. The third section in this chapter has reviewed the existing e-learning frameworks and the limitation for each of the frameworks. This chapter has also outlined the gaps between the existing frameworks, which act as a starting point in developing SeLF.

Chapter 3 has described the methods employed in this research. This chapter begins with an outline of the information system research paradigm. This is followed by information systems research methods and design, which describe the Design Science Research (DSR) and mixed methods and then by a description of the research design which provides the overview of research methods, research questions, research objectives, sampling techniques for both the survey and expert interviews, procedures for data collection and data analysis, as well as measures of reliability and validity. Additionally, ethical considerations and the research process flow chart are also included in this research methodology chapter.

Chapter 4 has discussed the synthesis of the e-learning framework. It begins with the initial development of SeLF, which was developed based on the literature review. The chapter continues with the explanation of the benefits of SeLF and ends with justification of the significance of SeLF.

Chapter 5 has presented data analysis and findings from the survey. Both results from the analyses of the quantitative and the qualitative data are presented. The presentation of the results is divided into two sections, one from data analysis of academicians' responses, and the other from data analysis of students' responses. Detailed statistical analyses such as factor and reliability analyses as well as manual coding are included in each section.

Chapter 6 has presented the experts' evaluation and perspectives toward SeLF through a series of interviews. This chapter refers to the experts' evolvement in the design process to evaluate and refine the design artefact. The chapter has provided analysis which was necessary to achieve the three objectives of this research. It begins with the profile for each of the seven participants. This is followed by the description of the research method in which manual coding that was used to analyse the qualitative data is explained. The next section in this chapter presents data analysis, which focuses on emerging themes. Four themes that were generated from this research are highlighted, namely: sustainability approach, sustainable education approach, higher education practice, and continuous improvements for SeLF.

Chapter 7 has reported on the revised version of SeLF. This version was made following amendments to the framework reported in Chapter 6 and based on DSR expert interviews about the research artefact in Appendix VII. This chapter begins with a presentation of the final version of the research artefact. Major and minor modifications are also discussed in this chapter. Major modifications involved in the research artefact were framework goals, practicability, area of focus, outcome measures, and additional elements, namely, the TBL elements. Minor modifications involved in the research artefact were amendments of the SeLF elements and description of these amended elements.

Chapter 8, the present chapter, discusses the findings of this research. It provides the summary of all the research phases and focuses on key research findings in response to the research questions. The chapter then discusses the significant impact of SeLF in the higher education sector. Also, this chapter concludes the research and this thesis. SeLF was developed and evaluated in this research to investigate the usefulness of this framework as a conceptual research framework within the education sector, particularly in the higher education setting. The main objective was to identify the characteristics of Sustainable e-Learning Framework for higher education. This has been achieved and the practicality of SeLF in higher education was evaluated through expert interviews. The limitations of this research are identified and discussed in this chapter. Directions for future research are also briefly discussed.

8.2.1 Summary of All Research Phases

The main outcome of this thesis was the development of the Sustainable e-Learning Framework to develop best practices in sustainable e-learning in higher education institutions in Malaysia. An initial framework was derived and synthesised from the review of related literature. The characteristics of this Sustainable e-Learning Framework were then evaluated based on a survey among academics and students from universities in Malaysia. Findings from the survey confirmed that the elements of the initial SeLF to be part of sustainable e-learning characteristics. Then, the necessary modifications were made to the initial SeLF to ensure its completeness and relevance to sustainable e-learning development and practices. As a result, a revised SeLF with four main elements and 31 elements arranged in an appropriate format was produced.

A literature review of TBL sustainability dimensions informed modifications of SeLF that were motivated by other components of this research. The review on TBL has highlighted points such as business performance and strategy plan in performing a sustainable approach. Thus, strategy plan has been considered as the input of SeLF and business performance that involves priorities, benefits, and measurement has been considered as an outcome. Thus, together with the survey findings and literature review on TBL, SeLF was finalised with four main elements and 31 elements. Along with strategy plan and TBL elements as input and priorities, benefits, and measurement as outcome. The three additional domains were input, SeLF elements, and outcome.

SeLF was evaluated by experts from various backgrounds such as e-learning, teaching, learning, and sustainable development. The iterative DSR interview technique was employed to evaluate SeLF usage, refine the research artefact, and identify its perceived significance. Four themes were identified and these themes corresponded to the second and third research questions to examine their relationships. Based on DSR interviews, experts indicated that the utility of SeLF for planning, implementing and measuring e-learning sustainability is supported.

8.3 Responses to Research Questions

The objectives of this research were as follows: 1) to ascertain the characteristics of a Sustainable e-Learning Framework for the higher education sector in Malaysia; 2) to find out the stakeholders' perspectives and expectations on the characteristics of sustainable e-learning; and, 3) to ascertain if the new Sustainable e-Learning Framework would assist Malaysian higher education stakeholders to become more sustainable. In order to achieve these research objectives, the following three research questions were formulated:

1. What are the characteristics of a Sustainable e-Learning Framework for the higher education sector in Malaysia?
2. What are the stakeholders’ perspectives and expectations on the characteristics of sustainable e-learning?
3. How can the new Sustainable e-Learning Framework assist the Malaysian higher education stakeholders to become more sustainable?

The following sections in this chapter will present the evidence in support of the claim that the objectives of this research have been achieved and all the research questions have been answered. These sections also provide a reflection on each of the research questions.

8.3.1 What Are the Characteristics of Developing a Sustainable E-learning Framework in Higher Education in Malaysia?

In response to the first question, the elements of SeLF were examined to explain the characteristics of sustainable e-learning. The findings of this thesis outline the characteristics of a Sustainable e-Learning Framework.

From the review of related literature that consequently led to the synthesis of an initial framework, the characteristics of e-learning which had been generally agreed upon, were identified. In order to identify e-learning characteristics that were perceived to be contributing to sustainable development, a survey was conducted. Data collected from this research and analysed in this thesis confirmed the participants' perceptions and beliefs on sustainable e-learning. This was achieved by using a mixed-methods approach that involved analysis of both the quantitative and the qualitative data from the survey and the interview. The data for the online survey were gathered from 108 academic staff and 207 students from universities in Malaysia. Detailed reports on data analysis and findings of the survey have been included in Chapter 5 of this thesis. It has been evident that the survey data analyses supported the characteristics of Sustainable e-Learning Framework; it was found that participants had responded positively towards the higher end of the Likert scale to the questions that included characteristics such as e-learning opportunities, e-learning motivations, e-learning strategy, database analytics, personalised learning, application, consistent infrastructure, effective browsing and connectivity, communication, participation, Web evolution, sustainable technology, sustainable education, and environmental control. These characteristics were prioritised according to the perceived contribution towards e-learning sustainability.

As a result, four key elements were identified along with 31 elements of the Sustainable e-Learning Framework. The refinement of these elements consisted of renaming some of them and combining shared elements under one dimension. The refinement measures have been analysed in Chapter 5 of this thesis and the outcome of the refinement was presented as a new framework called SeLF. The elements of the framework answered the first research question by providing strong evidence of the characteristics of a Sustainable e-Learning Framework, with four key elements and 31 elements identifying the features of sustainable e-learning.

8.3.2 What Are the Stakeholders' Perspectives and Expectations on the Characteristics of Sustainable E-learning?

Apart from making the identification of the characteristics of a Sustainable e-Learning Framework possible, the mixed-methods approach also enabled the researcher to make an assessment of e-learning from the perspectives of the stakeholders which included students, academic staff, and experts in e-learning, teaching and learning, and sustainable development. University students and members of the academic staff participated in the survey which utilised both analyses of the quantitative data (closed-ended questions) and qualitative data (open-ended questions). In addition, qualitative data were also analysed from the DSR interview sessions with the experts who had experience in e-learning, teaching and learning, and sustainable development.

Data analysis and findings from both the survey and expert interviews led to the identification of e-learning stakeholders' perspectives and their expectations on the characteristics of developing sustainable e-learning. Survey participants generally believed that sustainability is environment-friendly and supportive of e-learning initiatives. The outline of the identified characteristics of sustainable e-learning has been presented in Chapter 5 of this thesis.

The DSR expert interviews aimed to evaluate the utility of the principal research artefact (SeLF). There were seven participants with the essential background on both sustainability and e-learning. The DSR interviews had two iterations in which three experts had participated in the first while four experts participated in the second. The research artefact was modified based on the comments gathered from the first iteration, which led to a simpler yet more comprehensive research artefact. Based on the interviews, six out of seven experts verified the utility of SeLF for application in the higher education sector. SeLF was deemed as practical for the higher education sector as it covered broad aspects of e-learning and the Triple Bottom Line (TBL). According to an expert from an Australia institution who was interviewed in this research, SeLF covered all the higher education standards as outlined the TEQSA. One expert from Malaysia said that SeLF had the potential to be used in the Teaching and Learning Centre and departments with sustainable development goals. Another expert, also from Malaysia pointed out that SeLF would not only be applicable in the higher education sector, but also in the training and vocational sectors. The Malaysian expert added that SeLF had the ability to promote learning access and equity. The characteristics of sustainable e-learning that were verified by experts in the interview sessions included continuity of e-learning initiatives, long-term resources, fund availability, efficient and effective learning, alignment between learning and learning objectives, and ethics. Based on the experts' awareness on the TBL application in SeLF, it was noted that they had agreed that sustainable e-learning should create a positive impact towards the three aspects - economy, society, and environment. Therefore, the findings from both survey and expert interviews answered the second research question.

8.3.3 How Can the New Sustainable E-learning Framework Assist the Malaysian Higher Education Stakeholders to Become More Sustainable?

The DSR expert interviews contributed to a wider discussion on e-learning issues, specifically concerning e-learning sustainability in higher education. By using the DSR approach, the utility of the research artefact (SeLF) was evaluated by the experts in the interviews. The findings of the interviews demonstrated that SeLF could be adopted as an e-learning strategic planning tool for developing sustainable e-learning with potential positive impact on aspects of economy, society, and environment in achieving sustainability. In addition, SeLF would be able to inculcate sustainable values to e-learning stakeholders especially students.

However, findings from the DSR interviews also suggested that communication over the use of the framework is important for its successful implementation. A participant suggested that communication on e-learning initiatives taken using SeLF needs to be clear between the upper level of management and individual staff. The communication should involve stakeholders from the top-level management down to the individuals at the lowest rank in the hierarchy. The researcher believes that the communication should reinforce an institution's e-learning sustainability goals and promote sustainability values among e-learning stakeholders.

8.4 The Significant Impact of SeLF

This section discusses the significant impact of SeLF on the higher education sector. Based on the findings of this research, it can be concluded that SeLF contributes to e-Learning sustainability, higher education practices, and measuring attainment of institutional goals.

8.4.1 SeLF and Triple Bottom Line (TBL)

The analysis presented in Chapter 6 was derived from DSR expert interviews which aimed at evaluating the utility of SeLF. These discussions have revolved around SeLF contribution towards the Triple Bottom Line (TBL). Within the context of the environment, sustainability e-learning helps to preserve raw materials and resources, and reduce carbon emission and energy used through sustainable technology (Issa and

Isaias 2013). From the viewpoint of the economy, sustainability is concerned with cost efficiency (Issa and Isaias 2013) such as the cost of licensing software (Attwell 2004) and sustainable cost through mobility (Stansfield et al. 2009). Meanwhile, from a societal standpoint, sustainable e-learning initiatives considered easy innovation for both academicians and students to use (McGill, Klobas and Renzi 2014) and increased learning productivity (Leacock 2006). The TBL concept in evaluating business performance had been investigated by a number of researchers (Elkington 1998; BHERT 2000; Mitchell, Curtis and Davidson 2007; Fauzi, Svensson and Rahman 2010). Overall, experts viewed SeLF as an e-learning framework that aimed to benefit society, economy, and environment.

8.4.2 SeLF and Higher Education Practices

The implication of sustainability in e-learning has been augmented in this thesis by the literature review, survey, and expert interviews. In the latter of these, participants were of the view that the SeLF framework informed thinking in a manner likely to improve related issues in the organisation, technology, and pedagogy for students learning in the higher education sector. These issues include lack of funds, lack of long-term planning, incompatible technology, lack of course management, and lack of student engagement and feedback. This finding has been consistent with Stansfield's (2009) argument that developing sustainable e-learning would involve issues related to administration, culture, appropriate technology infrastructure and standards, user training and support, embracing innovation, appropriate pedagogy model and approaches, appropriate content, enhancement of learning with technology, and effective communication (Stansfield et al. 2009). These issues were also raised by some of the experts in the interview. Thus, sustainable e-learning has taken a new meaning. It has been discovered that sustainable e-learning would require good communication and agreement between organisation, technology, and the users. Furthermore, the DSR interviews also revealed that sustainable e-learning often involves more of the long-term goals over short-term e-learning goals.

8.4.3 SeLF and Other E-learning Frameworks

Compared to other e-learning frameworks cited in the published literature and mentioned by experts throughout the interviews, SeLF has been found to be different in several ways: first, SeLF has integrated sustainability dimensions in e-learning development; second, the sustainability dimensions have included measures of the impact of e-learning on the society, the economy, and the environment; third, it has defined the process to develop sustainable e-learning while supporting e-learning initiatives.

As discussed in Chapter 2 in this thesis, missing and similar components between the existing e-learning frameworks were identified. Although some e-learning frameworks had considered cost effectiveness, none of the frameworks incorporated sustainability measures decomposed along the TBL dimensions. The components comprised the global e-learning framework that was developed by Khan (2000) and pedagogy aspects included in e-learning pedagogy framework proposed by (Salmon 2005; Granic, Mifsud and Cukusic 2009) have been embedded in SeLF. Frameworks that had focused on e-learning quality (Moore 2005; Alkhattabi, Neagu and Cullen 2010; Casanova, Moreira and Costa 2011; Ossiannilsson and Landgren 2011) have been viewed as sustainability values in e-learning by SeLF. Compared to another e-learning evaluation framework developed by (Yunus and Salim 2011), SeLF evaluates e-learning by assessing the TBL indicators which measure the impact on the economy, the environment, and the society. Thus, it has been evident that SeLF has provided a framework different from those cited in the literature as its dimensions have been more comprehensive and complete with the inclusion of the TBL indicators. According to Mitchell, Curtis, and Davidson (2007), TBL indicators are essential to reflect an overall strategic objective. Stenzel (2010) has also added that these impact indicators on economy, environment, and society can be produced as a sustainability report.

In addition, as discussed in Chapter 6 of this thesis, one of the experts compared SeLF against the Higher Education Standards Framework established by the *Australian Tertiary Education Quality and Standards Agency (TEQSA) Act 2011.* This TEQSA framework consists of seven dimensions: (1) student participation and attainment; (2) learning environment; (3) teaching; (4) research; (5) institutional quality assurance; (6) governance and accountability; and, (7) representation and information management (TEQSA(Tertiary Education Quality and Standards Agency Act) 2014). According to the expert, all these dimensions were included in SeLF. For instance, SeLF consists of a participation element that aligned student participation and attainment domain, environment component to support learning environment domain, e-teaching and e-learning principles to support teaching domain, sustainable innovation element to support research domain, TBL measurement to support institutional quality assurance domain and governance and accountability domain, and technology and application components to support representation and information management domain. In fact, the focus of SeLF was on the development of sustainable e-learning initiatives and practices rather than on broad higher education practices. Within the context of Malaysian higher education, another expert viewed SeLF as a comprehensive e-learning framework compared to the Unified Theory of Acceptance and Use of Technology version 2 (UTAUT2) which only measures students' acceptance.

8.5 Research Implications

This research has several theoretical and practical implications. This section outlines these implications.

8.5.1 Theoretical Implications

This thesis has defined sustainable e-learning as "*Online education solution that performs sustainable practices to promote education equity (society), income equity (economy), and low carbon future (environment) while meeting the learners' present and future needs".* This supports and extends Robertson's (2008) definition which is, "e-learning that has become normative in meeting the needs of the present and future". More recently, Li, Duan, Fu, and Alford (2012) and Ibezim (2013) have indicated the importance of identifying suitable e-learning functionalities and technology that meet students' needs. Their data have shown that it is important to identify appropriate technologies to sustain e-learning. Therefore, a principal observation of this thesis is that sustainable e-learning should focus on meeting students' present and future needs while benefiting the three sustainability dimensions: people, economy, and environment.

Nevertheless, findings from the expert interviews have found that there would be people who would not consider embracing sustainability via e-learning but would still promote low paper usage, less carbon emission, and reliable IT support. However, these features would not ensure sustainability if e-learning initiatives were to be discontinued. This supports the conclusion made by McGill, Klobas, and Renzi (2014) who indicated that universities need to upgrade their technology to ensure it is sufficient and able to support continuation of e-learning initiatives. In this research, this was termed as 'technology-web evolution'. The Sustainable e-Learning Framework, SeLF, that was produced from this research and reported in this thesis has not only focused on environmental sustainability, but also focused on benefiting both the people and the economy.

Though research in sustainability is compelling, there are still huge gaps in understanding the concept of sustainable e-learning. This research has addressed sustainable e-learning in terms of technology, e-learning principles, application, and environment. Other organisational, financial, and management issue were not addressed in this research. Stansfield et al. (2009) have considered successful education content that meet students' needs as important for virtual campus initiatives. They have also identified the following six key issues related to the development of sustainable e-learning: 1) organisational issues; 2) technological issues; 3) pedagogical issues; 4) student issues; 5) financial issues; and, 6) management issues. Although all issues are important, this research took the first step by focusing on technological, pedagogical, student, and management issues. This allowed a better understanding of the sustainable e-learning concepts and its components.

Most importantly, this research led to the development of a Sustainable e-Learning Framework consisting of four dimensions: e-Teaching and e-Learning principles, technology, application, and environment. The explanatory mixed-methods approach chosen gave support in achieving the research objectives and providing empirical evidence of the characteristics of sustainable e-learning in higher education. Thus, it is anticipated that SeLF would enhance learners' present and future needs through e-learning. Based on verification by the experts during the interview, SeLF has the potential to improve current higher education practices to become more sustainable. Experts in the interview also verified that due to the integration of sustainability in SeLF, this framework was deemed a comprehensive version of the existing e-learning frameworks. This framework would benefit the sustainability dimensions, namely, the people, the economy, and the environment. In addition, SeLF would also promote education equity and lifelong learning among e-learning stakeholders.

8.5.2 Practical Implications

This thesis provides a more practical understanding of the sustainable e-learning concept in the higher education sector. With regard to the research artefact, that is SeLF, this framework can be applied in various departments in relation to e-learning practices, particularly in measuring sustainability in e-learning. This research artefact has the potential to improve sustainable practices in higher education. The integration of the TBL into the research artefact aimed to assist the formation of the strategy plan for sustainable e-learning, measure sustainability in e-learning, and implement sustainable e-learning. The findings of this thesis have provided a practical guide for e-learning stakeholders such as top-level management and policy makers who want more engagement in and support for sustainable e-learning initiatives. This practical guide could promote a higher rate of successful e-learning through sustainable e-learning initiatives. Examples on how SeLF is applied by stakeholders such as a Vice Chancellor, Chief Information Officer, Dean of Teaching and Learning, and lecturer were provided in Section 7.3. These examples described a comprehensive description of how to use SeLF based on the eight steps of the SeLF implementation process. These hypothetical examples of a balanced scorecard from learning and innovation, customer, internal process, and financial perspectives. Additionally, SeLF can benefit academics by providing a path for further research in different education sectors and different countries.

The findings of this thesis have indicated the influence of factors identified through the literature reviews and themes generated from expert interviews. These factors may have some influence on individual perspectives on sustainable e-learning, which include demographic aspects, individual background, job position, culture, society, and national education standards. When applied in educational practices, these findings might assist e-learning stakeholders in measuring the sustainability in e-learning in their respective institutions. By providing new directions for the future, the findings of the present research could encourage further research in different sectors within the region and in other parts of the world.

To sum this up, the practical implications of the findings of the present research and this thesis are the contribution towards filling the gap which was identified in the literature, the identification of the 31 sustainable e-learning components, and the development of a Sustainable e-Learning Framework, namely, SeLF. Furthermore, SeLF has added the ‘sustainability’ component, which was missing among existing e-learning frameworks. The integration of ‘sustainability’ component in SeLF is aimed at improving the current e-learning practices by placing an emphasis on their benefits to the people, the economy, and the environment.

8.6 Research Limitations

Despite contributions made by the present research and this thesis to the body of knowledge and implications for practices aforementioned in the earlier section of this chapter, this research also has several limitations. These limitations will be briefly discussed in this section.

First and foremost, this research focused on the higher education sector, particularly universities. The sample of participants was limited to those from higher education institutions. Participants from other industries or education sectors such as schools and professional training institutes may have different views on sustainable e-learning. There is still a need to investigate the perspectives of stakeholders from other e-learning education systems, sectors, and industries.

Secondly, this research only focused on the application of SeLF within the Malaysian context. The Malaysian government is committed to implementing education initiatives such as the iCGPA (Integrated Cumulative Grade Point Average), MOOCs (Massive Open Online Courses), APEL (Accreditation of Prior Experiential Learning), and 2u2i (2 years in university, 2 years in industry). The Malaysian higher education system has improved by 11 ranks within six years and from 36th place in 2012 to 25th in 2017 in U21 Ranking of National Higher Education Systems (Rahman 2017). E-learning features and practices might be different in other developing or developed countries. In addition, even though this research focused on Malaysia, locations, whether rural or urban, might produce different results due to different technological infrastructures and facilities, and e-learning acceptance level.

Thirdly, this research has limitations on the educational theory as it only considered e-learning pedagogy in general as part of the research artefact. It did not focus on the others such as andragogy and heutagogy. However, this research has considered the ten pedagogic principles for e-learning as discussed in the literature review.

