A GREEN IT/IS ASSESSMENT MODEL FOR ATTAINING SUSTAINABILITY IN MALAYSIA COLLABORATIVE ENTERPRISE

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DOCTOR OF PHILOSOPHY

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ABSTRAK

Pengembangan kemajuan semakin ketara dalam Enterprise Collaborative (CE), oleh itu pengamal Teknologi Maklumat (IT) mula mengamalkan inisiatif Hijau / IS Hijau dengan menggunakan kaedah penilaian sendiri secara manual berdasarkan soal selidik semakan dan standard ISO 14001 untuk mencapai kemampanan. Begitu juga, kesusasteraan mengenai Green IT / Information Systems (IS) amalan untuk mencapai kemampanan di CE masih di peringkat awal dan terdapat sedikit kajian tentang bagaimana untuk menilai amalan Hijau IS. Tetapi, model penilaian Teknologi Maklumat Hijau yang sedia ada memberi tumpuan kepada kecekapan tenaga dalam mengurangkan kesan negatif IT. Selain itu, CE menilai amalan Green IT / IS dengan hanya mempertimbangkan operasi kitar semula dan mengabaikan amalan IT / IS Green yang lain. Ini adalah kerana prospek kitar semula adalah sinonim dengan amalan Green IT / IS. Oleh itu, terdapat keperluan untuk menyediakan amalan IT / IS Hijau untuk dilaksanakan oleh pengamal IT di CE berdasarkan kepada model yang mudah digunakan tetapi komprehensif untuk menilai amalan IT / IS Green semasa CE dalam mencapai kemampanan ekonomi, sosial dan alam sekitar. Begitu juga, model penilaian sedia ada hanya menimbulkan kesedaran tentang potensi IT / IS Hijau dan menawarkan garis panduan praktikal untuk menilai Green IT / IS untuk mencapai kemampanan. Selain itu, terdapat pembolehubah bebas yang mempengaruhi amalan Green IT / IS di CE, oleh itu terdapat keperluan untuk model penilaian yang boleh digunakan oleh CE untuk memastikan bahawa pengamal IT mempertimbangkan pemboleh ubah ini semasa mengamalkan Green IT / IS dalam mencapai kemampanan dalam mereka operasi perusahaan. Oleh itu, kajian ini mencadangkan model penilaian IT / IS Hijau berdasarkan Rangka Kerja Kepercayaan-Hasil-Hasil untuk membantu para pengamal IT dalam menilai amalan IT IT / IS semasa mereka untuk mencapai kemampanan. Rangka kerja BAO sesuai untuk kajian ini, kerana rangka kerja tersebut menghubungkan hubungan antara pengaruh Green IT menilai kepercayaan pengamal IT tentang alam sekitar dan pengaruh kepercayaan mereka terhadap tindakan praktikum IT / IS Hijau dan hasil selanjutnya. Oleh itu, untuk membangunkan model penilaian IT / IS Hijau, kajian ini mengenal pasti amalan IT / IS Hijau yang akan dilaksanakan di CE dan pembolehubah bebas yang mempengaruhi amalan IT / IS Hijau di CE untuk mencapai kemampanan. Di samping itu, model ini membentuk penentu demografik sosial (penyederhanaan sederhana) dan ciri-ciri perusahaan (pembolehubah kawalan). Kajian ini memilih paradigma pragmatik (pendekatan kualitatif dan kuantitatif) menggunakan teknik pensampelan purposive untuk mengumpul data dari kajian kes (wawancara dan dokumen IT / IS Hijau), soal selidik dalam talian dan soal selidik kumpulan fokus. Kajian kes itu dijalankan di dua institusi universiti dan dua organisasi yang terdiri daripada lima belas informan yang menyediakan data untuk mengesahkan amalan IT / IS Hijau dan pembolehubah bebas yang diperoleh daripada kesusasteraan. Selepas itu data dikumpulkan menggunakan kaji selidik dalam talian dari seratus tiga puluh tiga responden di CE yang berpangkalan di Malaysia untuk mengesahkan model penilaian IT / IS Green yang dibangunkan. Begitu juga Alat Penilaian IT / IS Hijau (GAT) yang dilaksanakan untuk mengesahkan lagi pemakaian model penilaian IT / IS hijau dengan menjalankan kuesioner kumpulan fokus dengan mengumpulkan data daripada tiga puluh lima pengamal IT. Hasil daripada tesis ini mendedahkan bahawa pembolehubah bebas mempengaruhi amalan Green IT / IS, dan amalan Green IT / IS yang dikenal pasti adalah penting dan harus dilaksanakan oleh pengamal TI di CE untuk mencapai kemampanan ekonomi, sosial dan alam sekitar.

ABSTRACT

Sustainability has progressively become significant in Collaborative Enterprise (CE), thus Information Technology (IT) practitioners are beginning to practice Green IT/IS initiatives by also utilizing manual self-assessment methods based on checklists questionnaire and ISO 14001 standards to attain sustainability. Similarly, the literature on Green IT/Information Systems (IS) practices for attaining sustainability in CE is still in its infancy and there is little research on how to assess Green IT/IS practice. But, existing Green Information Technology (IT) assessment models focus on energy efficiency in reducing the negative impacts of IT. Moreover, CE assess Green IT/IS practices by only considering recycling operation and ignoring other Green IT/IS practices. This is mainly due to the prospect that recycling is synonymous with Green IT/IS practices. Consequently, there is need to provide the Green IT/IS practice to be implemented by IT practitioners in CE based on an easy-to-use but comprehensive model to assess CE current Green IT/IS practice in attaining economic, social and environmental sustainability. Similarly, existing assessment models only raises awareness on the potential of Green IT/IS and offer little practical guidelines to assess Green IT/IS for attaining sustainability. Besides, there are independent variables that influences Green IT/IS practice in CE, hence there is a need for an assessment model that can be utilized by CE to ensure that IT practitioners considers these variables when implementing Green IT/IS practice in attaining sustainability in CE operations. Therefore, this study proposes a Green IT/IS assessment model based on Belief-Action-Outcome (BAO) framework to aid IT practitioners in assessing their current Green IT/IS practice towards attaining sustainability. BAO framework is suitable for this study, because the framework propose links between the influence of Green IT/IS assess on IT practitioner's beliefs about the environment and the influence of their beliefs on Green IT/IS practice actions and subsequent outcomes. Accordingly, in order to develop the Green IT/IS assessment model, this study identifies the Green IT/IS practices to be implemented in CE and independent variables that influences Green IT/IS practice in CE for attaining sustainability. In addition, the model constitutes social-demographic determinants (moderating variables) and enterprise characteristics (control variables). This study opted for pragmatic paradigm (qualitative and quantitative approach) using purposive sampling technique to collect data from case study (interview and Green IT/IS documents), online survey and focus-group questionnaire. The case study was carried out in two higher eductaion institutions and two organizations which comprises of fifteen informants who provided data to verify the Green IT/IS practices and independent variables derived from the literature. Then, data was collected using online survey from one hundred and thirty-three respondents in CE based in Malaysia to validate the developed Green IT/IS assessment model. Likewise, a Green IT/IS Assessment Tool (GAT) was implemented to further validate the applicability of the Green IT/IS assessment model by carrying out focus-group questionnaire by collecting data from thirty-five IT practitioners. Results from this research reveals that the independent variables influences Green IT/IS practices, and the identified Green IT/IS practices are significant and should be implemented by IT practitioners in CE for attaining economic, social and environmental sustainability. The Green IT/IS assessment model can help CE towards reorienting their current corporate performance for a sustainable future and also assist IT practitioners to explicitly acknowledge enterprise areas to be recognized, resolved and further improved.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BAO	Belief Action Outcome
CBR	Case Based Reasoning
CE	Collaborative Enterprise
CIO	Chief Information Officer
CO	Carbon Monoxide
CO2	Carbon di Oxide
CV	Control variable
DV	Dependent Variable
ERP	Enterprise Raesource Planning
EPA	Environmental Protection Agency
GAT	Green IT/IS Assessment Tool
GDP	Gross Domestic Product
HTML	Hypertext Markup Language
ICT	Information Communication Technology
IS	Information Systems
ISO	The International Organization for Standardization
IT	Information Technology
IV	Independent Variable
KMO	Kaiser-Meyer-Olkin
KW	Kilowatts
LED	Light Emitting Diode
LCD	Liquid-Crystal Display
M	Moderating Variable
MYSQL	My Structured Query Language
NN	Nearest Neighbourhood
PC	Personal Computers
PCA	Principal Component Analysis
PHP	Hypertext Preprocessor
PLS	Partial Least Square
PLS-MGA	Partial Least Square-Multi-Group Analyses
RM	Malaysian Ringgit

SD	Standard Deviation
SEM	Structural Equation Modeling
SEMP	Sustainable Energy Management Program
SPSS	Statistical Package for Social Sciences
SQL	Structured Query Language
TBL	Triple Bottom Line
UML	Unified Modeling Language
UMP	Universiti Malaysia Pahang
USB	Universal Serial Bus
UTM	Universiti Technologi Malaysia
VFV	Variable Refrigerant Volume
WWF	World Wildlife Fund

CHAPTER 1

INTRODUCTION

1.1 Introduction

The purpose of this chapter is to introduce the research domain of Green Information Systems (IS) and Information Technology (IT) for sustainability attainment. Accordingly, this chapter presents the background and motivation of study, problem statement, research questions, research aim, research objectives, research scope, research contributions and thesis organization.

1.2 Background and Motivation

Over the last decade, due to the increasing impact of IT on society, economy, and environment, the management of IT hardware manufacturers and IT service enterprises are facing the challenges to achieve the concept of sustainability and Green IT/IS into account for their products and services (Molla et al., 2014). Green is an English word used to name a colour that is a combination of yellow and blue. However, as the years progress the colour Green got linked with environmental issue and thus, evolved to have a deeper meaning. Earth may no longer be a sustainable place for future generations to come if the present generation does not make any effort to decrease their carbon footprints (Nedbal et al., 2011).

Green is currently understood to mean environmentally friendly and energy efficiency. Whereas, sustainability refers to planning, implementing and investing in IT infrastructure that helps to achieve enterprise's short-term goals while preserving natural resources and helping to conserve the environment (Nedbal et al., 2011). Due to enormously growing consumption of natural resources, increased CO_2 emissions and the emergent awareness of environmental issues such as global climate change. IT

practitioners progressively recognize the importance of sustainable practice in Collaborative Enterprise (CE).

Sustainability has been considered an important concept in CE (Opitz et al., 2014). The leading understanding of sustainability was first formed by the Brundtland Commission's definition as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1985). Similarly, Green information technology and information systems (IT/IS) is a cooperating and incorporated set of process, people, software aimed at supporting IT practitioners goals that contribute to the environmental, economic or social performance of CE operations.

Figure 1.1 shows the need of Green IT/IS research. It can be seen that Green IT/IS practice helps to attain sustainability as started previously as resource usage to meet the needs of the present without compromising the future to achieve their own needs (Brundtland, 1985). Sustainability in turn aims to address global warming, climatic changes and environmental degradation (Hart, 1997; Elkington, 1997; Hart and Milstein 2003; Henriques and Richardson, 2013).

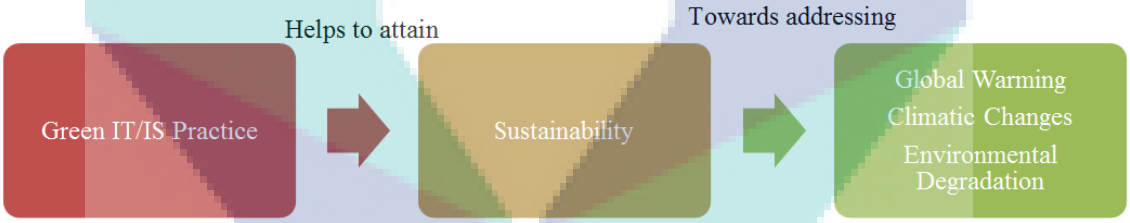


Figure 1.1 Importance of Green IT/IS
Source: Molla et al. (2014).

Figure 1.2 shows that Green IT/IS practice in CE aims to ensure cost saving decrease, energy efficiency, eco-friendly waste management, CO_2 emission reduction and natural resource conservation towards efficient use of natural resources such as water reduction, land preservation, fish depletion reduction etc. (Sharma and Jain, 2015). Green IT was first discussed by researchers such as Murugesan (2008) as the use of computer efficiently to reduce energy consumption, lessen cost incurred by IT usage and lastly to decrease Green House Gases (GHG) emitted from IT infrastructures. As the year's progress IS researchers such as Loeser (2013); Molla et al. (2014) decided to contribute to sustainability research and suggested the terms "Green IT/IS".

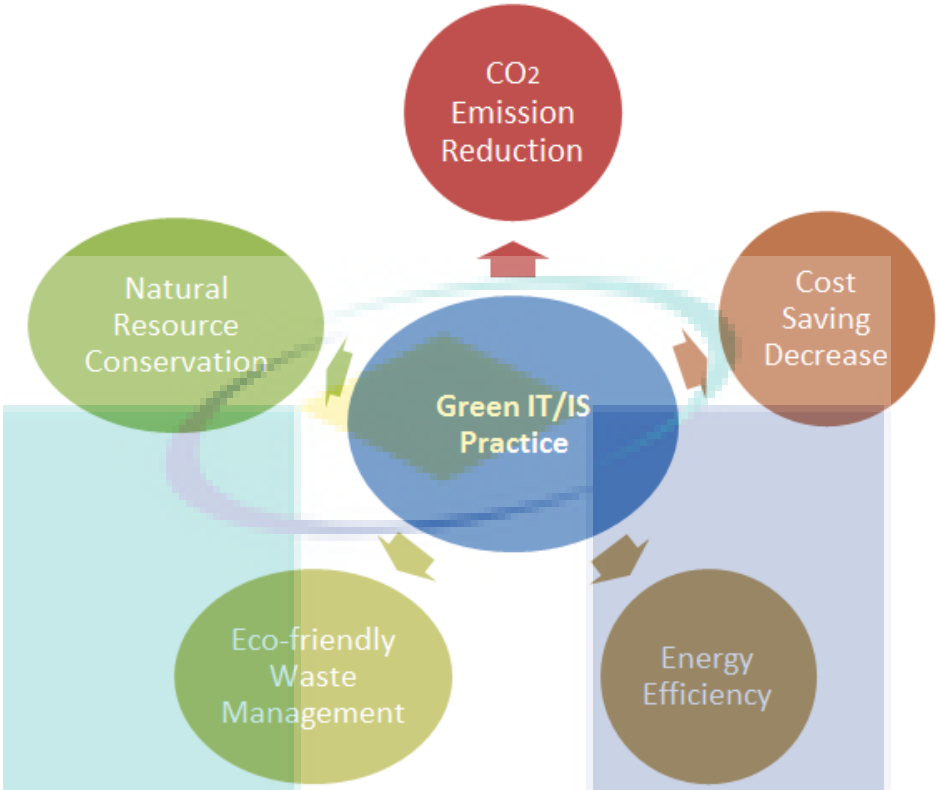


Figure 1.2 Aims of Green IT/IS

Source: Melville (2010); Nedbal et al. (2011).

Academic research and contribution to the domain of Green IT/IS was first discussed in 2008 (Loeser, 2013; Kotze et al., 2014). However, Brooks et al. (2012) mentioned that Green IT/IS research was first stated in Chief Information Officer (CIO) Magazine in 2007. Green IT/IS aims to utilize IS technologies to efficiently support enterprise going Green thereby reducing energy usage, electronic waste reduction, cost reduction of IT operation, Green House Gases reduction etc. (Asabere et al., 2016; Klör, 2016; Baggia et al., 2016). Accordingly, sustainability in CE comprises of three dimensions; economic, social and environmental (Boudreau et al., 2008; Chen et al., 2008; Molla, 2009a). The matching of economic profitability with social responsibility and environmental responsibilities is commonly known as the Triple Bottom Line (TBL) (Schmidt et al., 2009; Harmon and Auseklis, 2009, Melville, 2010; Molla et al., 2011; Nedbal et al., 2011; Dao et al., 2011; Opitz et al., 2014).

Over the decades sustainability has increasingly become an essential issue for both academic scholars and practitioners. This concern has expressed itself in government regulation expanding the responsibility of enterprise (Molla and Abareshi, 2011; Brooks et al., 2012), increasing responsiveness on training and enlightening IT

practitioners in sustainable strategies (Hasan et al., 2012; Molla, 2013; Roscia et al., 2013; Krishnadas and Radhakrishna, 2014). Thus, Figure 1.3 shows the target that CE should aim at if they want to go Green. Dao et al. (2011) suggested that by considering people (society) and planet (environment) in addition to profit (economic), effects on the environment and stakeholders will be incorporated and stable when anticipating alternatives, leading apparently to a more sustainable enterprise. In fact, it is claimed that long term profitability of any enterprise is best served by complementing profit with social and environmental goals (Dao et al., 2011).

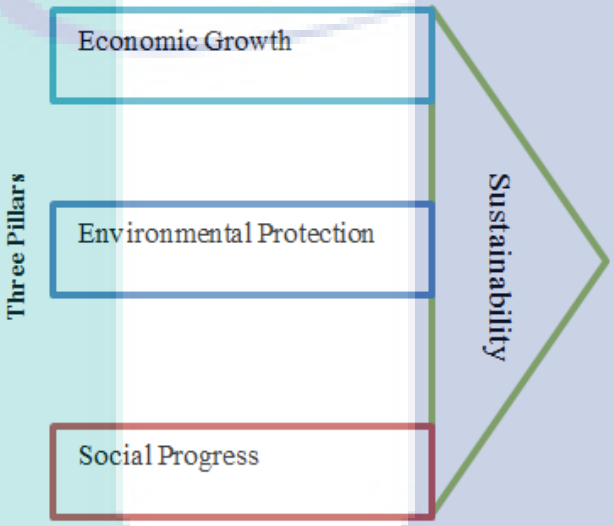


Figure 1.3 Triple bottom line target of sustainability
Source: Dao et al. (2011).

The essence of sustainability is that these three dimensions (profit, social and environment) need to be addressed concurrently rather than being viewed independently or with one of the dimensions greater than the other two (Brooks et al., 2012). However, prior study conducted by Nifa et al. (2016) suggested that economic, environment and social dimensions are not simultaneously considered by CE as stated in theory. This is based on results acquired by Nifa et al. (2016) which depicts that the economic dimension is mostly considered by CE more than social and environment dimensions which are not fully considered by CE in reality (Dao et al., 2011; Sakas and Kutsikos, 2014; Nifa et al., 2016) as shown in Figure 1.4.

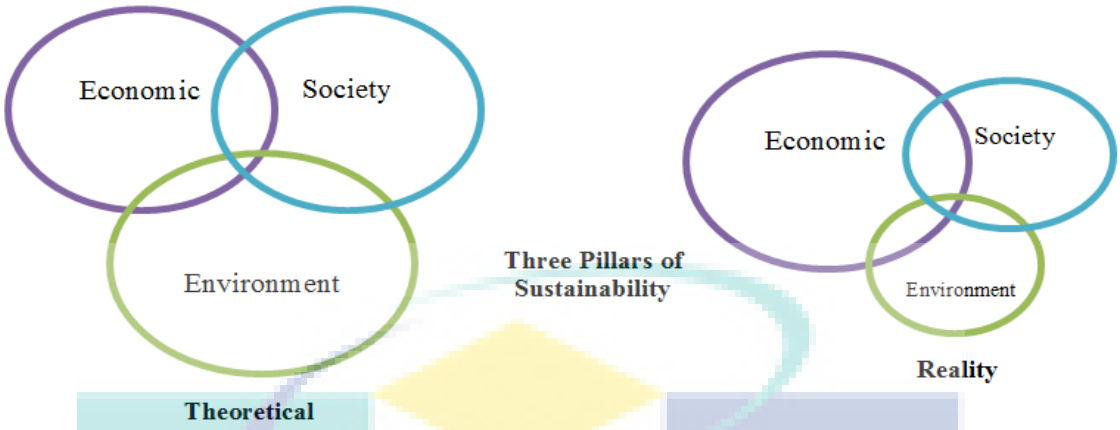


Figure 1.4 Theoretical and reality view of sustainability

Source: Nifa et al. (2016).

Green IT/IS have become one of the most recent alternatives to reduce energy consumption of IT operation and business operation in enterprise (Zheng, 2014), where IS can be defined as the usage of computer software and business and/or social applications that utilize information technology. Similarly, IT is defined as technologies dedicated to information storage, processing and communications. Thus, the concept of IT entails combination of hardware, telecommunications and office equipment that transform data into useful information in enterprise (Ijab and Molla, 2012). However, a study by IBM maintained that majority of enterprise do not possess Green technologies, let alone the capabilities to develop one to assist them to achieve profit, consider the social wellbeing and the environment (Butler and Daly, 2009).

Collaborative Enterprise (CE) is a system of communication among corporate practitioners that encompass the use of a collaboration platform, enterprise social networking tools, a corporate intranet and the public internet (Kim, 2008). CE enables IT practitioner in an organizations to share information with one another and work together on projects from different geographic locations through a combination of collaborative process (Sakas and Kutsikos, 2014). Thus, well-designed enterprise collaboration systems simplify the communication process, which has grown more complex for employees at many organizations due to the expansion of remote and global work environments (Vela et al., 2007), the accelerated pace of business operations and the rapidly increasing amounts of data that workers have to contend with (Tencati and Zsolnai, 2008). An overview of CE is illustrated in Figure 1.5.

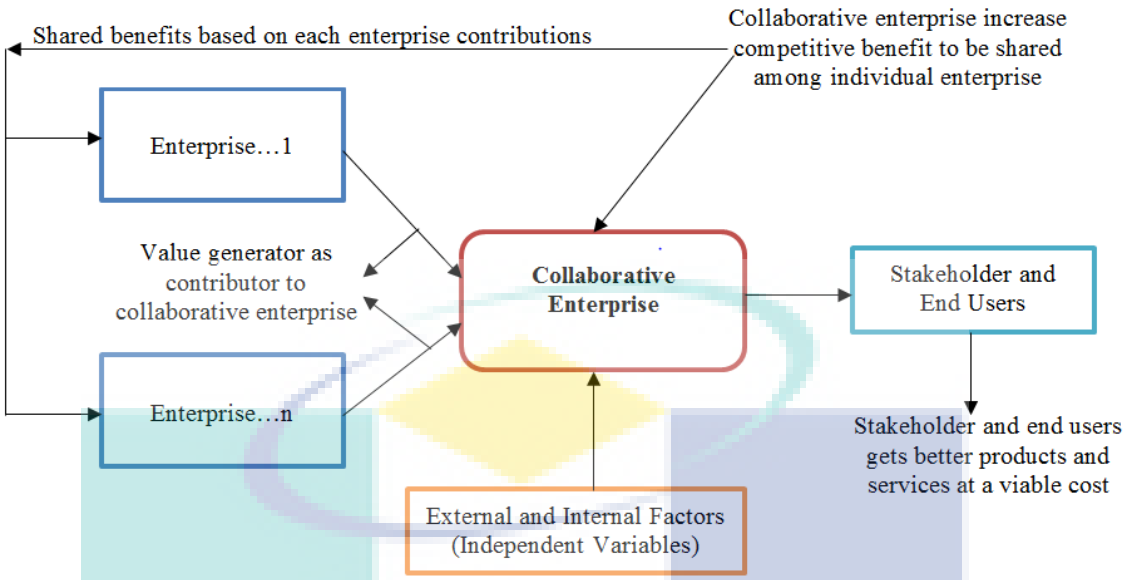


Figure 1.5 Overview of collaborative enterprise

Source: Sakas and Kutsikos (2014).

Figure 1.5 depicts an overview of CE showing how external and internal factors influence CE operations. Figure 1.5 further presents how enterprises collaborate in creating competitive advantage to stakeholder and end users. Although, Green IT/IS research has been investigated by prior studies in traditional organizations such as in IT based firms (Molla et al., 2014), banking industries (Sahu and Singh, 2016) etc. But, there are limited works that has been directed to CE based domain. Similarly, over the years there has been pressure from governmental and non-governmental organization, stakeholders and end users for CE to implement Green IT/IS practice.

Nowadays, CE carryout their organizational operations by deploying and utilizing resources that are facilitated by IT infrastructures (Tolomett and Saunders, 1998) which consumes electricity thereby emitting CO_2 to the atmosphere that adds to climatic changes, global warming and environmental degradation. Due to these environmental issues CE are implementing Green IT/IS practices in attempting to address environmental, economic and societal issues towards achieving efficient natural resource conservation, cost saving decrease, energy efficiency, eco-friendly waste management, and CO_2 emission reduction (Loeser, 2013). Accordingly, there is need for a Green IT/IS assessment model to support CE in measuring their current Green IT/IS practice in attaining economic, social and environmental sustainability towards a Greener society for future generations to come.

Prior Green IT/IS studies (Melville 2010; Bose and Luo, 2011; Butler, 2011a; Nedbal et al., 2011; Molla and Abareshi, 2012; Gholami et al., 2013; Rahim and Rahman, 2013; Cooper and Molla, 2014; Akman and Mishra, 2014; Mishra et al., 2014; Molla et al., 2014; Zheng, 2014; Akman and Mishra, 2015; Recker, 2016; Dalvi-Esfahani et al., 2017a; Dalvi-Esfahani et al., 2017b; Dezdar, 2017; Loeser et al., 2017) integrated existing frameworks, models or theories such as Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB), Technology Acceptance Model (TAM), norm activation theory, upper echelon theory, Resource-Based View (RBV), motivational theory, institutional theory, Technology-Organization-Environment (TOE) framework, Process-virtualization-theory (PVT), Diffusion of Innovation (DoI) theory and Belief-Action-Outcome (BAO) framework have been used to help examine the variables or factors that influence Green IT/IS practice in enterprises. However, these theories are only suitable in examining the variables that influences Green IT/IS practice and are less applicable in investigating the outcome of Green IT/IS practice implemented for attaining sustainability.

In choosing the theoretical framework for this study, the author sought a framework that can both help in exploring the variables that influences Green IT/IS practice and can also accommodate Green IT/IS practice implementation. The author found that BAO framework is suitable for this study, because the framework propose links between the influence of Green IT assess on IT practitioners and IT manager's beliefs about the environment and the influence of their beliefs on Green IT/IS implementation actions and subsequent outcomes. Respectively, this study aims to develop a Green IT/IS assessment model in CE based on belief-action-outcome framework. The model is developed based on identified Green IT/IS practices implemented and independent variables that influence Green IT/IS practice in CE.

1.3 Problem Statement

Sustainability has progressively become significant to research and practice in CE sector over the year as a result of rapid reduction of natural resources and sudden climatic changes (Hankel and Lago, 2016). Nevertheless, since 2007/2008 Green IT/IS has become an important concept in various domains as such CE are beginning to implement Green IT/IS practices in their enterprise process. The term "Green" is used to describe a practice that is more environmental friendly has given rise to an overuse

and often a misuse of the term resulting to CE using the idea of Green for economic gains only and not mainly for environmental protection (Park et al., 2012).

Nonetheless, due to the fast changing global weather requires IT practitioners in CE to respond to these changes and implement Green IT/IS practices, where Green IT/IS practice in CE could begin from organization's vision to support environmentally friendly paradigms (Hankel et al., 2016). Consequently, IT practitioners are beginning to implement Green IT/IS practice by adopting environmental management standards such as ISO 14001 (Zeng et al., 2005) and also utilizing manual self-assessment methods based on checklists questionnaire (Muladi and Surendro, 2014). Moreover, CE are utilizing Green energy sources, energy efficiency management system, cost reduction applications that guarantee the protection of the environment and economic sustainability that characterize the goals for future developments (Molla and Abareshi, 2012).

CE claims of "Green IT/IS" practice must be assessed against some standard (Ingram and Fernandez, 2012), where Green IT/IS practices aims to attain sustainability by reducing CO_2 emission, lessens waste generation, decreases electricity consumption, minimizing cost incurred and limiting natural resources utilization (Gu et al., 2015; Lundfall et al., 2015). Similarly, the literature on Green IT/IS practices in CE is still emerging and there are few research on how to assess Green IT/IS practice. But, existing Green IT assessment models focus on utilizing efficient energy and reducing the negative impacts of IT (Odeh and Meszaros, 2012), such as those developed by Green Grid (Belady et al., 2008), while others are mostly focused on data centers such as those developed by Molla et al. (2009) and Gartner (2013).