Although this research focused on contribution towards sustainable development, it has given due attention on providing insights for sustainability of education instead of education for sustainable development (ESD). This means that this research focused on developing a Sustainable e-Learning Framework that could assist higher education institutions become more sustainable in their e-learning practices rather than developing courses and pedagogies for sustainable development education. ESD was considered as part of the research artefact in the context of e-learning and e-teaching principles.

This research focused on the social, economic, and environmental approaches as they are part of the sustainability dimensions known as the Triple Bottom Line (TBL). In terms of socio-economic background, most developing countries have their unique transformation. As for Malaysia, the Malaysian government initiated a number of transformation initiatives to protect local businesses. Malaysia’s positive discrimination policy plays a vital role in promoting a balanced ethnic harmony.

Due to time and resource constraints in doctoral studies such as the present research, the researcher was only able to reach out to certain types of e-learning stakeholders to become participants of the data collection exercise. These participants comprised students, academicians, faculty dean, e-learning manager, online course coordinator, vice-chancellor, head of sustainable development department, and a member of UNESCO Learning Technologies staff. Therefore, there is a need to include the perspectives of the government as the policy makers.

Last but not least, this research only focused on developing and evaluating the Sustainable e-Learning Framework for higher education in Malaysia. Since implementation trials could take several years to accomplish, there were no implementation trials associated with the research to identify the practicality of SeLF in its setting due to the time limit associated with completing a doctoral research.

Future research building upon the present findings to implement SeLF in the actual e-learning environment is therefore needed.

8.7 Future Development

As discussed earlier in this chapter, there are implications noted from this research, from the theoretical and practical standpoints. The Sustainable e-Learning Framework is the first validated e-learning framework that embraces sustainability practices in e-learning. SeLF is practical and culturally relevant in e-learning practices in Malaysian higher education. Even though this research focused on developing SeLF for Malaysia, it can be applicable to both developed and developing countries due to its broad e-learning scope and sustainability dimensions.

In conclusion, this research has made a significant contribution in the form of evidence-based characteristics of Sustainable e-Learning Framework derived from the review of sustainability and e-learning literatures and an extensive quantitative and qualitative study of the stakeholders' perspectives and expectations. However, future research should consider the following recommendations to improve the application of SeLF: 1) reliability testing and validity check of SeLF; 2) implementation of SeLF in the actual e-learning setting; and, 3) generation of sustainability reports to ensure sustainability in e-learning.

8.8 Chapter Summary

This research explored the characteristics of sustainable e-learning in the higher education sector and produced a validated Sustainable e-Learning Framework to develop and measure best practices for sustainable e-learning in the Malaysian higher education sector. It is argued that SeLF would be significant in both e-learning and sustainable development as it has developed sustainability aspects by contributing to a positive impact on the Triple Bottom Line (TBL) and supporting e-learning initiatives. The integration of TBL in SeLF supports the planning, implementation, and measurement of sustainable e-learning by informing the development of strategic plans and measures of sustainability in e-learning that aimed to benefit society, economy, and environment. This framework has the potential to develop collaborations among e-learning and sustainable development practitioners, researchers, policy makers, and e-learning stakeholders concerning the characteristics of sustainable e-learning. Evidence-based practices and outcome evaluations for SeLF were explored in this research and have been documented in this thesis to enhance sustainable e-learning practices and future development in the higher education sector in Malaysia.

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Appendix I

Survey Instrument

Online Survey- Sample screen shots and survey items in Word format

curtin.asia.qualtrics.com

Curtin University

Dear Sir/Madam,

We are conducting a research study to develop and evaluate a sustainable e-learning framework for the higher-education sector in Malaysia. Your assistance in this research would be greatly appreciated and would assist in the success of its findings.

This research involves a survey which will take up to 20 minutes to complete. This survey contains four sections. Please read each statement and then circle the number or tick the box to indicate your opinion.

To complete the survey, please click on

https://curtin.asia.qualtrics.com/SE/?SID=SV_8kpPbnXfGZJPamh

We would appreciate it if you could complete this survey before 15 April 2014 if possible. However, if this is insufficient time, please respond as soon as convenient.

Participation in this research is completely voluntary and your responses will be completely anonymous. You may withdraw at any time without prejudice or negative consequences, and do not need to provide a reason. By completing the survey, you are consenting to participate.

Any information provided by you through the survey will be held strictly confidential. Information will not be disclosed to any parties besides the researchers, unless required to do so by law. Finally, the researchers will ensure that published material will not contain any information that could identify you or your organization.

We encourage you to participate because this research will provide valuable insights into e-learning and its sustainability. More importantly, it may also assist your university to enhance the teaching and learning it provides by using technology and the principles of sustainability. Your assistance in this research is greatly appreciated and it is crucial for the success of its findings.

If you need any additional information from us, please let us know by contacting me by e-mail at a.mohameds@student.curtin.edu.au. Alternatively, feel free to contact my supervisors, Dr Tomayess Issa at tomayess.issa@cbs.curtin.edu.au, or Dr. Torsten Reiners at t.reiners@cbs.curtin.edu.au or A/Professor Pedro Isaias at Pedro.Isaias@curtin.edu.au

This study has been approved under Curtin University's process for lower-risk studies (Approval Number IS_14_01. This process complies with the National Statement on Ethical Conduct in Human Research (Chapter 5.1.7 and Chapters 5.1.18-5.1.21). For further information in this study, contact the researchers named above or the Curtin University Human Research Ethics Committee. c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth 6845 or by telephoning 9266 9223 or by emailing hrec@curtin.edu.au

Thank you in advance.

Yours faithfully,

Aidrina binti Mohamed Sofiadin

Survey- Academic Staff

PERSONAL DETAILS

1. Gender
    - Male
    - Female
2. Age
    - Under 25 years
    - 25-29
    - 30-39
    - 40-49
    - Above 50
3. Please tick your position
    - Tutor
    - Lecturer
    - Senior Lecturer
    - Head of School/Faculty/Department
    - Dean of School/Faculty
    - Other:_________________
4. Please tick your year(s) of teaching experience
    - 0-1 year
    - 2-4 years
    - More than 5 years
5. Please tick your main teaching areas
    - Arts
    - Business/ Law/ Finance
    - Education
    - Health Science
    - Information Systems
    - Marine Institute
    - Pharmacy
    - Science / Engineering
    - Social Work
    - Other: ______________________
6. Please tick your university
    - Public university
    - Private university

E-LEARNING

7. Where do you normally access an e-learning system for teaching purposes?
    - At home
    - On campus
    - Public place (i.e. cyber café, restaurant, café)

8. Which of the following devices do you use to access an e-learning system for teaching purposes?

- Desktop
- Laptop/Notebook
- Smartphone
- Tablet
- Other: ______________________.

9. Please indicate the teaching method you are using in your institution (You may choose more than one option)

- CD-based teaching materials
- Face-to-face learning
- Blended learning
- Online learning
- Other:_____________________.

10. Do you prefer to have personalized teaching (i.e. personalized teaching based on your students' needs and preferences) in the future?

- Yes (give details) ____-
- No (give details) ____

11. Are you familiar with the following?

	Yes	No	Maybe
Green Computing (i.e. online storage such as Dropbox, Skydrive, Microsoft 365, Evernote)			
Semantic Web (i.e. Web 3.0, Web of Data)			
Intelligent Agents (i.e. Siri from Apple)			
Mobility (i.e. Mobile Learning)			
Personalization (i.e. personalized learning based on your own needs and preference)			
Sustainable development (i.e. reduce energy consumption, paper usage and material waste)			

12. What are the challenges/problems that you most often encounter when engaging in e-learning for teaching? (You can choose more than one option)

- Lack of accessibility
- Lack of facilities
- Lack of improvement
- Uninteresting contents
- Uninteresting tools
- Lack of maintenance
- Lack of materials
- Lack of privacy (copyright issues)
- Lack of publicity
- Poor response time
- Lack of security
- Inadequate technical support service

13. Please indicate your level of agreement regarding the importance of e-learning for teaching.

"Using e-learning will…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…improve online teaching delivery.					
…improve user interaction.					
…improve assessment management.					
…improve teaching management.					
…improve teaching quality.					

14. Please indicate your level of agreement with each of the following statements:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
E-learning allows academic staff to become more independent in their own teaching practice.	○	○	○	○	○
E-learning develops critical thinking.	○	○	○	○	○
E-learning provides creative and innovative teaching strategies.	○	○	○	○	○
E-learning provides an effective teaching strategy.	○	○	○	○	○

15. Rate the following e-learning characteristics in terms of their **performance** at your university.

	Poor	Moderate	Good	Excellent
Easy to learn/ interact				
Easy to remember				
Easy to use				
Effectiveness				
Efficiency				
Flexibility				
Privacy				
Readability				
Security				
User friendliness				

16. Please add other comments on the e-learning approach to teaching:

____.

LEARNING PRINCIPLES

17. Please tick the e-learning tools/activities you use for teaching and learning purposes. (You may choose more than one option.)

    - Assessment
    - Student registration and enrolment
    - Course management
    - Course delivery
    - Content sharing
    - Content development
    - Discussion board
    - Email
    - Feedback
    - Forum
    - Student performance record
    - Student portfolio
    - Student teamwork
    - Wiki
    - Other:______________________________

18. Rate the usefulness of e-learning activities in your current teaching and learning practice.

	Not Useful	Somewhat Useful	Useful	Very Useful
Collaboration				
Communication				
Critical & creative thinking				
Information literacy				
Information technology				
Interaction				
Teamwork				

19. Please indicate your level of agreement with the statement:

    "Using online learning materials in teaching encourages me to be…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…creative					
…innovative					
…IT-savvy					
…organized in my teaching (i.e. downloading and uploading material through e-learning system)					
…responsible regarding my teaching materials					

20. Please rate the usefulness of the following e-learning features in managing your teaching via an e-learning system:

	Not Useful	Somewhat Useful	Useful	Very Useful
Course management				
Course templates				
Online assessment				
Searching within courses/units				

21. Please add any other comments regarding the E-Learning Principles:

____.

TECHNOLOGY

22. To become more sustainable in your learning, tick which **technology you prefer** to use in your teaching and learning. (You may choose more than one option.)

- ○ Virtual technology
- ○ Massive Open Online Course (MOOC)
- ○ Web 2.0 (i.e. Social Network)
- ○ Web 3.0 (i.e. Personalization)
- ○ Mobile learning
- ○ Cloud computing (i.e. Dropbox, Skydrive, Evernote, Microsoft 365, Google Docs)

23. Please indicate your level of agreement with the following statement:“Semantic Web allows me to have…”

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…3D Visualization and interaction.					
…collaborative intelligent filtering (intelligent agents assist user to work smarter and more collaboratively).					
…distributed computing (run multiple software in a single system).					
…extended smart mobile technology					

24. Please indicate your level of agreement with the following statement:

“Using new technology (i.e. Web 2.0, Web 3.0) will make e-learning teaching contents more useful and meaningful because it …”

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…allows academic staff to approach the design process in an initiative and practical way.					
…allows personalization of contents.					
…provides better web browsing and communication.					
…provides easier access to comprehensive information.					

…provides easy-to-exchange learning content.					
… provides easy-to-use tools.					
… fosters information connectivity.					
… encourages learning using multiple resources.					
… enables learning content to be tagged.					

25. Rate the usefulness of the various types of data in an e-learning system.

	Not Useful	Somewhat Useful	Useful	Very Useful
Big data (a lot of data is open to a wide audience without it being hidden)				
Linked data (provide links between data sets)				
Data-driven science (data that adapt to changes, new users and content)				

26. Please indicate your level of agreement with the following statement:
"Intelligent agents (online assistance that helps to perform user's tasks) help me to…"

	Poor	Moderate	Good	Excellent
…improve my personal and professional skills.				
…improve productivity.				
…improve teaching quality.				
…improve pedagogical support.				
…improve technical support.				
…provide 24/7 support.				
…reduce cost.				
…reduce energy consumption.				
…reduce search time.				

27. Please add other comments about the new technology (i.e. Web 2.0, Web 3.0):
____.

APPLICATION

28. Do you agree that **mobility e-learning** will motivate academic staff to teach online?
    - Yes (give details)____
    - No (give details)____

29. Rate the **usefulness** of e-learning tools.

	Not Useful	Somewhat Useful	Useful	Very Useful
Automation process (facilitate the insertion of metadata)				
Data mining techniques (facilitate the adoption of the resources)				
Global database (use standards to ensure information can be readable by different systems and cross-platforms)				
Intelligent Agent				
Rubric				

30. Please indicate your level of agreement with the following statement:

"**Personalized teaching** allows me to…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…customize my teaching.					
…filter search results.					
…provide interesting contents.					
…have a virtual personal mentor/assistant.					

31. Please add other comments regarding the Application:

____.

SUSTAINABLE DEVELOPMENT

32. Are you aware of sustainable development?

  - Yes (give details)____
  - No (give details)____

33. Please indicate your level of agreement with the following statement:

"A sustainable environment in a university can be achieved by…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…reviewing the university's core values					
…allowing academic staff to make their own decision in future teaching.					
…meeting education needs while preserving the environment.					
…providing quality education.					
…using available teaching materials effectively.					

34. Please indicate your level of agreement with the following statement:

"Sustainable education can be achieved by…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…integrating sustainability issues in teaching experience.					
…integrating the concept of sustainable development across curricula.					
…articulating the benefits and limitations of being eco-literate.					

35. Please indicate your level of agreement with the following statement:

"Sustainable e-learning can be achieved by…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…classroom modifications.					
…consistent hardware infrastructures.					
…consistent network infrastructure.					
…consistent technology infrastructure.					
…green technology.					
…providing 24/7 technical support.					
…providing applications that reduce environmental impact.					
…providing applications that reduce workload.					
…providing e-learning contents that can be reused and repurpose.					
…providing facilities that consume low energy.					
…providing facilities that produce low carbon emission.					
…providing meaningful e-learning contents.					
…providing virtual personal assistance/mentor.					
…supporting curriculum adaptation in e-learning.					
…supporting pedagogy adaptation in e-learning.					

36. Please indicate your level of agreement with the following statements regarding “sustainable e-learning”.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
“ I believe sustainable e-learning can be achieved through support and awareness of sustainable development in university”					
“I believe adequate support for green technology usage can improve sustainable e-learning”					
“I believe sustainable e-learning can be achieved if sustainable development is integrated into the higher-education rating system requirement.”					
“I believe sustainable e-learning can be achieved through the availability and consistency of e-learning application.”					
“I believe sustainable e-learning can be achieved with the support of the university’s management personnel.”					
“I believe sustainable e-learning can improve and maintain quality of education while reducing cost.”					
“I believe sustainable e-learning can maintain raw materials for the seventh generations.”					
“I believe sustainable e-learning can reduce education cost.”					
“I believe sustainable e-learning can reduce environmental impact.”					

37. Please indicate your level of agreement with the following statement:

“To support sustainable e-learning, academic staff should improve their …”

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…critical thinking skills.					
…ICT skills.					
…online interaction.					
…online student assessment practice.					
…online tutoring.					
…teaching in a sustainable environment setting.					
…virtual classrooms management.					

38. Please indicate your level of agreement with the following statement:

“Participation of academic staff in sustainable e-learning can be improved by…”

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…a change in the likelihood of career development.					
…adding sustainable components to staff KPIs (Key Performance Indicators).					
…changes to the workload to make teaching attractive and sustainable.					

…conducting staff meetings to discuss the university's sustainable development aims.					
…creating a role in the faculty/school/department for sustainable development.					
…providing public recognition of staff.					
…providing rewards for sustainable development practices.					
…providing training and support.					

39. What are the challenges/problems you often encounter to support your teaching towards a sustainable e-learning? (You can choose more than one option)

   - Current facilities consume too much energy
   - Current technology does not support sustainable development
   - Lack of awareness of green technology
   - Lack of awareness of new technology (i.e. Web 3.0)
   - Lack of awareness of sustainable environment
   - Lack of knowledge of sustainable development
   - Lack of knowledge or ideas about sustainable initiatives
   - Lack of support and training
   - Other:_____________________________________.

40. To create a sustainable e-learning environment, do you have the opportunity to contribute to the improvement of e-learning in the future?

   - Yes (proceed to question 41)
   - No (give details)____

41. If 'Yes', what are the reason(s) for your inability to participate in e-learning initiatives? (You can choose more than one option)

   - I do not have the necessary pre-requisites (e.g. qualifications, position, seniority, experience)
   - I do not have the time to participate
   - Lack of e-learning development awareness
   - Lack of e-learning improvement
   - Lack of e-learning publicity
   - Other:_____________________________.

42. Please indicate your level of agreement with the following statement:

   "Communication and interaction among academic staff can ensure a sustainable e-learning system by…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…adaptability.					
…encouraging collegial sharing.					
…providing effective support.					
…establishing rapport and understanding others' roles.					
…using a common language.					

43. Please indicate your level of agreement with the statement:

"By switching from cell phone network to WiFi, I can…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…save substantial energy.					
…extend the battery's lifetime.					

44. Please indicate your level of agreement with the statement:

"Printing of teaching materials can be reduced by…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…providing guidelines on how to save on printing costs.					
…using software that eliminates irrelevant pages when printing.					
…providing online assessments.					
…providing online materials.					

45. Please indicate your level of agreement with the statement:

"Better browsing and connectivity between e-learning materials can help me to…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…save time.					
…reduce cost.					
…reduce energy consumption.					

46. Please indicate your level of agreement with the statement:

"Sustainable mobility allows me to have…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…environment friendly services.					
…faster access.					
…open data that serve mobility.					
…personalization.					
…to save battery life.					
…a user friendly interface.					

47. To save the environment, do you agree that using the new technology (i.e. Web 3.0) will reduce waste materials and energy consumption?

- ○ Yes
- ○ No

48. Give reasons for your response to Q.47.

____

Survey- Student

PERSONAL DETAILS

49. Gender
    - Male
    - Female
50. Age

    - 17-20
    - 21-25
    - 26-30
    - 31-40
    - Above 41

51. Please tick your highest level of education

    - Bachelor Degree
    - Master
    - Doctorate
    - Other:________________________

52. Please tick your main field(s) of study?

    - Arts
    - Business/ Law/ Finance
    - Education
    - Health Science
    - Information System
    - Marine Institute
    - Pharmacy
    - Science Engineering
    - Social Work
    - Other: ______________________

53. Please tick your university

    - Public university
    - Private university

E-LEARNING

54. Do you use e-learning?

    - Yes (Give details) ______________________ (go to Question 7)
    - No (go to Question 10)

55. Where do you normally access an e-learning system?

    - At home
    - On campus
    - Public place (i.e. Cyber café, restaurant, café)
    - Other: ______________________

56. Which of the following devices do you use to access an e-learning system?

- Desktop
- Laptop/Notebook
- Smartphone
- Tablet
- Other: ______________________.

57. Please indicate the learning method in your institution (You may choose more than one option)

- CD-Based teaching materials
- Face to Face learning
- Blended Learning
- Online Learning
- Other: (please specific)

58. What are the challenges/problems you often encounter when engaging in e-learning? (You may choose more than one option)

- Lack of accessibility
- Lack of collaboration
- Lack of improvement
- Uninteresting contents
- Uninteresting tools
- Lack of maintenance
- Poor content
- Lack of publicity
- Poor response time
- Lack of security
- Inadequate technical support service
- Other: ____.

59. Do you prefer to have **personalized learning** (i.e. personalized learning based on your own needs and preferences) in the future?

- Yes (Give Details)
- No (Give Details)

60. Are you familiar with the following?

	Yes	No	Uncertain
Green Computing (i.e. Online storage such as Dropbox, Skydrive, Microsoft 365, Evernote)			
Semantic Web (i.e. Web 3.0, Web of Data)			
Intelligent Agents (i.e. Siri from Apple)			
Mobility (i.e. Smart Mobile Technology)			
Personalization (i.e. Personalized learning based on your own needs and preference)			
Sustainable development (i.e. reduce energy consumption, reduce paper usage, reduce content waste)			
Virtual World (i.e. Immersive World, Avatar World, 3D Environment)			

61. Please indicate your level of agreement regarding the **importance of e-learning**.

Using e-learning will…

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…improve delivery of learning contents.					
…improve learning management.					
…allow online delivery and submission.					
…improve user collaboration.					

62. Please indicate your level of agreement with the following statements:

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
E-learning is important.					
E-learning is an effective learning tool					
E-learning develops students' critical thinking skills.					
E-learning allows students to become independent learners.					
E-learning leads to non-social environment.					
E-learning may lead to isolation from teacher and classroom.					
E-learning may impair a student's performance due to low motivation.					

63. Rate the following e-learning characteristics in terms of their **performance** at your university

	Poor	Moderate	Good	Excellent
Accessibility				
Environment Friendly				
Flexibility				
Readability				
Security				
User Friendliness				

64. Please add other comments on e-learning:

____.

LEARNING PRINCIPLE

65. Please tick the **e-learning tools/activities** you use for learning purposes. (You may choose more than one option)

- ○ Assessment
- ○ Course Management
- ○ Discussion Board
- ○ Email

- Feedback
- Forum
- Student Performance Record (ie. MyGrades)
- Student Portfolio
- Student teamwork
- Wiki
- Other:_______________________________

66. Rate the **usefulness** of e-learning activities in your current studies.

	Not Useful	Somewhat Useful	Useful	Very Useful
Collaboration				
Communication				
Critical & creativity thinking				
Information literacy				
Information technology				
Interaction				
Teamwork				

67. Please indicate your level of agreement with the statement:

"Using online learning content encourages me to …"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…learn by myself.					
…be motivated.					
…organize my learning activities (i.e. downloading and uploading content through e-learning system).					

68. Please add other comments regarding the Learning principles:

____.

TECHNOLOGY

69. To become more sustainable in your learning, tick which **technology you prefer.** (You can choose more than one option)

- An online course that meets my needs and aspirations (i.e.Web 3.0, Semantic Web)
- E-learning contents that can be stored and accessed via the internet (i.e. Dropbox, Skydrive. Evernote, Microsoft 365, Google Docs)
- Interface and user-oriented set of tools that allows a student to move along his/her own unique discovery path (i.e. virtual technology)
- Online course content that I can access for free (i.e. Massive Open Online Course (MOOC)
- Online group communication and discussion (i.e. Web 2.0, Social Network)
- Smart mobile technology that enables learners to have access anytime and anywhere (i.e. mobile learning)

70. Please indicate your level of agreement with the following statement :"E-learning systems that enable me to understand the content also …"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…have meaningful contents than enhance learning quality.					
…have intelligent agents that assist me to work more efficiently.					
…run multiple software in a single system.					
…have access anytime and anywhere and will provide intelligent solutions to web searching and content management.					

71. Please indicate your level of agreement with the following statement:

"New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it …"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…offers better web browsing & communication.					
…provides easier access to comprehensive information.					
…facilitates obtaining easy-to-exchange learning content.					
…provides information connectivity.					
…allows one to learning from multiple resources.					
tags learning content.					

72. Rate the following **benefits of intelligent agents** (an online assistance that helps to perform user's tasks) in e-learning activities?

	Not Useful	Somewhat Useful	Useful	Very Useful
Improve my personal and professional skills				
Improve productivity				
Provide 24/7 support				
Reduce cost				
Reduce energy consumption				
Reduce search time				

73. Please add other comments on the new Technology:

____.

APPLICATION

74. Do you agree that **mobility e-learning (i.e. Smart Mobile Technology)** will motivate students to learn?

- Yes (give details)
- No (give details)

75. Please indicate your level of agreement with the statement:" Personalized learning allows me to …"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…be independent in my learning.					
…customise my learning.					
…not be overloaded with information.					
…obtain interesting contents.					
…stay connected with my learning.					

76. Please add other comments on the Application:

____.

SUSTAINABLE DEVELOPMENT

77. Are you aware of **sustainable development**?

- Yes (give details)
- No (give details)

78. Please indicate your level of agreement with the following statement:

"Sustainable environment can be achieved by …"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…a review of university core values.					
…allowing students to make their own decision about future learning.					
…catering for educations need while preserving the environment.					
…providing quality education.					
…allowing one to use available learning contents effectively.					

79. Please indicate your level of agreement with the statement:

"Sustainable education can be achieved by …"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…integrating sustainability issues in learning experiences.					
…integrating sustainable development concept across education.					
…articulating the benefits and limitations of being eco-literate.					

80. Please indicate your level of agreement with the following statements regarding "sustainable e-learning".

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I believe sustainable e-learning can reduce the environmental impact of technology.					
I believe sustainable e-learning can improve student learning engagement.					

81. Please indicate your level of agreement with the statement:

"The amount of printing learning contents can be reduced by providing…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…guidelines on how to save printing costs.					
…online assessments.					
…online contents.					
…software that allows online editing and collaboration.					
…software that eliminates useless pages when printing.					
…technology to improve online reading.					

82. Please indicate your level of agreement with the statement:

"Better browsing and connectivity between e-learning contents can help me to…"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…save time.					
…reduce cost.					
…reduce energy consumption.					

83. Please indicate your level of agreement with the statement:

"For sustainability, mobile learning should offer me …"

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
…environment-friendly services.					
…faster access.					
…open data that serves mobility.					
…personalization.					
…the possibility of saving battery life.					
…a user-friendly interface.					

84. To save the environment, using new technology (i.e. Web 3.0) will **reduce e-waste**?

- ○ Yes
- ○ No

85. Why or why not?

____.

Academic staff: Quantitative Analysis – Descriptive statistics

ACADEMIC STAFF – e-Teaching N = 108								
Statements	**Mode**	**Mean**	**Std. Deviation**	**Strongly Disagree %**	**Disagree %**	**Neutral %**	**Agree %**	**Strongly Agree %**
Using online learning materials in teaching encourages me to be IT-savvy.	4	4.45	.519	0	0	0.9	52.8	46.3
Using online learning materials in teaching encourages me to be innovative.	4	4.32	.593	0	0.9	3.7	57.4	38.0
Using online learning materials in teaching encourages me to be organized in my teaching.	4	4.29	.565	0	0	5.6	60.2	34.3
Using e-learning will improve teaching management.	4	4.26	.702	0.9	0.9	6.5	54.6	37.0
Using online learning materials in teaching encourages me to be responsible regarding my teaching materials.	4	4.26	.647	0	0.9	8.3	54.6	36.1
Using e-learning will improve assessment management.	4	4.20	.694	0.9	0.9	7.4	58.3	32.4
Using online learning materials in teaching encourages me to be creative.	4	4.14	.571	0	0	10.2	65.7	24.1
Using e-learning will improve online teaching delivery.	4	4.11	.631	0.9	0	9.3	66.7	23.1
Using e-learning will improve teaching quality.	4	4.09	.677	0.9	0	13.0	61.1	25.0
E-learning provides an effective teaching strategy.	4	4.09	.620	0	0	14.8	61.1	24.1
E-learning provides creative and innovative teaching strategies.	4	4.07	.666	0	0	18.5	55.6	25.9
E-learning allows academic staff to become more independent in their own teaching practice.	4	3.94	.660	0	0.9	22.2	59.3	17.6
Using e-learning will improve user interaction.	4	3.78	.715	0.9	2.8	25	60.2	11.1
E-learning develops critical thinking.	4	3.67	.710	0	1.9	41.7	44.4	12.0

ACADEMIC STAFF – Technology N = 108								
Statements	**Mode**	**Mean**	**Std. Deviation**	**Strongly Disagree %**	**Disagree %**	**Neutral %**	**Agree %**	**Strongly Agree %**
Big data (a lot of data is open to a wide audience without it being hidden)	4	4.10	.579	0	0	12.0	65.7	22.2
Data-driven science (data that adapt to changes, new users and content)	4	4.41	.548	0	0	2.8	53.7	43.5
Linked data (provide links between data sets)	4	4.23	.574	0	0	7.4	62.0	30.6
Semantic Web allows me to have 3D Visualization and interaction.	3	3.56	.645	0	0.9	49.1	42.6	7.4
Semantic Web allows me to have collaborative intelligent filtering.	4	3.79	.698	0	0.9	34.3	50	14.8
Semantic Web allows me to have distributed computing.	3	3.59	.711	0	0.9	50.9	36.1	12.0
Semantic Web allows me to have extended smart mobile technology.	4	4.11	.688	0	0.9	15.7	54.6	28.7
Using new technology will make e-learning teaching contents more useful and meaningful because fosters information connectivity.	4	4.34	.583	0	0	5.6	54.6	39.8
Using new technology will make e-learning teaching contents more useful and meaningful because encourages learning using multiple resources.	4	4.28	.624	0	0	9.3	53.7	37.0
Using new technology will make e-learning teaching contents more useful and meaningful because provides easy-to-exchange learning content.	4	4.26	.632	0	0	10.2	53.7	36.1
Using new technology will make e-learning teaching contents more useful and meaningful because provides easy-to-use tools.	4	4.24	.682	0	0.9	11.1	50.9	37.0
Using new technology will make e-learning teaching contents more useful and meaningful because provides easier access to comprehensive information.	4	4.22	.616	0	0	10.2	57.4	32.4
Using new technology will make e-learning teaching contents more useful and meaningful because provides better web browsing and communication.	4	4.15	.681	0	0	16.7	51.9	31.5
Using new technology will make e-learning teaching contents more useful and meaningful because enables learning content to be tagged.	4	4.03	.716	0	0	24.1	49.1	26.9

Using new technology will make e-learning teaching contents more useful and meaningful because allows personalization of contents.	4	3.90	.640	0	0	25.9	58.3	15.7
Using new technology will make e-learning teaching contents more useful and meaningful because allows academic staff to approach the design process in an initiative and practical way.	4	3.78	.569	0	0	29.6	63.0	7.4

ACADEMIC STAFF – Application N = 108								
Statements	**Mode**	**Mean**	**Std. Deviation**	**Strongly Disagree %**	**Disagree %**	**Neutral %**	**Agree %**	**Strongly Agree %**
Personalized teaching allows me to provide interesting contents.	5	4.45	.586	0	0	4.6	45.4	50.0
Personalized teaching allows me to filter search results.	4	4.42	.582	0	0	4.6	49.1	46.3
Rubric (scoring tool)	4	4.34	.598	0	0.9	3.7	55.6	39.8
Personalized teaching allows me to have a virtual personal mentor/assistant.	4	4.34	.583	0	0	5.6	54.6	39.8
Personalized teaching allows me to customize my teaching.	4	4.31	.520	0	0	2.8	63.9	33.3
Intelligent Agent	4	4.01	.619	0	0	18.5	62.0	19.4
Global database (use standards to ensure information can be readable by different systems and cross-platforms)	4	3.90	.669	0	0	27.8	54.6	17.6
Data mining techniques (facilitate the adoption of the resources)	4	3.82	.593	0	0	27.8	62.0	10.2
Automation process (facilitate the insertion of metadata)	4	3.80	.576	0	0	28.7	63.0	8.3

ACADEMIC STAFF - Sustainable Development N = 108								
Statements	Mode	Mean	Std. Deviation	Strongly Disagree %	Disagree %	Neutral %	Agree %	Strongly Agree %
Better browsing and connectivity between e-learning materials can help me to reduce cost.	5	4.79	.454	0	0	1.9	17.6	80.6
Better browsing and connectivity between e-learning materials can help me to save time.	5	4.77	.445	0	0	0.9	21.3	77.8
Better browsing and connectivity between e-learning materials can help me to reduce energy consumption.	5	4.75	.476	0	0	1.9	21.3	76.9
By switching from cell phone network to WiFi, I can extend the battery's lifetime.	5	4.56	.752	0.9	1.9	4.6	25.0	67.6
By switching from cell phone network to WiFi, I can save substantial energy.	5	4.60	.610	0	0.9	3.7	29.6	65.7
Communication and interaction among academic staff can ensure a sustainable e-learning system by providing effective support.	4	4.23	.605	0	0	9.3	58.3	32.4
Communication and interaction among academic staff can ensure a sustainable e-learning system by establishing rapport and understanding others' roles.	4	3.93	.622	0	0	23.1	61.1	15.7
Communication and interaction among academic staff can ensure a sustainable e-learning system by encouraging collegial sharing.	4	3.86	.555	0	0	23.1	67.6	9.3
Communication and interaction among academic staff can ensure a sustainable e-learning system by using a common language.	4	3.75	.628	0	0	35.2	54.6	10.2
Communication and interaction among academic staff can ensure a sustainable e-learning system by adaptability.	4	3.69	.571	0	0	36.1	58.3	5.6
I believe adequate support for green technology usage can improve sustainable e-learning	4	4.12	.575	0	0	11.1	65.7	23.1
I believe sustainable e-learning can be achieved if sustainable development is integrated into the higher-education rating system requirement.	4	3.94	.660	0	0	25.0	56.5	18.5
I believe sustainable e-learning can be achieved through support and awareness of sustainable development in university	4	4.02	.580	0	0	15.7	66.7	17.6

Statements	Mode	Mean	Std. Deviation	Strongly Disagree %	Disagree %	Neutral %	Agree %	Strongly Agree %
I believe sustainable e-learning can be achieved through the availability and consistency of e-learning application.	4	4.06	.701	0	0	21.3	50.9	27.8
I believe sustainable e-learning can be achieved with the support of the university's management personnel.	4	3.99	.677	0	0	23.1	54.6	22.2
I believe sustainable e-learning can improve and maintain quality of education while reducing cost.	4	4.34	.644	0	0.9	6.5	50.0	42.6
I believe sustainable e-learning can maintain raw materials for the seventh generations.	4	4.13	.628	0	0	13.9	59.3	26.9
I believe sustainable e-learning can reduce education cost.	4	4.42	.613	0	0.9	3.7	48.1	47.2
I believe sustainable e-learning can reduce environmental impact.	5	4.51	.521	0	0	0.9	47.2	51.9
Participation of academic staff in sustainable e-learning can be improved by providing training and support.	5	4.41	.642	0	0	8.3	42.6	49.1
Participation of academic staff in sustainable e-learning can be improved by providing rewards for sustainable development practices.	5	4.29	.724	0	0	15.7	39.8	44.4
Participation of academic staff in sustainable e-learning can be improved by providing public recognition of staff.	4	3.98	.655	0	0	22.2	57.4	20.4
Participation of academic staff in sustainable e-learning can be improved by creating a role in the faculty/school/department for sustainable development.	4	3.96	.640	0	0	22.2	59.3	18.5
Participation of academic staff in sustainable e-learning can be improved by conducting staff meetings to discuss the university's sustainable development aims.	4	3.94	.653	0	0	24.1	57.4	18.5
Participation of academic staff in sustainable e-learning can be improved by changes to the workload to make teaching attractive and sustainable.	4	3.89	.646	0	0	26.9	57.4	15.7
Participation of academic staff in sustainable e-learning can be improved by adding sustainable components to staff KPIs (Key Performance Indicators).	4	3.71	.670	0	0	40.7	47.2	12.0

Statements	Mode	Mean	Std. Deviation	Strongly Disagree %	Disagree %	Neutral %	Agree %	Strongly Agree %
Participation of academic staff in sustainable e-learning can be improved by a change in the likelihood of career development.	4	3.67	.611	0	0	40.7	51.9	7.4
Printing of teaching materials can be reduced by providing guidelines on how to save on printing costs.	5	4.49	.648	0	1.9	2.8	39.8	55.6
Printing of teaching materials can be reduced by providing online materials.	5	4.72	.470	0	0	0.9	25.9	73.1
Printing of teaching materials can be reduced by providing online assessments.	5	4.66	.583	0	1.9	0	28.7	69.4
Printing of teaching materials can be reduced by using software that eliminates irrelevant pages when printing.	5	4.57	.567	0	0.9	0.9	38.0	60.2
Sustainable e-learning can be achieved by classroom modifications.	3	3.44	.646	0	2.8	55.6	36.1	5.6
Sustainable e-learning can be achieved by consistent hardware infrastructures.	4	3.85	.624	0	0	27.8	59.3	13.0
Sustainable e-learning can be achieved by consistent network infrastructure.	4	3.96	.625	0	0	21.3	61.1	17.6
Sustainable e-learning can be achieved by consistent technology infrastructure.	4	3.97	.618	0	0	20.4	62.0	17.6
Sustainable e-learning can be achieved by green technology.	5	4.48	.619	0	0	6.5	38.9	54.6
Sustainable e-learning can be achieved by providing 24/7 technical support.	5	4.49	.648	0	0.9	5.6	37.0	56.5
Sustainable e-learning can be achieved by providing applications that reduce environmental impact.	5	4.55	.570	0	0	3.7	38.0	58.3
Sustainable e-learning can be achieved by providing applications that reduce workload.	5	4.50	.588	0	0	4.6	40.7	54.6
Sustainable e-learning can be achieved by providing e-learning contents that can be reused and repurpose.	5	4.62	.488	0	0	0	38.0	62.0
Sustainable e-learning can be achieved by providing facilities that consume low energy.	5	4.61	.544	0	0	2.8	33.3	63.9

Statements	Mode	Mean	Std. Deviation	Strongly Disagree %	Disagree %	Neutral %	Agree %	Strongly Agree %
Sustainable e-learning can be achieved by providing facilities that produce low carbon emission.	5	4.60	.528	0	0	1.9	36.1	62.0
Sustainable e-learning can be achieved by providing meaningful e-learning contents.	5	4.59	.548	0	0	2.8	35.2	62.0
Sustainable e-learning can be achieved by providing virtual personal assistance/mentor.	4	4.41	.581	0	0	4.6	50.0	45.4
Sustainable e-learning can be achieved by supporting curriculum adaptation in e-learning.	5	4.44	.585	0	0	4.6	46.3	49.1
Sustainable e-learning can be achieved by supporting pedagogy adaptation in e-learning.	4	4.45	.553	0	0	2.8	49.1	48.1
Sustainable mobility allows me to have a user friendly interface.	5	4.44	.646	0	0	8.3	38.9	52.8
Sustainable mobility allows me to have environment friendly services.	5	4.48	.572	0	0	3.7	44.4	51.9
Sustainable mobility allows me to have faster access.	4	4.45	.553	0	0	2.8	49.1	48.1
Sustainable mobility allows me to have open data that serve mobility.	5	4.47	.618	0	0	6.5	39.8	53.7
Sustainable mobility allows me to have personalization.	4	4.26	.647	0	0	11.1	51.9	37.0
Sustainable mobility allows me to have to save battery life.	5	4.62	.607	0	0	6.5	25.0	68.5
To support sustainable e-learning, academic staff should improve their teaching in a sustainable environment setting.	4	4.41	.581	0	0	4.6	50.0	45.4
To support sustainable e-learning, academic staff should improve their online student assessment practice.	4	4.39	.609	0	0.9	3.7	50.9	44.4
To support sustainable e-learning, academic staff should improve their online tutoring.	4	4.35	.631	0	0	8.3	48.1	43.5
To support sustainable e-learning, academic staff should improve their online interaction.	4	4.34	.566	0	0	4.6	56.5	38.9
To support sustainable e-learning, academic staff should improve their ICT skills.	4	4.33	.564	0	0	4.6	57.4	38.0
To support sustainable e-learning, academic staff should improve their virtual classrooms management.	4	4.20	.608	0	0	10.2	59.3	30.6
To support sustainable e-learning, academic staff should improve their critical thinking skills.	4	3.85	.577	0	0	25.0	64.8	10.2

Student: Quantitative Analysis – Descriptive statistics

STUDENT – e-Learning N = 207								
Statements	**Mode**	**Mean**	**Std. Deviation**	**Strongly Disagree %**	**Disagree %**	**Neutral %**	**Agree %**	**Strongly Agree %**
E-learning is important.	5	4.40	0.710	1.4	0	4.3	45.4	48.8
E-learning is an effective learning tool.	5	4.32	0.760	1.0	1.0	9.2	43.0	45.9
E-learning develops students' critical thinking skills.	4	3.83	0.824	1.0	3.4	28.0	47.3	20.3
E-learning allows students to become independent learners.	4	3.93	0.750	1.0	0.5	24.6	52.7	21.3
E-learning leads to non-social environment.	4	3.75	0.790	1.0	4.8	26.1	54.1	14.0
E-learning may lead to isolation from teacher and classroom.	4	3.81	0.743	1.0	2.4	25.6	56.5	14.5
E-learning may impair a student's performance due to low motivation.	4	3.67	0.818	1.9	5.3	28.0	53.6	11.1
Using online learning content encourages me to learn by myself.	4	3.94	0.644	1.0	0.5	16.4	67.6	14.5
Using online learning content encourages me to be motivated.	4	3.73	0.700	1.0	0.5	34.3	53.1	11.1
Using online learning content encourages me to organize my learning activities (i.e. downloading and uploading content through e-learning system).	4	4.25	0.672	0.5	0.5	8.7	54.1	36.2

STUDENT – Technology N = 207								
Statements	**Mode**	**Mean**	**Std. Deviation**	**Strongly Disagree %**	**Disagree %**	**Neutral %**	**Agree %**	**Strongly Agree %**
E-learning systems that enable me to understand the content also have meaningful contents than enhance learning quality.	4	4.07	0.579	0	0	13.5	66.2	20.3
E-learning systems that enable me to understand the content also have intelligent agents that assist me to work more efficiently.	4	3.93	0.721	0	1.4	25.1	52.2	21.3
E-learning systems that enable me to understand the content also run multiple software in a single system.	3	3.60	0.769	0	1.4	53.1	29.5	15.9
E-learning systems that enable me to understand the content also have access anytime and anywhere and will provide intelligent solutions to web searching and content management.	4	4.27	0.707	0	0.5	13.5	44.4	41.5
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it offers better web browsing & communication.	4	4.14	0.624	0	0.5	12.1	60.9	26.6
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it provides easier access to comprehensive information.	4	4.19	0.598	0	0.5	8.7	62.3	28.5
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it facilitates obtaining easy-to-exchange learning content.	4	4.12	0.690	0	0.5	16.9	52.7	30.0
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it provides information connectivity.	4	4.19	0.652	0	0.5	12.1	55.6	31.9
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it allows one to learning from multiple resources.	4	4.15	0.700	0	0.5	16.4	50.2	32.9
New technology such as Web 2.0 and Web 3.0 makes e-learning contents more useful and meaningful because it tags learning content.	4	3.89	0.758	0	1.0	31.9	44.4	22.7

STUDENT – Application N = 207								
Statements	**Mode**	**Mean**	**Std. Deviation**	**Strongly Disagree %**	**Disagree %**	**Neutral %**	**Agree %**	**Strongly Agree %**
Personalized learning allows me to be independent in my learning.	4	3.93	0.553	0	0.5	17.4	70.5	11.6
Personalized learning allows me to customise my learning.	4	4.23	0.624	0	0.5	9.2	57.5	32.9
Personalized learning allows me to not be overloaded with information.	4	4.10	0.713	0	1.4	16.4	52.7	29.5
Personalized learning allows me to obtain interesting contents.	4	4.24	0.629	0	1.0	7.7	58.0	33.3
Personalized learning allows me to stay connected with my learning.	4	4.04	0.645	0	0.5	17.4	59.9	22.2

STUDENT – Sustainable Development N = 207								
Statements	**Mode**	**Mean**	**Std. Deviation**	**Strongly Disagree %**	**Disagree %**	**Neutral %**	**Agree %**	**Strongly Agree %**
Sustainable education can be achieved by integrating sustainability issues in learning experiences.	4	4.08	0.578	0	0.5	11.6	67.6	20.3
Sustainable education can be achieved by integrating sustainable development concept across education.	4	4.09	0.596	0	0.5	12.1	65.2	22.2
Sustainable education can be achieved by articulating the benefits and limitations of being eco-literate.	4	4.18	0.611	0	0.5	9.7	60.9	29.0
I believe sustainable e-learning can reduce the environmental impact of technology.	5	4.45	0.605	0	0	5.8	43.0	51.2
I believe sustainable e-learning can improve student learning engagement.	5	4.34	0.699	0	0.5	11.6	41.1	46.9
The amount of printing learning contents can be reduced by providing guidelines on how to save printing costs.	5	4.44	0.658	0	1.0	6.3	40.1	52.7
The amount of printing learning contents can be reduced by providing online assessments.	5	4.58	0.567	0	0	3.9	33.8	62.3
The amount of printing learning contents can be reduced by providing online contents.	5	4.56	0.619	0	0.5	5.3	31.9	62.3
The amount of printing learning contents can be reduced by providing software that allows online editing and collaboration.	5	4.49	0.660	0	0	9.2	32.9	58.0
The amount of printing learning contents can be reduced by providing software that eliminates useless pages when printing.	5	4.50	0.675	0	0.5	8.7	30.9	59.9
The amount of printing learning contents can be reduced by providing technology to improve online reading.	5	4.57	0.602	0	0	5.8	31.4	62.8
Better browsing and connectivity between e-learning contents can help me to save time.	5	4.60	0.581	0	0	4.8	30.0	65.2
Better browsing and connectivity between e-learning contents can help me to reduce cost.	5	4.56	0.643	0	0.5	6.8	29.5	63.3
Better browsing and connectivity between e-learning contents can help me to reduce energy consumption.	5	4.48	0.749	0	2.4	8.2	28.5	60.9

Statements	Mode	Mean	Std. Deviation	Strongly Disagree %	Disagree %	Neutral %	Agree %	Strongly Agree %
For sustainability, mobile learning should offer me environment-friendly services.	5	4.49	0.590	0	0	4.8	41.5	53.6
For sustainability, mobile learning should offer me faster access.	5	4.56	0.579	0	0	4.3	35.7	59.9
For sustainability, mobile learning should offer me open data that serves mobility.	4	4.26	0.695	0	0.5	13.0	46.9	39.6
For sustainability, mobile learning should offer me personalization.	4	4.07	0.696	0	0.5	19.3	52.7	27.5
For sustainability, mobile learning should offer me the possibility of saving battery life.	5	4.48	0.645	0	0	8.2	35.7	56.0
For sustainability, mobile learning should offer me a user-friendly interface.	4	4.26	0.682	0	0	13.5	46.9	39.6

Appendix IV

Sample of letter to expert interview participants

Dear …,

Invitation for conducting interview

My name is Aidrina binti Mohamed Sofiadin. I am currently completing research for my Doctorate in Information Systems at Curtin University.