According to Huang (2009); Azlin et al. (2016) a few CE claim that they implement Green IT/IS practices by only implementing recycling operation and ignoring other Green IT/IS practices that are necessary for sustainability attainment. This is mainly due to the prospect that recycling concept is synonymous with Green IT/IS practices. Correspondingly, Hankel and Lago (2016) mentioned that there is need to provide the Green IT/IS process to be implemented by IT practitioners in CE based on an easy-to-use but comprehensive model that also assess the current Green IT/IS practice implemented in CE. Similarly, prior Green IT/IS models only raises awareness on the potential of Green IT/IS. However, existing models offer little practical

guidelines on Green IT/IS practice initiatives to be deployed in enterprise current operations to improve sustainability attainment (Muladi and Surendro, 2014). Furthermore, findings from Molla et al. (2010) indicated that IT firms in Australia are favourable implementing Green IT practice, but their capability to measure the current Green IT practice is relatively less developed. Accordingly, CE needs to make decision based on their current Green IT/IS practice to assess if their present practice considers the environment, people and profit (Park et al., 2012; Lundfall et al., 2015). Besides, there are independent variables that influence Green IT/IS practice in CE. Hence, there is a need for an assessment model that can be utilized by CE to ensure that IT practitioners considers these independent variables when implementing Green IT/IS practices in their enterprise operations towards attaining sustainability (Gu et al., 2015).

1.4 Research Questions

Below are the research questions to be answered in this research;

i. What are the independent variables that influence Green IT/IS practice in collaborative enterprise?

ii. What is the Green IT/IS practices to be implemented in collaborative enterprise?

iii. How to assess the current Green IT/IS practice being implemented in collaborative enterprise?

1.5 Research Aim

This research aims to propose a Green IT/IS assessment model based on belief-action-outcome framework to assess IT practitioners current Green IT/IS practice implementation in collaborative enterprise.

1.6 Research Objectives

The objectives of this study are:

i. To identify the Green IT/IS practice to be implemented and independent variables that influences Green IT/IS practice in CE.

ii. To propose a Green IT/IS assessment model based on belief-action-outcome framework.

iii. To validate the proposed Green IT/IS assessment model using survey data.

iv. To validate the applicability of the proposed Green IT/IS assessment model using the implemented Green IT/IS assessment tool.

1.7 Research Scope

This research entails the development of a Green IT/IS assessment model based on Belief-Action-Outcome framework. Accordingly, this study mainly examines the independent variables that influence Green IT/IS practice as well as the Green IT/IS practice to be implemented by IT practitioners in Malaysia CE for attaining economic, social and environmental sustainability. Therefore, this study involves only CE in Malaysia. In addition, this study investigates the influence of social-demographic determinants (moderating variables) and enterprise characteristics (control variables) on Green IT/IS practice on CE. Likewise, a Green IT/IS assessment tool is further implemented to validate the applicability of the proposed Green IT/IS assessment model.

1.8 Thesis Organization

This thesis is organized into seven chapters.

Chapter 1 introduces the research area of concern. The chapter begins with a description of the research background, describing the focus of previous research relating Green IT/IS, problems arising based on previous studies. The chapter proceeds with a problem statement, containing the identified problems from previous studies. The chapter then clearly describes the research objectives, research questions, and scope of the research.

Chapter 2 reviews the literature related to the background of Green IT/IS practices in enterprise by discussing the concepts of Green IT and Green IS, after which an overview of CE is presented, then Green IT/IS practice in CE was discussed. Next the importance of Green IT/IS practice in CE was explained in detailed. Green IT/IS models and frameworks that is similar to this research study is reviewed next.

Chapter 2 proceeds to discuss on the issues and benefits of Green IT/IS practices in CE. The Green IT/IS practice implemented and independent variables that influence Green IT/IS practice is identified and reviewed to assist in developing the Green IT/IS assessment model in CE. Moreover, an overview of existing Green assessment model is presented. Next, exiting frameworks, models and theories applied to facilitate Green IT/IS practice in CE is reviewed. Presently implemented Green IT/IS standards are presented. Lastly, the current Green IT/IS practice culture in Malaysia is briefly discussed.

Chapter 3 describes the methodology used in the research. The chapter begins by introducing the research methodology. The chapter explains the research phases and activities of the research in detail.

Chapter 4 describes the preliminary study involving the case study using interview. The chapter proceeds by describing the case study, which was conducted in four collaborative enterprises based in Malaysia with a total of fifteen informants. The case study aims to verify the Green IT/IS practice and independent variables derived from the literature. The data collected from the interview session was analysed using descriptive and narrative analysis. Moreover, Green IT/IS documents utilized by the informants in implementing Green IT/IS practices in their enterprise were also analysed with the findings from the case study. The last section is on the verification of case study findings.

Chapter 5 presents an overview of belief-action-outcome framework. The chapter also presents the conceptualization of Green IT/IS assessment model based on belief-action-outcome framework. This chapter further presents the model hypotheses. The Green IT/IS assessment model comprises of independent variables, dependent variable, Green IT/IS practice, sustainability constructs, enterprise characteristics (control variables), and social-demographic determinants (moderating variables).

Chapter 6 describes the result and discussion for validating the proposed Green IT/IS assessment model. This chapter proceeded by presenting the validation of the Green IT/IS assessment model using online survey. The data was collected using survey questions and each question is based on the model independent variables and Green IT/IS practice. Data collected through the survey was analysed using SPSS and SmartPLS. Chapter 6 proceeds to present findings and discussion from SPSS and PLS-SEM data analyses. Lastly, Chapter 6 discusses on how the implemented Green IT/IS assessment tool is also used to validate the Green IT/IS assessment model aimed at testing the applicability of the Green IT/IS assessment tool in relation to how the tool assess and provides best practice recommendations to IT practitioners in CE.

Chapter 7 concludes the thesis by describing the research outcomes in relation to the achievement of the research question, research problem and research objectives. This chapter then summarizes the research and provides theoretical and practical implications. In conclusion, the chapter provide the limitations and future works.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter lays a theoretical foundation for detailed understanding on the concept and study approach in the research concern. It is performed by reviewing papers which provide clear views to the researcher in achieving research objective one. An overview of this chapter is presented in Figure 2.1 which illustrates the sections and related sub-sections presented in Chapter 2.

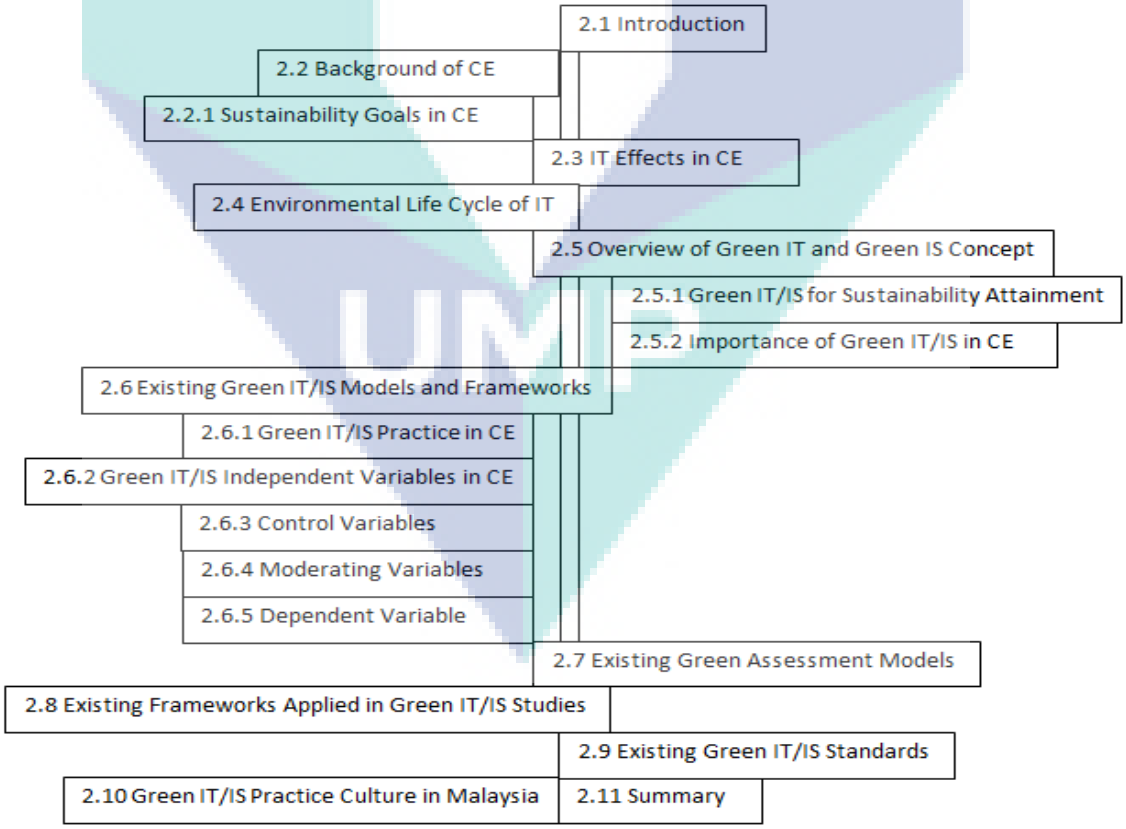


Figure 2.1 Overview for this chapter

2.2 Background of Collaborative Enterprise

Collaborative enterprise is derived from the word collaboration which is an activity that comprises of two or more stakeholders, working collectively towards achieving a shared goal towards the organizations vision and mission statement (Kim, 2008). In addition, CE is any establishment that carries out activities where two or more people contribute distinct resources and expertise to facilitate the collective development of the organization (Hale and White, 2014). In CE, the staffs and practitioners work on site or remotely from different location with the use of IS supported IT facilitated applications. CE deploys IT by using computer software, business and or social applications (Halal, 2001).

According to Tencati and Zsolnai (2008) the goals of CE are multidimensional hence different from other traditional enterprise by aiming to provide end users or stakeholders with social, economic and environmental values, where the values are mostly not fully considered by traditional enterprises. Moreover, CE deploys a well-designed enterprise collaboration systems that simplifies the communication process, which has grown more complex for staffs in other enterprises due to the expansion of remote and global work environments (Vela et al., 2007), in relation to accelerated pace of business operations and the rapidly increasing amounts of data that practitioners have to contend with (Vela et al., 2007).

Nowadays, CE carryout their organizational services by deploying and utilizing resources that are provided by IT infrastructures (Tolomett and Saunders, 1998) which consumes electricity thereby emitting CO_2 to the atmosphere that adds to climatic changes, global warming and environmental degradation. Hence, there is need to implement Green IT/IS practice in CE for cost saving decrease, energy efficiency, eco-friendly waste management, natural resource conservation and CO_2 emission reduction towards sustainability attainment (Molla et al., 2009).

2.2.1 Sustainability Goals in Collaborative Enterprise

The literature on Green IT/IS practice for sustainability attainment in CE is emerging but still in its infancy. Sustainability was defined by Brundtland (1985) as development that meets the needs of the present without affecting the ability of future generations to meet their needs. More lately, a triple bottom line (TBL) viewpoint of

sustainability has been embraced which considers sustainability to include society, natural environment, and economical state of the enterprise. Thus, Figure 2.2 outlines the sustainability goals to be attained in CE and it was first presented by Elkington, (1997); Henriques and Richardson (2013) as the 3ps; people, planet and profit.

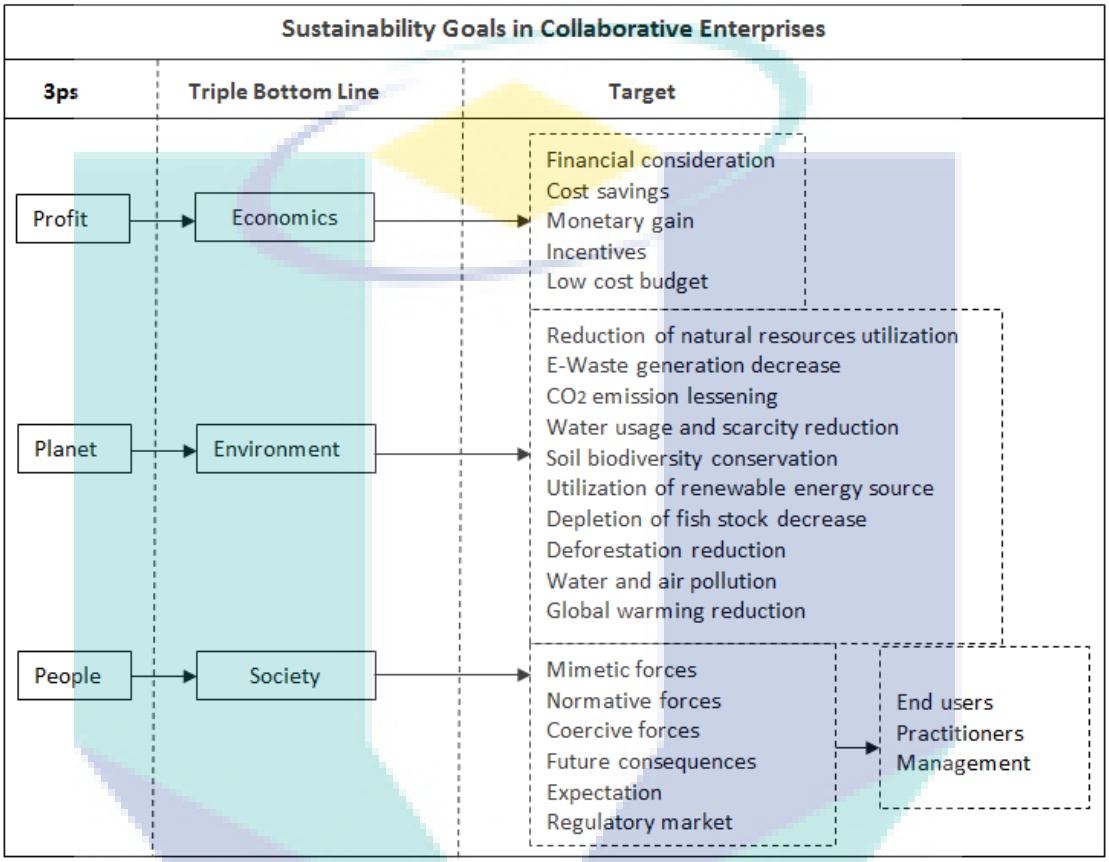


Figure 2.2 Sustainability goals in CE

Source: adopted from Elkington (1997).

Table 2.1 illustrates the need of 3ps in sustainability goals as discussed by previous researchers. Over the years the 3ps has been integrated in Green IT and Green IS research by academicians such as Chen et al. (2008); Molla et al. (2009a); Molla et al. (2009b); Sacchero and Molla, (2009); Harmon and Auseklis (2009); Schmidt et al. (2009); Butler (2011a); Molla et al. (2011); Molla and Abareshi (2011); Dao et al. (2011); Ijab et al. (2011); Nedbal et al. (2011); Brooks et al. (2012); Cooper and Molla (2013); Mishra et al. (2012); Chen and Kazman (2012); Molla and Abareshi (2011); Molla (2013); Chou (2013); Loeser (2013); Opitz et al. (2014); Simmonds and Bhattacherjee (2014); Esfahani et al. (2015a); Penzenstadler (2014); Zaman and Sedera (2016); Radu (2016); Gholami et al. (2016); Recker (2016) who also mention the 3ps

termed as the Triple Bottom Line (economic, social and environmental) in their research.

By considering the planet (effects on the environment), people (society) in relation to enterprise profit (economic) sustainability can be achieved in CE (Elkington, 1997; Hart, 1997; Hart and Milstein, 2003; Henriques and Richardson, 2013). Thus, CE need to consider the 3Ps in integrating Green IT/IS in their enterprise process. This is shown in Figure 2.2 and Table 2.1. It is to be known that each of the goal is important as such no one is more important that the other. Therefore, CE must set up their sustainability effort because Green IT/IS practices implemented by IT practitioners will go a long way in achieving sustainability.

Table 2.1 Sustainability goals in CE

3Ps	TBL	Target
Profit	Economics	Financial consideration- This is the amount of money the management is willing to invest into Green IT/IS practice (Chen et al., 2008; Molla, 2008; Seidel et al., 2010). This will directly influence enterprise decision in attaining sustainability (Jenkin et al., 2011; Chen et al., 2011). Cost savings- CE are mainly concerned with actions that will result in accomplishing of the objectives of sourcing at a cost lesser than the original cost (Molla et al., 2011; Zheng, 2014; Petzer et al., 2011). In essence, CE considers the cost of procuring IT equipment in relation to cost of normal IT facilities without Green labels (Nedbal et al., 2011; Ijab et al., 2012). Monetary gain- If there exists a financial gain, particularly in the difference between the amount earned from integrating Green IT/IS initiatives (Luan et al., 2016) and the amount spent in operating non eco-friendly practice in CE (Chen and Kazman, 2012; Lai et al., 2012; Hock et al., 2012; Recker, 2016). Incentives- This are additional reward that serves as inspiration to CE, if the management decides to give out rewards (Lintukangas et al., 2014) or incentives to practitioners that practice Green IT/IS, this might influence practitioners action towards adopting Green IT/IS (Molla and Cooper, 2014). Low cost budget- This is usually a type of pricing scheme where Green vendors set a moderately low price of Green IT/IS products in order to improve the demand for Green IT/IS facilities among CE (Esfahani et al., 2015a). Thus, a low cost pricing approach is an economic target that can influence CE to implement Green IT/IS practices (Zaman and Sedera, 2016).

Table 2.1 Continued

3Ps	TBL	Target
Planet	Environment	Reduction of natural resources utilization- The earth's natural resources are limited, which means that consumption of natural resources will eventually lead to depletion by humans (Chen et al., 2008; Seidel et al., 2010). Thus, there is need for CE to contribute to humanity by reducing the consumption of natural resources (Schmidt et al., 2010; Gholami et al., 2016; Radu, 2016). E-Waste generation decrease- E-waste refers to electronic waste generated from old, out-dated IT infrastructures (Jenkin et al., 2011; Butler, 2011b). These e-wastes are considered hazardous, as certain components of IT infrastructures contain materials that are toxic (Jung et al., 2011; Howard and Lubbe, 2012). The dangerous content of e-waste pose a threat to environment and human health. Thus, discarded IT wastes if wrongly disposed can percolate lead (Pb) and other substances into groundwater and soil (Ijab et al., 2012; Wati and Koo, 2012; Molla, 2013; Lei and Ngai, 2014). Greenhouse gases emission lessening- These includes several gases that trap heat in the air or atmosphere (Abareshi and Molla, 2013; Brocke et al., 2013). When these gases have been trapped for too long it results to climatic changes and theses gases includes CO_2, Methane (CH_4), Nitrous oxide (N_2O) and Fluorinated gas (Loeser et al., 2013). These gases are emitted from enterprise development and manufacturing process. Although, the amount of Greenhouse gases released by CE is little compared to other industries, there is still need to lessen the amount release by CE (Meacham et al., 2013). Water usage reduction- Water consumption lessening in CE can be achieved through a combination of changing attitude of practitioners in the enterprise, amending and/or changing facilities with water saving facilities to lessen general water utilization and increase enterprise reuse (Sakas and Kutsikos, 2014; McGibbon and Van Belle, 2013). To reduce water consumption in CE, it is essential to measure the current water use and set targets. Reducing CEs' water consumption is a means of resolving and also reducing the world water crisis. As of 2015, enterprise water use accounted for 5 per cent of world freshwater usage (Saha, 2014; Grant and Marshburn, 2014). Soil biodiversity conservation- A healthy soil provides nutrients to thousands of micro-organisms and plant and animal species in a region (Kotze et al., 2014). Species will disappear as a result of soil pollution or a lack of nutrients caused by the fertile upper layer of the soil being removed. Reversing land degradation also improves food security (Molla and Cooper, 2014). This is not only essential to the functioning of natural ecosystems but constitute an important resource for conserving the eco-system (Chou, 2013). Utilization of renewable energy source- it is advisable for CE to use renewable energy source and rely less on coal generated electricity that emits CO_2 to the atmosphere (Zaman and Sedera, 2016). Renewable energy can be derived from wind, sunlight, rain, waves, geothermal heat and tides. Furthermore, CE can use renewable energy source to provide energy for air, water cooling/heating, transportation across the organization, electricity generation and off-grid energy services (Radu, 2016; Gholami et al., 2016; Recker, 2016).

Table 2.1 Continued.

3Ps	TBL	Target
People	Society	Mimetic forces- are the pressure on CE to imitate operationally similar successful enterprise in the same business area without necessarily considering the organizational context (Chen et al., 2008; Molla, 2009a; Harmon and Auseklis, 2009). Mimetic pressure is supposed to certainly impact the intention of CE to implement Green IT/IS practices (Molla, 2008; Schmidt et al., 2009). Normative forces- are pressure that is embedded in the current process of professionalization (Butler and Daly, 2009; Molla et al., 2010). This pressure arises from the interchange of best practices among practitioners across different enterprise. Normative pressure is also pressure within the enterprise (Watson et al., 2010; Karanasios et al., 2010; Jenkin et al., 2011). Coercive forces- refer to pressure chastised in societal dependencies and expectations towards other enterprises (Chen et al., 2011; Butler, 2011b; Ijab et al., 2012). Also, various industry regulations and government exert coercive pressure on enterprises and determinedly drive Green IT/IS practice (Lei and Ngai, 2014; Ijab and Molla, 2012). Future consequences- If the consequence of future action is observed as harmful, a sense of guilt will surface because the attribution of harmful consequence that may occur in future based on CE current operations (Molla, 2013; Molla and Cooper, 2014; Grant and Marshburn, 2014). Expectation- If practitioners and management are mostly influenced by the strong belief that going Green will lead to enterprise cost saving (McGibbon and Van Belle, 2015; Zaman and Sedera, 2016) and reduction of resources they will support the Green IT/IS practice movement (Baggia et al., 2016). Regulatory market- This is the market where the government controls the determinants of demand and supply, such as who is allowed to purchase from the market, and/or what amounts may be charged (Benjamin and Munster, 2016; Radu, 2016). Thus, these market forces can affect CE implementing Green IT/IS practices (Gholami et al., 2016; Recker, 2016). End users- These are the domestic consumers that utilized developed IT based projects or services (Ninlawan et al., 2010; Molla et al., 2010; Cardoso and Carvalho, 2010). How they use and dispose the developed product can have an effect on the environment (Schmidt and Kolbe, 2011; Watson et al., 2011). Practitioners- These are the staffs, experts and professionals in CE that develop, implement and distribute products to end users (Wati and Koo, 2012; Abareshi and Molla, 2013; Brocke et al., 2013). The practitioners in CE are the people that will implements Green IT/IS practices in their day to day process in order for their enterprise to achieve sustainability (Loeser et al., 2013; Gholami et al., 2013; Meacham et al., 2013; Sakas and Kutsikos, 2014). Management - These are the stakeholders and decision makers in CE (Dalvi-Esfahani and Rahman, 2015; Radu, 2016), they introduce and enforce Green governance policies and strategies for the practitioners in the enterprise to adhere to (Savita et al., 2014; Zaman and Sedera, 2016; Akman and Mishra, 2015; Gholami et al., 2016). This governance polices ensures that the practitioner implements Green IT/IS initiatives laid down by the management (Seidel et al., 2010).

2.3 IT Effects in Collaborative Enterprise

This section provides a conceptual understanding of the effect of IT deployments in CE. Figure 2.3 shows the categories of IT effects to the natural environment which includes the direct effects, enabling effect and the systemic effects.

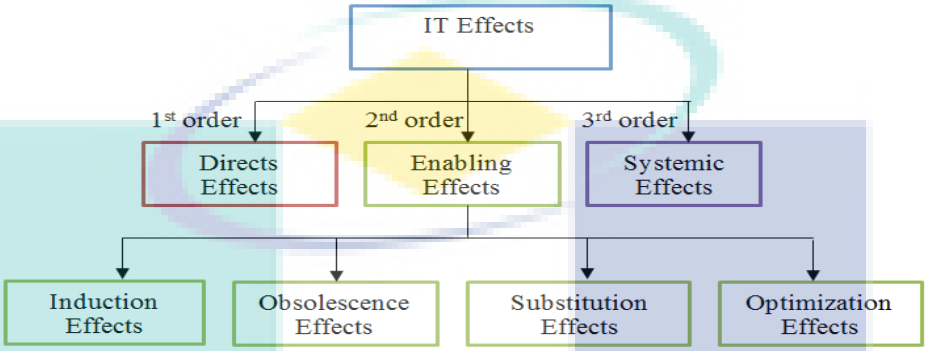


Figure 2.3 Categories of IT effects to the environment

Source: adopted from Hilty and Aebischer (2015).

The direct effects (first order) is a result of enterprise manufacturing, transport use and disposal of IT facilities impact on the environment that can be measured based on a life cycle assessment technique (Berkhout and Hertin, 2001). The direct effect comprises the demand for energy and materials during the whole product life cycle. These impacts results to negative effects as they signify the cost of providing IT services (Hilty and Aebischer, 2015). The enabling effects (second order) refers to the impact of applying IT services that may lead to unfavourable or favourable results in relation to sustainability attainment (Hilty and Aebischer, 2015). This enabling effect includes induction, obsolescence, substitution and optimization effect. Where the induction effect of IT leads to the utilization of other resource, for example a printer leads to the utilization of paper as it consumes it faster than a typewriter. Moreover, induction effects may also occur if IT products help to increase usage for other services (Berkhout and Hertin, 2001).

Next, obsolescence or degradation effect of IT can reduce the expedient life of another product because of incompatibility for instance a system that is no longer maintained by software updates is rendered out of date (Mickoleit, 2010). Substitution or de-materialization effect of IT relates to the use of IT facilities to interchanges the use of another services or resource e.g. an e-book reader can substitute printed books, which is sustainable since it avoids printing (Berkhout and Hertin, 2001). Hence,

substitution effect advances IT by offering replacement of physical process and products to digital services. Other examples include online music substitutes physical music media and teleconferences can used in place of travelling for business meetings (Mickoleit, 2010).

Optimization effect of IT is the use of IT to decreases the utilization of another resource resulting to less limited energy usage e.g. smart home systems that open or close windows based on forecasted weather, autonomous embedded programs in vehicles for fuel proficient driving, intelligent power delivery networks to diminish distribution and transmission losses, and smart lighting and heating systems in offices which maximizes energy efficacy thereby using IT to lessen another systems environmental effect (Hilty and Aebischer, 2015). Lastly, systemic effects (third order) refer to the long term response of the vigorous socio economic system to the availability and usage of IT systems, comprising behavioural life styles alterations in relation to economic change (Berkhout and Hertin, 2001). The systemic effects is only pertinent in CE where IT is mainly utilized as part of the end product, where the impact ranges from service that decreasing the quantity of negative environmental impacts through the utilization of IT such as in online banking, which lessens paper consumption and CO_2 emissions (Mickoleit, 2010). The discussion on the effect of IT usage on the natural environment helps to explain how Green IT/IS practice can be implemented as enabling effects for induction, obsolescence, substitution and optimization initiatives in attaining sustainability in CE.

2.4 Environmental Life Cycle of IT

This section describes the environmental life cycle of IT deployment in CE as presented in Figure 2.4. Thus, Figure 2.4 shows the environmental lifecycle for IT deployment presenting the first, second and third order of IT deployment in CE, where the vendors or merchant are the external wholesalers that supplies the outsourced IT hardware and software to CEs (Zheng, 2014). The practitioners are the IT experts and IT professional in CE that implements Green IT/IS practice towards environmental conservation, cost saving decrease, energy efficiency, eco-friendly waste management, natural resource conservation and CO_2 emission reduction. The end users are the consumers of the final software product or services, they utilized the product for

personal of business process and this product use also has an effect on the natural environment (Murugesan, 2008).