I am investigating the characteristics of a new sustainable e-learning framework for Malaysia. In an effort to evaluate the framework, I am conducting a series of interviews with experts in e-learning, sustainable development and/or teaching and learning.

You have been identified as an expert in one of these areas, and I invite you to participate in this study. This would entail reading the attached framework, reflecting on how it would assist you and people you work with to development more sustainable e-learning environments, and a 30 minute interview. More information is in the attached information sheet.

If you need any additional information please let me know by contacting me by email at a.mohameds@student.curtin.edu.au. Alternatively, feel free to contact my supervisors, Dr Brian von Konsky at b.vonkonsky@cbs.curtin.edu.au, or Dr. Torsten Reiners at t.reiners@cbs.curtin.edu.au.

If you are willing to participate, please reply to this email message, and attach a signed copy of the consent form that is included with this email. We will then schedule an interview for a time that is convenient for you.

Thank you for your consideration, your participation in greatly appreciated.

Sincerely,

Aidrina binti Mohamed Sofiadin

Appendix V

Participant Information Sheet

Curtin
University of Technology

Curtin University of Technology

School of Information Systems

Participant Information Sheet

My name is Aidrina binti Mohamed Sofiadin. I am currently completing a piece of research for my Doctorate in Information Systems at Curtin University of Technology.

Purpose of Research
I am investigating the characteristics of developing a sustainable e-learning framework for Malaysia and ascertain if the new sustainable e-learning framework will assist Malaysian higher-education stakeholders to become more sustainable

Consent to Participate
Your involvement in the research is entirely voluntary. You have the right to withdraw at any stage without it affecting your rights or my responsibilities. When you have signed the consent form I will assume that you have agreed to participate and allow me to use your data in this research.

Confidentiality
The information you provide will be kept separate from your personal details. Only the researchers will have access to this. The interview transcript will not have your name, the name of your institution, or any other identifying information. The interview recording and transcript will be kept on a secure computer for five years before being destroyed.

Further Information
If you need any additional information from us, please let us know by contacting me by email at a.mohameds@student.curtin.edu.au. Alternatively, feel free to contact my supervisors, Dr Brian von Konsky at b.vonkonsky@cbs.curtin.edu.au, or Dr. Torsten Reiners at t.reiners@cbs.curtin.edu.au. This study has been approved under Curtin University's process for lower-risk studies (Approval Number RDBS-62-15). If you have any concerns on the research ethics, please contact the researchers named above or the Curtin University Human Research Ethics Committee. c/- Office of Research and Development, Curtin University, GPO Box U1987, Perth 6845 or by telephoning 9266 9223 or by emailing hrec@curtin.edu.au.

Thank you very much for your involvement in this research, your participation is greatly appreciated

Curtin
University of Technology

PARTICIPANT INFORMATION SHEET

PHASE 1

Introduction – background behind the study

If you agree to participate, you will be asked to read a document that is just over 30 pages long. The document describes a framework that intends to help academics and higher education institutions to make learning more sustainable. You'll be asked to reflect on how this framework might be applied in your teaching or at your institution before participating in a 30 minutes interview. The interview will explore:

- How the sustainable e-learning framework benefits the e-learning stakeholder
- How the sustainable e-learning framework benefit the institution's e-learning
- Feedback on the characteristics of a sustainable e-learning framework
- Overview of the sustainable e-learning framework

The interview will be recorded and transcribed.

Please note:

- Taking part is voluntary and you can pull out at any time without any problem.
- Your withdrawal will not affect you in any way.
- Before the interview starts, you will be given an opportunity to ask questions.
- The interview will be recorded and subsequently transcribed. The recording will be destroyed after it has been transcribed.
- Materials such as drawings, notes, and artefacts arising from interview activities will be collected at the conclusion of the interview and analyzed by researchers.
- Your privacy is greatly respected and any information that could identify you or your institutions will not be included in any publications arising from your participation in this research
- The interviewer has signed a confidentiality form and cannot share information about you with any person.

If you have any questions before, during or after the interview, please call Aidrina Mohamed Sofiadin on +61 0431600498.

Thank you very much for you time. Please keep this information sheet for your records.

This study has been approved by the Curtin University Human Research Ethics Committee (Approval Number Approval Number RDBS-62-15). If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784 or emailing hrec@curtin.edu.au

Appendix VI

Expert Interview Consent Form

Curtin
University of Technology

Develop and evaluate a sustainable e-learning framework for the higher-education sector in Malaysia

CONSENT FORM

I ____________________________ have read the attached information sheet. Any questions I had have been answered to our/my satisfaction. I agree to participate in this research but understand that I can change my mind or stop at any time.

I understand that...	Initial Signature
• Taking part is voluntary and I can pull out at any time without any problem.	_____
• My withdrawal will not affect me in any way.	_____
• I have be given an opportunity to ask questions and all have been answered to my satisfaction.	_____
• The interview will be recorded and subsequently transcribed. The recording will be destroyed after it has been transcribed.	_____
• Materials such as drawings, notes, and artefacts arising from interview activities will be collected at the conclusion of the interview and analysed by researchers.	_____
• My privacy is greatly respected and any information that could identify me or my institutions will not be included in any publications arising from my participation in this research.	_____
	_____

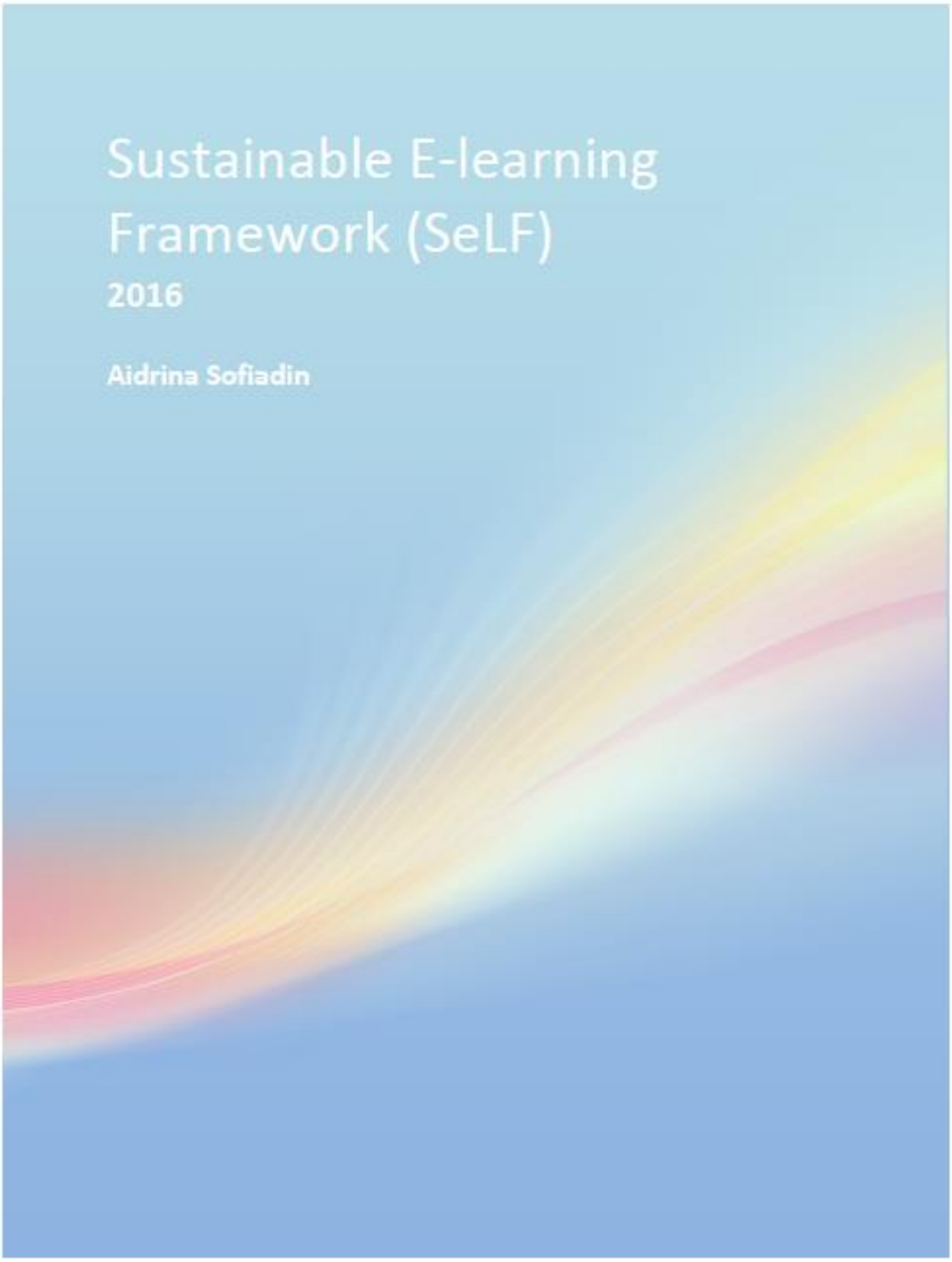
Signature ________________________ Date ____________________

Witness Signature ________________________ Date ____________________

Appendix VII

'SeLF glossy brochure' – handed to expert interview participants

(1st round of the interview)



About SeLF

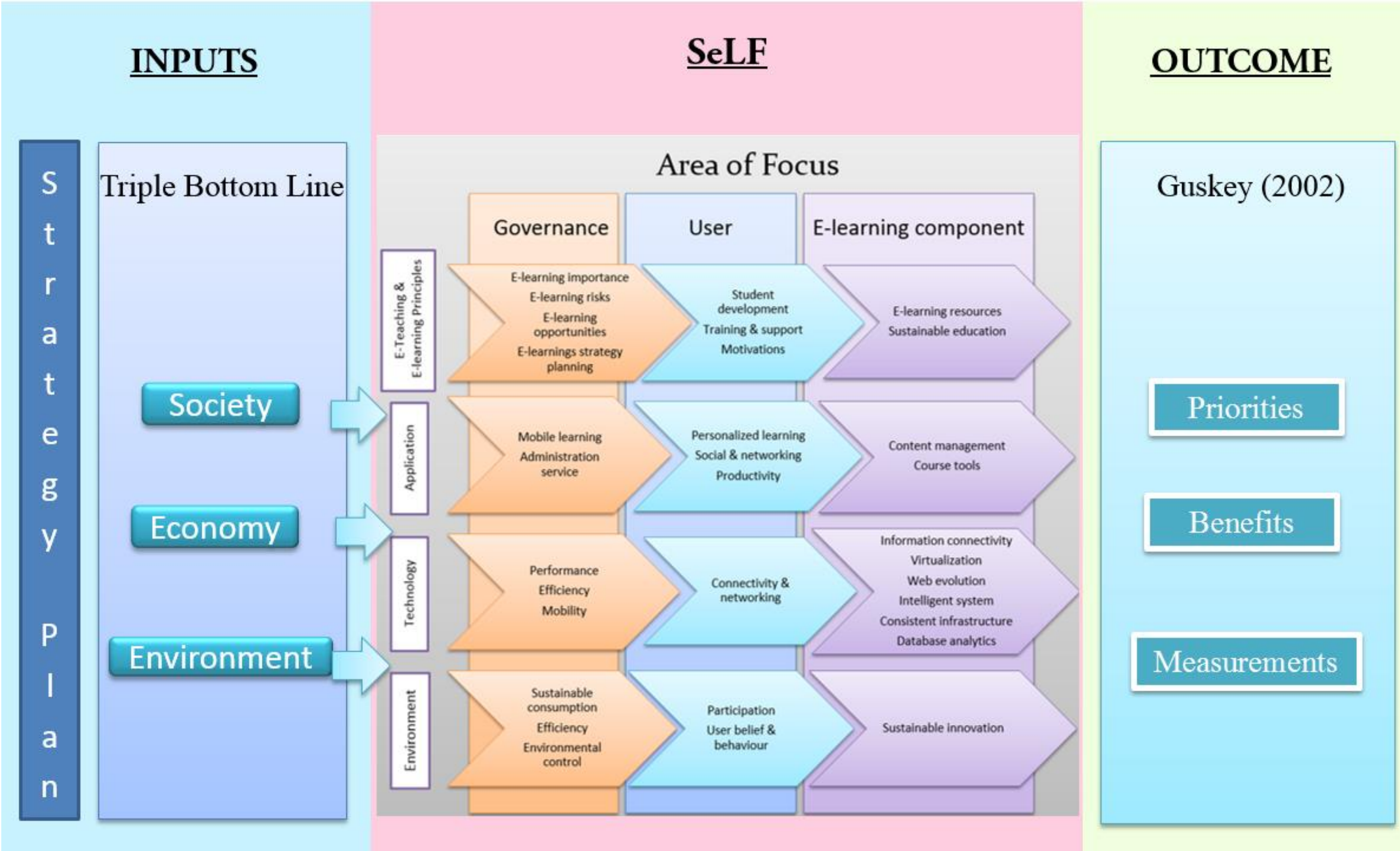
The sustainable e-learning framework (SeLF) characteristics of sustainable e-learning from the perspective of Malaysian higher education stakeholders. Based on the effective pedagogies presented by Husbands and Pearce (2012), SeLF supports pedagogies that foster student learning, assessment, and equity by taking into consideration their long-term learning outcomes and short-term goals

Why Does It Matter?
SeLF aims to provide an e-learning system that support continuous learning through efficient and effective learning . It was designed to assist Malaysian higher education stakeholders to become more sustainable. By contributing to the achievement of sustainable goals, SeLF complies with formal sustainable development plans such as those established by the 2005 World Summit, The Future We Want 2012, United Nations summit for the adoption of the post-2015 development agenda, 11th Malaysia Plan 2016-2020, and Malaysia Education Blueprint 2015-2025 (Higher Education). Hence, SeLF is an important means of promoting lifelong learning, education equity, and education on sustainable development.

What Will Success Look Like?
Sustainable goals focusing on education equity, equal access to affordable and quality higher education, and increased enrolment in higher education, will be achieved. Moreover, sustainable practice among Malaysian higher education stakeholders will be improved. E-learning as a knowledge or learning resources repository can provide access to knowledge that supports lifelong learning, and facilitates globalized online learning.

For whom is it intended?
The main users of this framework will be e-learning policy and governance committees and university executive leadership, who will use SeLF to guide and inform the e-learning policy of their respective institutions. Together with the involvement of other e-learning stakeholders, such as students and academic staff, SeLF is well-positioned to assist institutions to sustainably address the needs of learners now and in the future.

The Sustainable E-learning Framework (SeLF)



How SeLF works

SeLF acts as a guideline to facilitate the establishment and on-going monitoring of sustainable e-learning policy, while improving learning outcomes in a manner that benefits the economy, society, and environment.

Elements and descriptions of SeLF are intended to be valuable resources enabling policy makers to differentiate between sustainable and non-sustainable e-learning initiatives.

Steps to using SeLF

There are eight steps in the SeLF implementation process.

i) Align elements of the institutional strategic plan with e-learning goals or sustainable development goals based on a Triple Bottom Line analysis.

ii) Select the category that contributes to each e-learning or sustainable development goal.

iii) Identify the area of focus: Strategy, User, or E-learning Component based on each e-learning or sustainable development goal.

iv) Select the necessary element (sub-category) that will contribute to the e-learning goal or sustainable development goal and develop or enhance it in effective ways to support the goal.

v) Prioritize the selected elements based on institutional priorities.

vi) Articulate the benefits of developing or improving the element in a manner that justifies the priority ascribed to each element

vii) Identify metrics that can be used to measure goal attainment.

viii) Use identified metrics measures outcome against short-term and long-term goals, and manage policies and resources based on the needs of today and tomorrow.

The Triple Bottom Line

The concept of the Triple Bottom Line (TBL) includes three sustainability dimensions. These dimensions characterize how an initiative affects society, the environment, and the economy.

In this stage, users of the SeLF

- define TBL goals that contribute to sustainable e-learning based on societal, environmental, and financial factors; and

- identify appropriate SeLF elements that support these TBL goals .

Definitions of each TBL dimension are found in Table 1. These should be used to assist in defining sustainable e-learning goals.

TBL	SeLF definitions
Social	Sustainable e-learning aims to develop e-learning that ensures quality education, equity, educational achievement, and knowledgeable and innovative individuals, while promoting lifelong learning and balanced development.
Economy	Sustainable e-learning aims to improve the financial accessibility of tertiary education, and contributes to knowledge-intensive employment, and work-life balance through a viable online education.
Environment	Sustainable e-learning focuses on sustainable production and consumption that promotes eco-friendly e-learning principles and technological development as part of the action to counteract climate change and minimise its impact, in order to meet the needs of present and future generations.

Table 1: Definition of SeLF in terms of Triple Bottom Line components

The Elements of Sustainable E-Learning

SeLF consists of four categories: E-Teaching and E-learning Principles, Application, Technology, and Environment. Each of these categories consists of correlated sub-elements. Descriptions of sustainable e-learning elements are provided in the context of Priority, Benefit, and Measurement.
In addition, examples of each element are given, based on a review of the relevant literature.

The Areas of Focus

Each category has three areas of focus: Governance, User, and E-learning Component. Descriptions of the areas of focus are given in Table 2 below.

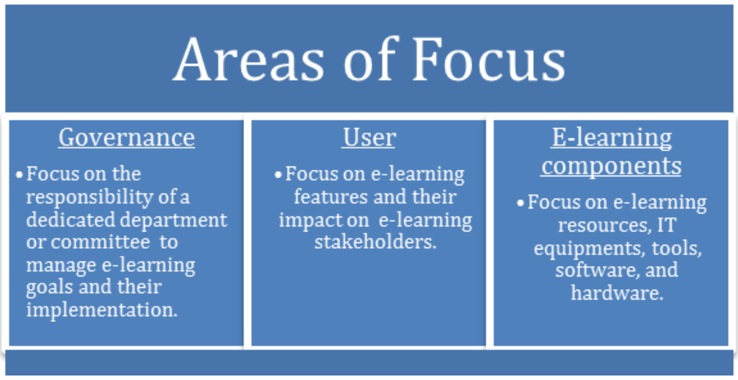
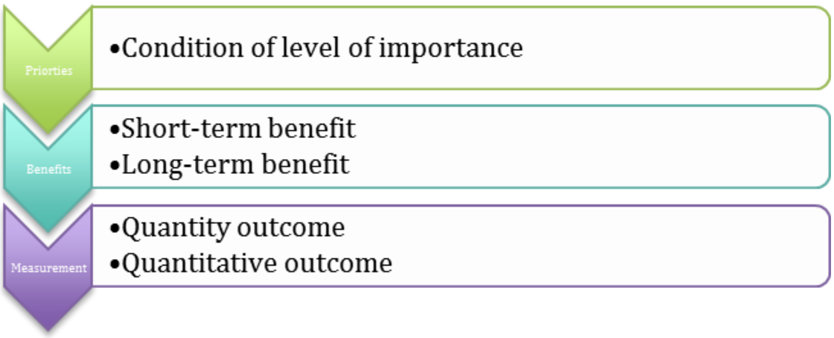


Table 2: Descriptions of the areas of focus

Outcome Measure

Elements contributing to the identification of goals are evaluated with respect to short-term and long-term benefits to the institution, the learner, and to society. The benefits should be mentioned when communicating identified institutional priorities to stakeholders, and to inform the establishment of metrics that can be used to measure outcome attainment.