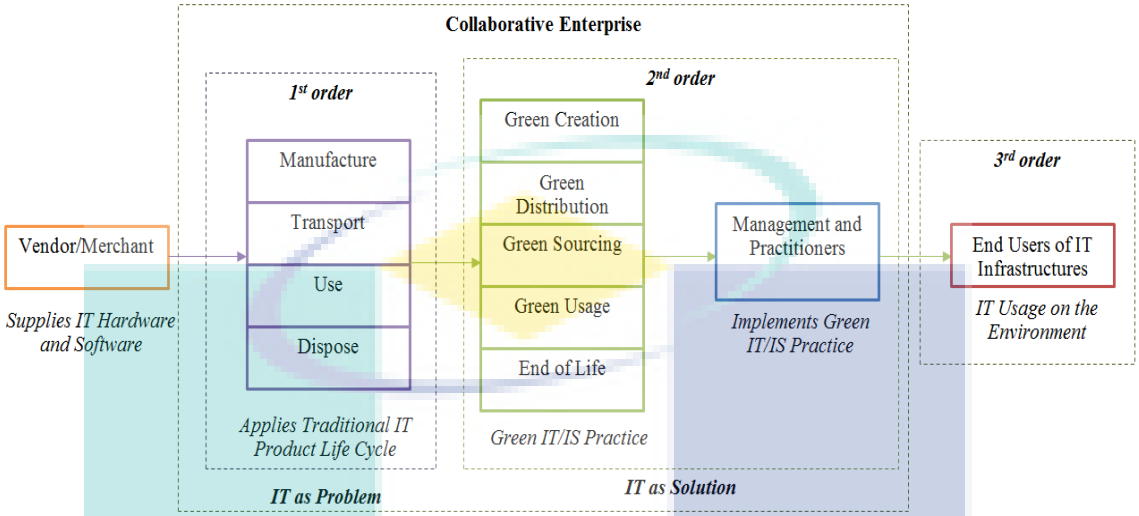


Figure 2.4 Environmental lifecycle for IT deployment

Source: Adapted from Berkhout and Hertin (2001); Zheng (2014).

The first order is as a result of traditional IT usage on the natural environment. In the first order CE manufactures, transports, use and disposes IT infrastructures, products and services without caring for the natural environment (Berkhout and Hertin, 2001). Over the years this has resulted to IT contributing to global warming and climatic changes by emitting about 2 per cent of CO_2 emission to the atmosphere (Zheng, 2014). Also, end of life materials waste generated from the manufacture phase are not ethically disposed-off and as such they contribute to damage the natural environment i.e. aquatic life, soil degradation, loss of biodiversity and water contamination and air pollution etc. (Molla et al., 2009a).

Green IT/IS practices in CE lessen the harmful environmental impact of CE manufacturing, transportation, usage and disposal of IT infrastructure and equipment (Molla, 2009a). Additionally, Green IT/IS practices includes considering eco-labels when procuring IT related hardware, virtualization and consolidation of communication servers and data base storage facilities, the usage of natural cooling, the deployment of thin clients and refurbishing of out-dated IT hardware to prolong their lifecycle (Murugesan, 2008). Based on this, Green IT/IS practices in CE encompass the resource requirements of utilizing IT infrastructure such as notebooks, desktop computers, network devices, servers, printers, the energy consumed by all of enterprise IT devices

and electronic waste produced when disposing out-dated IT facilities (Loeser et al., 2017), to address 2nd order effects of IT deployment.

Green IT/IS practices mainly concerns the progressive environmental gains that can be attained by lessening the negative ecological impacts of enterprise operations towards corporate sustainability advancement (Loeser et al., 2017). Green IT/IS thereby reveals opportunities to diminish enterprise business operational consumption of natural resources thus addressing 2nd order effects of IT deployment in collaborative enterprise. Therefore, Green IT/IS practice foster innovative solutions that reduce resource waste and CO_2 emissions during the design of end users' services and products thus reducing environmental footprint of enterprise activities.

The implementation of Green IT/IS potential into enterprise operations can produce cleaner end products and IT solutions, such as dematerialization creativities that replaces physical products with digital services such as e-books, e-music facilities (Loeser et al., 2017). Respectively, Molla (2009b); Loeser et al. (2017) categorized Green IT/IS practice into Green sourcing, Green operations, and end of life (Green disposal) to provide guidance to practitioners on how to reduce IT-related environmental effect by implementing Green IT/IS practices. In this thesis two more Green IT/IS practice namely Green creation and Green distribution are added to Green sourcing, Green operation (Green usage) and end of life as seen in Figure 2.4. These Green IT/IS practice are discussed in detailed in Section 2.6.1.

The impact of IT on the natural environment is categorized as direct impacts, enabling effects and lastly systemic effects of IT which leads to medium or long term changes of economic and societal behaviour towards sustainability attainment (Hilty and Aebischer, 2015). This thesis is more aligned to the second order effect of IT for sustainability attainment by identifying the Green IT/IS practice to be implemented and independent variables that influences the implementation of Green IT/IS practices in CE. This study is motivated to explore on the second order effect of IT, since in contrast to the first order, the second order effects have mostly positive implications, such as IT facilitated efficiency savings of CE internal operations as stated by Erek et al. (2012).

2.5 Overview of Green IT and Green IS Concept

Information technology refers to computer software, hardware and peripheral infrastructures, whereas information systems is an extensive concept that involves the human activities and technology components related to the running and management process of technology across enterprise (Loeser et al., 2017). IT conveys, process, or stores and provides information, whereas IS is an integrated set of software utilizing IT to support practitioners, group of professional, enterprise (Brooks et al., 2012). IS comprises of IT such as office computers, physical servers, network devices as well as shared facilities such as business applications and IT human resources in relation to skills, knowledge and database storage. Therefore, the use, design and disposal of IT in an environmental manner is coined as Green IT, whereas the utilizing IS to make CE Greener is known as Green IS (Murugesan, 2008). Green IT and Green IS aims to reducing the negative ecological impact of IT using IS to resolve ecological problems (Cooper and Molla, 2012). Correspondingly, Table 2.2 shows the contributions of Green IT and Green IS towards sustainability in CE.

Table 2.2 Contributions of Green IT and Green IS in CE

Green IT	Green IS
Green IT relates to environmental practices that have positive effect on procurement of material requirements (Green sourcing), energy consumption, and disposal of electronic waste of IT hardware (end of life) (Pernici et al., 2012).	Green IS utilize IS to implement environmentally friendly enterprise practice such as Green creation, distribution, and usage to support practitioners to better recognize the role of IS in resolving the sustainability issues (Pernici et al., 2012).
Lei and Ngai (2013) cited Molla et al. (2011) by defining Green IT as a methodical application of eco-sustainability standards, which involves product stewardship, pollution prevention and use of clean technologies for the design, procurement, usage, and disposal of electronic wastes.	Green IS is a set of systems, technologies, organization, people, and environment collaborating to support sustainable enterprise process (Lei and Ngai, 2013). Green IS aims to reengineer enterprise process by deploying IS based innovations.
According to Loeser (2013) Green IT aims to decrease IT related energy consumption that accounts for approximately 2% of global Greenhouse gas emissions.	Green IS offers innovative solutions that address the outstanding 98% of global Greenhouse gas emissions (Loeser, 2013).
It can be said that Green IT aims to resolve the adverse first order environmental effect of the design, operation, and disposal of IT infrastructures (Cooper and Molla, 2013).	Green IS encompasses the helpful second order effects (Greening of production and business process) by lessen resource utilization; reducing waste emissions during enterprise operations (Cooper and Molla, 2013).

Table 2.2 Continued.

Green IT	Green IS
Loeser (2013) added that Green IT practice aligned to initiatives and measures which decline the negative environmental effect of operations, manufacturing and end of life of IT infrastructure and equipment.	Green IS concerns practices that govern the asset in, running, deployment and management of enterprise systems in order to diminish the harmful environmental impacts of IT related systems (Loeser, 2013).
Green IT includes a number of practices such as data center airflow and power management, electronic waste supervision, server and storage virtualization, IT sourcing practices that cogitate environmental criteria, personal computer power supervision, policies that advocate the deliberation of environmental criteria in both procurement and disposing of IT (Cooper and Molla, 2013).	Green IS provides guidance to practitioners approach orientation and enterprise core procedures (Loeser, 2013), where these Green IS initiatives include reducing intensifying cost of energy, enforcing ecological legislation regarding energy efficiency and e-waste disposal.
Green IT supports use of renewable power source to run IT infrastructure in CE and the ecological consciousness of practitioners in their respective enterprise (Cooper and Molla, 2013).	Green IS aims to bring solution for ecological issues while at the same time, increase task performance (Cooper and Molla, 2013).
Green IT refers to the technology used in the design, maintenance, and use of computer software systems and networks for the distribution and processing of data (Brooks et al., 2012).	Green IS includes total cost of ownership including macro and micro economic issues, competent systems usage in regards to social, environmental and ethical practices relating to IT use, acquisition, and disposal (Brooks et al., 2012).

In summary, Green IT address the decrease of IT related energy utilization that accounts for almost 2 per cent of global CO_2 emissions, where traditional IT usage in CE is seen as the problem, while Green IS provides innovative software solutions that resolves the outstanding 98 per cent where IT is seen as the solution (Jenkin et al., 2011). Although, the transformation of any enterprise process with the support of Green IS entails a holistic long term governance plan. Accordingly, this thesis integrates Green IT and Green IS as Green IT/IS to support CE implement both Green IT and Green IS practice that provides a systematic approach for sustainability attainment.

2.5.1 Green IT/IS for Sustainability Attainment

IT/IS have been the greatest force for productivity improvement in the last decade. Green IT/IS refer to initiatives that directly or indirectly address sustainability in enterprise as seen in Figure 1.1 in Chapter 1 (Page 2). Although, IT practitioners have begun to focus on Green IT/IS, there is little research in this area that examined Green IT/IS practice to be implemented in CE. Green IT addresses energy consumption

and waste related with the use of hardware and software, such as improving the energy efficiency of hardware and data centers, consolidating servers using virtualization software, and reducing waste associated with out-dated equipment (Murugesan, 2008).

Green IT/IS refers to the development and utilization of information systems to enable sustainability initiatives. Green IT/IS implementation comprises, collaborative group software and tele-presence systems to enable remote conferences and reduce the negative environmental impacts associated with travel; environmental applications to track and monitor environmental related issues such as emissions, waste, water consumption, toxicity, carbon footprints and applications to optimize IT product routing and transportation, thus decreasing the amount of energy utilized in moving products (Jenkin et al., 2011).

According to Sarkis et al. (2013) Green IT/IS include both infrastructural and organizational aspects of environmental technology. Green IT/IS concern integrated sets of systems (including people, process, software, and information technologies) to support economic, environmental, and social goals (Gholami et al., 2013; Sarkis et al., 2013). Presently, CE have several opportunities to implement Green IT/IS initiatives while improving productivity, reducing costs, and enhancing profitability (Lago et al., 2013). However, IT practitioners poor practices results in many forms of waste; unused resources, energy inefficiency, noise, friction, and emissions are all waste products that subtract from economic efficiency. Such poor practices could be improved by implementing Green IT/IS in to their enterprise process (Boudreau et al., 2008).

In IT/IS community, sustainability has become an important issue in the narrow sense of reducing the direct environmental impacts of IT use that contributes to climatic changes, increase in energy consumption and increase in cost of IT infrastructure usage. Although, energy efficiency in hardware and data centers continues to receive a great deal of research, given the potential to decrease emissions and lessen energy costs (Dedrick, 2010). Recycling of computer hardware, network infrastructure and electronic waste is also a necessity for enterprises to implement. CE such as Dell and Toshiba advertise Green designs emphasizing reusability and elimination of e-wastes (Molla et al., 2014). Therefore, Green IT/IS practice implementation can help CE attain sustainability.

2.5.2 Importance of Green IT/IS in Collaborative Enterprise

This section explores on why Green IT/IS implementation is important and what are the issues faced in implementing Green IT/IS practices in CE. Presently, IT accounts for approximately 2% of world CO_2 emissions; this is equivalent to aviation industry (Chen et al., 2011). In fact, this 2% includes only the in-use phase of hardware, in the remaining 98% software is utilized in enterprise in implementing business and in supporting society needs, as well as delivering end-user applications (Brooks et al., 2012; Savita et al., 2014). According to Cardoso and Carvalho (2010) Green IT/IS assist enterprise understand the interaction of IT and energy use in production process in order to assess the impact on carbon productivity.

Green IT/IS implementation aid IT practitioners understand the effects of IT investment policies on carbon productivity (Lago et al., 2013). Green IT/IS practice also enhances optimization of environmental corporate decisions towards CE attaining sustainability goals (Molla, 2013). Furthermore, Green IT/IS implementation provides information across various stakeholders (IT managers, IT practitioners, and governments) to promote eco-efficiency, eco-equity, and eco-effectiveness (Chen et al., 2008). Moreover, Green IT/IS includes the dimensions of environmental sustainability, the economics of energy efficiency, and the total cost of ownership, which includes the cost of disposal and recycling (Molla et al., 2014).

Currently, Green IT/IS practice implementations in enterprise is affected by issues such as cost of Green IT/IS solutions, unclear business value in Greening IT, lack of government incentives, lack of business leadership on Green IT/IS, the extent of sophistication, inadequate skills and training of practitioners, absence of enforceable government regulations and the extend of Green IT/IS practice in the industry (Dedrick, 2010) and longer time taken to implement Green IT/IS practices in CE. According to Nathalia (2011) Green IT/IS practices in enterprise strives to achieve economic viability and improved system performance and use, while abiding by social and ethical responsibilities.

2.6 Green IT/IS Models and Frameworks

Green IT/IS hold greater promise for addressing broader sustainability issues in CE. Nevertheless, very little research has examined this potential of Green IT/IS in CE.

This is due, in part, to the general lack of awareness of the impacts of IT/IS. On the other hand Green IT/IS has gain reliance for the past decade, as such few studies have been carried out to contribute towards Green IT/IS practice as shown in Table 2.3. Thus, Table 2.3 summaries the related Green IT/IS research that has been carried out, aimed at achieving sustainability.

Table 2.3 Related works (existing Green IT/IS models and frameworks)

Authors, Year & Contribution	Model Components	Problem Addressed	Research Method Applied	Limitation(s)	Derived Independent Variables
Dalvi-Esfahani et al. (2017a) identified different psychological variables that influence managers of enterprise to adopt Green IT/IS.	The model comprises of observable characteristics, psychological cognitive base and values as independent variables and Green IT/IS as dependent variable.	Prioritized the identified psychological variables for managerial actions.	Upper echelon theory based on a hybrid interpretive structural modelling and analytic network process method.	No investigation was carried out on how the authors can increase ecological awareness of practitioners, towards the environment.	IT governance.
Loeser et al. (2017) developed a model that associates enterprise beliefs about ecological sustainability to Green IT and IS.	Entails environmental orientation as beliefs, Green IS strategy, Green IT practice, Green IS practice as actions and organizational benefits as outcomes.	Described both negative and positive outcome for both environment and organization.	They collected data using survey from118 senior level IT executives.	Did not examine the negative outcomes, neither did they explore the environmental benefits.	IT practitioners, IT strategy.
Dalvi-Esfahani et al. (2017b) develop a model to explain how managers diffuse IS strategies for environmental sustainability in enterprise.	The model entails of awareness of consequences, ascription of responsibility, personal norm and personal values as variables that influences intention to adopt Green IS.	Studied the moderating effect of personal values on managers' plan to adopt Green IS based on the norm activation theory.	Survey from 146 samples that were analysed using Partial Least Squares (PLS) SEM.	The research mainly considers the environmental dimension of sustainability.	IT governance.

Table 2.3 Continued.

Authors, Year & Contribution	Model Components	Problem Addressed	Research Method Applied	Limitation(s)	Derived Independent Variables
Sahu and Singh (2016) designed model to show the correlation among nineteen variables that affects Green IS adoption.	The model comprises of environmental, social and economic components.	Examined the critical drivers for successful adoption and implementation of Green IS implementations in organizations.	Cases study of two Indian banks to validate the variables.	No insights regarding Green IS implementation in the banks was presented in their study.	IT governance, technologies and system, motivating forces.
Deng and Ji (2015) presented a framework on enterprise Green IT adoption.	Comprises of technological, pressure, as independent variables. Organizational Green IT adoption as mediating variable and sustainable competitive advantage as dependent variable.	Offers a broad review of previous Green IT adoption studies.	Literature review	Practitioners in the enterprise are not considered in the research.	IT governance, technologies and system, motivating forces.
Ainin et al. (2016) investigated the issues that affect the adoption intensity of Green IT practices.	Comprises of institutional pressure, consideration of future consequences and openness as independent variables and adoption of Green IT practices as dependent variable	Studied the impact adoption of Green IT practice in enterprise performance.	Data was collected using questionnaire and analysed using SEM-AMOS tool.	Data was collected from different industries.	Motivating forces.
Molla and Cooper (2014) researched on Greening enterprise data centres	Institutional drives; data centers best practices, expectancy, motives and ability as variables.	Aimed to examine how to Green enterprise data centers.	Data was collected using survey and analysed using SPSS and PLS-SEM.	Did not examine the effect of control variables.	Motivating forces, information availability.

Table 2.3 Continued.

Authors, Year & Contribution	Model Components	Problem Addressed	Research Method Applied	Limitation(s)	Derived Independent Variables
Zheng (2014) proposed a Green ITIS adoption model.	Organization, business strategy, technology and environment as and Green ITIS adoption intention as variables.	Examined the role of business strategy in Green ITIS adoption.	Literature review.	Mostly concerned about business strategies in corporate social responsibility.	IT governance, IT strategy, technologies and system.
Molla et al. (2014) developed a Green IT framework grounded on belief-action-outcome approach.	Organizational context, information acquisition capability, Green IT belief, Green IT attitude, pro-environmental IT practice as variables.	Studied how Green IT attitude and beliefs influence the pro-environmental behaviour of IT professionals	Collected data using survey and analysed using SEM-AMOS.	Data was collected from IT professionals in Australia only.	IT governance, IT practitioners, Information availability.
Ijab and Molla (2012) studied on Green IS and developed a conceptual framework.	Entails top management, environmental steward, IS manager and professionals as independent variables and Green IS practices as dependent variable.	Created a description of IS in enterprise to develop, deploy, use and integrate for sustainability.	Literature review.	The authors were mainly concerned about Green IS strategies variable.	IT practitioners, IT strategy, IT governance.
Erek et al. (2012) designed a matrix model to address the pillars of sustainability.	The model comprises of govern, make, source and deliver.	Served as a basis for managing sustainability management in IT based organizations.	Critical literature review.	The research is mainly grounded on IT value chain procedures.	IT governance.
Loeser et al. (2012) developed a typology of Green IS implementation strategies.	Green IS strategies for innovation, efficiency, credibility and transformation.	Helps to identify key dimensions for eco-sustainability.	Exploratory case study research of four organizations.	The study is only centered on Green IS strategy.	IT strategy.

Table 2.3 Continued.

Authors, Year & Contribution	Model Components	Problem Addressed	Research Method Applied	Limitation(s)	Derived Independent Variables
Jenkin et al. (2011) presented a multilevel research framework for Green IT and IS research.	Comprises of environmental sustainability motivating forces, environmental sustainability initiatives, environmental orientation of organization and employee.	Aimed to resolve environmental sustainability in multi-domains.	Extensive literature review.	More in-depth investigation of the framework was not carried out.	IT practitioners, IT strategy, IT governance, Motivating forces.
Widjaja et al. (2011) examined Green IT awareness among IT professionals.	Comprises of IT impact on environment, Green IT knowledge, IT professional's role in Green IT, Green IT practice, Green IT commitment, action to Green IT, Green IT governance and personal commitment as variables.	Investigated Green IT awareness and attitude among IT professionals in Indonesian.	Data was collected using survey and analysed using SPSS.	Collected data from 2008 till 2010 from Indonesia industries only.	IT practitioners, IT governance. Information availability.

As stated in Table 2.3 Dalvi-Esfahani et al. (2017a) identified different psychological drivers which influence managers of enterprise to adopt Green IT/IS within their organizations. The drivers are explored using upper echelon theory to examine their interdependency and interrelationship based on a hybrid interpretive structural modelling and analytic network process method to prioritize them to organize suitable managerial actions. The authors proposed a model that comprises of observable characteristics, psychological cognitive base and values as independent variables and Green IT/IS as dependent variable. The drivers were identified from the literature and additional confirmed by domain experts. However, the authors did not investigate how they can increase environmental awareness of practitioners, towards attaining sustainability.

Loeser et al. (2017) explained the procedures that associate enterprise beliefs about environmental sustainability to Green IT and Green IS activities implemented, and the organizational gains to be derived from these practices. The researchers developed a model that comprises of environmental orientation as beliefs, Green IS strategy, Green IT practice, Green IS practice as actions and organizational benefits as outcomes. They collected data using survey from 118 senior level IT executives. Finding from their study revealed that Green IS strategies mediate the association between implementation of Green IS practices and Green IT practices and the environmental orientation that results to organizational gains in form of cost decreases, Green innovation capabilities and business reputation improvement. Although, the authors designed a model that describes both negative and positive outcome for both environment and organization, they did not examine on the negative outcomes, neither did they explore the environmental benefits.

Dalvi-Esfahani et al. (2017b) studied the moderating effect of personal values on managers' plan to adopt Green IS based on norm activation theory. The researchers went further to develop a model to explain how managers anticipate diffusing Green IS strategies in enterprise for facilitating environmental sustainability. The model comprises of awareness of consequences, ascription of responsibility, personal norm and personal values as variables that influences intention to adopt Green IS. Survey was also employed to collect data (146 valid samples) that were analysed using Partial Least Squares (PLS)-Structural Equation Modeling (SEM). The limitation of their study is attributed to the endogeneity of the data based on the fact that the data was collected at a single point in time. Additionally, the research mainly considers the environmental dimension of sustainability, economic and social dimension were not fully explored.

Sahu and Singh (2016) examined the critical drivers for successful adoption and implementation of Green IS implementations in organizations. The authors carried out literature review to identify the drivers and suggested using cases study of two Indian banks to validate the drivers. The authors attempted to show an interrelationship among the identified nineteen drivers presented in a designed model. The identified nineteen variables includes leaders obligation, environment changes, industry's vision and strategy, resource allocation, expert selection, communication, conflicts resolution, standards adoption, human resource induction and training, efficient organization

structure, cost-benefit analysis, inspection/audits, financial support, technological advancement, system integration, rivalry pressure, awareness and lastly government policies. Furthermore, the authors integrated interpretive structural modelling to design the model based on academicians and IT expert's opinion. The authors claimed to adopt case study of two banking firms, however no insights regarding Green IS implementation in the banks was presented in their study.

Deng and Ji (2015) researched on enterprise Green IT adoption and presented a framework on enterprise Green IT adoption. For researchers, the study offers a broad review of previous Green IT adoption studies and a medium for future research. For practitioners, the study offers policy makers and managers a systematic investigative framework in controlling their business decisions. The framework drivers comprise of external drivers which included technological context (relative advantage, technological complexity, technological compatibility) and institutional pressure (coercive pressure, mimetic pressure and normative pressure) and internal motivations (top management support, Greening of organizational culture and strategic intent). The mediating variable is organizational Green IT adoption and sustainable competitive advantage as dependent variable. However, the research focused only on management in the organization. Practitioners in the enterprise are not considered in the research, besides the authors did not fully consider the technology and systems driver.

Ainin et al. (2015) studied the impact of Green IT practice adoption in enterprise performance and investigated the issues that affect the adoption intensity of Green IT practices across Iran in relation to enterprise's performance. The researchers developed a research model drivers comprises of institutional pressure, consideration of future consequences and openness as independent variables and adoption of Green IT practices as dependent variable, where the industry type and size of the enterprise are the control variables. Data was collected using questionnaire and analysed using SEM-AMOS. The study further investigated a large number of common Green IT practices across variety of industries hence the researchers did not focus on a particular industry type. Molla and Cooper (2014) researched on Greening enterprise data centres by considering institutional drives; data centers best practices, expectancy, motives and ability as variables. The authors utilized survey to collect data from 96 useable samples from enterprise data centres based in Australia. Where, data centers best practice is a

formative variable the other are reflective variables. The data were analysed using SPSS and Smart PLS tools. The sample was from Australia; also the authors did not have enough samples (only 96 samples) to test differences between these two groups. In addition, they did not examine the effect of control variables such as enterprise sector, age of respondents and size of the enterprise among the surveyed data centres.

Zheng (2014) researched on the adoption of Green ITIS based on proof from corporate social responsibility to research into the role of business strategy in Green ITIS adoption. Based on the technology organization environment framework, the authors proposed a Green ITIS adoption model with the elements of business strategy, and three aspects of Green motivations under the instruction of corporate social responsibility theoretic perspective. The model drivers comprises of organization, business strategy, technology and environment as independent variable and Green ITIS adoption intention as dependent variable, proposed using survey to validate the model in future. However, the authors did not consider the variables which influence Green ITIS adoption decision in enterprise.

Molla et al. (2014) examined how Green IT attitude and beliefs influence the pro-environmental behaviour of IT professionals and developed a research framework grounded on belief-action-outcome approach. The framework comprises of organizational context, information acquisition capability, Green IT belief, Green IT attitude, pro-environmental IT practice and demographic characteristics (gender, age and education). Data were collected from a sample of 322 IT professionals and analysed using SEM to validate the framework. Their study contributed to the formation of IT professionals' ecological beliefs and also evaluated the association between IT practices and ecological sustainability among IT professionals. However, data from their research was limited to Australian participants and the dimension of IT-specific ecological practices was not thorough.

Ijab and Molla (2012) studied on Green IS from the theory of practice viewpoint aimed at understanding how Green IS surfaces and also created a description of IS in enterprise to develop, deploy, use and integrate for sustainability. The researchers then investigated how Green IS strategies become recurring and what sustainability results to. They developed a conceptual framework which included top management, environmental steward, IS manager and professionals as independent variables and

Green IS practices (pollution prevention practice, product stewardship practice and sustainable development practice) as dependent variable, however no empirical data was stated. Erek et al. (2012) presented a research outline in matrix format that shows potential fields of action towards address social, economic and environmental pillars of sustainability to be integrated into established enterprise practices. The model comprises of govern, make, source and deliver. The model also serves as a foundation for holistic implementation of sustainability management in IT based organizations as an evaluating tool for potential Green measures along explicit value chain phases and managerial levels. However, no empirical data was presented by the authors to validate the model.

Loeser et al. (2012) conducted an exploratory case study research of four organizations from different industries and developed a typology of Green IS implementation strategies. The researchers provided insights which were compared with current literature in which findings from the case study was summarized in to five propositions that states the features of Green IS strategies. The presented propositions direct the implementation of Green IS strategies for innovation, efficiency, credibility and transformation. Although, the researchers conducted a comprehensive explanatory study, the study is only centered on conceptualized Green IS strategy for organizational perspective towards reducing environmental effects, other pertinent driver are not explored.

Jenkin et al. (2011) presented an agenda for Green IT/IS research by developing a multilevel research framework aimed at guiding upcoming research in Green ITIS domain. The authors aimed to resolve environmental sustainability in environmental psychology, social marketing and management domains. The developed research framework drivers comprises of environmental sustainability motivating forces, environmental sustainability initiatives (Green IT/IS strategies and Green IT/IS), overall environmental orientation of organization and employee (environmental cognitions, environmental attitude, environmental behaviour and environmental impacts). No empirical data was stated. However, the researchers proposed a set of prepositions and a more in-depth validation of the framework was not carried out. Widjaja et al. (2011) provided an initial insight into Green IT awareness among IT professionals in Indonesian and showed an association between awareness levels and attitude of other

countries. Data was collected from 105 IT professionals from a sample of over 1000 professionals of different industries. Their research comprises of IT's impact on environment, Green IT knowledge, IT professional's role in Green IT, Green IT practice, Green IT commitment, action to Green IT, Green IT governance and personal commitment as variables.

SPSS Anova test was used to analyse the data based on respondents' age, gender, education and occupation, reliability and validity test was carried out on the variables. The limitation of their study attributes the fact that they collected data from 2008 till 2010 from Indonesia industries only. Based on the reviewed 14 studies it is imperative that research on Green IT/IS offers opportunity for CE to act proactively in terms of sustainability. Thus, Green IT/IS practice implementation is a plausible attempt for CE to resolve the current environmental issues, and can also enhance the economic performance of enterprise. Therefore, IT practitioner's implementing Green IT/IS practices can lead to economic, social and environmental benefits to CE as well as to humanity.

The reviewed studies (see Table 2.3) mainly investigated independent variables that influence Green IT/IS practice in organizations. However, none of this studied incorporated the Green IT/IS practice in their models or frameworks. In addition, none of the reviewed studies narrowed down their research to collaborative enterprise domain. Similarly, none of the existing work investigated Green IT or Green IS practice in CE specifically. Likewise, none of the reviewed studies aimed at assessing the current Green IT/IS practice implemented by IT practitioners in CE based on independent variables and/or Green IT/IS practices.

Therefore, there is need for a study that considers the independent variables that is needed to examine how the independent variables or factors influences CE towards implementing Green IT/IS practice as well as the Green IT/IS practice to be implemented for sustainability attainment in CE. To this end, it is requried to further develop a Green IT/IS assessment model to promote sustainability attainment in CE. Besides, Table 2.3 clusters the derived independent variables (IT practitioners, IT governance, technologies and systems, motivating forces, IT strategy and information availability) as seen in the last row in Table 2.3. Thus, each of the independent variables is further discussed in Section 2.6.2.