Example of using SeLF

This section provides an example of how SeLF will be used in practice. This example was based on the eight steps in the implementation of SeLF.

Example of overall outcomes based on the eight steps of the SeLF process.
Objective of Malaysia's Ministry of Education cited in the Malaysia Higher Education Blueprint 2015:
To make e-learning an integral component of tertiary education by transforming common undergraduate courses into one Massive Open Online Course (MOOC) and encourage teachers to deliver 70% of the program using a blended learning approach.

INPUT

Strategy Plan:
Develop and implement the MOOC strategy through e-learning.
Triple Bottom Line:
People: Develop an e-learning approach that ensures equitable access to quality open e-learning resources while simultaneously supporting the sustainable development concept.

SeLF

Category	Area of focus	Element (Subcategory)	Reason
E-Teaching and E-learning Principles	E-learning component	E-learning resources	Improves e-learning accessibility by providing open e-learning resources such as online assignments, quizzes, tests, and lecture notes.
Technology	User	Web evolution	Maximizes the use and increased availability of e-learning materials.
Environment	Governance	Efficiency	Provides affordable or free education because the e-learning resources are open and accessible to all.

OUTCOMES

Priorities

- Ongoing transformation of e-learning resources so that they are aligned with teaching and learning requirements.
- E-learning resources and Web evolution are of greater importance than efficiency elemental towards the environment.

Benefits

- Increase in student enrolments and course completions.
- Increase in e-learning usability and accessibility.

Measurements

- Establish collaboration with high-profile MOOC companies such as Coursera and EdX.
- Explore platforms for MOOCs development.

Comprehensive descriptions of each of the eight steps in the SeLF implementation process.

In this section a detailed description for each of the eight SeLF steps are described.

INPUT

VIII) Align elements of the institutional strategic plan with the e-learning goal or sustainable development goal based on a Triple Bottom Line analysis

In defining strategic plan, university leaders typically identify the current status and future aspirations regarding teaching and learning at the institution. This includes identifying the key factors that can guide an institution towards e-learning sustainability.

In this case, the strategic plan example aims to improve current e-learning and becomes more sustainable through the provision of open e-learning resources.

INPUT

IX) Select the category that contributes to the e-learning or sustainable development goal.

To support the strategic plan, a clearly defined sustainable e-learning objective is required. Therefore, to ensure that an objective contributes to sustainability, sustainable e-learning goals should be based on the societal, environmental, and financial 'bottom line'.

In this example, sustainable e-learning goals based on the societal, environmental, and financial 'bottom line' were elaborated as shown in the Table 3 below.

TBL	Sustainable E-learning goal
Social	Develop an e-learning approach that ensures equity access to quality education while promoting lifelong learning and the concept of sustainable development.
Economy	Develop an e-learning approach that improves tertiary education attainment and work-life balance through a sustainable online education solution.
Environment	Develop an e-learning approach that focuses on sustainable production and consumption that promotes eco-friendly e-learning principles and technological development as part of the action to counteract climate change and its impact, in order to meet the needs of present and future generations.

Table 3: Example for sustainable e-learning goals based on TBL.

Based on the defined sustainable e-learning goals, the appropriate SeLF category and elements that support both the strategic plan and the TBL goals are identified.

SeLF

X) Identify the area of focus: Strategy, User, or E-learning Component based on e-learning goal or sustainable development goal.

Once the strategy plan and sustainable e-learning goals have been defined, the appropriate category that supports those goals is selected.

In this example, improving sustainable e-learning through accessibility involves all four SeLF categories: E-Teaching and E-learning Principles, Application, Technology, and Environment.

The reasons for selecting these categories are given below:

Category	Reason
E-Teaching and E-learning Principles	Learning pedagogy and curriculum are the backbone of the e-learning resources.
Technology	Technology plays an important role in supporting e-learning platforms.
Environment	Since the learning resources can be accessed and viewed online, the need for paper and travel will decrease.

Once the related category has been selected, the area of focus needs to be identified based on Governance, User, or E-learning Component.

XI) Select the necessary element (sub-category) that will contribute to the e-learning goal or sustainable development goal and develop or enhance it in effective ways to support the goal.

Based on the selected category, the area of focus is identified. Then, the appropriate element (sub-category) needs to be identified and action taken to either develop or improve the element to support the goal.

Category	Area of focus	Element (Subcategory)	Reason
E-Teaching and E-learning Principles	E-learning component	E-learning resource	Improves e-learning accessibility by providing open e-learning resources such as online assignments, quizzes, tests, and lecture notes.
Technology	User	Web evolution	Maximizes the use and increases e-learning materials availability.
Environment	Governance	Efficiency	When the e-learning resources are open and accessible to all, education becomes affordable or free.

Table 4: Example for selected elements contribution.

As shown in the Table 4 above, the required elements were selected along with reasons showing why they contribute to achieving the defined sustainable e-learning goal.

In the next step, the selected elements are prioritized.

XII) Prioritize the selected elements based on institutional priorities.

Once the required elements have been identified and selected, they will be prioritize based on the current e-learning environment and the availability of support such as funds and expertise.

The selected elements were prioritized as shown in the Table 5 below.

	Very Urgent	**Less Urgent**
Very Important	• E-learning resource • Web evolution	-
Less Important	-	• Efficiency

Table 5: Example how selected elements were prioritized.

By allocating the elements to the above table, the user will have a clear idea of the level of importance of each element and how it can be improved or developed to achieve the sustainable e-learning goal.

XIII) Articulate the benefits of developing or improving the element in a manner that justifies the priority ascribed to each element.

Once the level of importance of the selected elements has been established, the benefits of each the element needs to be articulated.

This step can be done as shown in Table 6 below.

Category	**Area of focus**	**Element (Subcategory)**	**Benefits**
E-Teaching and E-learning Principles	E-learning component	E-learning resource	Allows students to access their lecture notes and assessments and take their quizzes and tests online. Enhances quality and flexibility of e-learning resources. Encourages students to apply knowledge in a broader context.
Technology	User	Web evolution	Provides platforms to support learner-centred, self-directed, peer-to-peer and social learning approaches.
Environment	Governance	Efficiency	Offers affordable e-learning resources.

Table 6: Example on outline the benefits of each selected element.

Once the benefits of each element have been expressed, the final step entails measuring the outcome.

XIV) Identify metrics that can be used to measure goal attainment.

Measures can be applied to any context such as quality, efficiency, development, maintenance, innovation, cost, and profit.

In this case, the measurements considered for the selected elements are as follows.

- <u>The e-learning resource</u>

  Gauge the quality of e-learning open educational resources to ensure that they meet students' present and future needs.

- <u>Web evolution</u>

  Measure the flexibility and extendibility of the e-learning platforms and the ability to adapt open tools to access, reuse, develop, and share e-learning resources on the Web.

- <u>Efficiency</u>

  Use efficiency standards to measure the consumption of resources including computers, servers, and printers.

XV) Use identified metrics measures outcome against short-term and long-term goals, and manage policies and resources based on the needs of today and tomorrow.

Once the selected elements were measured, the user will have a clear view of the outcome of the elements in relation to short-term and/or long-term goals. Therefore, user will then able to manage policies and resources to meet the required goals.

Sustainable E-learning Elements

Areas of focus based on the categories and sub-categories of sustainable e-learning.

Category	Area of Focus	Sub-category
E-teaching and E-learning Principles	Governance	E-learning importance
		E-learning risks
		E-learning opportunities
		E-learning strategy planning
	User	Student development
		Training and support
		Motivations
	E-learning Component	E-learning resource
		Sustainable education
Application	Governance	Administration service
	User	Personalized learning
		Social and networking
		Productivity
		Mobile learning
	E-learning Component	Course management
		Course tools
Technology	Governance	Performance
		Efficiency
		Database analytics
		Consistent infrastructure
	User	Connectivity and Networking
		Mobility
	E-learning Component	Information connectivity
		Virtualization
		Web evolution
		Intelligent system
Environment	Governance	Sustainable consumption
		Efficiency
		Environmental control
	User	Participation
		User belief and behaviour
	E-learning Component	Sustainable innovation

Categories and Sub-categories

The elements of sustainable e-learning were grouped into categories and sub-categories for ease of use. The grouping is intended to assist people who are contributing to sustainable e-learning initiatives or sustainable development goals.

Layout

The definition of each element of sustainable e-learning is presented within the appropriate categories and sub-categories. Each element definition consists of the element name, overall description, and descriptions of area of focus.

E-Teaching and E-Learning Principles

- E-learning importance
- E-learning risks
- E-learning opportunities
- E-learning strategy planning
- Student development
- Training and support
- Motivations
- E-learning resource
- Sustainable education

E-learning Importance

The e-learning pedagogy should engage the learner, meaning that it must focus on directing attention to the most important parts without compromising instructional quality.

Priority
Identify the priority of improvement of e-learning to promote the importance of offering e-learning to students and academic staff.

Benefit
Develop an e-learning approach that supports the sustainability goals while improving the quality of online education.

Measures
Measure the benefits of delivering online pedagogy and determine whether it meets the needs of today and tomorrow.

Example for E-learning Importance:

Evaluate students' learning performance, technology, and academic staff teaching performance as part of the e-learning critical success factor (Masrom, Zainon and Rahiman 2008).

Priority
Define the priority of improvement of e-learning technology and tools that are able to evaluate performance in terms of students' learning, technology, and academic staff.

Benefit
Develop use of e-learning tools such as Intelligent Agents that provide reports on students, technology, and academic staff evaluation, which will help to improve the quality of online education.

Measures
Evaluate the performance on student learning, academic staff teaching, and technology and measure it to identify any opportunity for taking e-learning initiatives that meet the needs of today and tomorrow.

E-learning Risks

Identify e-learning risks that include reasons for students not following an e-learning course, copyright issues, and the plagiarism issue. Risks should be identified and overcome so that e-learning can survive any changes to instructional practice.

Priority

Develop alternative or initiative to reduce e-learning risks to improve security and change management associated with e-learning.

Benefit

Anticipate and prepare for any e-learning risk and manage changes to reduce the impact of the risk.

Measures

Identify and access the e-learning risks by developing a risk management system to measure the present and future impact or opportunity to improve e-learning.

Example for E-learning Risks:

E-learning requires high investment in e-learning infrastructure(Puteh 2008).

Priority
Identify the level of importance of purchasing e-learning IT equipment.

Benefit
Authorize the use of backup power supplies and stabilizer to protect expensive equipment.

Measures
Identify the risks associated with investing in e-learning infrastructure and measure the return on investment.

E-learning Opportunities

Determine the advantages of e-learning that can help e-learning to survive any rapid changes in technology and students' learning needs.

Priority

Promote the importance of e-learning initiatives as a means of creating energy efficiency, cleaner production, renewable resources, and environmental finance through e-learning.

Benefit

Increase awareness of the benefits of e-learning by observing market trends and solving current e-learning problems.

Measures

Identify measures such as energy efficiency, cleaner production, renewable resources, and environmental finance.

Example for E-learning Opportunities:

Develop e-learning leadership in e-learning research, developing guidelines or standards for e-learning programs' accreditation *(Raja Hussain 2004).*

Priority
Emphasize the importance of research that identifies and develops e-learning standards and guidelines that will improve the quality of online education.

Benefit
Promote the benefit of conducting e-learning research and findings that will improve current e-learning status and identify e-learning trends.

Measures
Evaluate the e-learning quality and assess any opportunity to enhance e-learning through e-learning research.

E-learning Strategy Planning

E-learning strategy should focus on providing everyone with full access to quality education for promoting sustainable development, gender equality, and women's empowerment.

Priority

Devise an e-learning strategy that will endure the momentum of rapid change of technology and pedagogies.

Benefit

Track and review the strategic plan implementation to gauge new opportunities for today's and the future's market.

Measures

Assess the e-learning strengths, weaknesses, opportunities, and threats (SWOT analysis) to ensure the success of the strategic plan's implementation.

Example for E-learning Strategy Planning:

Develop an e-learning course structure and assessment process for online teaching and learning *(Raja Hussain 2004).*

Priority

Establish the level of importance of plans that will improve e-learning so that it can readily adapt to rapid changes in technology and pedagogies, and meet students' needs.

Benefit

Track and review the strategic plan to identify new e-learning initiatives that align with e-learning objectives.

Measures

Assess the e-learning strengths, weaknesses, opportunities, and threats (SWOT analysis) that will help to improve e-learning course development.

Student Development

E-learning should promote education for peace and human development that will help to improve quality of life and economy. Student development ensures that everyone has the necessary knowledge and skills for employment and entrepreneurship while promoting sustainable development.

Priority

Provide support to students so that their learning is enhanced and is reflected in their performance.

Benefit

Enable students' skills and abilities to be transferred to work and professional contexts.

Measures

Monitor and report on student learning goals to measure learning outcomes if the learning objective meets students' present and future needs.

Example for Student Development:

Focus on developing students' communication skills, critical thinking, creative thinking, and problem solving skills(Issa, Issa and Chang 2012).

Priority

Emphasize the importance of providing support to students that will improve their learning performance and skills development.

Benefit

Promote the advantages of providing student support as a means of improving their learning and skills development.

Measures

Assess student learning performance to measure the extent to which they have achieved their learning goals.

Training and Support

The capacity of the education system can be improved through the development of training programmes that will assist students and staff to overcome any difficulties with e-learning.

Priority

Establish the importance of training and link this with the e-learning goals.

Benefit

Identify the benefits of developing a learning culture to encourage competitiveness in order to enhance e-learning skills. Furthermore, encourage the training with support from management such as the board of directors.

Measures

Evaluate the training outcome through feedback in order to measure the productivity or profit that determines return on investment.

Example for Training and Support:

Conduct training to develop e-learning content and increase the use of e-learning facilities (Puteh 2008).

Priority

Provide e-learning training on content development and the use of e-learning tools.

Benefit

Identify the benefits (for students and academic staff) of establishing e-learning pedagogies by through the use of e-learning tools and the development of e-learning content.

Measures

Examine post-training feedback to measure the impact of training on e-learning and user behavior.

Motivations

When implementing an e-learning pedagogy, it is important to sustain student interest and motivation. Learning materials should ensure that students remain interested and motivated to learn.

Priority

Recognize that motivation is developed and sustained when students are encouraged to engage in self-reflection and have a sense of control of their own learning tasks..

Benefit

Outline the benefits of offering appropriate rewards or recognition for students' learning and teachers' teaching as an extrinsic motivation.

Measures

Identify intrinsic motivation that will assist students to reflect on their personal reasons for wanting to learn. Evaluate the students' learning progress and provide feedback that motivates students to improve their learning.

Example for Motivations:

Develop an organizational e-learning culture to motivate e-learning engagement among academic staff(Noh et al. 2012).

Priority

Offer initiatives such as awards and recognition for e-learning usage and lecturers' online evaluation to promote an e-learning culture.

Benefit

Identify the benefits of promoting e-learning culture among academic staff, and also its benefits in terms of students' learning outcomes.

Measures

Evaluate motivations that influence the e-learning professional development of academic staff.

E-learning Resources

E-learning resources should be accessible to anyone in order to promote educational equity and improve education outcomes . E-learning resources should embrace the principles of effective e-learning pedagogy and online course architecture.

Priority
Emphasize the importance of developing reusable learning objects and shared and open e-learning resources.

Benefit
Identify the benefit of developing e-learning resources and promoting open and reusable online resources.

Measures
Gauge the quality of e-learning resources to ensure that they meet students' present and future needs.

Example for E-learning Resources:

Design e-learning materials that are up-to-date, recyclable, renewable, and readily available (Gundogan and Eby 2012).

Priority
Express the importance of developing learning objects to ensure that e-learning materials are up-to-date, reusable, and accessible.

Benefit
Identify the benefits to students' learning of having up-to-date e-learning materials and reusable e-learning materials in e-content development.

Measures
Assess the quality of e-learning resources in terms of accessibility and reusability to ensure that e-learning resources meet students' present and future needs.

Sustainable Education

Sustainable education helps to promote Education for Sustainable Development (ESD), support sustainable development by providing sustainable information and education, and improve education and awareness of climate change.

Priority

Highlight the importance of knowledge regarding sustainability in order to promote sustainable practices and enhance awareness through sustainable education.

Benefit

Deliver benefit to both academic staff and students by acknowledging sustainability practices and innovation such as green business and green buildings.

Measures

Measure the effectiveness of ESD by assessing the learning goals, learning progress, learning outcomes, and learning impacts in terms of sustainable education.

Example for Sustainable Education:

Promote ESD among academic staff and students to promote social responsibility and commitment to a sustainable future (Barth and Rieckmann 2012).

Priority

Introduce new and innovative teaching and learning approaches that include ESD and make it an integral part of e-learning courses.

Benefit

Offer recognition of and awards for sustainability practices and innovation as part of ESD outcomes.

Measures

Evaluate ESD outcomes and their impact on students' attitudes and behaviors regarding sustainable development.

Application

- Administration service
- Personalized learning
- Social and networking
- Productivity
- Mobile learning
- Course management
- Course tools

Administration Service

The availability of e-learning administration service via e-learning will help to increase enrolment in higher education and accelerate human capital development for an advanced nation through social mobility improvement.

Priority

Emphasize the importance of improving administrative services so that they can support collaborative learning.

Benefit

Institution will have a professional network locally, regionally, and globally to keep up-to-date with e-learning administration service. This provides opportunities to join relevant associations or groups on social media sites such as Facebook, Twitter, and LinkedIn to engage with students' social networking activities. Furthermore, the concepts of administration-centered e-learning culture should be developed to enhance administration.

Measures

The administrative processes can be measured via students' feedback and learning outcomes.

Example for Administration Service:

IT Implement IT strategies for the administration of e-learning courses and communications between administrative staff, academic staff, and students (Puteh and Hussin 2007).

Priority

Establish approaches that will improve communications and e-learning administration.

Benefit

Promote the benefits of using the concepts of administration-centered, professional network and social media sites as means of improving communications.

Measures

Assess the quality of the administration service based on feedback from administrative staff, academic staff, and students.

Personalized Learning

Personalized learning focuses on providing knowledge that is relevant to each student's needs. Hence, everyone will have the opportunity to access high quality education programmes that are relevant to their learning interests and that will encourage lifelong learning.

Priority

Implement e-learning initiatives that will improve students' flexibility, increase students' interest, and give students choices in terms of what they want to learn to enhance personalized learning.

Benefit

Acknowledge benefits of personalized learning that will allow the students to have their own personal learning goals and provide feedback on their progress through regular assessment that is part of the personalized learning initiative.

Measures

Assess the effectiveness and efficiency of personalized learning in meeting student's present and future needs to promote education equity.

Example for Personalized Learning:

Allow personalization of e-learning course to meet students' needs and satisfaction (Jeong, Choi and Song 2012).

Priority

Highlight learning units and prior students' learning performance and experience that will optimize the learning course.

Benefit

Acknowledge benefits of personalized learning that will improve students' learning effectiveness and students' satisfaction.

Measures

Access data related to the students' academic records so that course outcomes can be optimized.

Social and Networking

Promote collaboration among academicians, students, and industrial people especially those in rural communities by delivering education, training, knowledge, and appropriate and affordable technologies. Moreover, sustainable development and lifestyle awareness can be promoted through this strategy.

Priority

Prioritize initiatives that enhance students' social networking by providing social tools and enabling the sharing of information or knowledge that will enhance students' collaboration.

Benefit

Promote the advantages of using social media tools to support students' social learning networking and allow repurpose of e-learning content to be able to fit the students' preferences.

Measures

Use free social media monitoring tools to monitor students' social learning activities in order to measure its effectiveness and efficiency of sharing. Moreover, students' feedback can be used to measure the outcome of social networking tools that support students' learning.

Example for Social and Networking:

Integrate social and networking tools in e-learning so that students have the opportunity to interact and collaborate with each other and with academic staff (Aczel, Peake and Hardy 2008).

Priority

Prioritize social networking tools that can be integrated in e-learning to enhance student's collaboration and participation in online course discussion.

Benefit

Acknowledge the advantage of using social media tools as part of online course pedagogies to support students' social learning.

Measures

Monitor students' social learning activities to measure students' commitment to online discussion.

Productivity

Focus on the importance of supporting teaching and learning productivity and educational institutions to conduct sustainable development research and innovation.

Priority

Customize online courses so that they can accurately deliver the required learning outcomes.

Benefit

Take advantages of online tools such as mobile apps and devices to support students' learning efficiently online.

Measures

Measure the return on investment of online tools that motivate students to improve their learning outcomes.

Example for Productivity:

Provide a student online learning tool that supports student interaction and assists with problem-solving and learning so that the exercise is productive (Slof et al. 2010).

Priority

Define priority of student online learning tools based on its effectiveness in supporting student's interaction and productive exercise.

Benefit

Recognize the advantages of student online learning tools in supporting students' learning and skills development.

Measures

Assess the effectiveness of student online learning tools by evaluating students' learning outcomes as a result of using the tools.

Mobile Learning

Mobile learning increases ICT access and significant mobilization of e-learning resources that support the basic human right to education and learning at all levels, and enables people to learn anytime and anywhere.

Priority

Emphasize the importance of mobile learning in improving student's engagement in active online discussion through mobile apps such as Twitter, Facebook, or Google Handouts.

Benefit

Offering learning flexibility and anywhere and anytime access to e-learning. Thus, viewing course materials, announcements and notifications on mobile devices will enhance the effectiveness of student's experience in mobile learning.

Measures

Obtain feedback on mobile learning course by creating mobile surveys and pools to receive suggestions and measure the effectiveness of the mobile learning strategy.

Example for Mobile Learning:

Use mobile learning to provide fast information and interactive learning environments *(Cavus and Ibrahim 2009; Cavus and Uzunboylu 2009).*

Priority

Acknowledge the importance of mobile learning in delivering fast information and interactive learning environments based on students' current needs.

Benefit

Outline the benefits of providing e-learning access using mobile devices and its impact on students' learning experience.

Measures

Assess feedback on mobile learning to receive suggestions and measure the effectiveness of mobile learning strategy.

Course Management

Course management refers to the ability to manage quality and innovative programmes where students have the opportunity to contribute to improving their course.

Priority

Implement e-learning initiatives by developing course management tools that allow academic staff and students to create, edit, reuse, and combine e-learning contents.

Benefit

Explain how the online course management component can enhance the usability of course management software that is easier to install, use and extend, and that maximizes learning productivity. In addition, determine whether the online course management offers a central content platform that includes a well-defined search functionality and allows the reuse of content.

Measures

Measures whether the content management tools will speed up information retrieval, reduce operational costs, and limit reliance on IT resources.

Example for Course Management:

Develop a learning object repository that stores and manages learning contents and reusable learning objects (Sural 2010).

Priority

Emphasize the importance of e-learning course management by means of a learning object repository and an administrative application that improve the development of e-learning contents.

Benefit

Demonstrate how a learning object repository can store and manage learning contents and how an administrative application can manage students' records and learning performance.

Measures

Assess the quality of content management based on feedback from e-learning designers, developers, and academic staff.

Course Tools

Effective course tools should be provided through e-learning to ensure that everyone has the required literacy and numeracy skills so that they can fully benefit from the course.

Priority

Acknowledge the importance of developing online tools that support course activities to meet the learning outcomes. Moreover, identify the significance of course tools that have the right functionality to enhance learning productivity and are easy to use.

Benefit

Outline the benefits of online course tools that are able to enhance the functionality of existing course tools that will support online collaboration for group learning and course content development.

Measures

Gauge the usage of the course tools in improving learning outcomes and their ability to assist students to complete their tasks more efficiently.

Example for Course Tools:

Provide authorizing tools (i.e. tools that grant access or authority) to develop reusable learning objects and manage online course (Sural 2010).

Priority

Define priority of course tools such as authorizing tools and assessment tools based on their impact on students' learning outcomes.

Benefit

Highlight the benefits of using authorizing tools to assist academic staff to develop reusable learning objects.

Measures

Measure the effectiveness of the online course tools based on their impact on learning outcomes.

Technology

- Performance
- Efficiency
- Mobility
- Connectivity and networking
- Information connectivity
- Virtualization
- Web evolution
- Intelligent system
- Consistent infrastructure
- Database analytics

Performance

Focus on technology performance that aims to provide a quality, reliable, sustainable, and strong infrastructure that provides everyone with affordable and equitable access to education.

Priority

Focus on initiatives such as improvements to e-learning usability, flexibility, and Internet and technology infrastructures that will improve e-learning performance.

Benefit

Outline the benefits of improving support to bolster e-learning technology performance. Additionally, acknowledge the benefits of conducting formal training to ensure IT expertise in maintaining and improving e-learning performance.

Measures

Evaluate technological performance by measuring the learners' reactions and behavior in terms of e-learning performance. Moreover, measure results that indicate the effect of e-learning on students' learning, academic staff's teaching, and on the university overall.

Example for Technology Performance:

Technology needs to be up-to-date and sufficiently stable to sustain the e-learning initiative (McGill, Klobas and Renzi 2014).

Priority

Implement initiatives such as making improvements to updated and sustainable technology infrastructures that will improve e-learning performance.

Benefit

Outline the benefits of ensuring up-to-date and stable technology that adapt to changes in technology infrastructure and user capacity.

Measures

Evaluate technological performance by measuring the learners' attitudes and behavior regarding the performance of e-learning technology.

Efficiency

Efficiency focuses on continuous improvement of technology infrastructure to improve resource-use efficiency and encourage greater adoption of clean and eco-friendly technologies.

Priority

Enhance e-learning efficiency by developing a standardized process that identifies new ways to improve the reuse of e-learning resources and avoid costly technological adoption.

Benefit

Acknowledge the advantage of investing in technology competency that will save cost, energy, and human power while increasing productivity.

Measures

Calculate the cost effectiveness and cost efficiency of e-learning development.

Example for Technology Efficiency:

Focus on maintaining low delivery costs once learning resources have been developed and stored in an e-learning repository (Ali 2004).

Priority

Develop online learning contents and store these in an e-learning repository.

Benefit

Allows students to access educational materials at low cost, and promotes equitable education.

Measures

Measure the cost effectiveness and cost efficiency of education delivery.

Mobility

Encourage mobility that reduces carbon emissions in order to promote green sustainability and flexibility.

Enhancement

Implement mobility support such as just-in-time and on-demand learning to reduce carbon footprint resulting from transportation events. Use a mobile agent based on semantic web technology to improve access to and searches of online courses and library.

Empowerment

Enable students to access online learning resources at anytime and anywhere using their mobile device, and that may encourage lifelong learning.

Measures

Assess the need for access to online resources to be accessed and measure the impact of mobility on students' engagement in their online learning.

Example for Mobility:

Focus on providing technology platform that is responsive and mobile compatible to support mobile learning and portable e-learning environment.

Priority

Ensure learning to occur anywhere with responsive, streamline, powerful, and easy to use e-learning.

Benefit

Allow students to access educational materials anywhere through their mobile devices without going to the campus.

Measures

Measure the platform performance and capability to ensure e-learning can work efficiently in multiple platforms such as iOS and Android.

Connectivity and Networking

Provide and expand digital connection through a nationwide broadband infrastructure that will support economic expansion, social inclusion and growth. This involves the establishment of a physical network infrastructure, information structure, platform, ICT devices and equipment that enhance the delivery of online learning and education access.

Priority

Enhance Internet connection by improving wireless network performance to allow students to access e-learning. Actions that can be taken to improve wireless network performance include location of router, up-to-date firmware and network adapter drivers, and optimizing the Internet connection. Moreover, the adoption of mobile networks can enhance Internet connectivity.

Benefit

Recognize the benefits of accessing the Internet through mobile networks such as LTE-M and 5G that provide optimal connectivity to the Internet. Furthermore, the campus should give students the permission to access the Internet network on campus.

Measures

Measure the accessibility of e-learning and Internet connection to determine the network's efficiency. Internet connection speed should be gauged to measure the consistency of information connectivity.

Example for Connectivity and Networking:

Provide reliable IT connection to Malaysia's national communications grid to enable students to have Internet access (Puteh and Hussin 2007).

Priority

Ensure reliable IT connection to increase e-learning access and reduce students' frustration.

Benefit

Promote the benefits of providing Internet network on campus to students in order to improve accessibility and connectivity.

Measures

Measure the accessibility of e-learning and reliability of the Internet connection in order to identify and improve network efficiency.

Information Connectivity

Establish a support system that includes technology, big data, data-driven science, co-operation infrastructure, and improved data monitoring systems that will promote recycling, and reuse of e-learning resources and provide relevant supplementary information.

Priority

To ensure information connectivity, develop linked data that can be shared with and linked to the big data.

Benefit

Information connectivity can help to close the digital divide in rural locations and improve access to reliable and timely information.

Measures

Information connectivity can be measured using data quality metrics for structured information types. Networked measures can be used to access Linked Data mappings.

Example for Information Connectivity:

Availability, contextual usage, and quality of exploratory e-learning resources that facilitates multiple e-learning resources that meet student's preferences (Sridharan, Deng and Corbitt 2010).

Priority

Recognize the importance of availability, contextual usage, and quality of exploratory e-learning resources in improving information connectivity to meet the needs of both the academic staff and the students.

Benefit

Information connectivity will ensure information availability and improve contextual usage and quality of exploratory e-learning resources.

Measures

Assess data quality metrics to ensure that both academic staff and students obtain essential educational materials.

Virtualization

A virtual environment can support domestic technology development, research, and innovation while promoting comprehensive and sustainable development and fostering innovation. E-learning efficiency and cost savings can be improved through virtualization.

Priority
Invest in virtual machines including audio, clipboard, printer, smart cards, and drives.

Benefit
Through the use of a virtual desktop, students can ensure that their learning tasks are safe at all times even though their devices may be lost or stolen.

Measures
Determine whether the use of virtualization meets the learning goals. Moreover, peak CPU utilization can be used as a measure of virtualization efficiency.

Example for Virtualization:

Increase the acceptance of the concept of virtual education by academic staff and students (Puteh and Hussin 2007).

Priority
Invest in the necessary virtual machines to provide an enriched e-learning environment that will increase students' acceptance of the novel concept of a virtual class.

Benefit
Acknowledge the benefits of the virtual learning environment in terms of students' learning performance and personal safety.

Measures
Measure the virtualization efficiency to ensure optimum e-learning performance that may increase students' e-learning acceptance.

Web Evolution

The adoption of the new features offered by the new Web will help to produce relevant and effective learning outcomes. Economic considerations should be taken into account in order to develop an eco-friendly economic, social, and technologically feasible development.

Priority

Enhance the e-learning platform by utilizing Web-based technologies such as Moodle, Blackboard Collaborate, and E-portfolio to maximize access and engagement.

Benefit

Describe the benefits of adopting new Web-based technologies and how it will benefits students' learning.

Measures

Gauge the evolution process and its impact on the structure of content and connectivity.

Example for Web Evolution:

Web development that includes instructional designers and graphic designers to provide wider relevance of Web-based materials (Lateh and Raman 2004).

Priority

Establish the importance of Web-based technologies that require the use of supporting technologies and learning resources to transform Web-based content to learner-centered delivery by effectively promoting interactive e-learning.

Benefit

Describe the benefits of providing a broader range of Web-based materials that are relevant to teaching and learning.

Measures

Assess market trends on the adoption of Web-based technologies to identify significant features that will improve e-learning.

Intelligent System

An Intelligent System (IS) provides learners with relevant knowledge for employment and entrepreneurship by analyzing their learning trends that will promote lifelong learning opportunities for all.

Priority

Stress the importance of IS as a meaningful technology that students can use in their online learning since it can promptly return answers to critical assessment questions and allows fast data entry and manipulation, which align learning activities with learning goals.

Benefit

An IS gives students decision-making empowerment in an area of curriculum, enabling them to develop a sense of ownership of their learning.

Measures

Understand the characteristics of an Intelligent System to measure the educational value that it has contributed. Also, measurement factors could include scalability, usability, reliability, quality, and usage of the Intelligent System.

Example for Intelligent System:

Intelligent Agents that assist students to perform learning activities and provide academic staff with clear and objective information regarding students' learning performance (Azevedo and Scalabrin 2005).

Priority

Emphasize the importance of Intelligent Agents to support students in their learning activities.

Benefit

Intelligent Agents can improve students' learning outcomes.

Measures

Assess the scalability, usability, reliability, quality, and usage of the Intelligent System and its impact on students' learning performance.

Consistent Infrastructure

Facilitate sustainable infrastructure development by providing technological and training support. The technology infrastructure includes all the hardware, software, and network facilities that support the operation and management of e-learning.

Priority

Ensure that a consistent infrastructure exists to support e-learning performance. Also, prioritize the initiatives that can improve the existing process, automation, and standards that prevent the infrastructure from adapting to rapid changes in technology and pedagogy.

Benefit

The benefits of a consistent and reliable IT infrastructure include: prevention of compatibility problems, reduced workload for IT staff, and improved troubleshooting communication between IT staff and e-learning users.

Measures

Measure the reliability, effectiveness, and costs of the infrastructure's performance.

Example for Consistent Infrastructure:

Provide an adequate ICT infrastructure to offer an excellent e-learning platform (Raja Hussain 2004).

Priority

Recognize the importance of consistent infrastructure in e-learning performance. Also, prioritize the initiatives that can improve existing process, automation, and standards that prevent the infrastructure from adapting to rapid changes in technology and pedagogy.

Benefit

The benefits of consistent IT infrastructure include the prevention of compatibility problems, reduced workload for IT staff, and improved troubleshooting communication between IT staff and e-learning users.

Measures

Measure the reliability, effectiveness, and costs of the infrastructure's performance.

Database Analytics

Database analytics provides equitable opportunities for better access to quality higher education to develop the knowledge and skills, ethics and morality required to succeed in a competitive and changing environment.

Priority

Define the importance of information-rich content availability that will enhance the database. Also, prioritize the use of analytic content such as Analytic Workspace Manager that will enhance the database.

Benefit

Users can analyze multi-dimensional data from various perspectives.

Measures

The use of Analytic Workspace Manager provides calculated measures on a range of values. On the other hand, Online Analytical Processing can be used to measure queries between multi-dimensional analytical data that provides reports on budgets, finance, and management.

Example for Database Analytics:

Improve the design and development data analytics models that aim to maximize learning accuracy at the lowest cost in terms of computation and big data processing efficiency (Al-Jarrah et al. 2015).

Priority

Define the importance of data analytics in improving learning outcomes and how e-learning can meet students' needs.

Benefit

Maximize the use of information stored in the database while saving costs on computation and improving the efficiency of big data.

Measures

Evaluate the report on budgets, finance, and management using Analytic Workspace Manager or Online Analytical Processing.

Environment

- Sustainable consumption
- Efficiency
- Environmental control
- Participation
- User belief and behavior
- Sustainable innovation

Sustainable Consumption

Strengthen technological capacity to be more sustainable in consumption and production to meet the needs of the present and future generations.

Priority

Stress the importance of making choices on smarter energy innovation to reduce the carbon footprint. Also, prioritize the need to develop performance standards regarding sustainable consumption that will limit the potential damage that innovation can do to the environment.

Benefit

Promote behavior change regarding consumption choices and make it an entry point to a broader discussion on sustainable development that is related to e-learning.

Measures

Estimate the opportunity for e-learning innovation and strategic growth and measure the innovation in terms of economics and environmental performance.

Example for Sustainable Consumption:

Use of resource-efficient and low carbon producing technologies to improve performance aligned with environmental sustainability (Tseng et al. 2013).

Priority

Emphasize the importance of sustainable consumption of e-learning resources and the importance of adopting technologies that produce low carbon emissions as part of a sustainable development approach.

Benefit

In the development and management of e-learning, stakeholders are encouraged to make sustainable consumption choices.

Measures

Assess the carbon footprint report to measure the impact on the environment of the consumption of e-learning resources.

Efficiency

Efficiency focuses on providing equal access to affordable and quality higher education through affordable and efficient Internet access.

Priority
Stress the importance of improving learning environments so that they become more efficient, thereby enabling the prompt and efficient delivery of education to students. Promote energy efficiency in e-learning technology as this can improve the efficiency of the learning environment.

Benefit
This encourages e-learning stakeholders to change their consumption patterns and contribute to making the e-learning environment more efficient.

Measures
Implement efficiency standards to measure the consumption of resources including computers, servers, and printers.

Example for Environment Efficiency:

Cost efficiency of technology in terms of education access rates, course fees, and learning materials(Andersson 2008).

Priority
Ascertain the importance of improving learning environments so that they become cost efficient in terms of education fees and accessibility to educational materials.

Benefit
Encourage e-learning stakeholders to make sustainable consumption choices that will promote cost efficiency of e-learning technology and courses.

Measures
Implement efficiency standards to measure the consumption of e-learning resources associated with hardware, software, and course development.

Environmental Control

Minimize waste generation through recycling, and reuse of e-learning resources. Environmental control also refers to self-managed changes to learning or work space. The key component of environmental control is collaborative space's flexibility, availability, and ease of use.

Priority

Highlight the importance of environmental control by providing knowledge to e-learning stakeholders, and showing how it can improve learning or teaching practices to become more sustainable.

Benefit

Empower the e-learning stakeholders to change and adapt to sustainable innovation and practices without being restricted.

Measures

Measure the outcome of enhanced environmental control in improving students' learning performance and e-learning effectiveness.

Example for Environmental Control:

Increase knowledge of environmental guidelines to address the climate change issues (Callan and Bowman 2010).

Priority

Highlight the importance of delivering knowledge and developing standards for environmental control that will help to reduce the impact on the environment resulting from e-learning technology.

Benefit

Allow e-learning stakeholders to obtain knowledge about environmental control.

Measures

Measure the impact of e-learning technology on the environment while improving students' learning performance and e-learning effectiveness.

Participation

Promote active participation among the e-learning community to promote sustainable practices in institutions.

Priority
Highlight the importance of students' participation in the development of a learning environment and its impact on the students' learning.

Benefit
Determine students' prior knowledge in order to promote confidence that will enhance their participation in the learning environment.

Measures
Measure the effectiveness of the e-learning environment by determining the percentage of people who were engaged in participating in the learning environment.

Example for Participation:

Continuous motivation to develop and participate in e-learning initiatives that meet the needs of students and academic staff(McGill, Klobas and Renzi 2014).

Priority
Highlight the importance of motivating the students to participate in e-learning development to ensure the system meets their learning needs.

Benefit
Allow students to have the opportunity to share their knowledge with other students and also academic staff via learning activities.

Measures
Calculate the percentage of user participation and topics of discussion in order to identify the mechanisms that drive e-learning to meet the students' needs.

User Belief and Behavior

Everyone believes in free, equitable and quality education that will reduce gender inequality, increase effective ICT use to improve learning outcomes, increase enrolments in higher education, and increase the number of qualified academicians. These beliefs will encourage the adoption of sustainable practices.

Priority

Emphasize the importance of observing user beliefs and behavior regarding e-learning and its impact on the professional development of academic staff, and students' learning development.

Benefit

Allow teachers and students to share their experiences and thoughts on changing practices in their teaching and learning.

Measures

Measure the performance of the learning outcomes according to its effectiveness and efficiency in order to improve user belief and behavior. Additionally, share the performance accomplishments, refereed experiences, and constructive feedback so as to improve students' attitude and behavior regarding e-learning.

Example for User Belief and Behavior:

Build a sustainable e-learning development culture that provides the opportunity to share new ideas and develop commitment to high quality courseware (Leacock 2006).

Priority

Emphasize the importance of developing a sustainable e-learning development culture to refine e-learning user belief and behavior towards rapid change in technology and learning needs.

Benefit

Assist teachers and students to adapt to the changes based on the sharing of teaching and learning experiences.

Measures

Measure the performance of the learning outcomes and users' participation in e-learning activities.

Sustainable Innovation

Develop an innovative ecosystem that supports university-driven research and development with significant growth that ensures a low carbon future.

Priority

Highlight the contribution of sustainable innovation in the e-learning environment that will meet social expectations and encourage commitment to sustainable development.

Benefit

Allow all e-learning stakeholders to have the opportunity to suggest, design, and build sustainable innovation that will support the e-learning environment. Also, allow e-learning stakeholders to benefit from the use of green technology, long-term products lifetime, reusable products, and low cost products.

Measures

Measure the effectiveness of the sustainable innovation in improving e-learning in terms of short-term goals and long-term goals.

Example for Sustainable Innovation:

Adopt strategy that offers long-term benefits of e-learning innovations(Callan and Bowman 2010).

Priority

Highlight the importance of implementing a strategy that promotes e-learning stakeholders' contribution to sustainable innovation in e-learning environment that will help meet students' present and future needs.

Benefit

Develop skills in designing and developing sustainable innovation that will support the e-learning environment and provide long-term benefits to e-learning stakeholders.

Measures

Measure the achievement of the sustainable innovation strategy in terms of its impact on improving e-learning in terms of short-term goals and long-term goal.

SeLF and the Triple Bottom Line

SeLF contributions to Sustainable Development goals established by the United Nations Summit 2015.

TBL	Variable
Social	➢ Equality ➢ Healthy environment ➢ Free from fear and violence through sustainable development ➢ Sustainable Development Goal 4: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all."
Economy	➢ Participations and commitment among countries, stakeholders, and societies. ➢ Sustainable Development Goal 9: "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation."
Environment	➢ Sustainable production and consumption to meet present and future generations' needs. ➢ Eco-friendly economic, social, and technological development. ➢ Sustainable Development Goal 12: "Ensure sustainable consumption and production patterns". ➢ Sustainable Development Goal 13: "Take urgent action to combat climate change and its impact".

SeLF contributions to Sustainable Development goals based on 11th Malaysia Plan.

TBL	**Thrust 10 of 10: Malaysia beyond 2020**
Social	➢ Knowledgeable and innovative individuals ➢ Education equity
Economy	➢ Reduce income inequity ➢ Increase quality of life
Environment	➢ Low carbon emissions

The contributions of the categories and sub-categories of sustainable e-learning to the Triple Bottom Line (TBL).