2.6.1 Green IT/IS Practice in Collaborative Enterprise

Green IT/IS practices in CE is implemented by deploying several initiatives, thus it is important to identify these practices. Also, with reference to the first part of the first research objective mentioned in Section 1.6; to identify the Green IT/IS practice to be implemented in CE. The practices were derived from prior studies by (Molla et al., 2008; Murugesan, 2008; Jia and Bai, 2009; Ijab et al., 2010; Ninlawan et al., 2010; Seidel et al., 2010; Nathalia et al., 2011; Pichetpongsa and Campeanu, 2011; Lai et al., 2012; Raza et al., 2012; Dick et al., 2013; Sarkis et al., 2013; Krishnadas and Radhakrishna, 2014; Saha, 2014; Sharma and Jain, 2015). Thus, Figure 2.5 shows the Green IT/IS practice to be implemented in CE for sustainability attainment.

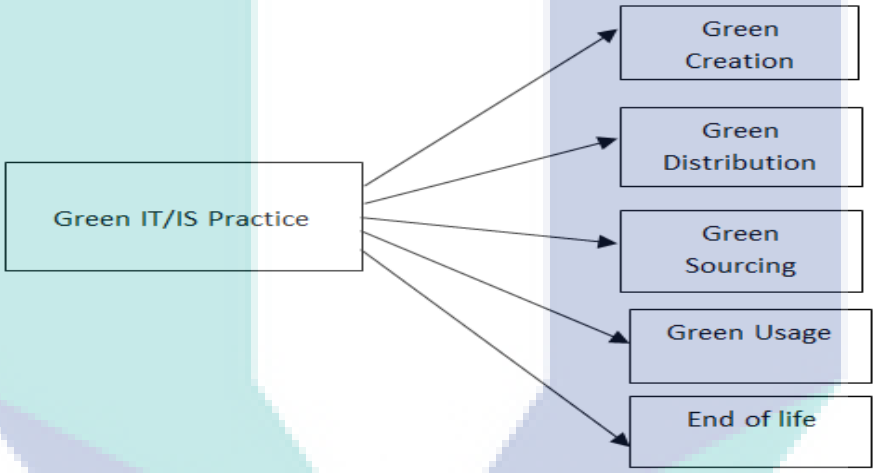


Figure 2.5 Green IT/IS practice implementation in CE
Source: Murugesan (2008); Molla and Cooper (2010); Sharma and Jain (2015).

As seen in Figure 2.5, the Green IT/IS practice implemented in CE comprises of Green creation, Green distribution, Green sourcing, Green usage and end of life as discussed briefly;

2.6.1.1 Green Creation

From a design viewpoint, Green creation refers to the role of IT in supporting enterprise's sustainability initiatives (Raza et al., 2012). Green creation is implemented when IT practitioners utilizes analytical information systems for organizational process, environmental management (Ninlawan et al., 2010) and carbon foot print analysis in design and production activities (Sarkis et al., 2013). It also comprises IT based low CO_2 enterprise solutions such as telecommuting, IP telephony, thin client, web based

business services, videoconferencing and virtual collaboration (Krishnadas and Radhakrishna, 2014).

2.6.1.2 Green Distribution

This practice involves deploying systems with automated components, computers (Molla and Cooper, 2010; Saha, 2014), and other auxiliary subsystems with limited impact to the environment (Pichetpongsa and Campeanu, 2011). This practice also emboldens operative process and increases the reutilization and reuse proportion of developed products (Chen and Kazman, 2012; Nadinastiti and Kridanto, 2014). Moreover, this practice entails sterile delivery systems to encourage minimal unwanted materialization (Molla and Abareshi, 2011; Sharma and Jain, 2015), which increases the competence of enterprise, thereby lowering resource consumption (Molla, 2013; Chou, 2013; Mohankumar and Anand, 2015).

2.6.1.3 Green Sourcing

This practice encourage environmentally preferable IT infrastructure purchasing in enterprise (Molla and Cooper, 2010). This involves eco-friendly sourcing practices such as analysis of environmental foot print of IT hardware, evaluation of Green track record of software application and IT/IS services providers (Ijab et al., 2010), integrating Green issues such as recyclable design (Molla, 2009a) and packaging in merchant evaluation, and inclusion of social concerns such as the presence of harmful materials in IT operations as well as in Green procurement decisions (Lai et al., 2012).

2.6.1.4 Green Usage

From a usage perspective, this practice involves enhancing energy efficiency in powering and cooling enterprise IT assets and reducing IT induced CO_2 emissions (Jia and Bai, 2009; Ninlawan et al., 2010; Dick et al., 2013). This practice aims to bring about energy consumption reduction (Murugesan, 2008; Seidel et al., 2010; Saha, 2014) by optimizing of energy utilization without reducing the installed power base (Pichetpongsa and Campeanu, 2011; Ijab and Molla, 2012; Sharma and Jain, 2015), structural avoidance results in reduction installed power capacity (Raza et al., 2012; Sarkis et al., 2013; Krishnadas and Radhakrishna, 2014; Mishra et al., 2014).

2.6.1.5 End of Life

From disposal or end of life perspective, this practice refers to initiatives which involves refurbishing (Molla et al., 2008; Dick et al., 2013), recycling, reusing (Jia and Bai, 2009; Ijab et al., 2010; Molla and Cooper, 2010) and disposing IT hardware in an ethical eco-friendly manner (Nathalia et al., 2011; Lai et al., 2012).

As discussed, Green IT/IS practice comprises of Green creation, Green distribution, Green sourcing, Green usage and end of life. Each of the Green IT/IS practice initiatives are implemented to achieve social, environmental and economic goals of sustainability in CE as shown in Table 2.4.

Table 2.4 Green IT/IS practice matrix for sustainability attainment in CE

Green IT/IS Practice	General objectives	Environmental	Social	Economic
Green creation	-Minimize material input. -Maximize finished output. -Control pollution risks. -Comply with institutions standards. -Lessen CO_2 emission. -Implement continuous training to staffs on sustainability.	-Decrease CO_2 emission and waste. -Deploy proficient production technologies. -Minimizing hazardous substances. -Go for products that lessen the impact of environmental degradation. -Deploy commuting to decrease CO_2 emission.	-Utilize knowledge management tools -Implement lasting standards. -Development of environmental friendly software. -Carryout Green training and education among practitioners. -Use power management systems.	-Utilize cloud computing and virtualization to reduce hardware cost. -Utilize grid computing for lesser energy cost. -Install thin clients and use natural cooling to decrease energy cost. -Lessen the use of consumable supplies
Green distribution	-Use clean renewable natural energy like solar. - Deploy efficient UPS and transformers. -Substitute laptop for computers. -Reduce energy by Green electricity providers if available. -Use proficient stand by power system.	-Deploy autonomous switches. -Conduct environmental impact analysis for each alternative to be implemented in the institution. -Use materials that are bio-degradable with high degrees of biodegradation. -Use e-forms to reduce paper usage.	-Lessen and monitor CO_2 footprint. -Use video conferencing and telecommuting. -Install energy proficient communication servers. -Carryout maintenance to extend IT hardware infrastructure life.	-Practice double side printing. -Switch off computers services when not in use. -Install energy proficient light. -Utilize collaborative online tools. -Reduce water usage and implement rain water harvesting.

Table 2.4 Continued.

Green IT/IS Practice	General objectives	Environmental	Social	Economic
Green sourcing	-Purchase IT infrastructure with Green label only. -Create lasting incentive systems. -Make preference for IT merchants that have a Green track record.	-Think of the environment when making purchases. -Check for ISO 9001, 14001. -Purchase product having the environmental labels.	-Recruiting Green practitioners. -Comply with social standards. -Patronize certified vendors. -Purchase IT infrastructure only when needed.	-Check for eco-labels such as Energy Star. -Procure computer related facilities with easy repair, upgrading and trouble-free to extend product life cycle.
Green Usage	-Underline commitment of management. -Carryout standardized Green reporting. -Cooperate with stakeholder in the institutions. -Configure and set PCs to sleep mode or energy saving when not in use.	-Carryout environmental marketing. -Comply with environmental guidelines from external associations such as Greenpeace. -Test, monitor and track energy usage within the institution. -Deploy energy proficient services.	-Implement Green IT documentation report. -Carryout customer relationship management training. -Create lasting incentive systems by minimizing hazardous substances. -Implement systems to measure the amount of energy utilized.	-Provides Green IT incentives. -Provide financial reimbursement for staffs who implement Green IT initiatives. -Deploy durable, flexible systems and services for long-term use.
End of Life	-Implement ethical waste disposal. -Keep track of toxic materials generated from institutional process. -Reuse, recycle and refurbish resources if possible. -Integrate reuse, refurbish, reduce and recycle computer and equipment to reduce waste.	-Recycles equipment such as batteries ink, paper and cartridges. - Safe disposal of waste. -Support take back and recycling initiatives. -Take legacy or out dated systems offline after successful upgrading or installation of new systems. -Reuse out-dated computer hardware.	-Refurbish old computers hardware. -Disposes of electronic wastes in an environmentally friendly manner. -Donate old computers to charitable organizations. -Utilize products that are safe to use and products that contains a reduced amount of toxic or non-toxic.	- Reuse of IT infrastructure. -Adhere to ecological regulations on dumping electronic waste. -Practice electronic waste management. -System should be transferable so that it can be used by other users after disposal by former owners.

Table 2.4 shows the Green IT/IS practice matrix for sustainability attainment in CE highlighting how these organizations can minimize the negative impacts of IT

infrastructure operations on environment and maximizing energy efficiency during the product life cycle of IT deployment. Likewise, CE can promote sustainability by concurrently implementing the Green IT/IS practice initiatives presented in Table 2.4.

2.6.2 Independent Variables (IV) that Influences Green IT/IS Practice in CE

Findings from Table 2.3 shows the variables have been suggested by different researchers in their models or framework. Accordingly, this section provides answer to the second part of the first research objective; which aims to identify the independent variables that influences Green IT/IS practice in CE (see Section 1.4). The identified independent variables were derived by reviewing existing related research (see Table 2.3). The derived independent variables based on findings from Table 2.3 are shown in Figure 2.6. Hence, in Table 2.3 the independent variables that are similar are clustered together and separate independent variables are isolated and also cross-checked with variables presented by prior Green IT/IS studies as discussed in Section 2.6.

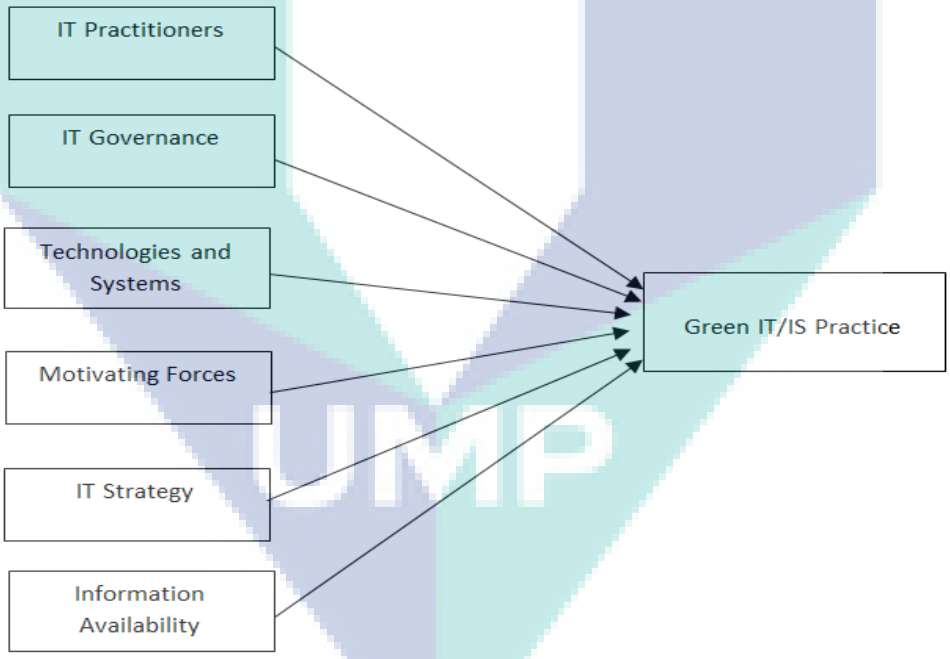


Figure 2.6 Independent variables that influences Green IT/IS practice in CE

Figure 2.6 shows the independent variables that influences Green IT/IS practice in CE, where the independent variables is the input or the case of an action in relation to Green IT/IS practices in CE. The independent variables that were identified from the literature include; IT practitioners, IT governance, technologies and systems, motivating forces, IT strategy and information availability. Hence, each of the independent variables is described;

2.6.2.1 IT Practitioners

These are employees in CE (IT professionals, environmental staffs and IT staffs) (Mangla et al., 2015). The employees' commitment is mandatory in enterprise for planning, deploying, validating and maintaining enterprise system with sustainability considerations in mind (Karanasios et al., 2010; Esfahani et al., 2015b). Thus, the practitioners' cooperation is based on their shared interest and stakes in fulfilling the objectives or requirements of the enterprise (Mishra et al., 2014). This can be seen as part of the environmental ethics/stewards in the enterprise (Akman and Mishra, 2014; Deng and Ji, 2015).

2.6.2.2 IT Governance

In implementing Green IT/IS practices, the management is able to redesign how employees in CE advancing their future sustainability goals, especially those facilitated by information systems (Zheng, 2014; Butler, 2011b). The management works together with the employees to realize social, economic and environmental as well as the aims of the enterprise (Savita et al., 2014; Mangla et al., 2015; Esfahani et al., 2015a). The management must provide training successions and campaigns to inform employees on how techniques such as telematics can improve Green IT/IS and why commitment of management (IT manager) is essential in implementing Green IT/IS (Esfahani et al., 2015b; Deng and Ji, 2015; Uddin at al., 2015). Therefore, this independent variable determines the rules and regulation initiated by IT managers in ensuring that the staffs in the enterprise implements Green IT/IS practices in organizational process (McGibbon and Van Belle, 2013; Penzenstadler, 2014).

2.6.2.3 Technologies and Systems

This independent variable mostly defines the features of technology which would affect Green IT/IS practice (Karanasios et al., 2010). Therefore, technology and systems refers to infrastructure that enable Green IT/IS related operations (McGibbon and Van Belle, 2013; Akman and Mishra, 2014), these technology and systems are utilized by IT practitioners who possesses the knowledge and skills to implement Green IT/IS practices in CE (Mishra et al., 2014; Deng and Ji, 2015).

2.6.2.4 Motivating Forces

This independent variable comprises of internal and external pressure that controls how CE conducts business in relation to Green IT/IS practice based on standard set mostly by government or industries (Howard and Lubbe, 2012; Jenkin et al., 2011). These standards and regulation are dedicated to sustain external groups and usually include responding to pressure from government, regulatory bodies, and internal pressure within the enterprise (Karanasios et al., 2010; Ainin et al., 2015; Krishnadas and Radhakrishna, 2014). Furthermore, these regulations refer to additional measures targeting long term sustainability, by avoiding fines and penalties and also conserving the environment (Savita et al., 2014; Mangla et al., 2015; Esfahani et al., 2015b).

Government regulation and policies are put in place to ensure IT practitioners respond to environmental issues and incorporate it into their business strategy (Jenkin et al., 2011; Mishra et al., 2014), which is usually required, but also in the form of guidelines. Government regulations may apply to the state, the entire territory, or district-wide (Deng and Ji, 2015). Moreover, another type of standard is the industry based standard which includes compulsory formal rules (Jenkin et al., 2011).

2.6.2.5 IT Strategy

This independent variable mainly involves description of CE in terms of organization scope, size and management structure (Karanasios et al., 2010; Jenkin et al., 2011). Furthermore, IT strategy describes how CE implements their business plans (Molla et al., 2008; Gholami et al., 2013). In addition, IT strategy also aims to support CE in reducing operating costs in organizational day-to-day process (Ainin et al., 2015; Deng and Ji, 2015). Besides, IT strategy is the most prominent motivators of Green IT/IS and it aims to reduce carbon emissions by achieving sustainability in CE (McGibbon and Van Belle, 2013; Krishnadas and Radhakrishna, 2014; Savita et al., 2014; Mangla et al., 2015).

2.6.2.6 Information Availability

According to Boudreau et al. (2008) the need for information by IT practitioners has leads them to seek systems that provide ubiquity such as the usage of laptop to communicate with other practitioners, uniqueness such as navigation systems to

transport developed software products/services to end users. Unison, which is involved when team members uses synchronized schedule, and lastly universality which involves services that has high functionality such as smart phones that provide practitioners with the latest Green information relating to the natural environment, global warming and climatic changes (Watson et al., 2011). Considering these four information drivers is a key component in creating sustainable CE (Butler, 2011a). In addition, Hasan et al. (2012) stated that information dissemination can assist to reduce energy consumption, which is one of the aims of CE as there is a clear cost saving that comes with the use of less energy. Accordingly, Table 2.5 shows the independent variable and their related attributes derived from prior Green IT/IS studies.

Table 2.5 Independent variables and associated attributes

Independent Variables	Attributes
IT Practitioners	Attitude- This is the degree to which an individual assesses behaviour as un-favourable (Molla et al., 2014). With reference to sustainability, attitude reflects IT practitioner's evaluative judgment about the current process implemented in the enterprise, whether the current practice is either harmful or beneficial to the environment. Thus, a positive attitude is necessary for Green IT/IS practice to be successful (Akman and Mishra, 2014). Ethics- This is the moral principles that direct IT practitioner's behaviour in implementing Green IT/IS practices. It mostly deals with the norms and principles (Mangla et al., 2015). Social-culture- Involves IT practitioners' customs, practices and behaviour that exist within an organizational process. It is the way in which IT practitioners work daily. This is based on the enterprise Green life style (Esfahani et al., 2015b). Capabilities- This is the ability of IT practitioners to implement Green IT/IS practices efficiently or successfully (Deng and Ji, 2015). It is influenced by the physical tangible and feasible in-tangible infrastructures and assets that represent management ability to deploy and co-ordinate resources to implement Green IT/IS practices (Akman and Mishra, 2014). Beliefs- Refers to an enduring group of perceptions and cognition about the concept of Green IT/IS and enterprise sustainability (Molla et al., 2014; Mishra et al., 2014). Knowledge- Knowledge is hold by IT practitioners and it is required for the utilization of physical resources within enterprise (Akman and Mishra, 2014; Negulescu and Doval, 2014). Hence, knowledge is an asset such as information, knowledge can be seen as capabilities which include the understandings, insights and applied know how of IT practitioners in the enterprise (Molla et al., 2014). Experience- The skill acquired over a period of practical experience can influence IT practitioners to implement Green IT/IS practices, because the experienced IT practitioners are more open to new ideas (Mishra et al., 2014). Commitment- This is the quality or state of IT practitioners being dedicated to the Green IT/IS practice implementation (Karanasios et al., 2010).

Table 2.5 Continued.

Independent Variables	Attributes
IT Governance	Policy- Refer to Green IT/IS principle or course of action proposed by managerial board in CE (Molla et al., 2008; Howard and Lubbe, 2012). Policy includes guidelines, general requirements and principles in the enterprise (Jenkin et al., 2011; Karanasios et al., 2010). Leadership- This is management action of directing and leading all staffs in an organization to implement Green IT/IS practice (Ainin et al., 2015; Molla, 2009a). Structure- How and who are involved in the management board can also determine if they will encourage Green IT/IS practice (Seidel et al., 2010; Chen et al., 2011). Financial consideration- This is the amount management is willing to invest into Green IT/IS practice (Vykoukal et al. 2011; Zheng, 2014; Butler, 2011b; Esfahani et al., 2015a). Financial consideration also includes cost saving, budget, economics, low cost (McGibbon and Van Belle, 2013; Deng and Ji, 2015; Mishra et al., 2014).
Technologies and Systems	Hardware- This attributes comprises wiring, machines, and other physical infrastructure, components of a computer or other electronic facilities that are deployed and utilized to implement Green IT/IS practice (Karanasios et al., 2010). Software- These are the computer applications and other systems applications used by IT practitioners in CE (McGibbon and Van Belle, 2013). Database- Includes layers of structured set of data retained in a computer, and can be accessible in various methods such as enterprise data centers when Green IT/IS practices can be stored and reused (Deng and Ji, 2015). Network communication- These are the network that enables network operations, management, and communication connectivity of IT practitioners when they utilize the enterprise network system for carrying out business process (Mishra et al., 2014). Server storage- This is the server that is used to store, access, secure and manage digital data. Enterprise used such servers for accessing and storing Green data through the internet and over shared network (Akman and Mishra, 2014).
Information Availability	Ubiquity (communicate, exchange) - This is the usage of information to communicate and to have access to information unconstrained. According to Boudreau et al. (2008) the need for information by IT practitioners leads them to seek IS that offers ubiquity such as the usage of systems for communication (Boudreau et al., 2008; Chen et al., 2008). Uniqueness (processing) - This comprises precise and unique information (Melville, 2010). Uniqueness involves application such as Enterprise Resource Planning (ERP) systems to manage the transportation of developed products/services to end users/ consumers (Huang, 2009; Pitt et al., 2011) Unison (transfer, flexibility) – Refers to dissemination of the same information across CE, hence unison relates to CE having consistent information. Furthermore, in unison, all IT practitioners involved in a project use same schedule information (Watson et al., 2011; Butler, 2011a; Hasan et al., 2012). Universality (sharing, access) - Universality involves services that have more functionality such as systems that provide IT practitioners with the latest Green IT/IS information relating to the environment and climate (Howard and Lubbe, 2012; Meacham et al., 2013).This involves latest information with more functionality and incompatibilities reduction across CE business process (Abareshi and Molla, 2013).

Table 2.5 Continued.

Independent Variables	Attributes
Motivating Forces	Coercive pressure- Refers to pressure chastised in societal dependencies and expectations towards other enterprise (Howard and Lubbe, 2012; Jenkin et al., 2011). Also, various industry regulations and government exert coercive pressure on CE that influence the implementation of Green IT/IS (Ainin et al., 2015). Hence, Gholami et al. (2013); Molla and Cooper (2014); McGibbon and Van Belle (2015) mentioned that coercive pressure from government, regulatory body encourage enterprise to deploy Green IT/IS practices. Mimetic pressure- This is the pressure to imitate operationally similar successful CE in the same business area without necessarily considering the enterprise context (Savita et al., 2014; Mangla et al., 2015). Mimetic pressure is supposed to certainly impact the intention of CE to implement Green IT/IS practices (Esfahani et al., 2015b; Deng and Ji, 2015). Normative pressure- This pressure arises from the interchange of best practices among practitioners across different enterprise. Normative pressure is pressure within the enterprise (Akman and Mishra, 2014). It is derived when the management induces IT practitioners to implement Green IT/IS practices. Molla (2013); Chun and Ngai (2013); McGibbon and Van Belle (2013) mentioned that normative pressure influence Green IT/IS. Incentives- refers to financial supports provided by enterprise as rewards for their organizational staffs for implementing Green IT/IS practices. This can encourage IT practitioners to implement Green IT/IS initiates. Presently Government of some countries such as Australia, New Zealand, USA, European Union, etc. provides incentives and reimburse CE that implement Green IT/IS practices (Krishnadas and Radhakrishna, 2014). Future consequences- If the consequence of future action is observed as harmful, a sense of guilt will surface because the attribution of harmful consequence that will occur in future (Jenkin et al., 2011). This can influence IT practitioners to positively changing their attitudes towards Green IT/IS practice implementation (Molla et al., 2014).
IT Strategies	Initiatives- This is the current practice, act or scheme employed by IT practitioners (Jenkin et al., 2011; Karanasios et al., 2010; Ainin et al., 2015). Hence, the initiatives employed by the enterprise will influence Green IT/IS practice (Molla et al., 2008; Dolci et al., 2015). Procedure- This is the present method of carrying out enterprise process (Gholami et al., 2013; Esfahani et al., 2015b). Thus, the current procedure can influence CE Green IT/IS practices implementation (McGibbon and Van Belle, 2013). Routine and Services- These are sequence of actions regularly implemented in CE (Deng and Ji, 2015; McGibbon and Van Belle, 2013). These routines also affect CE implementing Green IT/IS practices into their business process (Savita et al., 2014). Moreover, the specific amount of services offered to the general public by the enterprise will determine if they can implement Green IT/IS practice or not (Akman and Mishra, 2014). Regulatory market- This is the market where the government controls the determinants of demand and supply (Negulescu and Doval, 2014; Uddin at al., 2015), such as who is allowed to purchase from the market, and/or what amounts may be charged (Mangla et al., 2015). Thus, these market forces can affect enterprise going Green (Penzenstadler, 2014).

2.6.3 Control Variables (CV)

These are variables that constantly describe the characteristics of CE. The Control Variables (CV) identified from the literature as described below.

2.6.3.1 Enterprise Size

Enterprise size may affect strategic resources, which strongly correlate to enterprise performance (Esfahani et al., 2015b; Cheng and Ma, 2015). Thus, the present study includes enterprise size and measures based on enterprise's total assets (Vykoukal et al., 2011; Mangla et al., 2015). According to Ainin et al. (2015) Green IT/IS practice differs according to the size of the enterprise. Smaller firms have a less sophisticated understanding of technical IT issues while larger firms are usually in possession of more technology, finance and human resources (Luan et al., 2016; Lintukangas et al., 2014; Ainin et al., 2015; Molla and Abareshi, 2011). However, larger enterprises are also disadvantaged as they tend to be less agile and flexible than smaller enterprise (Negulescu and Doval, 2014). In contrast, smaller enterprise are expected to be more innovative, as they require less communication, less coordination and less external influence to make decisions (Schmidt and Kolbe, 2011).

2.6.3.2 Enterprise Sector

Enterprise in different industry sectors may perform differently in terms of Green IT/IS practice (Savita et al., 2014; Ainin et al., 2015 Mangla et al., 2015; Esfahani et al., 2015b). As enterprise in different industry sectors have dissimilar needs, it appears that those in more information intensive sectors are more likely to implement Green IT/IS practices than those in less IT intensive sectors (Luan et al., 2016; Lintukangas et al., 2014; Chen et al., 2011). Hence, CE such as customer service industries such as banking, airlines, courier services, etc. which tend to have more information content in their operations are more likely to utilize Green IT/IS for competitive advantage than those in manufacturing or engineering sector (Molla and Abareshi, 2011, Kotze et al., 2014; Krishnadas and Radhakrishna, 2014).

2.6.3.3 Timing

The time an enterprise was established may affect its intention to implement Green IT/IS practice (Luan et al., 2016; Vykoukal et al., 2011). Hence, timing is

considered as a control variable to identify if the time an enterprise was established will influence Green IT/IS practices (Mangla et al., 2015; Esfahani et al., 2015b). Thus, an enterprise which was established in the year 2010 may be more interested in Green IT/IS practices than a different enterprise that was founded in 2016 (Cheng and Ma, 2015; Negulescu and Doval, 2014).

2.6.3.4 Revenue

This variable was first mentioned by Chen et al. (2011) as a control variable in their research stating that enterprise with sufficient financial resources are able to experiment with new practices and cope with implementation failures. Hence, the revenue or profit acquired by an enterprise over a period of time (annually) may influence if the enterprise implement Green IT/IS practice. This variable was also stated by Schmidt and Kolbe (2011); Loeser et al. (2013); Zheng (2014) in their study where all researchers highlighted that revenue incurred over a period of time is a factor that influences enterprise decision to utilize new inventions.

Therefore, the CV derived from the literatures as described in Section 2.6.3.1 to 2.6.3.4 comprises of timing, sector, size and revenue of the enterprise.

2.6.4 Moderating Variables (M)

The Moderating Variable (M) is a variable that regulate certain independent variables. The moderating variables are derived based on previous research on Green IT/IS practice by Molla et al. (2009b); Molla et al. (2014); Mishra et al. (2014); Dalvi-Esfahani and Rahman (2016). These moderating are critical in understanding how IT practitioners and IT managers make decisions about implementing Green IT/IS practices. The moderating or socio-demographic variables are discussed below.

2.6.4.1 Gender

The relationship between gender of IT practitioners and IT manager in regards to the implementation of Green IT/IS practice has produced mixed results. For example, Molla et al. (2014); Mishra et al. (2014) reported that a person's gender does predict Green attitude. Furthermore, gender differences have been found not to have an influence on practitioners implementing Green practices in their enterprise. However,

other research has detected significant differences in environmentally responsible behaviour because of gender differences.