Category	Sub-category	The Triple Bottom Line		
		Society	Economy	Environment
E-teaching and E-learning Principles	E-learning importance	Promote education equity	Improve educational achievement and job equity.	Reduce paper usage and carbon footprint.
	E-learning risks	Reduce students' frustration and limited learning outcomes.	Reduce the risk of losing ROI (return on investment) in implementing e-learning.	Minimize energy use and carbon footprint.
	E-learning opportunities	Access to quality education.	Improve ROI.	Reduce carbon emission through sustainable innovation.
	E-learning strategy planning	Ensure e-learning meets every learner's needs.	Improve knowledge collaboration across country.	Ensure effectiveness of practicing sustainable consumption.
	Student development	Develop knowledgeable and innovative individuals.	Improve job and income equity.	Improve students' knowledge and skills towards eco-friendly approach.
	Training and support	Provide appropriate skills and support to e-learning user.	Reduce hiring of foreign experts by developing local expertise.	Reduce paper usage by provide online references such as online tutorials.
	Motivations	Improve students' engagement in their learning.	Self-motivated individuals with improved education performance.	Promote eco-friendly behavior and practice.
	E-learning resource	Provide a quality learning resources.	Reduce cost in content development and delivery.	Reuse of learning resources.
	Sustainable education	Develop knowledge of sustainability.	Improve innovation regarding green architecture such as green building.	Reduce carbon footprint.

Category	Sub-category	The Triple Bottom Line		
		Society	Economy	Environment
Application	Administration service	Understand user need and deliver necessary service.	Energize job market and reduce administration and management costs.	Implement environmental standards for sustainable e-learning practice.
	Personalized learning	Achieve student personal learning goals.	Reduce shortage of employees with specific skills and promote sustainable professional development.	Personal eco-friendly awareness.
	Social and networking	Enhance connection among academicians and industry experts.	Improve value and productivity through social networking.	Promote discussion on environmental issues such as climate change.
	Productivity	Improve productivity.	Save cost free productivity tools.	Going paperless
	Mobile learning	Offer customized education content for students to be accessed on their own mobile device.	Revolutionize education to compete effectively in the global economy.	Increase environmental awareness
	Course management	Provide system quality, information quality, and instructional quality.	Reduce cost of human power to manage content manually.	Reduce resources consumptions such as paper and building space.
	Course tools	Maximize the course outcome.	Save cost while improving students' learning.	Provide tools that empower students to become more eco-friendly.

Category	Sub-category	The Triple Bottom Line		
		Society	Economy	Environment
Technology	Performance	Enhance learning/ teaching productivity	Reduce cost while improve e-learning quality. Monetize the institution's assets.	Reduce energy use, carbon footprint.
	Efficiency	Improve students learning and productivity and enhance e-learning access.	Save cost through energy efficiency, create jobs in energy efficiency project, and encourage energy efficient innovations.	Save energy resources and reduce pollution.
	Mobility	Anytime and anywhere education access.	Availability of online education and services through mobile phones.	Reduce emissions and reduce fossil fuel use.
	Connectivity and Networking	Support collaboration among students.	Contribution towards Gross Domestic Product (GDP) growth	Reduce carbon emissions
	Information connectivity	Assist academicians and learners in information search, reuse, and integration.	Foster creativity and innovation in the digital economy.	Reduce resources waste.
	Virtualizatio n	Faster server provisioning, improve disaster recovery, support data transfer to the cloud.	Save money on hardware and software, since less hardware is require.	Reduce energy consumption and data center footprint.
	Web evolution	Offer solutions that enhance learning/ teaching	Provide education that can be access anywhere.	Reduce resources such as energy, transportation, and paper
	Intelligent system	Promotes new insights by provide better and faster decisions on both learning and teaching.	Reduce cost on generating reports	Raise environmental awareness and support energy savings.
	Consistent infrastructure	Avoid compatibility problems and improve communication on troubleshooting issues.	Reduce cost on infrastructures modification.	Reduce resource consumption and carbon footprint.
	Database analytics	Improve learning by providing better insights.	Improve business innovation while save cost.	Creation of environmental report and goal.

Category	Sub-category	The Triple Bottom Line		
		Society	Economy	Environment
Environment	Sustainable consumption	Encourage wise use of resources.	Building "clean-energy economy" and long-term economic growth.	Reduce energy, resource consumption, and carbon emission.
	Efficiency	Ongoing access to learning environment while reduces travel, material, and improves performance.	Reduce cost of renewable technologies, training costs, and material costs.	Lower energy and fewer CO2 emissions
	Environmental control	Develop sustainable lifestyle	Reduce travel and accommodation costs	Reduce carbon footprint.
	Participation	Increase learning participation and collaboration.	Leads to job creation.	Increase knowledge and awareness on environment issue.
	User belief and behavior	Improve professional development and learning values.	Develop professional and innovative attitudes and behaviors toward digital economy.	Develop environmental rights to enhance core values and fundamental beliefs about the environment.
	Sustainable innovation	Effective and efficient access to learning environment.	Reduce costs for travel, accommodation, and maintaining the facility and equipment.	Reduce carbon footprint; eliminate the need for paper.

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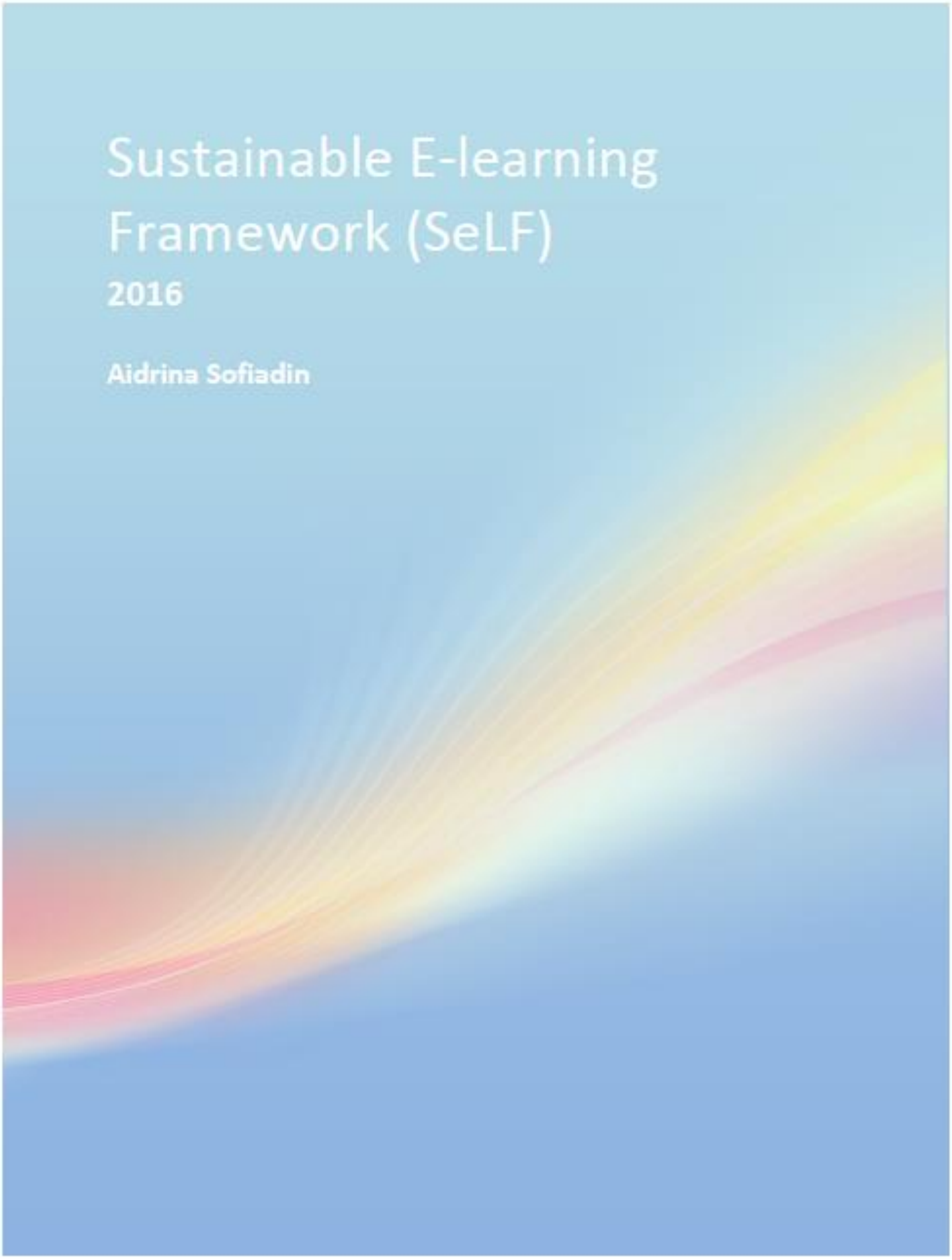
Appendix VIII

'SeLF glossy brochure' – handed to expert interview participants

(2nd round of the interview)



About SeLF

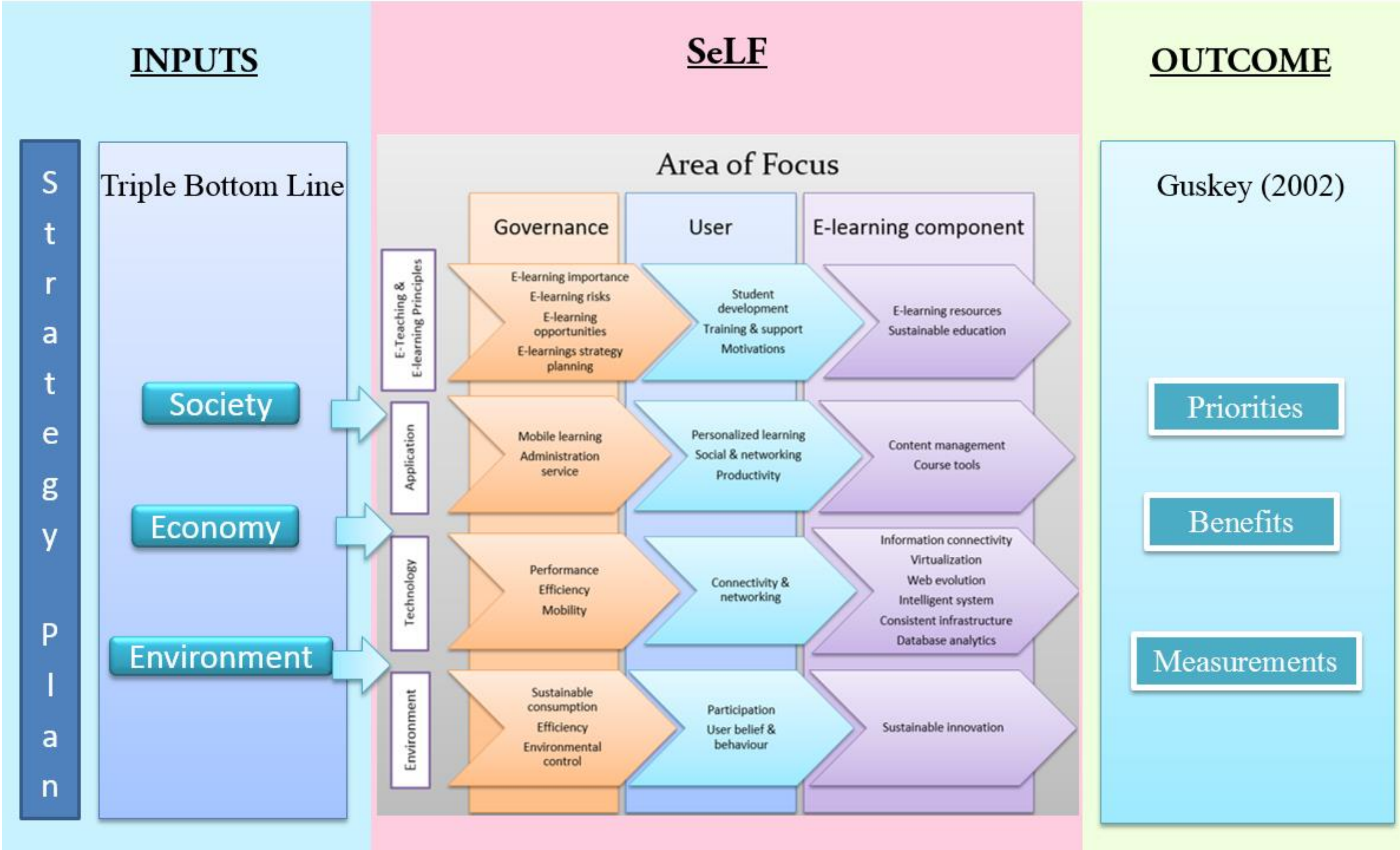
The sustainable e-learning framework (SeLF) delineates the characteristics of sustainable e-learning from the perspective of Malaysian higher education stakeholders. Based on the effective pedagogies presented by Husbands and Pearce (2012) , SeLF supports pedagogies that foster student learning, balanced assessment, and equity by taking into consideration their long-term learning outcomes and short-term goals.

Why Does It Matter?
SeLF aims to provide an e-learning system that supports continuous learning through efficient and effective learning activities. It was designed to assist Malaysian higher education stakeholders to become more sustainable. By contributing to the achievement of sustainable goals, SeLF complies with formal sustainable development plans such as those established by the 2005 World Summit, The Future We Want 2012, United Nations summit for the adoption of the post-2015 development agenda, 11th Malaysia Plan 2016-2020, and Malaysia Education Blueprint 2015-2025 (Higher Education). Hence, SeLF is an important means of promoting lifelong learning, education equity, and education on sustainable development.

What Will Success Look Like?
Sustainable goals focusing on education equity, equal access to affordable and quality higher education, and increased enrolment in higher education, will be achieved. Moreover, sustainable practice among Malaysian higher education stakeholders will be improved. E-learning as a knowledge or learning resources repository can provide access to knowledge that supports lifelong learning, and facilitates globalized online learning.

For whom is it intended?
The main users of this framework will be e-learning policy and governance committees and university executive leadership, who will use SeLF to guide and inform the e-learning policy of their respective institutions. Together with the involvement of other e-learning stakeholders, such as students and academic staff, SeLF is well-positioned to assist institutions to sustainably address the needs of learners now and in the future.

The Sustainable E-learning Framework (SeLF)



How SeLF works

SeLF acts as a guideline to facilitate the establishment and on-going monitoring of sustainable e-learning policy, while improving learning outcomes in a manner that benefits the economy, society, and environment.

Elements and descriptions of SeLF are intended to be valuable resources enabling policy makers to differentiate between sustainable and non-sustainable e-learning initiatives.

Steps to using SeLF

There are eight steps in the SeLF implementation process.

ix) Align elements of the institutional strategic plan with e-learning goals or sustainable development goals based on a Triple Bottom Line analysis.
x) Select the category that contributes to each e-learning or sustainable development goal.
xi) Identify the area of focus: Governance, User, or E-learning Component based on each e-learning or sustainable development goal.
xii) Select the necessary element (sub-category) that will contribute to the e-learning goal or sustainable development goal and develop or enhance it in effective ways to support the goal.
xiii) Prioritize the selected elements based on institutional priorities.
xiv) Articulate the benefits of developing or improving the element in a manner that justifies the priority ascribed to each element
xv) Identify metrics that can be used to measure goal attainment.
xvi) Use identified metric measures to monitor short-term and long-term goals, and manage policies and resources based on the needs of today and tomorrow.

Application of SeLF for e-learning development in higher education institutions.

The framework is intended to develop or improve sustainability in e-learning in higher education institutions. The elements of SeLF encompass matters that a higher education institution would ordinary be expected to address in directing and evaluating sustainability in its e-learning development, implementation and ongoing use, including managing any associated risks. Each of the elements addresses an underlying area of risk to be managed. These risks may impact e-learning sustainability in terms of e-learning usage and long-term usability and resources availability

The application of SeLF can be applied from top-level policy makers to individual stakeholders; school, academic staff, or students. The use of SeLF requires communication channels such as seminars, training, and email, which is important to promote stakeholders' contribution, awareness, and engagement in the decision making process. Alternatively, aspects such as ethics, culture, peace, and tolerance can be taken into consideration in ensuring the application of SeLF respects the e-learning stakeholders, society, economy, and the environment.

The Triple Bottom Line

The concept of the Triple Bottom Line (TBL) includes three sustainability dimensions. These dimensions characterize how an initiative affects society, the environment, and the economy.

In this stage, users of the SeLF

- define TBL goals that contribute to sustainable e-learning based on societal, environmental, and financial factors; and

- identify appropriate SeLF elements that support these TBL goals .

Definitions of each TBL dimension are found in Table 1. These should be used to assist in defining sustainable e-learning goals.

TBL	SeLF definitions
Social	Sustainable e-learning aims to develop e-learning that ensures quality education, equity, educational achievement, and knowledgeable and innovative individuals, while promoting lifelong learning and balanced development.
Economy	Sustainable e-learning aims to improve the financial accessibility of tertiary education, and contributes to knowledge-intensive employment, and work-life balance through a viable online education.
Environment	Sustainable e-learning focuses on sustainable production and consumption that promotes eco-friendly e-learning principles and technological development as part of the action to counteract climate change and minimise its impact, in order to meet the needs of present and future generations.

Table 1: Definition of SeLF in terms of Triple Bottom Line components

Users evaluate institutional objectives against each dimension of the triple bottom line, and use this to guide the application of SeLF to sustainably implement and management sustainable e-learning at their insitution.

The Elements of Sustainable E-Learning

SeLF consists of four categories: E-Teaching and E-learning Principles, Application, Technology, and Environment. Each of these categories consists of correlated sub-elements. Descriptions of sustainable e-learning elements are provided in the context of Priority, Benefit, and Measurement.

The Areas of Focus

Each category has three areas of focus: Governance, User, and E-learning. Descriptions of the areas of focus are given in Table 2 below. Depending on the institution's setting, the connection between elements of SeLF and the area of focus can be restructured to ensure the significance impact of each element.

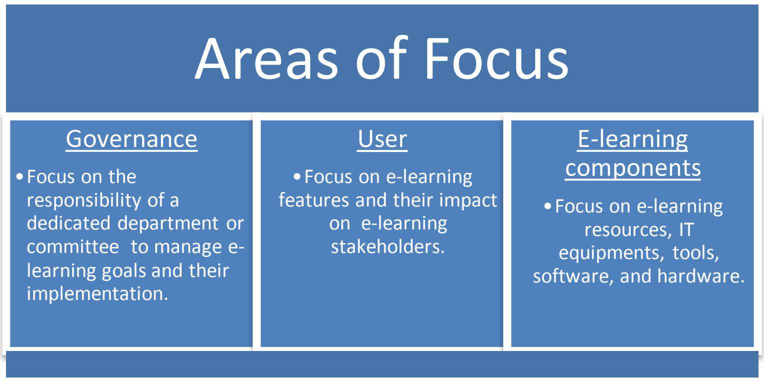
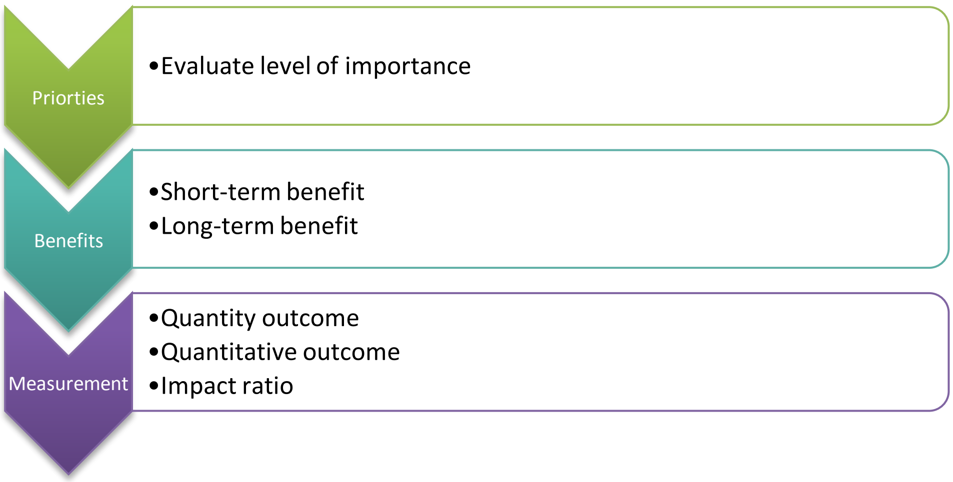


Table 2: Descriptions of the areas of focus

Outcome Measure

Elements contributing to the identification of goals are evaluated with respect to short-term and long-term benefits to the institution, the learner, and to society. The benefits should be mentioned when communicating identified institutional priorities to stakeholders, and to inform the establishment of



metrics that can be used to measure outcome attainment.

Sustainable E-learning Elements

Areas of focus based on the categories and sub-categories of sustainable e-learning.

Category	Area of Focus	Sub-category
E-teaching and E-learning Principles	Governance	E-learning importance
		E-learning risks
		E-learning opportunities
		E-learning strategy planning
	User	Student development
		Training and support
		Motivations
	E-learning Component	E-learning resource
		Sustainable education
Application	Governance	Administration service
	User	Personalized learning
		Social and networking
		Productivity
		Mobile learning
	E-learning Component	Course management
		Course tools
Technology	Governance	Performance
		Efficiency
		Database analytics
		Consistent infrastructure
	User	Connectivity and Networking
		Mobility
	E-learning Component	Information connectivity
		Virtualization
		Web evolution
		Intelligent system
Environment	Governance	Sustainable consumption
		Efficiency
		Environmental control
	User	Participation
		User belief and behaviour
	E-learning Component	Sustainable innovation

Table 3: Sustainable E-learning categories, area of focus, and sub-categories.

Categories and Sub-categories

The elements of sustainable e-learning were grouped into categories and sub-categories for ease of use. The grouping is intended to assist people who are contributing to sustainable e-learning initiatives or sustainable development goals.

Layout

The definition of each element of sustainable e-learning is presented within the appropriate categories and sub-categories. Each element definition consists of the element name, overall description, and descriptions of area of focus.