Furthermore, Molla et al. (2009b) reported that women have more favourable attitudes toward the environment and recycling and were more likely to engage in environmentally friendly and recycling behaviour than men. In addition, Dalvi-Esfahani and Rahman (2016) indicated that men pay significantly less attention to Greenhouse gas (GHG) reduction activities than women. Besides, Molla et al. (2009b) mentioned that women are also more likely to characterize global climate change as the most important environmental issue than men.

2.6.4.2 Age

A number of researchers have explored the relationship between age and attitudes and behaviour toward Green practices implement in enterprise. Some have reported significant association between age and environmental attitudes and behaviour (Molla et al., 2009a; Mishra et al., 2014). Awareness of environmental issues is higher and more stable among people aged 55-60 years, those aged 25-35 years have strong but unstable concern, and middle-aged citizens manifest a stable subset of concerns for the environment (Molla et al., 2014). Moreover, researchers such as Dalvi-Esfahani and Rahman (2015) believed that as the age of individuals increases, their engagement with "reduce, reuse, and recycle" activities increases, however others have found a significant and negative association between age and practitioners going Green.

2.6.4.3 Education

A few studies have investigated the influence of education on Green IT/IS practice. However, the findings are inconclusive. Some found negative association between the educational levels of IT practitioners in relation to Green IT/IS practice. Researchers such as Molla et al. (2009b); Molla et al. (2014) found significant positive relationships between education level and Green IT/IS practice implementation by IT professionals. Furthermore, other researchers such as Mishra et al. (2014); Dalvi-Esfahani and Rahman (2016) reported that the education status of IT practitioners is a moderating variable that determines if IT practitioners will decide to implement Green IT/IS practice.

The moderating or socio-demographic variables identified from the literature as discussed in Section 2.6.4.1 to 2.6.4.3 comprises of include age, gender and education.

2.6.5 Dependent Variable (DV)

The dependent variable is the output or the effect of independent variables in CE implementing Green IT/IS practices. The dependent variable is influenced by the independent variables and at times the control variables. Thus, dependent variable depends on independent variables, while independent variables influence dependent variable. Based on the aim of this thesis which is "to develop a Green IT/IS assessment model", the dependent variable is Green IT/IS practice similar to prior studies (Dalvi-Esfahani et al., 2017b; Ainin et al., 2015; Zheng, 2014; Ijab and Molla, 2012; Jenkin et al., 2011) where either Green IT and Green IS practice was deployed as the dependent variable.

2.7 Existing Green Assessment Models

Assessment is mainly conducted to evaluate the knowledge, advancement and the skill of the participant to implement acquired knowledge to solve problems such as the implementation of Green IT/IS practice (Odeh and Meszaros, 2012). Assessment is thus an indispensable tool and can be utilized to test the learning capabilities and progress of IT practitioners Green IT/IS practices implementation (Shriberg, 2002; Alghamdi et al., 2017). At the moment, one of the main challenges confronting CE today is defining and achieving sustainability goals which includes identifying and developing Green IT/IS operational standards and best practices, and most significantly, assessing the current Green IT/IS practices against those best practices.

Over the decade, the trend towards Green IT/IS practices has infiltrated CE daily operations. But without an enterprise based accepted Green IT/IS assessment model, the burden of assessing Green IT/IS practice in CE lies with each individual enterprise, which has led to inconsistencies and an inability for comparison and assessment in CE (Odeh and Meszaros, 2012). Hence, a few Green assessment models has been developed by prior studies to measure the current Green IT and ICT practice implemented in enterprise as seen in Figure 2.7.

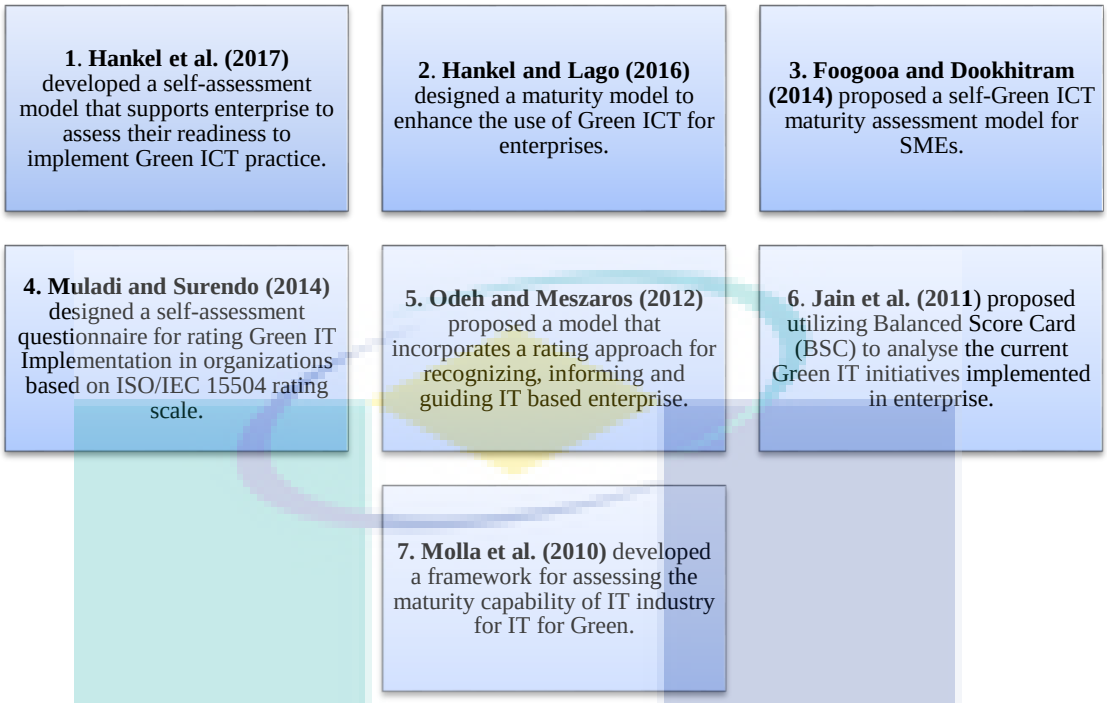


Figure 2.7 Prior Green assessment approaches

Figure 2.7 shows prior studies that have contributed in developing models or frameworks to assess Green IT or ICT practice in enterprises. One of such studies was Hankel et al. (2017) where the authors developed a self-assessment model that supports enterprise to assess their readiness to implement Green ICT by considering attitude, policy, practice, technology and governance as independent variables that influences Green ICT adoption. However, the authors did not consider the Green IT/IS practice to be implemented. Next, are Hankel and Lago (2016) who designed a maturity model to enhance the use of Green ICT for enterprises. The authors assumed that assessing the level of development of Green ICT promotes awareness and motivation.

Foogooa and Dookhitram (2014) proposed a self-Green ICT maturity assessment model for small and medium based enterprise which is simple, easily accessible and also efficient, besides the assessment questions were simply understood and the answers could be easily categorized. Moreover, for the self-assessment model to be functional there is need for a minimal ICT knowledge from the IT practitioners. Likewise, Muladi and Surendo (2014) designed a self-assessment questionnaire for rating Green IT Implementation in organizations based on ISO/IEC 15504 rating scale which consisted of strategy, technology, process and man as independent variables to be

measured. The limitation of their study is that the author did not consider any Green IT/IS practice.

Odeh and Meszaros (2012) proposed a model that incorporates a rating approach for recognizing, informing and guiding IT based enterprise toward sustainability attainment. Their rating model comprised of innovative recognition, economic security, environmental preservation and social responsibility. However, the authors' model is mostly concerned in rating sustainability drivers and not directly rating Green IT/IS practices in CE. Equally, Jain et al. (2011) proposed utilizing Balanced Score Card (BSC) to analyse the current Green IT initiatives implemented in enterprise aimed at achieving sustainability. The BSC aimed at translating enterprise's managerial goal into a set of sustainability performance procedures for Green IT evaluation success. However the study is more concerned with economic sustainability.

Molla et al. (2010) developed a framework for assessing the maturity capability of IT industry for IT for Green. The authors draw from the perspectives of enterprise capability and performance measurement in developing the assessment framework for analysing IT for Green capability of IT firms based on eco-innovation, eco-process, eco-portfolio, eco-marketing and eco-value which entail 52 performance indicators. Besides, Molla et al. (2010) presented indices values for different levels of maturity and further showed the application of the framework by surveying firms in the Australian IT sector. The framework used 5 point rating which comprises of Very Low (30-49), Basic (30-49), Average (50-69), Advanced (70-89), and Optimising (>= 90). The limitation of their study lies in the fact that the authors' only assessed the Green IT maturity and not the current Green IT practice. In addition, their assessment framework does not provide guidelines on how IT firms can improve their current Green IT practice.

Findings from Molla et al. (2010) indicated that IT firms in Australia are favourable adopting Green IT practice, but their capability to measure the current Green IT practice is relatively less developed. Likewise, Hankel et al. (2017) mentioned that in implementing Green ICT in Dutch education sector, ICT managers requested for a model that can;

- Provide a more comprehensive insight into Green ICT practice improvement.
- Make available knowledge about how well they are doing as compared to others enterprises.

- Establishment of a shared language for knowledge exchange between CE.
- Support ICT departments in CE by providing a way that guides IT practitioners on how they contribute towards attaining sustainability goals.

Based on the proceeding discussion, the reviewed seven studies are only concerned with assessing the independent variables that influenced Green IT or ICT practice. However, prior studies did not fully consider the Green IT/IS practices in their self-assessment models. In addition, the reviewed studies are concerned with either Green IT or Green ICT practice assessment in enterprise. Hence, there are fewer Green IS or Green IT/IS assessment models. A plausible explanation for this is that the literature on Green IS and Green IT/IS is still new and evolving. Consequently, due to the lack of an existing assessment model that is concerned with Green IT/IS practice and also the scarce research available on Green IT/IS practice assessment in CE there is need for a model that can provide an agenda on Green IT/IS practice and independent variables assessment for IT practitioners in CE.

The proposed model can further help in assessing Green IT/IS practice of CE, and also assist in providing an agenda for independent variables that influence Green IT/IS practice. Additionally, the Green IT/IS assessment model can also provide a set of guidelines for determining each Green IT/IS practice based on several indicators to assist IT practitioners in reviewing, managing and improving their sustainability performance as seen in Table 2.4. Furthermore, the Green IT/IS assessment model can help ascertain the progress being made with the development level reached and Green IT/IS practice to ensure that IT practitioners remains fully engaged with Green IT/IS practices.

2.8 Existing Frameworks, Model and Theories Applied in Green IT/IS Studies

Several frameworks, models and theories have been applied for Green IT and Green IS research to address sustainability issues in enterprise. Accordingly, Figure 2.8 shows the existing frameworks, models and theories that has been previously applied to facilitate Green IT/IS practice implementation in CE. Hence, Figure 2.8 presents a summary of the review of fourteen frameworks, models and theories identified that have been applied in prior studies. For each reviewed study, the theoretical basis, and core construct are derived from the literature and explained in Section 2.8.1 to 2.8.14.

1. Theory of Reasoned Action (TRA) (Sarkar and Young, 2009; Mishra et al., 2014).
2. Theory of Planned Behaviour (TPB) (Akman and Mishra, 2014; Dezdar, 2017).
3. Technology Acceptance Model (TAM) (Schmidt et al., 2010; Akman and Mishra, 2015).
4. Norm activation model (Lei and Ngai, 2014; Dalvi-Esfahani et al., 2017b).
5. Upper echelon theory (Dalvi-Esfahani et al., 2017a).
6. Resource Based View (RBV) (Rahim and Rahman, 2013; Simmonds and Bhattacherjee, 2014; Deng and Ji, 2015).
7. Natural Resource Based View (NRBV) (Chen et al., 2011; Rahim and Rahman, 2013).
8. Motivational theory (Molla, et al., 2009a; Bose and Luo, 2011; Molla and Abareshi, 2011; Molla and Abareshi, 2012).
9. Institutional theory (Sarkar and Young, 2009; Butler, 2011a; Chen et al., 2011; Lei and Ngai, 2012).
10. Technology-Organization-Environment (TOE) framework, (Molla, 2008; Bose and Luo, 2011; Nedbal et al., 2011; Cooper and Molla, 2014; Zheng, 2014).
11. Process-Virtualization-Theory (PVT) (Bose and Luo, 2011; Nedbal et al., 2011).
12. Diffusion of innovation Theory (DoI) (Schmidt et al., 2010; Bose and Luo, 2011; Nedbal et al., 2011; Cai, Chen and Bose, 2013).
13. Organizational information processing theory (Lei and Ngai, 2012).
14. Belief-Action-Outcome Framework (BAO) (Melville, 2010; Gholami et al., 2013; Molla et al., 2014; Recker, 2016; Loeser et al., 2017).

Figure 2.8 Frameworks, models and theories applied in prior Green IT/IS research

The frameworks, models and theories adapted by prior Green IT and Green IS studies are discussed below;

2.8.1 Theory of Reasoned Action (TRA)

The Theory of Reasoned Action (TRA) provides an important fundamental conceptual model for examining human behaviour (Ajzen and Fishbein, 1980). The aim of the TRA is to investigate the relationship between attitude and behaviour based on two major concepts: principles of compatibility and behavioural intention. The TRA model traditionally involves four constructs which includes attitude towards behaviour, subjective norms, behavioural intention, and actual behaviour. Additionally, the model

has been found successful in prior studies for predicting behaviours towards enterprise adopting Green IT (Sarkar and Young, 2009; Mishra et al., 2014).

2.8.2 Theory of Planned Behaviour (TPB)

Theory of Planned Behaviour (TPB) is a conceptual framework developed as an extension to the theory of reasoned action (Ajzen, 1991). Moreover, TPB is well established for human behaviour related studies and used to hypothesize the individuals' intention to perform the behaviour (Nchise, 2013). In addition, TPB constructs includes attitude towards behaviour, subjective norms, perceived behavioural control, intention to use, and behaviour. So, according to the TPB, IT practitioners are likely to engage in a Green IT/IS behaviour if they believe that the behaviour will lead to particular outcomes which they value (Smelser and Baltes, 2001). The theory of planned behaviour was adopted by Akman and Mishra (2014); Dezdar (2017) in their research on Green IT adoption.

2.8.3 Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM), was introduced by Davis in 1989 (Davis, 1989), and is adopted to understand and predict the process of user acceptance or adoption of information systems (Akman and Mishra, 2015). TAM establishes that the Perceived Ease-of-Use (PEU) and Perceived Usefulness (PU) can predict ones' attitude towards the use of a given technology. Then, the Attitude-Towards-Use (ATU) can, in turn, predict the behavioural intention to use and, finally, intention predicts the Actual Use (AU) of that technology (Davis, 1989). TAM also suggests that external factors influence intention and actual use through centric effects on perceived usefulness and perceived ease of use (Husin et al., 2017). TAM has previously been adopted by Schmidt et al. (2010); Akman and Mishra (2015) to explore Green IT acceptance.

2.8.4 Norm Activation Model (NAM)

Norm Activation Model (NAM) was developed by Schwartz (1974) in the context of human behaviour, was widely applied to study various kinds of pro-social behaviour (Dalvi-Esfahani et al., 2017b). NAM, is one of the most widely applied model in predicting individual pro-environmental behaviour, assumes that people's pro-

environmental or pro-social behaviours are driven by their personal norm, rather than the evaluation cost and benefit or personal affect (Schultz et. al. 2005). Moreover, NAM comprises of three constructs for exploring individuals' pro-social behaviour awareness of consequences, ascription of responsibility, and personal norms (Lei and Ngai, 2014). Accordingly, Lei and Ngai (2014); Dalvi-Esfahani et al. (2017b) adapted NAM to explain the formation of an organizational decision maker's intention to adopt Green IT in his/her organization.

2.8.5 Upper Echelon Theory

Upper Echelon Theory (UET) was proposed by Hambrick and Mason (1984) which is deeply rooted in the behavioural theory of an organization. In UET the values, psychological characteristics and demographic compositions of firms leaders are the most important actors within an organization an also account to understand better organizational outcome. The premise of UET is that organizational outcomes are directly influenced by the perceptions, values, and expertise of those individuals who occupy prominent managerial positions in the organization (Dalvi-Esfahani et al., 2017a). The underlying premise of UET is that executives interpret their strategic environment through their personal experiences, values, and personalities, and their strategic choices are made upon those backgrounds (Hambrick, 2007). This theory was adopted by Dalvi-Esfahani et al. (2017a) for modelling behavioural drivers of Green IT/IS adoption.

2.8.6 Resource Based View (RBV)

Resource Based View (RBV) was proposed by Wernerfelt (1984) to explain the competitive advantage of an enterprise. It suggests that an organization's competitiveness is based on its resources rather than products (Wade and Hulland, 2004). Firm resources can classified into three constructs namely physical capital resources, human capital resources and organizational capital resources (Barney, 1991). Applying RBV to IT adoption context has the potential for identifying variables towards competitive advantage (Wade and Hulland, 2004). Moreover, RBV becomes a useful tool to explain the potential of IT for Green competitive advantage. Therefore, RBV has been employed by Rahim and Rahman (2013); Simmonds and Bhattacherjee (2014); Deng and Ji (2015) in their research on Green IT and Green IS respectively.

2.8.7 Natural Resource Based View (NRBV)

Hart (1995) proposed the Natural Resource Based View (NRBV) by incorporating the natural environment into RBV. According to Hart (1995), there are three strategic constructs pollution prevention, product stewardship and sustainable development, each with an emphasis on well-defined environmental objectives. Inherently, Green IT adoption is consistent with the underlying assumption of NRBV. Through adopting Green IT, organizations can acquire environmentally-oriented resources and capability, which, in turn, are the potential sources of competitive advantage (Deng and Ji, 2015). The NRBV was previously adopted by Chen et al. (2011); Rahim and Rahman (2013) in their research in Green IT and Green IS.

2.8.8 Motivational Theory

The theory of organizational motivation explains the motives behind organizational actions and views an enterprise as a collective self whose behaviour is influenced by human motivational factors (Eklim and Rahim, 2015). In the context of IT adoption, motives are defined as the desire that initiates the activities of an organization to adopt an innovative system such as Green IT/IS (Molla and Abareshi, 2012). The motivation theory comprises of three constructs motives and they include competitiveness, legitimation and social responsibility (Rahim et al., 2007). Thus, motivational theory provide useful insights to what extent ethical and sustainability considerations, even if economic benefits are not tangible in the immediate short term, influence the IT decision making process (Eklim and Rahim, 2015). The motivation theory was adopted by Molla (2009a); Bose and Luo (2011); Molla and Abareshi (2011); Molla and Abareshi (2012) to investigate the influence of environmental sustainability motivations on the adoption of IT for Green and Green IT.

2.8.9 Institutional Theory (INT)

Institutional Theory (INT) seeks to explain how organizations become influenced under social pressures (Chen et al., 2011). Moreover, institutional theory provides a rich, complex view of how organizations become homogeneous in broad institutional environments, sometimes due to external sources, other times from within the organization (Meyer and Rowan, 1977; DiMaggio and Powell, 1983). Institutional theory is conceptualized through three constructs namely normative, mimetic, and

coercive isomorphism. The institutional theory was adopted Sarkar and Young (2009); Butler (2011a); Chen et al. (2011); Lei and Ngai (2012) to mainly identify the external pressures motivating enterprises to adopt Green IT and Green IS practices.

2.8.10 Technology-Organization-Environment (TOE) Framework

The TOE framework was developed by Tornatzky et al. (1990) from Rogers's (1995) diffusion of innovation theory by adding the environmental context as a third factor together with Roger's two factors of technology and organisations. This addition was important for addressing innovation use in a complex environment in which the external environment could provide both constraints and opportunities (Bose and Luo, 2011). The TOE provides a generic foundation that integrates the organisational, technological and environmental contexts to understand the factors that could affect the assimilation of technologies. Prior studies Molla (2008); Bose and Luo (2011); Nedbal et al. (2011); Cooper and Molla (2014); Zheng (2014) adopted TOE to developed their Green IT and Green IS research models.

2.8.11 Process-Virtualization-Theory (PVT)

The Process-Virtualization-Theory (PVT) was developed by Overby (2008) to provide theoretical foundation for investigating the question: what factors affect the virtualizability of the Green IT implementation process in organizations? Accordingly, PVT was conceptualized to explain and predict whether a process is amenable or resistant to being conducted virtually. The independent variables of the virtualization process include sensory requirement, relationship requirements, synchronism requirements and lastly identification and control requirements. The dependent variable, process virtualizability, helps describe how amenable a process is to being conducted without physical interaction between people or between people and objects. However, there are three moderating variables which include representation, reach and lastly monitoring capability. In addition, PVT was employed by Bose and Luo (2011); Nedbal et al. (2011) for Green IT implementation in organizations.

2.8.12 Diffusion of Innovation (DoI) Theory

Diffusion of innovation (DoI) theory was proposed by Rogers (1995) to offers rich explanations of how new innovations are adopted, and how adoption decisions are

affected by perceptions of the technology itself as well as the characteristics of the adopting enterprise and its environment. Rogers (2005) identifies five attributes of innovations which includes relative advantage, compatibility, complexity, trial-ability, and observability. DoI theory is a powerful descriptive tool, less strong in its explanatory power, and less useful still in predicting outcomes and providing guidance as to how to accelerate the rate of adoption. Accordingly, in the DoI theory, a technological innovation passes through four stages which comprises of knowledge, persuasion, implementation, and lastly confirmation. Despite the popularity of the DoI theory, researchers have criticized for its bias towards the technological component of the adoption process. The argument offered by these scholars is that other relevant, contingent factors, beyond the technical features of an innovation should be considered for deeper understanding to emerge. Over the years the DoI theory has be adopted in Green IT and Green IS research by Schmidt et al. (2010); Bose and Luo (2011); Nedbal et al. (2011); Cai, Chen and Bose (2013) respectively.

2.8.13 Organizational Information Processing Theory

The organizational information processing theory was suggested by Galbraith (1974) by identifying information processing needs, information processing capability as the independent variables and information processing performance as dependent variable. The theory is based on the fact that organizations need quality information to cope with environmental uncertainty and improve their decision making. According to the organizational information processing theory, uncertainty in the environment faced by an organization triggers its information processing needs, such as investing in IT (Lei and Ngai, 2012). The organizational information processing theory was utilized by Lei and Ngai (2012) in conceptualizing their Green IS assimilation model.

2.8.14 Belief-Action-Outcome (BAO) Framework

The Belief-Action-Outcome (BAO) framework was proposed by Melville (2010) who derived the framework from Coleman's (1986) micro-macro-model to propose links between the influence of social and organizational sustainability contexts on individuals' and organizations' beliefs about the environment and the influence of their beliefs on sustainability actions and subsequent outcomes. In addition, BAO framework helps to identify how individual beliefs are translated into action. The BAO

framework provides the insight that IT practitioner personal capabilities can contribute toward their formation of environmental beliefs and attitudes. The framework therefore links macro-level (organizational) variables with micro-level (individuals) variables to study the role of IT/IS for sustainability. This implies that managerial beliefs and commitments lead to organizational action that eventually leads to outcomes. The consequences of this can result in a better environment. The BAO framework was adopted by Gholami et al. (2013); Molla et al. (2014); Recker (2016); Loeser et al. (2017) in their research in Green IT and Green IS adoption.

Findings from Section 2.8 reveal that a number of frameworks, model and theories have been assimilated to help understand the variables or factors that influence organizational Green IT and Green IS practices, as presented in Figure 2.7 and Section 2.8. While these theories are valuable in understanding constructs to Green IT/IS practice implementation, they are less applicable in explaining the outcome of Green IT/IS practice implementation except for BAO framework, natural resource-based view, and diffusion of innovation theory. Respectively, in choosing the theoretical framework for this thesis, the author sought a framework that can both help in understanding the variables that influences Green IT/IS practice, and also integrate them with the outcomes of the Green IT/IS practice implementation.

To this end, the author found that Melville's BAO framework was suitable for this purpose, since the DoI theory is more concerned about technological implementation only by adopting the initialization, integration and maturity of information systems. Likewise, NRBV cannot accommodate the independent variables that influences Green IT/IS but only applies to Green IT/IS practice implemented. Correspondingly, by synthesizing the BAO discussed in Section 2.8.14, the Green IT/IS assessment model is developed to capture the independent variables that influences Green IT/IS practice and the Green IT/IS practice to be implemented in CE as presented in Section 5.3, Figure 5.2 in Chapter 5 of this thesis.

2.9 Existing Green IT/IS Standards

This section aims to review the existing Green IT/IS standards. Presently government agencies have proposed to implement certain guidelines that support Green IT/IS practices in general. Green IT/IS practices can lead to decrease in energy costs from cooling, servers and lighting. Many countries (Switzerland, Australia, Japan, US, New Zealand, China, UK, across Europe, Singapore, Malaysia, Hong Kong) worldwide have introduced several Green IT/IS standards and guidelines. These standards were derived from the literatures and as explored in this section as shown in Figure 2.9.

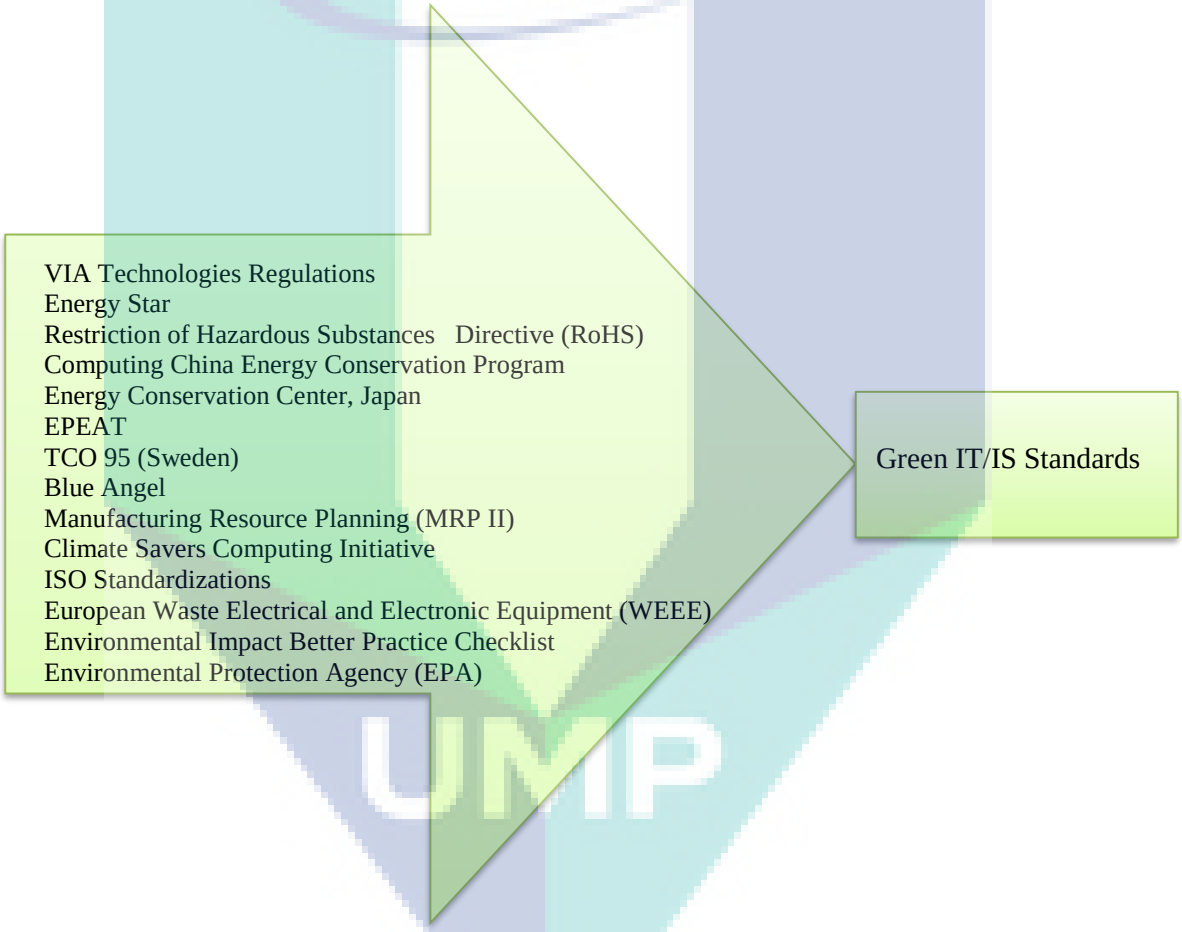


Figure 2.9 Existing Green IT/IS standards

Source: Compiled from Raza et al. (2012).

Figure 2.9 shows the existing Green standards and Table 2.6 briefly discusses these standards. Accordingly, these standards can be adopted by CE mainly to reduce energy usage, cost reduction and reduce pollution to the environment.

These standards can support IT practitioners attain sustainability in CE. However, none of the exising standsard is able to address social, economic, and environmental dimension of sustianability.

Table 2.6 Review of existing Green IT/IS standards

Standards	Description	Environment	Economic	Societal
VIA Technologies Regulations	VIA was adopted as a set of internal regulations implemented in order to develop products without using dangerous materials in its production of chipsets and processors. In customary IT development process, lead is used to fasten the silicon core to enable integration onto the motherboard over tiny solder. VIA's lead free engineering technologies do not involve a lead bead and the solder balls now comprises of a silver, tin and copper composite (Raza et al., 2012).	✓	×	✓
Energy Star	It is a universal standard for energy proficient electronic equipment that was created by the United States Environmental Protection Agency in 1992 and is now accepted and adheres to by several countries (Harmon and Auseklis, 2009; Butler, 2011a; Raza et al., 2012). Energy Star denotes the amount of energy utilized by a product and automatically switched into sleep mode when not active or in use. Energy Star supported products lessens energy waste (Huang, 2009; Schmidt et al., 2009; Cater-Steel and Tan, 2011; Krishnadas and Radhakrishna, 2014).	✓	✓	×
Restriction of Hazardous Substances Directive (RoHS) Computing	In February 2003, the European Union implemented the Restriction of Hazardous Substances Directive (RoHS) (Raza et al., 2012; Cater-Steel and Tan, 2011). The law restricts the use of "6" hazardous materials in manufacturing different types of electronic and electrical tool and equipment (Butler and Daly, 2009; Butler, 2011a). The standard has been concentrating on eco-friendly manufacturing and design process with better effectiveness of its services and products. The standard also carryout markets awareness on the benefits of Green computing for sake of the surroundings, as well as production (Schmidt et al., 2009; Jia and Bai, 2009).	✓	×	✓

Table 2.6 Continued.

Standards	Description	Environment	Economic	Societal
China Energy Conservation Program	In 1998, the China National Development and Reform Commission (NDRC) instituted the China Energy Conservation Program (CECP), a non-profit association aimed to manage, administer and adopt the certificate for environmentally friendly products, water saving and energy conserving. They are committed to encourage manufacturers and developers to develop resource proficient products and support consumers for Green buying decisions (Raza et al., 2012).	✓	✓	×
EPEAT	Electronic Product Environmental Assessment Tool (EPEAT) is a dominant tool for environmental rating that helps to categorize Green computers and other electronic equipment (Butler, 2011a). The EPEAT system was developed and comprehended in conjunction with practitioner and decision makers from the government, business, advocacy and academic discipline (Raza et al., 2012; Harmon and Auseklis, 2009). EPEAT is used by numerous countries to certify and showcase their Greener production and designs. EPEAT listed products are almost free of environmental dangerous element with less toxins in manufacturing to efficient process and easier recycling (Cater-Steel and Tan, 2011).	✓	×	×
TCO 95 (Sweden)	The Confederation of Professional Employees, Tjänstemannens Central-Organization (TCO) in Sweden initiated a series of initiatives in partnership with private enterprise and government to achieve sustainable development and protect environment. It combines sound business economics, good environmental practice and provides an overall approach whereby enterprise can integrate concerns relating to ecology and the environment into their everyday decision making process. The standard is based on "Six E's" which signifies high standards in economy, energy, ergonomics, emissions, ecology and efficiency (Raza et al., 2012).	✓	✓	×
Energy Conservation Center, Japan	In Japan, the Energy Conservation Center is devoted for educating and training enterprise managers, creating public awareness on energy conservation, on energy conservation movement and exposition (Raza et al., 2012).	✓	×	×

Table 2.6 Continued.

Standards	Description	Environment	Economic	Societal
Blue Angel	The Blue Angel (Blauer Engel) is the first environment associated German certification for services and products across the world. It was initiated in 1977 (Butler, 2011a). The Blue Angel logo was adopted from the UNEP logo (United Nations Environment Programme), which was founded in 1972 (Raza et al., 2012).	✓	×	×
Manufacturing Resource Planning (MRP II)	It is a system of standards, which regulate limitation on radiation from electrostatic, electrical and magnetic fields for computer and office techniques and was accepted by SWEDAC (Swedish National Board for Measurement and Testing - by National department of standards of Sweden) in 1990 (Raza et al., 2012).	✓	×	×
Climate Savers Computing Initiative	It was developed by Google and Intel in 2007 and is a non-profit group of eco-conscious consumers, business and conservation enterprise. Its main aim is to promote implement of smart technologies that can improve energy efficiency of a computer (Raza et al., 2012).	✓	×	×
ISO Standardizati-ons	ISO 14001 is a tool that comes in the form of a collective CD/handbook and was made available in 1996 and then reviewed in 2004 has proved very successful (Cater-Steel and Tan, 2011). It is now implemented in more than 159 countries and has provided enterprise with a powerful management tool to improve their environmental performance (Schmidt et al., 2009; Raza et al., 2012).	✓	×	×
Environmental Impact Better Practice Checklist	In December 2007, the Australian Government's Information Management Office (AGIMO) issued the 'Environmental Impact Better Practice Checklist' to help enterprise reduce the effect of their Information And Communication Technology (ICT) activities on the environment (AGIMO 2007). The aim of the checklist, reproduced is to support enterprise in managing the environmental impact of ICT related and products (Cater-Steel and Tan, 2011).	✓	×	×

Table 2.6 Continued.

Standards	Description	Environment	Economic	Societal
WEEE	The European Waste Electrical and Electronic Equipment Directive became law in 2003. It levies the responsibility for electrical and electronic waste on the equipment manufacturers (Harmon and Auseklis, 2009; Butler and Daly, 2009; Cater-Steel and Tan, 2011). The intent of the directive is to lessen waste from electronic equipment and electrical and to offer incentives for designing equipment that improves environmental performance throughout the product lifecycle (Butler, 2011a; Schmidt et al., 2009).	✓	×	×
Environmental Protection Agency (EPA)	In the United States of America the Environmental Protection Agency (EPA) has many regulations covering environmental issues and dangerous substances across the whole range of manufacturing and manufacturing sectors (Butler and Daly, 2009; Butler, 2011a; Krishnadas and Radhakrishna, 2014).	✓	×	×

Table 2.6 shows the existing Green IT/IS standards implemented by CE in attempting to achieve environmental, economic and social sustainability. However, the reviewed standards provided awareness to IT practitioners on environmental friendly practices that are to implemented in their enterprise, these standards do not provide a model for IT practitioners to assess and improve their current Green IT/IS practice in achieving both environmental, economic and social sustainability. In addition, the reviewed standards do not consider the variables that influences Green IT/IS practice, they only provide checklist on Green IT/IS practice initiatives based on a few Green IT/IS practices. Consequently, there is need for a model that can serve as a standard that provides the independent variables and associated attributes that influences Green IT/IS practice as well as the complete Green IT/IS practice to be implemented in CE.

2.10 Green IT/IS Practice Culture in Malaysia Collaborative Enterprise

This section explores on the background, status, motivators and inhibitors of Green IT/IS practice in Malaysia CE.

2.10.1 Background and Status of Green IT/IS Practice in Malaysia CE

In December 2009, a conference on climatic change took place in Copenhagen, Denmark titled "United Nations Climate Change Conference 2009", in this 15th Conference of Parties (COP-15), Dato' Seri Najib bin Tun Abdul Razak the former Prime Minister of Malaysia signed a pledge that Malaysia would contribute to the reduction of up to 40 % of CO_2 emissions in the year 2020 as compared to CO_2 level in the 2005 (KeTTHA, 2010). Undeniably, this was a moral and motivated pledge made by His Excellency the then Prime Minister of Malaysia to the international community and since then collaborative enterprise such as organization and institutions stands by the prime minister to support, implement Green IT/IS practice to contribute to this goal (Greentech.my, 2016).

"KeTTHA" was established by the former Prime Minister of Malaysia on the 9th of April 2009 as the "Ministry of Energy, Green Technology and Water" to help provide strategic role of achieving autonomy and mitigating climatic changes and environmental issues. KeTTHA motto is "Go Green, Save Water, Save Energy" (KeTTHA, 2010). Since 2009, KeTTHA has supported the country towards implementing Green technology as one of the emerging influencers of economic growth. KeTTHA was thus inaugurated to facilitate the progress of a knowledge society which would promote a sustainable and better way of living by guiding the country towards a Greener Malaysia (Khalil et al., 2018). KeTTHA acknowledges the need and prominence of implementing Green IT/IS practice. KeTTHA believes that enterprise day-to-day operations may possess indirect or direct impact on the natural environment nationally or internationally (Nifa et al., 2016).

KeTTHA is committed to contribute towards the reduction of negative effects imposed on the natural environment caused by societal daily activities by striving to meet the needs of the present without compromising the wants of the future (Nifa et al., 2016). KeTTHA further aims to champion a Green future for the continued wellbeing of the planet. In implementing Green practices, KeTTHA's objectives are geared towards decreasing harm to the natural environment caused by enterprise daily operations at work. Consequently, aspiring to install Green value and norms among CE in Malaysia, by planning to be a leader in disseminating Green practice strategies to the Malaysian public and in public sectors. KeTTHA also provides funding to CE willing to

implement Green IT/IS practice that directly contributes to conserving the natural environment (Khalil et al., 2018). Furthermore, Malaysia is one of the countries committed to support sustainability by adhering to the guidelines such as that of ISO 14001 standards.

The ISO 14001 standard is a practical tool widely used to achieve sustainable development by guiding organizations in controlling the impact of their activities on environment, and acquiring external certifications for the practices employed (Foo, 2013). Researchers such as Amran et al. (2010); Foo (2013) have criticized ISO 14001 standard for its inadequacy of addressing economic and social dimension. Accordingly, due to Malaysian government endorsements towards development of Green enterprise in the country, a few CEs such as IT based firms, government based institutions have begun to implement Green IT/IS practices to support this national voluntary practice to decrease their Greenhouse gas emission as promised by the former Prime Minister in Copenhagen Denmark (Amran et al., 2010).

Thus, CEs in Malaysia are committed in reducing Malaysia Green House Gases (GHGs) emission by 40 per cent per GDP by 2020 (KeTTHA, 2010). These arguments are also supported by Mat et al. (2011) where the authors mentioned that most enterprise in Malaysia are presently implementing Green IT/IS practice for achieving sustainability. Respectively, this can be attributed to the fact that several benefits can be derived when organizations balance the social, environmental and economic goals of sustainability. In addition, four CE based in Malaysia were selected as case studies in Chapter 4 (see Table 4.2) to explores on the background and status of Green IT/IS practice in the organizations by examining the independent variables that influences Green IT/IS practice and the current Green IT/IS practice implemented as seen in Table 4.3 and 4.4 in Chapter 4.

2.10.2 Motivators and Inhibitors of Green IT/IS Practice in Malaysia CE

The motivator are factors that encourage IT practitioners to implement Green IT/IS in CE, whereas the inhibitors prevent IT practitioners from implementing Green IT/IS practices in CE, as presented in Figure 2.10 and 2.11.

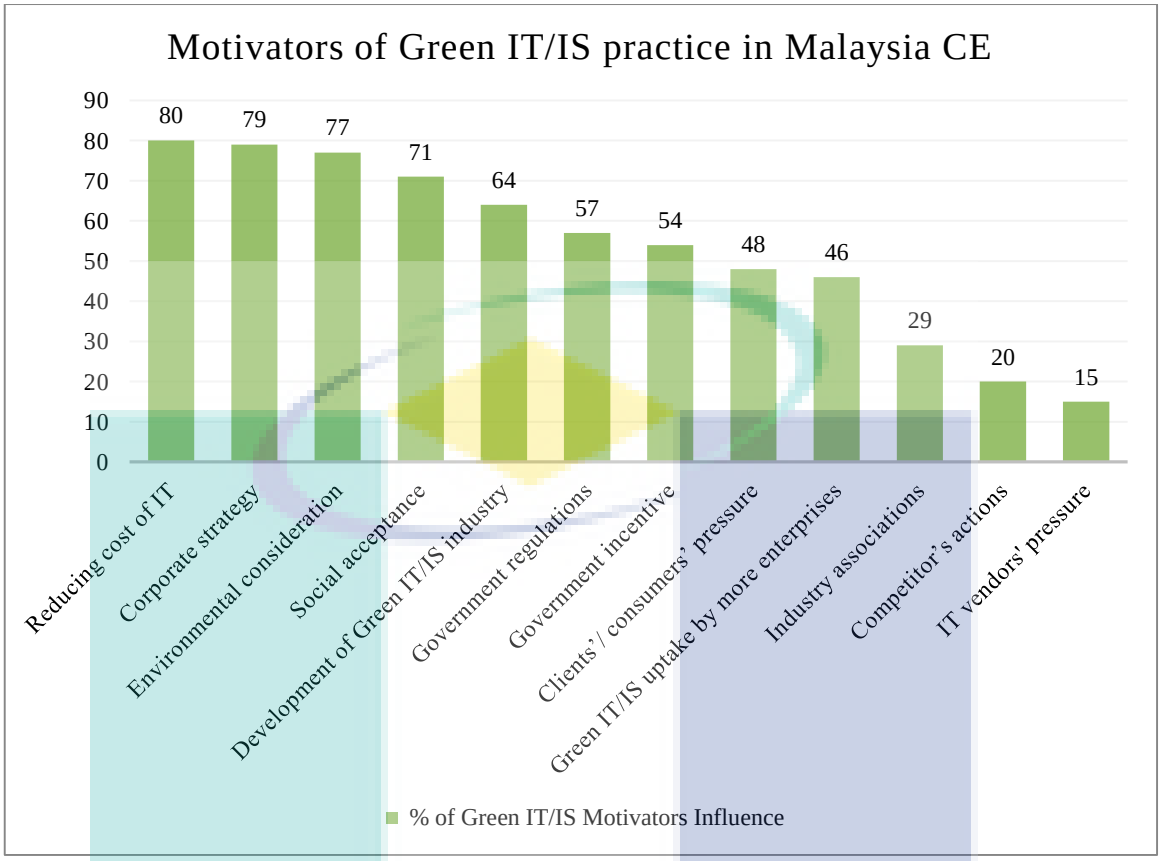


Figure 2.10 Motivators of Green IT/IS practice in Malaysia CE

Source: Molla et al. (2009a); Dedrick (2010).

Figure 2.10 shows the motivators that encourages CE in Malaysia to implement Green IT/IS practice. Accordingly, CE motivations for implementing Green IT/IS can include an economic expectation of enhancing efficiency, a regulatory response of ensuring compliance and a normative objective of attaining legitimacy (Mat et al., 2011; Nifa et al., 2016). The tension between the regulatory and ethical pressure on the one hand and the business case for top-line revenue and bottom-line costs on the other hand can influence the pace of Green IT/IS practice. Findings from prior studies Molla et al. (2009a); Dedrick (2010) suggest that the main motivations for Green IT/IS practice implementation are strategies that emphasize not only environmental consideration but also cost savings. However, the least motivators that drives CE in Malaysia to implement Green IT/IS practice is pressure from IT vendors that supplies IT infrastructures.

This implies that as corporate IT budgets continue to shrink, IT practitioners may turn to Green IT/IS implementation if Green solutions are affordable and yield tangible benefits.

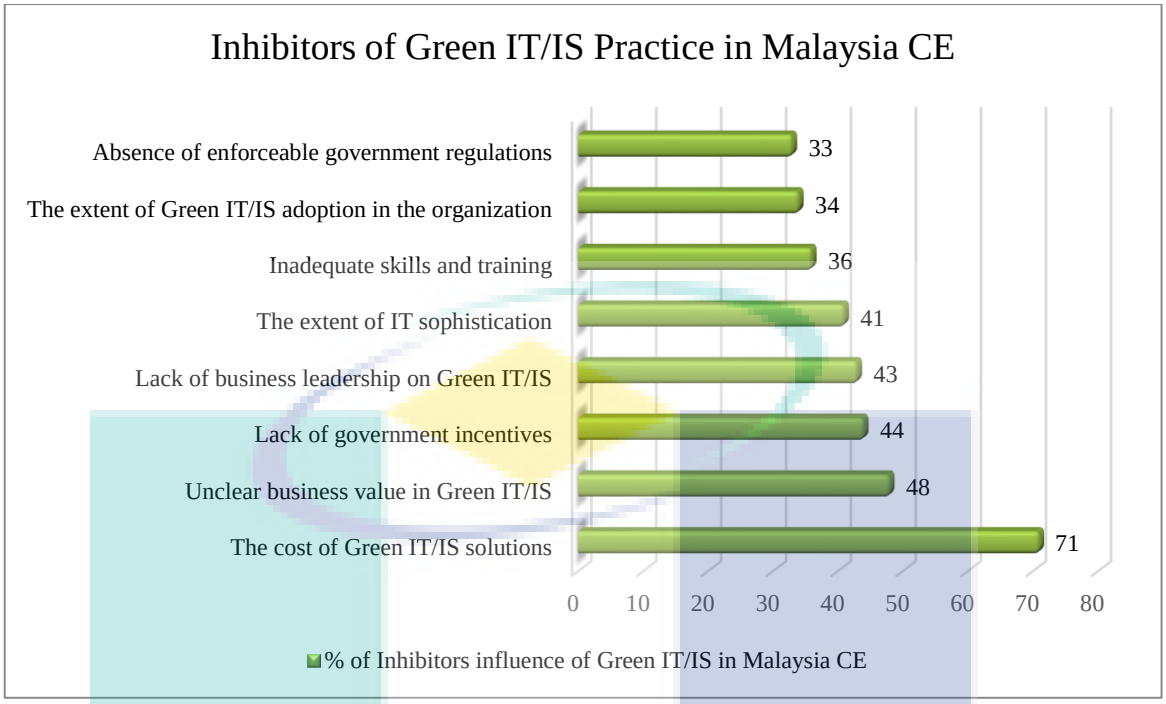


Figure 2.11 Inhibitors of Green IT/IS Practice in Malaysia CE

Source: Molla et al. (2009b); Dedrick (2010).

Therefore, findings from Figure 2.10 reveal that 71% of respondents are pursuing legitimacy within the wider social context as concerned entities of global and local communities for Green IT/IS practice implementation. The development of IT industry in providing Green IT/IS products and services appeared as one of the top five. Despite KeTTHA propagation for Green IT/IS implementation since 2009, forces from competitors, IT vendors and client's pressure have not so far emerged as motivating factor for enterprise implementing Green IT/IS practice (Nifa et al., 2016). Most of the existing Green IT/IS regulations are non-binding. As a result, a significant number of CE do not yet see government laws or incentives as driving their Green IT/IS practice.

Figure 2.11 shows the inhibitors that prevents CE in Malaysia to implement Green IT/IS practice. Accordingly, it can be seen that the cost of Green IT/IS solutions top the list followed by unclear business value, and lastly absence of enforcement government regulations is the lease inhibitor similar to finding presented by Mat et al. (2011). Nevertheless, the cost perception does not appear as a major inhibitor for those organisations that have budgeted for Green IT/IS and allocated other resources. Absence of enforceable government regulations is the least of all the inhibitors as suggested by Nifa et al. (2016) in their study. This implies that in the short to medium

term, internal rather than external factors within Malaysia CE might significantly influence Green IT/IS practice implementation.

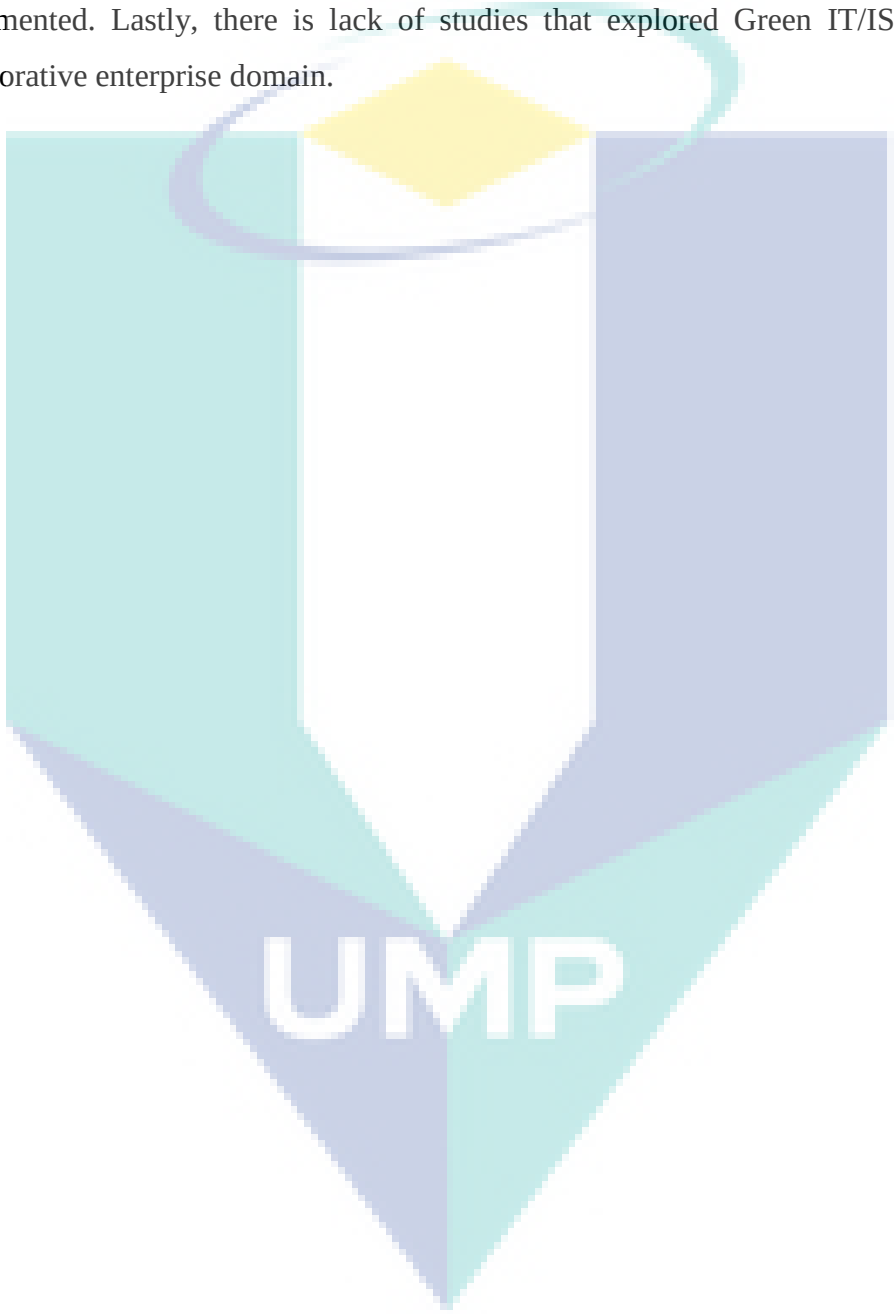
Figure 2.11 shows the inhibitors that prevents CE in Malaysia to implement Green IT/IS practice. Accordingly, it can be seen that the cost of Green IT/IS solutions top the list followed by unclear business value, and lastly absence of enforcement government regulations is the lease inhibitor similar to finding presented by Mat et al. (2011). Nevertheless, the cost perception does not appear as a major inhibitor for those organisations that have budgeted for Green IT/IS and allocated other resources. Absence of enforceable government regulations is the least of all the inhibitors as suggested by Nifa et al. (2016) in their study. This implies that in the short to medium term, internal rather than external factors within Malaysia CE might significantly influence Green IT/IS practice implementation.

2.11 Summary

This chapter lays a theoretical background in achieving the first research objective which aimed to identify the Green IT/IS practice to be implemented and independent variables that influences Green IT/IS practice in CE as mentioned in Section 1.6 in Chapter 1. The chapter proceeded by describing the background of CE and also discussed describing IT effects in CE, environmental life cycle of IT, the concepts of Green IT and Green IS, after which Green IT/IS practice in CE was reviewed followed by sustainability goals in CE and then for Green IT/IS for sustainability attainment. Next the importance of Green IT/IS practice in CE was explained in detailed. Existing Green IT/IS models and frameworks that are similar to this study was reviewed next to derive the independent variables. The chapter proceeded to discuss on the identified Green IT/IS practice, independent variables. Moreover, control, and moderating variables as well as dependent variable were identified to provide a roadmap in developing the Green IT/IS assessment model.

Existing Green assessment model was discussed. After which prior frameworks, models and theories employed in Green IT and Green IS research was reviewed. Next, this chapter reviewed existing Green IT/IS standards and Green IT/IS culture practice in Malaysia. Finally, the summary of the chapter is presented. Hence, at the end of this chapter, the author identified that existing Green assessment models are more appropriate for Green IT assessment in organizations. Besides, prior Green assessment

models only raises awareness on the potential of Green IT/IS. However, these models offer little practical guidelines on Green IT/IS practice initiatives to be deployed in enterprise current operations to improve sustainability attainment. Similarly, there is lack of a Green IT/IS assessment model that considers the independent variables that influences Green IT/IS practice and also considers Green IT/IS practice to be implemented. Lastly, there is lack of studies that explored Green IT/IS practice in collaborative enterprise domain.



CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter discusses the methodology that has been applied in this thesis in order to meet the research objectives of this study. In addition, this chapter describes the research phase, research activities, outputs and research objectives.

3.2 Research Methodology

Research methodology is a structured set of guidelines or activities to help in generating research results that are valid and reliable (Bergold and Thomas, 2012). Research methodology represents a work plan and a thought logical plan which helps to avoid the state in which the evidence does not actually address the research objectives (Creswell, 2009). As such, research methodology can be considered as the structure and components that holds the research work together (Adom and Ankrah, 2016). It is also a blueprint for the collection, measurement, and analysis of data. An appropriate research methodology is essential to determine the type of methodology used which is very important in achieving the research objectives (Bergold and Thomas, 2012).

The author opted for a mixed methods design utilizing both quantitative and qualitative research methods in order to identify the Green IT/IS practice to be implemented and independent variables that influences Green IT/IS practice in CE and to propose and validate the Green IT/IS assessment model based on belief-action-outcome framework. The complementary use of quantitative and qualitative method allow the researcher to capture a more complete, holistic, and contextual view of the

phenomenon under study (Bergold and Thomas, 2012), in turn, contributing to the validity and robustness of the results than either approach alone.

Table 3.1 shows the research flow which comprises of four main phase that includes literature review, preliminary study, model development, and lastly model validation. The explanation of the research methodology as shown in Table 3.1 covers various activities, objectives, methods and outputs for each research phase and chapters in this study.

Table 3.1 Research flow

Phases and Chapters	Activities	Output/Delivery	Research Objective
Phase 1 Chapter 2 → Literature Review	Critical Literature Review	-Related Works -Green IT/IS Process -Independent Variables that influence Green IT/IS Practice	Research Objective 1
Phase 2 Chapter 4 → Preliminary Study	Carryout Case Study Analyse Interview Transcripts Analyse Green IT/IS Documents Quality Criteria of Case Study	-Analysis of Interview data and Green IT/IS Document -Verified Independent Variables that influence Green IT/IS -Verified Green IT/IS Process -Quality Criteria of Case Study	Research Objective 2
Phase 3 Chapter 5 → Propose Model	Refine and Revise Green IT/IS Process and Independent Variables	-Proposed Green IT/IS Assessment Model based on Belief-Action-Outcome Framework	
Phase 4 Chapter 6 → Model Validation	Carryout Survey to Validate Green IT/IS Assessment Model Use Implemented Green assessment tool to Validate Proposed Model based on Focus-group Questionnaire	-Analysed Survey Data Results using SPSS (Descriptive, Explorative and Inferential Results) and SmartPLS 3 (Assessment of Measurement and Structural model Results)	Research Objective 3
		-Analysed Questionnaire Data using SPSS (Descriptive and Principal Component Analysis)	Research Objective 4

3.2.1 Research Paradigm, Approach and Strategy

A paradigm is a shared world view that represents the beliefs and values in a discipline and that guides how problems are solved. Hence, a research paradigm direct and guides thinking and action (Guba and Lincoln, 1994) and can be identified in terms of post-positivist, constructivist, participatory and lastly pragmatic (Denzin and Lincoln, 2000). Respectively, Table 3.2 shows the types of research paradigms adopted in information systems research.

Table 3.2 Research paradigm, approach and strategy of inquiry

Paradigm	Approach	Strategy of Inquiry	Method
Post-positivist	Quantitative	Experimental design	Measure attributes, rating behaviour.
Constructivist	Qualitative	Ethnographic design	Field observation.
Participatory	Qualitative	Narrative design	Closed ended interviews.
Pragmatic	Mix methods	Mix methods design	Interview and survey questionnaire.