Overview of the four main categories.

Category 1: E-Teaching and E-Learning Principles

Scope

- Curriculum
- Learning pedagogy
- Student participation and attainment
- Training
- Quality Assurance
- Usability
- Awareness

Objectives

- Ensure education access
- As part of the “Education for All” initiative
- Promote education for peace and human development through use of e-learning.
- Promote participations and commitment among e-learning stakeholders through training and support.
- Support sustainable development by providing sustainable information, education, and training.
- Education system’s capacity through improved teacher training, sustainability curricula development, and training programmes development.
- Promote Education for Sustainable Development (ESD) through sustainable education
- Sustainable Development Goal 4 (2015): “Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.”
- Improve education and awareness on climate change through sustainable education.

Reference Point

- 2005 World Summit
- The Future We Want 2012
- United Nations summit for the adoption of the post-2015 development agenda

Category 2: Application

Scope

- Data Management
- E-learning tools and software
- Accessibility
- Flexibility
- Collaboration

Objectives

- Support the human rights education and learning at all levels through use of e-learning where people can learn anytime and anywhere.
- More effective ICT usage to improve learning outcomes.
- Significant mobilization of resources
- Improve learning activities through appropriate e-learning tools

Reference Point

- 2005 World Summit
- The Future We Want 2012
- United Nations summit for the adoption of the post-2015 development agenda

Category 3: Technology

Scope

- Information and Technology Management
- Accessibility
- Innovation
- Communication
- Hardware

Objectives

- ➢ Ensure education access
- ➢ Meet rural communities need by providing appropriate and affordable technologies.
- ➢ Improve education access by developing and strengthening education infrastructure
- ➢ Support domestic technology development, research, and innovation.
- ➢ Increase ICT access and affordable Internet access.
- ➢ Sustainable Development Goal 9: “Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.”

Reference Point

- ❖ 2005 World Summit
- ❖ The Future We Want 2012
- ❖ United Nations summit for the adoption of the post-2015 development agenda

Category 4: Environment

Scope

- E-learning environment
- Green development
- New environmental paradigm
- Economic prosperity
- Social justice

Objectives

- ➢ Importance of supporting educational institutions to conduct sustainable development research and innovation
- ➢ Sustainable production and consumption to meet present and future generations' need.
- ➢ Sustainable Development Goal 9: "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation."
- ➢ Quality, reliable, sustainable, and strong infrastructure that provide affordable and equitable access for everyone.
- ➢ Sustainable Development Goal 12: "Ensure sustainable consumption and production patterns"

Reference Point

- ❖ The Future We Want 2012
- ❖ United Nations summit for the adoption of the post-2015 development agenda

Descriptions on each sub-category.

"E-teaching and E-learning Principles" category

SeLF element	Description
E-learning importance	The e-learning pedagogy should engage the learner, meaning that it must focus on directing attention to the most important parts without compromising instructional quality.
E-learning risks	Identify e-learning risks that include reasons for students not enroll to an e-learning course, copyright issues, and the plagiarism issue. Risks should be identified and overcome so that e-learning can survive any changes to instructional practice.
E-learning opportunities	The e-learning approach should be flexible to survive any rapid changes in technology and students' learning needs.
E-learning strategy planning	E-learning strategy should focus on providing everyone with full access to quality education for promoting sustainable development, gender equality, and women's empowerment.
Student development	E-learning should promote education for peace and human development that will help to improve quality of life and economy. Student development ensures that everyone has the necessary knowledge and skills for employment and entrepreneurship while promoting sustainable development.
Training and support	The capacity of the education system should be improved through the development of training programmes that will assist students and staff to overcome any difficulties with e-learning. Encourage the training with support from management such as the board of directors.
Motivations	When implementing an e-learning pedagogy, it is important to sustain student interest and motivation. Learning materials should ensure that students remain interested and motivated to learn. Outline the benefits of offering appropriate rewards or recognition for students' learning and teachers' teaching as an extrinsic motivation.
E-learning resource	E-learning resources should be accessible to anyone in order to promote educational equity and improve education outcomes. E-learning resources should embrace the principles of effective e-learning pedagogy and online course architecture.
Sustainable education	Sustainable education helps to promote Education for Sustainable Development (ESD), which support sustainable development by providing sustainable information and education, and improve education and awareness of climate change.

"Application" category

SeLF element	Description
Administration service	The availability of e-learning administration services will help to increase enrolment in higher education and accelerate human capital development for an advanced nation through social mobility improvement. Students and staff should be encouraged to join relevant associations or groups on social media sites such as Facebook, Twitter, and LinkedIn to engage with students' social networking activities.
Personalized learning	Personalized learning focuses on providing knowledge that is relevant to each student's needs. Hence, everyone will have the opportunity to access high quality education programmes that are relevant to their learning interests and that will encourage lifelong learning.
Social and networking	Promote collaboration among everyone especially those in rural communities by delivering education, training, knowledge, and appropriate and affordable technologies. Moreover, sustainable development and lifestyle awareness can be promoted through this strategy.
Productivity	Focus on the importance of supporting teaching and learning productivity and educational institutions to conduct sustainable development research and innovation.
Mobile learning	Mobile learning increases ICT access and significant mobilization of e-learning resources that support the basic human right to education and learning at all levels, and enables people to learn anytime and anywhere.
Course management	Course management refers to the ability to manage quality and innovative programmes where students have the opportunity to contribute to improving their course.
Course tools	Effective course tools should be provided through e-learning to ensure that everyone has the required literacy and numeracy skills so that they can fully benefit from the course.

“Technology” category

SeLF element	Description
Performance	Focus on technology performance that aims to provide a quality, reliable, sustainable, and strong infrastructure that provides everyone with affordable and equitable access to education.
Efficiency	Efficiency focuses on continuous improvement of technology infrastructure to improve resource-use efficiency and encourage greater adoption of clean and eco-friendly technologies.
Mobility	Encourage mobility that reduces carbon emissions in order to promote green sustainability and flexibility.
Connectivity and Networking	Provide and expand digital connection through a nationwide broadband infrastructure that will support economic expansion, social inclusion and growth. This involves the establishment of a physical network infrastructure, information structure, platform, ICT devices and equipment that enhance the delivery of online learning and education access.
Information connectivity	Establish a support system that includes technology, big data, data-driven science, co-operation infrastructure, and improved data monitoring systems that will promote recycling, and reuse of e-learning resources and provide relevant supplementary information.
Virtualization	A virtual environment can support domestic technology development, research, and innovation while promoting comprehensive and sustainable development and fostering innovation. E-learning efficiency and cost savings can be improved through virtualization.
Web evolution	The adoption of the new features offered by the new Web will help to produce relevant and effective learning outcomes. Economic considerations should be considered to develop an eco-friendly economic, social, and technologically feasible development.
Intelligent system	An Intelligent System (IS) provides learners with relevant knowledge for employment and entrepreneurship by analyzing their learning trends that will promote lifelong learning opportunities for all.
Consistent infrastructure	Facilitate sustainable infrastructure development by providing technological and training support. The technology infrastructure includes all the hardware, software, and network facilities that support the operation and management of e-learning.
Database analytics	Database analytics provides equitable opportunities for better access to quality higher education resources using big data and linked-data, to develop the knowledge and skills, ethics and morality required to succeed in a competitive and changing environment.

“Environment” category

SeLF element	Description
Sustainable consumption	Strengthen technological capacity to be more sustainable in consumption and production to meet the needs of the present and future generations.
Efficiency	Efficiency focuses on providing equal access to affordable and quality higher education through affordable and efficient Internet access.
Environmental control	Minimize waste generation through recycling, and reuse of e-learning resources. Environmental control also refers to self-managed changes to learning or work space. The key component of environmental control is collaborative space’s flexibility, availability, and ease of use.
Participation	Promote active participation among the e-learning community to promote sustainable practices in institutions.
User belief and behavior	Everyone believes in free, equitable and quality education that will reduce gender inequality, increase effective ICT use to improve learning outcomes, increase enrolments in higher education, and increase the number of qualified academicians. These beliefs will encourage the adoption of sustainable practices.
Sustainable innovation	Develop an innovative ecosystem that supports university-driven research and development with significant growth that ensures a low carbon future.

SeLF elements and the Sustainable Development

SeLF contributions to Sustainable Development goals established by the United Nations Summit 2015.

TBL	Variable
Social	➢ Equality ➢ Healthy environment ➢ Free from fear and violence through sustainable development ➢ Sustainable Development Goal 4: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all."
Economy	➢ Participations and commitment among countries, stakeholders, and societies. ➢ Sustainable Development Goal 9: "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation."
Environment	➢ Sustainable production and consumption to meet present and future generations' needs. ➢ Eco-friendly economic, social, and technological development. ➢ Sustainable Development Goal 12: "Ensure sustainable consumption and production patterns". ➢ Sustainable Development Goal 13: "Take urgent action to combat climate change and its impact".

SeLF contributions to Sustainable Development goals based on 11th Malaysia Plan.

TBL	Thrust 10 of 10: Malaysia beyond 2020
Social	➢ Knowledgeable and innovative individuals ➢ Education equity
Economy	➢ Reduce income inequity ➢ Increase quality of life
Environment	➢ Low carbon emissions

SeLF elements and the Triple Bottom Line

The contributions of the categories and sub-categories of sustainable e-learning to the Triple Bottom Line (TBL).

Category	Sub-category	The Triple Bottom Line		
		Society	Economy	Environment
E-teaching and E-learning Principles	E-learning importance	Promote education equity	Improve educational achievement and job equity.	Reduce paper and printing usage and carbon footprint consumed in traditional learning.
	E-learning risks	Reduce students' frustration and limited learning outcomes.	Reduce the risk of poor ROI (return on investment) in implementing e-learning.	May lead to overconsumption of ICTs materials.
	E-learning opportunities	Access to quality education.	Improve ROI.	Reduce carbon emission through sustainable innovation.
	E-learning strategy planning	Ensure e-learning meets every learner's needs.	Improve knowledge collaboration across country.	Ensure effectiveness of practicing sustainable consumption.
	Student development	Develop knowledgeable and innovative individuals.	Improve job and income equity.	Improve students' knowledge and skills towards eco-friendly approach.
	Training and support	Provide appropriate skills and support to e-learning user.	Reduce hiring of foreign experts by developing local expertise.	Reduce paper usage by provide online references such as online tutorials.
	Motivations	Improve students' engagement in their learning.	Self-motivated individuals with improved education performance and job readability.	Motivates learner to develop eco-friendly behavior and practice.
	E-learning resource	Provide a quality learning resources.	Reduce cost in content development and delivery.	Reuse of learning resources.
	Sustainable education	Develop knowledge of sustainability.	Improve innovation regarding green architecture such as green building.	Reduce carbon footprint.

Category	Sub-category	The Triple Bottom Line		
		Society	Economy	Environment
Application	Administration service	Understand user needs and deliver necessary services.	Energize job market and reduce administration and management costs.	Implement environmental standards for sustainable e-learning practice.
	Personalized learning	Achieve student personal learning goals.	Reduce shortage of employees with specific skills and promote sustainable professional development.	Personal eco-friendly awareness.
	Social and networking	Enhance connection among academicians and industry experts.	Improve value and productivity through social networking.	Promote discussion on environmental issues such as climate change.
	Productivity	Improve productivity.	Save cost free productivity tools.	Going paperless
	Mobile learning	Offer customized education content for students to be accessed on their own mobile device.	Transform education to use technology consistent with that used in the in the global economy.	Increase environmental awareness
	Course management	Provide system quality, information quality, and instructional quality.	Reduce cost of human power to manage content manually.	Reduce resources consumptions such as paper and building space.
	Course tools	Maximize the course outcome.	Save cost without purchasing own learning tools or software.	Provide tools that empower students to become more eco-friendly.

Category	Sub-category	The Triple Bottom Line		
		Society	Economy	Environment
Technology	Performance	Enhance learning/ teaching productivity	Reduce cost while improve e-learning quality. Monetize the institution's assets.	Improve institution green report on energy usage and carbon footprint.
	Efficiency	Improve students learning and productivity and enhance e-learning access.	Save cost through energy efficiency, create jobs in energy efficiency project, and encourage energy efficient innovations.	Improve resources consumption and reduce pollution.
	Mobility	Anytime and anywhere education access.	Availability of online education and services through mobile phones.	Reduce emissions and reduce fossil fuel use.
	Connectivity and Networking	Support collaboration among students.	Contribution towards Gross Domestic Product (GDP) growth	Reduce carbon emissions in travel.
	Information connectivity	Assist academicians and learners in information search, reuse, and integration.	Foster creativity and innovation in the digital economy.	Reduce resources waste.
	Virtualization	Faster server provisioning, improve disaster recovery, support data transfer to the cloud.	Save money on hardware and software, since less hardware is require.	Reduce energy consumption and data center footprint.
	Web evolution	Offer solutions that enhance learning/ teaching	Provide education that can be access anywhere.	Reduce resources such as energy, transportation, and paper.
	Intelligent system	Promotes new insights by provide better and faster decisions on both learning and teaching.	Reduce cost on generating reports.	Raise environmental awareness and support energy savings.
	Consistent infrastructure	Avoid compatibility problems and improve communication on troubleshooting issues.	Reduce cost on infrastructures modification.	Reduce resource consumption and carbon footprint.
	Database analytics	Improve learning by providing better insights.	Improve business innovation while save cost.	Creation of environmental report and goal.

Category	Sub-category	The Triple Bottom Line		
		Society	Economy	Environment
Environment	Sustainable consumption	Encourage wise use of resources.	Building “clean-energy economy” and long-term economic growth.	Reduce energy, resource consumption, and carbon emission.
	Efficiency	Ongoing access to learning environment while reduces travel, material, and improves performance.	Reduce cost of renewable technologies, training costs, and material costs.	Lower energy and fewer CO2 emissions
	Environmental control	Develop sustainable lifestyle	Reduce travel and accommodation costs	Reduce carbon footprint.
	Participation	Increase learning participation and collaboration.	Leads to job creation.	Increase knowledge and awareness on environment issue.
	User belief and behavior	Improve professional development and learning values.	Develop professional and innovative attitudes and behaviors toward digital economy.	Develop environmental rights to enhance core values and fundamental beliefs about the environment.
	Sustainable innovation	Effective and efficient access to learning environment.	Reduce costs for travel, accommodation, and maintaining the facility and equipment.	Reduce carbon footprint; eliminate the need for paper.

Example of using SeLF

This section provides an example of how SeLF can be used in practice. This example was based on the eight steps in the SeLF implementation process given on page 3.

Example of overall outcomes based on the eight steps of the SeLF process.
Objective of Malaysia's Ministry of Education cited in the Malaysia Higher Education Blueprint 2015:

To make e-learning an integral component of tertiary education by transforming common undergraduate courses into one Massive Open Online Course (MOOC) and encourage teachers to deliver 70% of the program using a blended learning approach (Malaysia Ministry of Education 2012)

EXAMPLE INPUT

Strategy Plan:
Develop and implement course-based MOOCs.

Triple Bottom Line:
Society: Develop an e-learning approach that ensures equitable access to quality open e-learning resources while simultaneously supporting the sustainable development concept.
Economy: Provide affordable education for students who cannot afford a traditional university education.
Environment: Reduce carbon emission on travel, ICTs, paper and printing usage, residential energy, and campus site operation.

SeLF

Category	Area of focus	Element (Subcategory)	Reason
E-Teaching and E-learning Principles	E-learning component	E-learning resources	Improves e-learning accessibility by providing open e-learning resources such as online assignments, quizzes, tests, and lecture notes.
Technology	User	Web evolution	Maximizes the use and increased availability of e-learning materials.
Environment	Governance	Efficiency	Provides affordable or free education because the e-learning resources are open and accessible to all.

EXAMPLE OUTCOMES

Priorities

- Ongoing transformation of e-learning resources so that they are aligned with teaching and learning requirements.
- Referring to SeLF elements, e-learning resources and Web evolution may have greater importance than efficiency elemental towards the environment.

Benefits

- Increase in student enrolments and course completions.
- Increase in e-learning usability and accessibility.

Measurements

- Measures the impact of MOOC towards society, economy, or environment aspects. For instance, rate on learning performance in using MOOC.

Comprehensive descriptions of each of the eight steps in the SeLF implementation process.

In this section a detailed description for each of the eight SeLF steps are described.

EXAMPLE INPUT

XVI) Align elements of the institutional strategic plan with the e-learning goal or sustainable development goal based on a Triple Bottom Line analysis

In defining a strategic plan, university leaders typically identify the current status and future aspirations regarding teaching and learning at the institution. This includes identifying the key factors that can guide an institution towards e-learning sustainability.

Based on this example of case, the strategic plan example aims to improve current e-learning and becomes more sustainable through the provision of open e-learning resources.

XVII) Select the category that contributes to the e-learning or sustainable development goal.

To support the strategic plan, a clearly defined sustainable e-learning objective is required. Therefore, to ensure that an objective contributes to sustainability, sustainable e-learning goals should be based on the societal, environmental, and financial ‘bottom line’.

In this example, sustainable e-learning goals based on the societal, environmental, and financial ‘bottom line’ were elaborated as shown in the Table 4 below.

TBL	Sustainable E-learning goal
Social	Develop an e-learning approach that ensures equity access to quality education while promoting lifelong learning and the concept of sustainable development.
Economy	Develop an e-learning approach that improves tertiary education attainment and work-life balance through a sustainable online education solution.
Environment	Develop an e-learning approach that focuses on sustainable production and consumption that promotes eco-friendly e-learning principles and technological development as part of the action to counteract climate change and its impact, in order to meet the needs of present and future generations.

Table 4: Example for sustainable e-learning goals based on TBL.

Based on the defined sustainable e-learning goals, the appropriate SeLF category and elements that support both the strategic plan and the TBL goals are identified. Furthermore, based on the defined goals, the impact size on the TBL will be measured to identify the impact ratio between society, economy, and environment.

XVIII) Identify the area of focus: Governance, User, or E-learning Component based on e-learning goal or sustainable development goal.

Once the strategy plan and sustainable e-learning goals have been defined, the appropriate category that supports those goals is selected.

In this example, improving sustainable e-learning through accessibility involves all four SeLF categories: E-Teaching and E-learning Principles, Application, Technology, and Environment.

The reasons for selecting these categories are given below:

Category	**Reason**
E-Teaching and E-learning Principles	Learning pedagogy and curriculum are the backbone of the e-learning resources.
Technology	Technology plays an important role in supporting e-learning platforms.
Environment	Since the learning resources can be accessed and viewed online, the need for paper and travel will decrease.

Table 5: Reasons for selecting each categories.

Once the related category has been selected, the area of focus needs to be identified based on Governance, User, or E-learning Component.

XIX) Select the necessary element (sub-category) that will contribute to the e-learning goal or sustainable development goal and develop or enhance it in effective ways to support the goal.

Based on the selected category, the area of focus is identified. An example is shown Table 6 below.

Category	**Area of focus**
E-Teaching and E-learning Principles	E-learning component
Technology	User
Environment	Governance

Table 6: Example of selected category and identified area of focus

Once the area of focus has been determined, the element that supports the sustainable e-learning goals is identified.

XX) Prioritize the selected elements based on institutional priorities.

Once the required elements have been identified and selected, they will be prioritize based on the current e-learning environment and the availability of support such as funds and expertise.

The selected elements were prioritized as shown in the Table 7 below.

	Very Urgent	**Less Urgent**
Very Important	• E-learning resource • Web evolution	-
Less Important	-	• Efficiency

Table 7: Example how selected elements were prioritized.

By allocating the elements to the above table, the user will have a clear idea of the level of importance of each element and how it can be improved or developed to achieve the sustainable e-learning goal.

XXI) Outline the benefits of developing or improving the element.

Once the level of importance of the selected elements has been established, the benefits of each the element needs to be articulated.

This step can be done as shown in Table 8 below.

Category	**Area of focus**	**Element (Subcategory)**	**Benefits**
E-Teaching and E-learning Principles	E-learning component	E-learning resource	Allow students to access their lecture notes and assessments and take their quizzes and tests online. Enhances quality and flexibility of e-learning resources. Encourages students to apply knowledge in a broader context.
Technology	User	Web evolution	Provides platforms to support learner-centred, self-directed, peer-to-peer and social learning approaches.
Environment	Governance	Efficiency	Offers affordable e-learning resources.

Table 8: Example on outline the benefits of each selected element.

Once the benefits of each element have been expressed, the final step entails measuring the outcome.

XXII) Identify metrics that can be used to measure goal attainment.

Measures can be applied to any context such as quality, efficiency, development, maintenance, innovation, cost, and profit. Furthermore, measurement on the impact size on how each elements would affect the society, the environment, and the economy 'bottom line' can be done. For instance, weight indicators or impact ratio on element's impact on the TBL components can be done to measure the impact size.

In this case, the measurements considered for the selected elements are as follows.

- The e-learning resource

  Gauge the quality of e-learning open educational resources based on students' feedback to ensure that they meet students' present and future needs.

- Web evolution

  Evaluate the flexibility and extendibility of the e-learning platforms and the ability to adapt open tools to access, reuse, develop, and share e-learning resources on the Web.

- Efficiency

  Use efficiency standards (such as Commonwealth measures and National Strategy on Energy Efficiency) to measure the consumption of resources including computers, servers, and printers. Standards should be identified as a cost effective reduction measure (Taylor 2010).

XXIII) Use identified metrics measures outcome against short-term and long-term goals, and manage policies and resources based on the needs of today and tomorrow.

Once the selected elements were measured, the user will have a clear view of the outcome of the elements in relation to short-term and/or long-term goals. Therefore, user will then able to manage policies and resources to meet the required goa

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