Source: Creswell (2009).

The term 'positivism' was coined by Auguste Compte to reflect a strict empirical approach in which claims about knowledge are based directly on experience; it emphasizes facts and the causes of behaviour (Denzin and Lincoln, 2000). Post-positivist paradigm holds that the scientific method is the only way to establish truth and objective reality. The positivists would conclude that, any scientific method does not yield any tangible results on the nature is not valid. Positivism is based upon the view that science is the only foundation for true knowledge. It holds that the methods, techniques and procedures used in the natural and social sciences offer the best framework for investigating social world (Guba and Lincoln, 1994). Accordingly, post-positivism reflects a deterministic philosophy which causes may determine the effects or outcomes and is adopted for quantitative studies (Creswell, 2009).

Constructivism is basically a paradigm based on observation and scientific study about how people learn. This paradigm believes that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences (Creswell, 2009). In this paradigm, researchers must ask questions, explore, and assess what participants know. Accordingly, Adom and Ankrah (2016) describes the constructivism philosophical paradigm as an approach that asserts that people construct their own understanding and knowledge of the world through experiencing things and reflecting on those experiences. It is based on the analogy or basis that people form or construct much of what they learn through experience such as by observing (Denzin and Lincoln, 2000). The constructivism paradigm adopts qualitative observation method in conducting research.

Next, is participatory paradigm which is grounded towards planning and conducting research with people whose life-world and meaningful actions are under study. Accordingly, this means that the aim of the inquiry and the research questions develop out of the convergence of two perspectives that of science and of practice. In the best case, both sides benefit from the research process (Creswell, 2009). Therefore,

the participatory paradigm enables researchers to step back cognitively from familiar routines, forms of interaction, and power relationships in order to fundamentally question and rethink established interpretations of situations and strategies (Bergold and Thomas, 2012). Since, participatory paradigm poses certain questions about knowledge and research in a radical way, the paradigm is more linked to qualitative methodology by utilizing interviews to stimulate further development (Bergold and Thomas, 2012).

Pragmatic paradigm has what Tashakkori and Teddlie (1998), and Creswell (2009) see as intuitive appeal that employ methods that are appropriate in exploring data from mixed methods (Creswell, 2009). For these reasons it can be argued that the pragmatic paradigm can be adopted for the purpose of social and management research endeavours as this is congruent with the mixed quantitative and qualitative approach taken within the predisposition of practitioner-based research (Guba, 1990). Correspondingly, Tashakkori and Teddlie (1998) argued that there are three approaches to research quantitative, qualitative and mixed methods.

The quantitative approach tends to be associated with the post-positivistic paradigm, which employs strategies of inquiry such as experimentation and survey and methods of data collection (see Table 3.2) that are pre-determined measures resulting in numeric data (Armitage, 2007). By contrast the qualitative approach tends to be associated with constructivist and participatory paradigms which employs strategies such as the case study or narrative and uses methods or data collection such as observation, interview resulting in open ended data (see Table 3.2) textual data (Tashakkori and Teddlie, 2003). Besides, the mixed methods approach is associated with the pragmatic paradigm and strategies that involve collecting data in a simultaneous or sequential manner using methods that are drawn from both quantitative and qualitative procedures that best addresses the research question/s (Creswell 2009).

Therefore, this study employs pragmatic paradigm (mixed method), where Tashakkori and Teddlie (1998) noted that there are three areas where a mixed method is suitable to a mono-methods approach. Firstly is the ability to answer research questions that other approaches cannot; mixed methods can answer simultaneously confirmatory and exploratory questions which is analogous with this thesis. Secondly, pragmatic paradigm provides stronger inferences through depth and breadth in answer to complex social phenomena (Armitage, 2007). Thirdly, pragmatic paradigm provides the

opportunity through divergent findings for an expression of differing viewpoints. As recommended by Bryman (2004) this study employs mixed methods by utilizing data from qualitative research (case study by interview) to facilitate quantitative research (survey questionnaire). Hence, the author collected data using interview, utilized in collecting data from selected case studies to verify or confirm the independent variables that influence Green IT/IS practice and Green IT/IS practices implementation identified from the literature.

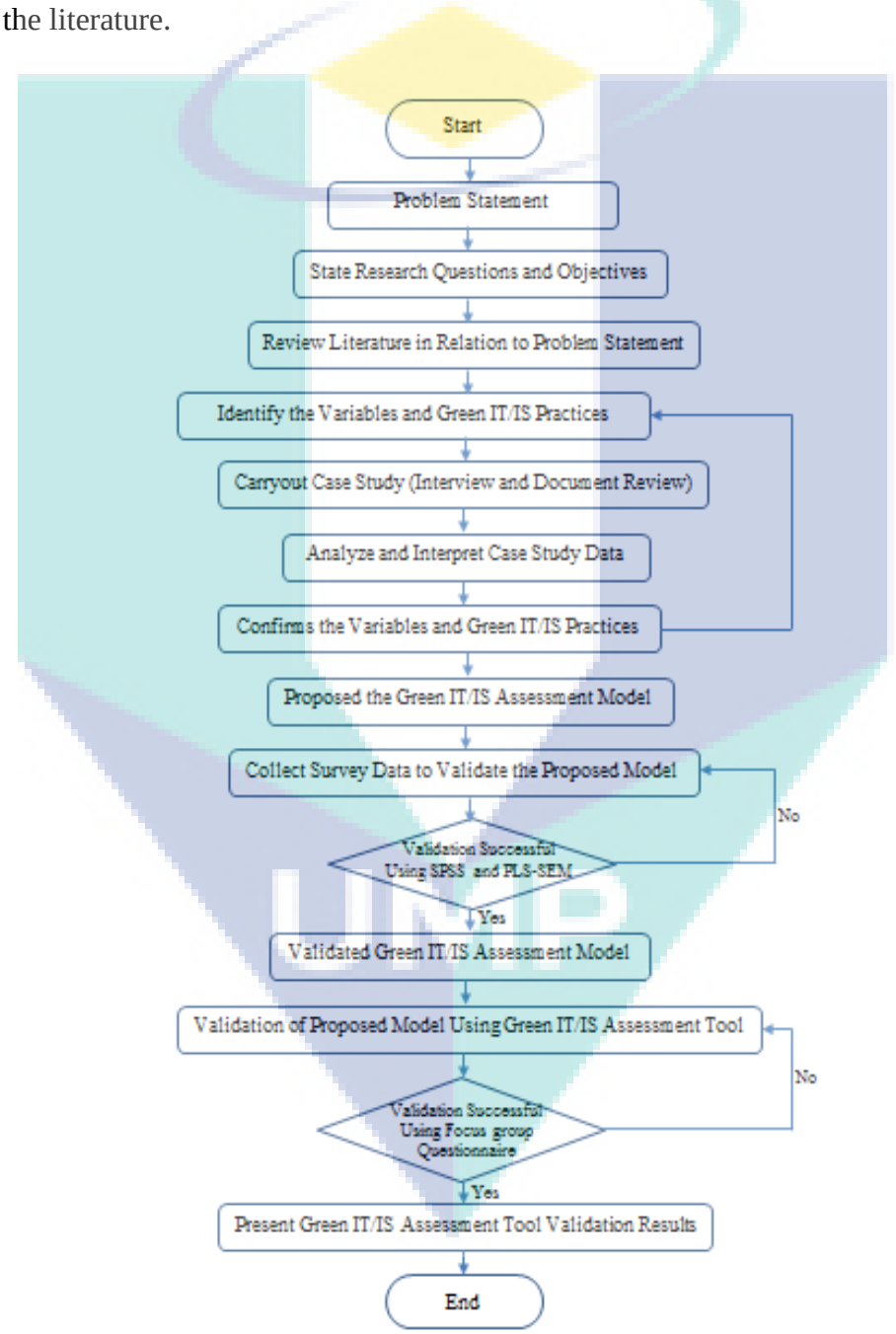


Figure 3.1 The flow chart for the thesis

Figure 3.1 shows the flow chart of the study based on mixed mode approach. In addition, survey and focus-group questionnaire was also employed to collect data in

using the implemented GAT to validate the developed Green IT/IS assessment model.To this end, the author argues that pragmatic paradigm is suitable for this study. Correspondingly, the following sections below provide details of how qualitative and quantitative methods were adopted in this study.

3.2.2 Population and Sample

This study adopted mixed mode research method (qualitative and quantitative) to explore into the independent variables that influences Green IT/IS practice and the Green IT/IS practice to be implemented in CE. Similar to research on environmental sustainability and Green IT conducted by Sacchero and Molla (2009); Opitz et al. (2014), where Sacchero and Molla (2009) first collected data using survey from only twenty-four respondents and also collected data using interview from three informants (CIOs and ICT managers). Similarly, Opitz et al. (2014) collected data from five different case studies and later collected data using questionnaire from seventy-one respondents in German based enterprises to determine the independent variables that influence how enterprise govern their Green IT implementation.

The sampling frame for this study comprises selected CE based in Malaysia, purposive sampling was adopted, in which the informants for the interview and participants for the survey were selected based on their knowledge and experience in implementing Green IT/IS practices in their respective enterprise. Accordingly, each participant selected for data collection in this study possess more than one year experience in implementing Green IT/IS practices in his/her enterprise as recommended by Karanasios et al. (2010); Ijab and Molla (2012); Loeser et al. (2012), selected informants in case study should possess more than one year experience so that they can provide credible data in the area that is being investigated. Hence, purposive sampling is applied since this sampling technique is commonly used in exploratory, explanatory and descriptive research. Thus, purposive sampling was employed to obtain data from the case study, survey and focus-group questionnaire sessions.

3.2.3 Phase – 1: Literature Review

Phase 1 encompasses the reviewing of journals, conference proceeding, book chapters, books, workshops literatures on Green IT/IS practice in CE. This phase provides answers to the first and second research questions namely; What are the independent variables that influence Green IT/IS practice in collaborative enterprise?, and What is the Green IT/IS practices to be implemented in collaborative enterprise?, as stated in Section 1.4 in Chapter 1 that is presented in Section 2.6.1 and 2.6.2 in Chapter 2. Additionally, this phase aims to accomplish the first research objective which is to identify the Green IT/IS practice to be implemented and independent variables that influences Green IT/IS practice in CE as stated in Section 1.6 of Chapter 1.

3.2.4 Phase – 2: Preliminary Study

This phase comprises case study data collection using interview and Green IT/IS practice documents, sampling method and interview data analysis. This phase aims to verify the identified Green IT/IS practice implemented in CE and independent variables that influences Green IT/IS practice in CE derived from the literatures as presented Chapter 4. Thus, this research concern IT practitioners in CE based in Malaysia, similar to research done by Tedre et al. (2009); Nikkheslat et al. (2012); McGibbon and Van Belle (2013); Akman and Mishra (2014); Molla et al. (2014); Asabere et al. (2016). Where, their research were carried out in university institutions in which the researchers studied on how universities can reduce energy usage, lessen cost incurred and decrease CO_2 emission within their campuses and research done by Boudreau et al. (2008); Molla (2008); Dedrick (2010); Curry et al. (2011); Lai et al. (2012); Butler (2011b); Howard and Lubbe (2012); Ainin et al. (2015). Where, the authors researched on independent variables that motivates and discourages CE in implementing Green IT/IS practices in their respective organizations.

3.2.4.1 Case Study Context and Setting

Myers (1997) states that qualitative research approaches become progressively useful as the focus of IS research changes from technical to managerial and administrative issues. Meanwhile, implementing Green IT/IS practices is a managerial issue that determines the deployment of IT/IS throughout an enterprise. Hence, a qualitative research method seems to be appropriate towards providing answers to the

research questions (see Section 1.4). Moreover, researchers such as Benbasat et al. (1987) argued that the association between IT/IS usage and enterprise strategy is a domain that could be further explored using a structured platform of case studies. For this reason, this thesis carried out case studies to confirm the independent variables that influences Green IT/IS practice and Green IT/IS practice implemented in CE.

Yin (2011) added that case study is suitable in obtaining rich and comprehensive understanding of practices from multiple perspectives. Moreover, case study approach has the benefit that data from several sources of evidence can be integrated through triangulation (Dubé and Paré, 2003) and is mostly useful for enterprise research which is linked to IT practitioner's roles and perception (Benbasat et al., 1987). Furthermore, Yin (2011) defined case study as an empirical investigation that explores an existing phenomenon in detailed within real life perspective. Yin (2011) added that just as research can be interpretive, critical or positivist, case study research can be explanatory, descriptive or exploratory, where each of these three methods can be either adopted as a single or multiple case studies.

Therefore, this thesis opted for multi case and also applies the approach suggested by Miles et al. (1994); Yin (2011) in conducting case study research. In addition, this study followed the recommendation provided by Dubé and Paré (2003) for confirming the independent variables and Green IT/IS practice with case study method. Hence, qualitative research is also employed in this research using case study, similar to previously research carried out by Schmidt and Kolbe (2011); Seidel et al. (2010); Karanasios et al. (2010); Savita et al. (2014); Opitz et al. (2014); Dolci et al. (2015) which was used to verify the independent variables that influence Green IT/IS practice and Green IT/IS practice to be implemented in CE derived from the literatures. Moreover, this study conducted fifteen semi-structured interviews with informants from four CE in Malaysia where all four CE have been listed as leading sustainability based enterprise for the past five years in Malaysia.

The selected case study in this thesis comprises two institutions University Malaysia Pahang (UMP) (Case study A) and Universiti Teknologi Malaysia (UTM) (Case study B) and two organizations Ministry of Energy, Green Technology and Water (Kettha) (Case study C) and Malaysia Green Technology Corporation (GreenTech) (Case study D). Each selected case study was explored based on how the enterprise

implement Green IT/IS practices towards achieving sustainability. These CE were selected because the two universities are leading sustainability frontiers in institutions of higher learning in Malaysia (Mygreenump, 2016; Sustainable_utm, 2016), whereas the two organizations are pioneers of Green IT/IS practice for sustainability attainment in Malaysia.

Case study A, UMP is an engineering technology based enterprise located in Gambang and Pekan, Malaysia to be the most prominent Green technology based enterprise in the world (Mygreenump, 2016). Case study A mainly focus on recycling computer and other related waste materials generated in its enterprise into commercially sustainable products. Case study A aims to maximize utilization and reuse of generated waste material in order to reduce and preserve natural resources (Mygreenump, 2016). Case study A is currently the fourth in Malaysia and fifty-eight most Green institution in the world based on Green metric as depicts in Figure 3.2.

Ranking	University	Country	Total Score	Setting and Infrastructure	Energy and Climate Change	Waste	Water	Transportation	Education
58	Universiti Malaysia Pahang		6168	1220	943	975	690	955	1385
4	Universiti Malaysia Pahang		6168	1220	943	975	690	955	1385

Figure 3.2 UI Green metric ranking of UMP

Source: UI Green Metric (2016).

Case study B UTM is a leading Engineering, Technology and Science based enterprise with an innovation based sustainable environment. The enterprise sustainability center was officially lunched on April 2011 (Sustainable_utm, 2016). The enterprise sustainable development vision aimed at realizing Green lifestyle as personal and common culture providing progressive initiatives to future generation for them to imitate for continuously improvement (Sustainable_utm, 2016). Based on UI Green Metric World University Ranking UTM was ranked at number sixth in Malaysia and eighty-five as the world most Green institution as seen in Figure 3.3.

Ranking	University	Country	Total Score	Setting and Infrastructure	Energy and Climate Change	Waste	Water	Transportation	Education
85	Universiti Teknologi Malaysia		5866	1366	821	798	690	820	1371
6	Universiti Teknologi Malaysia		5866	1366	821	798	690	820	1371

Figure 3.3 UI Green metric ranking of UTM

Source: UI Green Metric (2016).

Case study C, Kettha was established to help provide a strategic role of achieving autonomy and mitigating climatic changes. The enterprise motto is "Go Green, Save Water, Save Energy" (KeTTHA, 2010). Hence, the enterprise is committed to contribute towards the reduction of negative effects imposed on the natural environment caused by societal daily activities by striving to meet the needs of the present without compromising the wants of the future. In implementing Green IT/IS practices, Case study C objectives are geared towards decreasing harm to the natural environment caused from enterprise daily operations and activities at work (KeTTHA, 2010).

Case study D, GreenTech Malaysia previously known as Pusat Tenaga Malaysia was inaugurated to serve as a strategic tool for socio-economic development in Malaysia in line with the country's Green Technology Policy in 2009 (Greentech.my, 2016). Moreover, Case study D encourages the deployment of energy efficiency equipment in government-linked agency. GreenTech Malaysia also offers consultancy training services relating to electricity audits, efficient electricity management and Green technology financing schemes to external organizations that want to adopt latest Green IT/IS practices (Greentech.my, 2016).

The insights derived from the interview data are compared to existing literature related to the independent variables and Green IT/IS practice. Accordingly, the corroborated findings from both the secondary data (literature review in Chapter 2) and primary data (interview data and Green IT/IS documents in Chapter 4) are used to confirm the independent variables and Green IT/IS practice presented in Chapter 2 (see Section 2.6.1 and 2.6.2). Hence, the case study was carried out using designed semi-structured interview instrument to collect data from the selected case studies. To this end, three academics and two practitioners who possess experience and in-depth

knowledge on information system where contacted to check the reliability (internal consistency) and validity of the open-ended interview questions.

Next, participants (informants) were invited by sending invitation by email to qualified prospective participants. The participants contact information were gotten from their enterprise sustainability departmental website from which the author checked that they are currently engaged in Green IT/IS practices in their respective enterprise. Furthermore, the author also explored the participants' professional profile to check that they have experience on Green IT/IS practices in relation to sustainability attainment. After sending the email (containing an overview and need of the research) the author followed up with phone call to inquire if they will be interested to be interviewee to proceed with the research.

After which interested participants were asked to choose a date and time of their convenience at the informants enterprise where the interview sessions was conducted using semi-structured interview as a suitable data collection instrument. Semi-structured interview is considered as an exploratory tool and is precisely needed in understanding participants' perception towards the identified independent variables and Green IT/IS practice. The interview session was conducted across all four CE from December 2016 to March 2017, where each of the interviews lasted for duration of 40 minutes to an hour. During the interview sessions with the informants' permission, their replies to the interview questions were manually documented hence no voices tape-recorded was used for this purpose. Furthermore, data was collect from Green IT/IS documents utilized in the Enterprise IT Department and Green Centres in attaining sustainability.

Data from the Green IT/IS documents was used to compliment data collected from the interview session to confirm that similar data was collected. Lastly, the interview transcript (hand written) and collected Green IT/IS documents were analysed using descriptive and narrative analysis to present findings relating to independent variables that influences Green IT/IS practice and Green IT/IS practice implementation as seen in Chapter 4 of this thesis.

3.2.4.2 Case Study Instrument and Protocol

To achieve a comprehensive perception of Green IT/IS within the studied CE, different types of data collection were combined as suggested by Yin (2011). Data

triangulation was applied by analyzing semi-structured interviews (using non-probability; purposive sampling technique) and internal Green IT/IS documents (as stated in Section 3.2.4). An outline relating to independent variables that influence Green IT/IS practice and Green IT/IS practice implemented was e-mailed to the selected informants in advance. Yin (2011) suggested associating the findings of the within-case analysis with a cross-case analysis, which simplifies a profounder understanding of the cases and highlights the differences between them. By choosing particular categories that are pertinent for the unit of analysis, the emergent patterns of case study research can be improved by searching for similarities and differences.

During the interviews, questions asked relates to the independent variables (IT practitioners, IT governance, technologies and systems, motivating forces, IT strategy and information availability) that influence Green IT/IS practice in CE and the Green IT/IS practice (Green creation, Green distribution, Green sourcing, Green usage and end of life) implemented in CE. Respectively, the independent variables and Green IT/IS practice derived from the literatures are confirmed by the interview data gotten from the selected case study. Thus, data was collected regarding the independent variables and Green IT/IS practice, until the interviews sessions did not reveal any new information, which is an indication that theoretical saturation was achieved as recommended by Yin (2011). Details of the case studies and informants can be seen in Table 4.1 and Table 4.2 in Chapter 4. The interview question can be seen in Appendix A.

3.2.4.3 Quality Criteria of Case Study Findings

The next phase verifies the quality of case study findings based on the following criteria; credibility, transferability, dependability and confirmability. Morris (2006); Creswell (2009) and Yan and Barbara (2009) mentioned that; to ensure the trustworthiness of finding from qualitative data; credibility, transferability, dependability and confirmability are qualitative terms used to check the reliability and validity of qualitative data.

3.2.5 Phase – 3: Model Development

This phase involves the development of the proposed Green IT/IS assessment model. This phase aims to provide answer to the last research question; how to assess the current Green IT/IS practice being implemented in collaborative enterprise?, (as

stated in Section 1.4). Respectively, the model is developed to accomplish the second research objective, (as stated in Section 1.6) which is to propose a Green IT/IS assessment model based on belief-action-outcome framework. The Green IT/IS assessment model is proposed based on Belief-Action-Outcome (BAO) framework designed by Melvin (2010). Melville (2010) argued that sustainability involves human behaviour and the broader social, economic, and environmental context; it therefore covers both IT manager and IT practitioners. This study opted for belief-action-outcome framework in developing the proposed Green IT/IS assessment model because BAO framework helps to explore the independent variables that influence organizational Green IT/IS practice and is also applicable in explaining the outcome of Green IT/IS practice implementation as stated in Section 2.8.14. Moreover, application of BAO in developing the proposed Green IT/IS assessment model is further discussed in Section 5.3 and 5.4 respectively in Chapter 5.

3.2.6 Phase – 4: Model Validation

This phase aims to achieve the third research objective mentioned in Section 1.6 which aims to validate the proposed Green IT/IS assessment model using survey data.

3.2.6.1 Survey Protocol

Quantitative research was employed using online survey to collect data among IT practitioners to validate the developed Green IT/IS assessment model. The data from the survey was analysed using Statistical Package for Social Sciences (SPSS) as utilized by researchers such as Lintukangas et al. (2014); Opitz et al. (2014); Luan et al. (2015); Baggia et al. (2016) where the authors deployed SPSS to analyse their data on Green IT and Green IS integration in enterprises. Besides, Partial Least Square-Structural Equation Modeling (PLS-SEM) was also applied to analysed the survey data towards confirming the analysis carried out by SPSS similar to prior studies (Molla, 2009a; Chen et al., 2011; Vykoukal et al., 2011; Molla et al., 2014; Ainin et al., 2015). Where the researchers used PLS-SEM to validate data they collected from survey.

The survey instrument questions were designed based on previous research studies on Green IT and Green IS practice implementation (see Table 3.3 and 3.4). In addition, for sustainability economic is measured based in Green souring, social is measured using Green distribution and Green usage, whereas environmental is

measured using Green creation and end of life items. The respondents were asked to select the importance of different attributes or items used to measure each independent variable in regards to Green IT/IS practice and current Green IT/IS practice implemented in their respective enterprise. Before administering the questionnaire to purposively selected respondents, three IS domain experts checked face and content validity of the questions which lead to the refinement of a few questions based on the feedback from the experts. Next, the link (survey monkey) to the survey was sent via e-mail alongside a cover letter to potential respondents that currently implement Green IT/IS practice in their enterprise. The email addresses were gotten from their enterprise website. The respondents were about 1,190 purposively sampled from Thirty-six CE in Malaysia.

Table 3.3 Operationalization of independent variables and related items

Independent Variables	Code	Items to Measure Independent Variables	References
IT Practitioners	ITP1	Positive attitude of IT practitioners.	(Jenkin and McShane, 2008).
	ITP2	Ethical consideration of IT practitioners.	(Molla et al., 2011).
	ITP3	Social-culture of IT practitioners.	(York et al., 2009; Molla et al., 2011).
	ITP4	General capabilities of IT practitioners.	(Info~Tech, 2007; Molla et al., 2011).
	ITP5	Beliefs of IT practitioners in relation to climate and environment.	(Elliot and Binney, 2008).
	ITP6	Knowledge of IT practitioners in relation to climate and environment.	(Elliot and Binney, 2008; Info~Tech, 2008).
	ITP7	Experience of IT practitioners in the industry.	(Accenture, 2008; Molla et al., 2011).
	ITP8	IT practitioners' commitment.	(York et al., 2009; Molla et al., 2011).
IT Governance	ITG1	Formal enterprise structures.	(Hart, 1997; Molla et al., 2011).
	ITG2	Management playing leading role.	(Hart, 1997; Gartner, 2008; CFO, 2009).
	ITG3	Management support.	(Hart, 1997; CFO, 2009).
	ITG4	Management investigation on ways to reduce IT power consumption.	(Hart, 1997; Gartner, 2008).
	ITG5	Management advocates the use of equipment by potential IT suppliers.	(Hart, 1997; CFO, 2009; Molla et al., 2011).
	ITG6	Management policy for the use of software to reduce overall wastes.	(Hart, 1997; Murugesan, 2008; Molla et al., 2011).
	ITG7	Management policy on staff's use of IT in an energy efficient manner.	(Hart, 1997; Molla, 2009b).
	ITG8	Allocated budgets and other resources by management.	(Hart, 1997; Molla, 2009b).

Table 3.3 Continued.

Independent Variables	Code	Items to Measure Independent Variables	References
Technologies and Systems	TS1	Transforming its enterprise operations to be paperless.	(Info~Tech, 2007; Mines, 2008).
	TS2	Server/Storage virtualization and consolidation to reduce energy usage.	(Elliot and Binney, 2008; Info~Tech, 2008).
	TS3	Use of teleconferencing for meetings.	(Nunn, 2007; Molla et al., 2011).
	TS4	Use of video conferencing for daily operations.	(Accenture, 2008; Molla et al., 2011).
	TS5	Use of telecommuting for transporting around the enterprise.	(Molla, 2009b; Molla et al., 2011).
	TS6	Use of on-line collaboration tools for enterprise day-to-day operations.	(Molla, 2009b; Molla et al., 2011).
	TS7	Installation of software to reduce overall emissions and wastes.	(Info~Tech, 2007; Molla et al., 2011).
	TS8	Installation of software to reduce overall use of hazardous materials.	(Mines, 2008; Molla et al., 2011).
Motivating Forces	MF1	The pressure from government and non-governmental bodies.	(Kant, 2009; Chen et al., 2011; Butler, 2011a).
	MF2	Management involvement influences Green IT/IS practice implememtation.	(Chen et al., 2011; Butler, 2011a).
	MF3	Provision of government incentives and other resources.	(Chen et al., 2011; Butler, 2011a).
	MF4	The actions of other enterprise competitors.	(Daly and Butler, 2009; Kant, 2009).
	MF5	Pressure from clients, consumers and vendors.	(Daly and Butler, 2009; Kant, 2009).
	MF6	Encouragement from external associations.	(Daly and Butler, 2009; Kant, 2009).
	MF7	Future consequences of firms actions	(Chen et al., 2011).
IT Strategy	ITS1	Tackling the carbon foot print of IT systems.	(Schulz, 2009; Molla and Cooper, 2014).
	ITS2	Own industrial strategy.	(Molla et al., 2011).
	ITS3	Financial returns on investment.	(Molla et al., 2011).
	ITS4	Plan initiatives on how to achieve sustainability.	(Chen et al., 2011).
	ITS5	Effective routines to facilitate the combination of newly acquired knowledge.	(Daly and Butler, 2009; Kant, 2009).
	ITS6	Refine procedures to facilitate the combination of newly acquired knowledge.	(Daly and Butler, 2009; Butler, 2011a).
	ITS7	Develop business opportunities based on sustainability perspective.	(Loper and Parr, 2009; Molla, 2009b).
Information Availability	IA1	Providing latest data relating to the environment and climate across the enterprise.	(Daly and Butler, 2009; Butler, 2011a).
	IA2	Usage of data to communicate and have access to information unconstrained.	(Butler, 2011a).
	IA3	Providing precise and unique data within the enterprise.	(Daly and Butler, 2009; Molla and Cooper, 2014).
	IA4	Providing same and consistent data across the industry.	(Daly and Butler, 2009; Molla and Cooper, 2014).

Table 3.4 Operationalization of Green IT/IS practice and related items

Green IT/IS Practice	Code	Items to Measure IT/IS Practice	References
Green Creation	GC1	Concerned about the energy consumption of cooling and lighting in our enterprise.	(Info~Tech, 2007; Velte et al., 2008; Elliot and Binney, 2008; Gartner, 2008).
	GC2	Concerned about the efficiency of powering our hardware infrastructure.	(Velte et al., 2008; Molla, 2009b; Schmidt et al., 2009).
	GC3	Considers environmental factors in the design of enterprise infrastructure and IT infrastructure.	(Accenture, 2008; Velte et al., 2008; Schmidt et al., 2009; Molla, 2009a)
	GC4	Relocate our enterprise's data center near clean sources of renewable energy.	(Molla, 2009a; Molla et al., 2011).
	GC5	Use electricity from Green energy providers in our enterprise.	(Molla et al., 2011).
	GC6	Enforces power management in our enterprise.	(Schmidt et al., 2009; Molla, 2009b).
Green Distribution	GD1	Install software to make production more environmentally friendly in our firm.	(Gartner, 2008; Schmidt et al., 2009; Molla, 2009b).
	GD2	Retire energy inefficient systems in our enterprise.	(Murugesan, 2008; Molla, 2009a; Schmidt et al., 2009).
	GD3	Analyses software induced energy bill separately from overall corporate.	(Gartner, 2008; Schmidt et al., 2009).
	GD4	Engaging the service of a professional service provider to maintain our firms.	(Info~Tech, 2007; Gartner, 2008; Schmidt et al., 2009).
	GD5	Install more energy efficient lightings in our enterprise.	(Molla, 2009a; Schmidt et al., 2009).
	GD6	Upgrades to efficient transformers and UPS in our enterprise.	(Schmidt et al., 2009).
	GD7	Auditing the power efficiency of systems and technologies for lesser power consumption.	(Gartner, 2008; Velte et al., 2008; Schmidt et al., 2009).
	GD8	Eliminates and de-commission unused services and systems.	(Elliot and Binney, 2008; Schmidt et al., 2009).
Green Sourcing	GS1	Install software to make material sourcing more environmentally friendly.	(Elliot and Binney, 2008; Velte et al., 2008; Schmidt et al., 2009).
	GS2	Buys recycled hardware equipment for enterprise use.	(Elliot and Binney, 2008; Schmidt et al., 2009).
	GS3	Makes preference to hardware suppliers that have a Green track record.	(Gartner, 2008; Molla, 2009b; Schmidt et al., 2009).
	GS4	Gives weight to environmental considerations in enterprise equipment procurement.	(Accenture, 2008; Gartner, 2008; Velte et al., 2008; Molla, 2009a; Schmidt et al., 2009).
	GS5	Deploy environment-friendly software procurement policy.	(Accenture, 2008; Schmidt et al., 2009).
	GS6	Purchase hardware equipment from vendors that offers take back option.	(Velte et al., 2008; Schmidt et al., 2009).

Table 3.4 Continued.

Green IT/IS Practice	Code	Items to Measure IT/IS Practice	References
Green Usage	GU1	Environmental consideration in planning IT usage and operations.	(Info~Tech, 2007; Accenture, 2008; Gartner, 2008; Molla, 2009b; Velte et al., 2008).
	GU2	Applied power management features of IT equipment regularly used.	(Info~Tech, 2007; Velte et al., 2008; CFO, 2009; Molla, 2009a)
	GU3	Turn off associated data center system when not in use to saves energy.	(Velte et al., 2008; CFO, 2009; Molla, 2009a)
	GU4	Print report on both side of a paper to reduce paper wastage.	(Info~Tech, 2007; Velte et al., 2008; CFO, 2009)
	GU5	Utilizes IT equipment that has functions to monitor workloads and shut down when unused.	(Velte et al., 2008; CFO, 2009; Molla, 2009b)
	GU6	Uses free cooling within the enterprise to reduce incurred energy cost.	(Info~Tech, 2007; Velte et al., 2008; CFO, 2009; Molla, 2009a)
End of Life	EOL1	Recycle consumable equipment such as batteries, ink cartridges, and paper.	(Info~Tech, Gartner, 2008; 2007; Molla, 2009a; Schmidt et al., 2009)
	EOL2	Disposes hardware equipment in an environmentally friendly manner.	(Info~Tech, 2007; Gartner, 2008; Murugesan, 2008; Molla, 2009b; Schmidt et al., 2009)
	EOL3	Carryout policy on managing electronic waste.	(Velte et al., 2008; Molla, 2009a; Schmidt et al., 2009)
	EOL4	Reuse hardware equipment.	(Gartner, 2008; Molla, 2009b; Schmidt et al., 2009)
	EOL5	Refurbish old, out-dated and obsolete hardware equipment.	(Gartner, 2008; Molla, 2009b; Schmidt et al., 2009)

Data was collected from the online survey from January 2017 to April 2017 using the deployed survey questionnaire. The survey question (see Appendix B) is divided into four sections; section one consists of a short introduction which included the need for the research and a brief definition of few key terminologies. The respondents were also assured of their anonymity. Secondly, the demographic characteristics of the respondents and their respective enterprise which used ordinal scale are presented next. The third section consists of question to measure the independent variables that influence Green IT/IS practice based on attributes or item derived from the literatures (see Table 3.3). The final section comprises questions to validate the Green IT/IS practice derived from the literatures (see Table 3.4). The survey question to measure the independent variables and Green IT/IS practice are shown in Appendix B.

Next, the participants were asked questions to measure the level of importance of each independent variable's and Green IT/IS practice attribute using Likert scale with five response categories (1-5) was used where "1" indicates not important and "5" represents the very important. The higher the selected value, the more important the attribute or item is in relation to the measured independent variable or Green IT/IS practice. Furthermore, for sample size Hair et al. (2006) stated that sample sizes between 100 and 200 would be appropriate and sufficient to proceed with quantitative study. Thus, survey invitation was sent to prospective participate through their official organizational e-mailed collected from the enterprise's website. Participants were chosen using purposive sampling, where each participant was selected based on their experience, knowledge and current role in their respective enterprise.

To confirm each participant is suitable to provide data needed in validating the identified independent variables and Green IT/IS practice, each participant's profile and background was confirmed through their enterprise Green IT/IS practice departmental website. Email request messages were sent to qualified participant to partake in the survey session at the convenience of the participant. Each email sent contains a cover letter regarding the research and the need for the research alongside web address link to the questionnaire for potential respondents. After sending three rounds of reminders a total of 133 anonymous completed responses from a cross region of CE in Malaysia were received. The sample is between medium ranges, hence acceptable based on similar sample utilized in prior studies as seen in Table 3.5.

Table 3.5 Justification of sample size

Authors, Year and Contribution	Focus of Study and Context	Methodology	Statistical Tool
Dalvi-Esfahani et al. (2017b) investigate the role of the personal values on managers' intention to adopt Green IS.	Green IS adoption for Managers in Malaysia.	146 questionnaires.	PLS-SEM
Loeser et al. (2017) examined how IT executives create organizational benefits by translating environmental strategies into Green IS initiatives.	Green IT and Green IS in US, Germany, Canada, Australia and new Zealand organizations.	Survey of 118 IT executives.	PLS-SEM
Kotze et al. (2014) examined the key drivers of Green IS in companies.	Green IS in South African listed companies.	28 survey respondents.	SPSS
Molla and Cooper (2014) researched on Greening data centers.	Green practice in Australian data center operator.	97 survey samples.	PLS-SEM and SPSS

Table 3.5 Continued.

Authors, Year and Contribution	Focus of Study and Context	Methodology	Statistical Tool
Schmidt et al. (2011) explored the contribution of Green IT in IT departments.	Green IT practice in Germany enterprises.	116 survey samples.	SPSS
Kuo and Dick (2009) examined the Greening of organizational IT.	Green IT practice in Australia.	30 survey samples.	SPSS
Opitz et al. (2014) proposed how to govern Green IT.	Green IT governance in Australia.	71 completed questionnaire	SPSS
Ainin et al. (2016) studied the impact of Green IT practice in organizational performance.	Green IT in Iran (Tehran stock exchange).	277 survey questionnaire.	SEM-AMOS
Lintukangas et al. (2014) studied supply risks as drivers of Green supply management adoption.	Green practice in Finnish companies.	165 survey response.	SPSS
Molla and Ahmad (2012) examined the influence of Eco-sustainability motivations for Green IT and Green IS adoption.	Green IT practice in Australia.	176 survey data.	SEM-AMOS
Jung et al. (2011) explored Green management performance in small and medium sized corporations.	Green practice in Korean corporations.	178 survey samples.	SPSS
Molla (2013) identified IT sustainability performance drivers.	Green IT practice in Australia.	133 survey responses.	SEM-AMOS and SPSS
Benitez-Amado et al. (2010) investigated Green management capabilities in relation to technological IT and human IT.	Green practice in Spanish firms.	203 survey responses.	PLS-SEM
Abareshi and Molla (2013) researched on Greening logistics and its impact on environmental performance.	Greening logistics and transport operation in Australia.	279 survey response.	SEM-AMOS
Baggia et al. (2016) examined the awareness towards Green IS.	Green IS in Slovenia enterprise.	222 survey response.	SPSS
Molla (2009) explored organization motivation for Green IT.	Green IS in Australia and New Zealand.	109 survey response.	SPSS
Molla et al. (2011) proposed a Green IT Readiness Model.	Green IT in Australia, New Zealand and USA.	143 survey response.	SEM-AMOS
Cooper and Molla (2014) investigated the level of Green IT assimilation in organization.	Green IT assimilation in in US, Australia and New Zealand.	148 survey response.	PLS-SEM
Cater-Steel and Tan (2011) explored the relationship between IT Service Management and Green IT.	Green IT service management in Australia.	65 survey response.	SPSS
Gholami et al. (2017) studied Green IS use in social enterprise.	Green IS in small social enterprise	83 survey response.	PLS-SEM
Wati and Kuo (2012) carried out a study towards Green IS adoption behaviour.	Green IS in US.	100 survey response.	PLS-SEM
Sacchero and Molla (2009) researched on environmental consideration in ICT infrastructure decision making.	Green ICT in Australia.	24 survey response and 3 interviews.	SPSS

Table 3.5 Continued.

Authors, Year and Contribution	Focus of Study and Context	Methodology	Statistical Tool
Akman and Mishra (2015) examined sector diversity in Green IT practice.	Green IT practice in Turkey.	182 survey response.	PLS-SEM
Widjaja et al. (2014) investigated IT professionals' awareness on Green IT.	Green IT practice in Indonesia.	105 survey response	SPSS
Esfahani et al. (2015) examines the individual factors that influence organizational decision-makers to adopt Green IS.	Green IT practice in Malaysia.	50 survey response from scholars.	TOPSIS Technique
Chen et al. (2011) studies an institutional perspective of Green IT/IS.	Green IT/IS from 22 countries.	75 survey responses.	PLS-SEM

3.2.6.2 Missing Values (Treatments)

Missing data typically refer to the absence of one or more values within a study variable(s) contained in a dataset. The development is often the result of a questionnaire participant choosing not to provide a response to a survey item. In this study 82% of the respondents provided completed data whereas the remaining 18% had missing data, hence SPSS was used to treat missing data by replacing missing data with mean scores.

3.2.6.3 Statistical Tools and Survey Data Analysis Procedure

This study used Statistical Package for Social Sciences (SPSS) version 22 and SmartPLS version 3 (Partial Least Square-Structural Equation Modeling). SPSS is utilized to carryout descriptive, exploratory and inference statistical test. SPSS is a windows-based program used for analysis of data through table and graphs. Whereas, SmartPLS allows estimating complex cause effect relationship models with variables. It uses a component based estimation approach. Furthermore, SmartPLS can be used for out-sample prediction purposes and it consist of two sub models; the measurement model and structural model. Accordingly, in this thesis SPSS is used to analyse the survey data towards validating the proposed Green IT/IS assessment model whereas the SmartPLS is further used to corroborate results from SPSS. Moreover, there are three important parts in data analysis which are, namely: exploration of data, descriptive statistics and inferential statistics that are carried out in this thesis in analyzing the survey data using SPSS.

3.2.6.4 Exploration of Data

Data exploration aims to clarify the original findings produced from previous literature works. There are many types of procedures to explore or screen the data, namely; descriptive tables, histograms and box plots. These can be used to inspect outliers and visually show the relationship between variables (Pallant, 2007). In this research the items were refined based on normality and reliable correlation of data which was checked before further analysis. Hence, before proceeding to inferential analysis normality, reliability, validity or linearity analysis was carried out in this thesis as seen in Table 6.2 and 6.3 in Chapter 6.

Normality Test

A normality test can be checked through the normal distribution of data and it has always been associated with the feel for data analysis process. Normality test can be carried out by deploying test such as Kolmogorov-Smirnov and Shapiro-Wilk test, which is applicable were the samples size is not large (Pallant, 2007). A sample size is said to be medium if above 100 and large if above 200 as mentioned by Hair et al. (2006). Skewness and kurtosis is another test that determine the normality of a given dataset, if the skewness and kurtosis values are between the range of -2 and +2, then the data is normally distributed and if the skewness and kurtosis values are above +3 or below -3 indicates that the variable is not normally distributed. In this thesis, the collected survey data were studied to determine whether they were normally distributed and therefore capable of satisfying parametric assumptions and, with that, inferential statistics can proceed. Therefore the Skewness and Kurtosis are used to carryout test for normality in this thesis as seen in Table 6.2 in Chapter 6. According to George and Mallery (2005), values of Skewness and Kurtosis between ±2 are acceptable.

Reliability and Validity

Reliability and validity are two elements use in the instrumental measurements evaluation such as survey questionnaire. Where validity refers to the degree in which an instrument such as questionnaire measure what is intended to measure. Three types of validity are employed in this study, face, content and construct validity. Face validity is carried out by domain experts to check the grammatical and format of the questions in the survey, whereas content validity measures the extent that the body of literature

surrounding the construct. In this thesis, content validity is maintained by adopting instrument that have been extensively used, validated, and tested for reliability by previous researchers (see Table 3.3 and 3.4). Construct validity refers to the degree to which evidence and theory support the interpretation of the test scores entailed by the proposed use of test. In this thesis, construct validity was determine by correlation, exploratory factor analysis in SPSS (see Table 6.3) and convergent validity (see Table 6.14 and 6.15) and discriminate validity (see Table 6.16-6.18) in PLS-SEM.

Reliability refers to degree to which the measure of concept is stable. Accordingly Hair et al. (2006) defined reliability as the extent in which the questionnaire (instrument) gives the same result consistently. The Cronbach's alpha is used to measure the internal consistency reliability coefficient. In addition, the value of alpha measures the internal consistency ranging from 0-9. Helms et al. (2006) provide the following rules of thumb: "> 0.9 – Excellent, > 0.8 – Good, > 0.7 – Acceptable, > 0.6 – Questionable, > 0.5 – Poor and < 0.5 – Unacceptable". The closer Cronbach's alpha coefficient is to 1.0 the greater the internal consistency of the items or attributes in the scale. In this thesis the Cronbach's alpha reliability test is shown in Table 6.2.

Correlation Analysis (Test of Validity/Linearity)

Correlation analysis provides an idea of how much of variation in one variable can be attributed to its relationship to another variable. Correlation however, does not imply causation it merely suggests that a relationship exists between variables. Correlation is one of the most frequently used analyses to study the relationship among variables and this test can also investigate the linearity characteristics of variables. Correlation coefficient is often denoted as ρ or r, which measures the degree of correlation. The most common is the Pearson correlation coefficient (r), which is sensitive only to a linear relationship between two variables. In this thesis, the correlation analysis is being used to explore the strength of relationship for the independent variables and dependent variable and dependent variable, Green IT/IS practice, and Green IT/IS practice and sustainability attainment based on the values suggested by Cohen et al. (2013) as seen in Table 3.6. In this thesis the correlation analysis is shown in Table 6.3.

Table 3.6 The strength of relationship

No.	Correlation Coefficient	Type of Strengths
1	0.1 to 0.29 OR -0.1 to -0.29	Weak
2	0.30 to 0.49 OR -0.30 to -0.49	Moderate
3	0.50 to 1.0 OR -0.50 to -1.0	Strong

Source: Cohen et al. (2013).

3.2.6.5 Descriptive Statistics

Descriptive statistics can be defined as the summary of distribution scores by using tabular or graphical presentations and computation of statistical measures (Cooper and Schindler, 2008). As the name implies, descriptive statistics are used to describe the data collected in research studies and to accurately characterize the variables under observation within a specific sample. Descriptive analyses are frequently used to summarize a study sample prior to analyzing primary data. This provides information about the overall representativeness of the sample, as well as the information necessary for other researchers to replicate the study (Curwin and Slater, 1991). In this thesis the percentage, frequency, mean and standard deviation values are used to describe the demographic profile of participants and items in the survey and questionnaire as seen in Table 6.1 and 6.2.

3.2.6.6 Inferential Statistics

Inferential statistics, unlike descriptive statistics, provide ways of testing the reliability of the findings of a study and "inferring" characteristics from a small group of participants or the sample onto the population. Where descriptive statistics just describe the data, inferential statistics further allow the researcher to explain what the data means. Inferential statistics can also make judgments on the probability that an observed difference between variables. This thesis utilized regression, partial correlation analysis and multiple regression moderating analysis to infer the hypotheses testing. Table 6.5 shows the type of analysis for each hypothesis testing in this thesis.

Regression Analysis

Regression analysis is a statistical test for the investigation of the relationship between variables in which they control for many alternative explanations and variables simultaneously (Statistics.laerd, 2017a). Regression analysis is utilized in this thesis to

validate if the independent variables (IT practitioners, IT governance, technologies and systems, IT strategy, motivating forces and information availability) influence the dependent variable (Green IT/IS practice) hence confirming if the hypotheses (H1 to H6) are supported or not supported (see Table 6.6). In addition, regression analysis is carried out to predict the changes in the dependent variable in response to changes in the Green IT/IS practice (Green creation, Green distribution, Green sourcing, Green usage and end of life) in the model (H7a to H7e) (see Table 6.7). As well as H11, H12 and H13 for measuring sustainability attainment (see Table 6.8). According to Hair et al. (2006) in regression analysis the *F* statistics, *t*-statistics and significant value (known as *p*-value) are considered to make a decision to accept or reject a regression test as shown below:

If *p*-value for *F*-test < significant level α =0.05 (Significant Influence)

If *p*-value for *F*-test > significant level α =0.05 (Not significant Influence)

Multiple Regression Moderating Analysis

Multiple regression moderating analysis is an extension of simple linear regression. It is used to predict the value of a variable based on the value of two or more other variables (Statistics.laerd, 2017a). Multiple regression moderating analyses is used to test the hypotheses (H9a, H9b, H9c, H10a, H10b and H10c), moderating variables (gender, age and education) based on two independent variables (IT practitioners and IT governance) in this thesis as presented in Table 6.10 and 6.11.

Partial Correlation Analysis

Partial correlation is a measure of the strength and direction of a linear relationship between two continuous variables whilst controlling for the effect of one or more other continuous variables (also known as 'control' variables or 'covariates') (Statistics.laerd, 2017b). Hence, partial correlation was carried out in this thesis to validate the relationship between the control variables (timing, sector, size, revenue) in relation to the dependent variable where the hypotheses includes H8a, H8b, H8c, H8d H8e as presented in Table 6.9.

One-Way ANOVA

Analysis of variance (ANOVA) is a parametric statistic test employed to compare means of different values among three or more independent groups. Anova is suitable to be use when the measurement is a continuous variable and when the explanatory variable has more than three groups. It allows researchers to know if there is significant difference between two or more groups' in-terms of their mean value (Statistics.laerd, 2017a). A variable is said to be significant if the *P* value obtained is < α. Whereas if the *P* value obtained > α, it is said not to be significant among the independent variables. In this thesis one-way Anova is used to carryout non-bias analysis for bias test as shown in Section 6.3.2, Table 6.4 in Chapter 6. In addition, one-way Anova is used to test the moderating effect of age distribution on IT practitioners and IT governance as seen in Table 6.26 and 6.27 respectively in Chapter 6.

3.2.6.7 Partial Least Square-Structural Equation Modelling (PLS-SEM)

Structural Equation Modeling (SEM) is a second-generation multivariate (involving two or more variables) data analysis method that is often used in computer science information systems research because it can test theoretically supported linear and additive causal models. In SEM there are two sub-models in a structural equation model; the inner model specifies the relationships between the independent and dependent variables, whereas the outer model specifies the relationships between the variables and their observed attributes or items also known as measurement model.

In SEM, a variable is either exogenous (independent variable) or endogenous (dependent variable). Similarly, Partial Least Square (PLS) is a modelling approach to SEM with no assumptions about data distribution (Hair et al., 2006). In particular, PLS-SEM allows for complex models that include reflective and formative measurement of items (Lowry and Gaskin, 2014). Thus, PLS-SEM becomes a good alternative when sample size is small and applications have little available theory. Moreover, PLS-SEM is also useful in research projects especially when there are limited participants and that the data distribution is skewed (Wong, 2013). Therefore, PLS-SEM was utilized in this thesis to provide more insight to the survey data after analyses with SPSS. The findings from PLS-SEM are used to corroborate results from SPSS. Below are the following

analyses that were carried out in this thesis using PLS-SEM to perform to further validate the developed Green IT/IS assessment model.

PLS Algorithm

The PLS algorithm is a sequence of regressions in terms of weight vectors. The weight vectors obtained at convergence satisfy fixed point equations. Hence, in this thesis PLS algorithm is used to analyse the factor loading of each item used to measure the independent variables, Green IT/IS practice, sustainability, and dependent variable (see Table 6.14 and 6.15 loading column), where each values should be greater than "0.5" but less than "1" as suggested by Hulland (1999).

Bootstrapping

Bootstrapping is a nonparametric procedure that allows testing the statistical significance of various PLS-SEM results such as path coefficients, Cronbach's alpha, and R^2 values. PLS-SEM relies on a nonparametric bootstrap procedure to test the significance of estimated path coefficients. In bootstrapping, subsamples are created with randomly drawn observations from the original set of data (with replacement). The subsample is then used to estimate the PLS path model. This procedure is repeated until a large number of random subsamples have been created, typically about 5,000 (Hair et al., 2012). The parameter estimates (e.g., outer weights, outer loadings and path coefficients) estimated from the subsamples is utilized to derive estimates.

With this information, *t*-statistics values are calculated to measure hypothesis significance (see Table 6.19). Hence, in this thesis the *t*-values from bootstrapping is used to validate the hypotheses H1, H2, H3, H4, H5, H6 between the independent variables also referred to as formative variables and dependent variable as well as H7a, H7b, H7c, H7d, H7e relationship between the dependent variable and Green IT/IS practice also referred to as reflective variables variable. As well as H11, H12 and H13 for measuring sustainability attainment (see Table 6.14 and 6.15). Lastly, bootstrapping was also applied to validate the hypotheses H9a, H9b, H9c, H10a, H10b, H10c between the moderating variables (gender, age and education) and two independent variables (IT practitioners and IT governance) (see Figure 6.4 and 6.5).

Importance-Performance Map Analysis (IPMA)

SmartPLS 3 provide information on the relative importance of independent variables in explaining the dependent variables using the Importance-Performance Map Analysis (IPMA). The IPMA test extends the results of PLS-SEM by also taking the performance of each independent variable into account. As a result, conclusions can be drawn on two dimensions (i.e., both importance and performance), which is particularly important in order to prioritize CE actions toward the independent variables that influence Green IT/IS practice. Consequently, it is preferable to primarily focus on improving the performance of those variables that exhibit a large importance regarding their explanation of a certain target construct but, at the same time, have a relatively low performance. Hence, IPMA was accrued out in this thesis as seen in Table 6.20.

Blindfolding Test

To assess the total effect for dependent variable and Green IT/IS practice, the blindfolding test was deployed in SmartPLS3, where blindfolding is samples re-use technique. It allows calculating Stone-Geisser's Q^2 value, which represents an evaluation criterion for the cross-validated predictive relevance of the PLS path model. Besides evaluating the magnitude of the R^2 values as a criterion of predictive accuracy, researchers may desire to also examine Stone-Geisser's Q^2 value as a criterion of predictive relevance. The Q^2 value of variables in the PLS path model is obtained by using the blindfolding procedure (Hair et al., 2012). Hence, each Q^2 value should be greater than "0" as suggested by Hair et al. (2013), thus results from blindfolding (Q^2 value) is presented in Table 6.21.

Multiple Group Analysis

Multi-group analysis allows to test if pre-defined data groups have significant differences in their group-specific parameter estimates. In this thesis multi group analysis is used to validate the hypotheses H8a, H8b, H8c and H8d, where the effects of the control variables (timing, sector, size and revenue) in relation to the dependent variable is determined in relation to the significance of probability based on the significant result at the 5% probability of error level, if the *p*-value is smaller than 0.05 as shown in Table 6.22 to Table 6.25.

Discriminate Validity

The discriminate validity ensures that a variable has the strongest relationships with its own indicators in comparison with than any other variable in the model. Discriminate validity is assessed by considering the cross-loadings values which must be greater than 0.5 but less than 1 (Henseler et al., 2015). Thus, in this thesis the discriminate validity is analysed for all independent variables and dependent variable as well as the Green IT/IS practice and dependent variable as well as Green IT/IS praftice and sustainability as seen in Table 6.16 to 6.18.

3.2.6.8 Green IT/IS Assessment Tool Evaluation

This phase involves the evaluation of the implemented Green IT/IS Assessment Tool (GAT) (see Appendix D) to accomplish the last research objective which aims to further validate the applicability of the proposed Green IT/IS assessment model using the implemented Green IT/IS assessment tool (see Section 1.6 in Chapter 1). Thus, GAT is implemented in PHP MySQL similar to prior studies (Yang, 2012; Zouhair et al., 2014) who utilized PHP to implement an agent and CBR web based tool in their research. Furthermore, this study is similar to Kwon et al. (2007); Gawali and Meshram (2009); Shen et al. (2015) where the author implemented agent web based systems and Kwon et al. (2007); Yang (2012); Chang et al. (2016); Chen and Ma (2015) who implemented their CBR systems based on an online platform.

Next, data was collected using focus-group questionnaire to test for the applicability of GAT in validating the proposed Green IT/IS assessment model similar to Belecheanu et al. (2003) who measured the applicability in their CBR based application. Data was collected from thirty-five IT practitioners similar to Chang et al. (2016) who utilized data from thirty-two respondents in their research on evaluating an agent-CBR based online bookstore and Ghazalli and Murata (2011) who collected data from only fifteen respondents to evaluate their CBR-AHP tool. In addition, the system architectures are designed to illustrate how software agents and Case Based Reasoning (CBR) are applied for Green IT/IS assessment and best practice recommendation (see Appendix D). The validation of the model using GAT is carried out using focus-group questionnaire as suggested by Hallie and Darlene (2005) derived from prior studies O'Keefe and O'Leary (1993); Curet et al. (1996); Zhang and Adipat (2005); Aziz and

Kamaludin (2014) and was conducted in a focus-group session within seven selected CE in Malaysia (same CE from the survey data collection) that implements Green IT/IS practices. Hence, employing IT practitioners as respondents since they possess detailed knowledge towards Green IT/IS practice implementation in their enterprise. The focus-group questionnaire data collection session lasted for 30 minutes (15 minutes to demonstrate the tool and another 15 minutes for the participants to answer the questionnaire).

The first part of the questionnaire comprises of the demographic characteristic of the respondents, whereas second part of the questions measures the applicability of GAT (see Appendix C for questionnaire), similar to the procedure carried out by Belecheanu et al. (2003) in their CBR based research. In addition since the questionnaire was designed to validate the applicability of GAT, the participants were asked to select the importance of different items used to measure the tool. At the end of our focus-group questionnaire a total of thirty-five experts valid responses was gotten which is accepted and appropriate to proceed with validating GAT based on the number of responses used in prior studies, where Ghazalli and Murata (2011) collected data from fifteen respondents, whereas Chang et al. (2016) utilized data from thirty-two respondents in their research on evaluating an agent-CBR based online bookstore.

Accordingly, descriptive analysis and factor analysis (principal component analysis) was later carried out to determine the applicability of GAT. Factor analysis is a statistical technique deployed to identify the structure of the relationship between questionnaire item and participants responds (Cooper and Schindler, 2008). The criteria for statistical significance of factor loading can be classified based on their magnitude (Greater than + 0.30 = minimum consideration level, + 0.40= more important and + 0.50 = practically significant). Hence, descriptive analysis and factor analysis is used to test the applicability of the implemented GAT in this thesis (see Table 6.29 and 6.30). Furthermore, Kaiser-Meyer-Olkin (KMO) was also employed to further analyse the applicability of GAT, where KMO test is a measure of how suited a data is for factor analysis. KMO employs test of sampling adequacy for each item by measuring the proportion of variance among items that might be common variance. While KMO values around 0.5 are barely acceptable, higher KMO values are ordered as mediocre

(0.5–0.7), good (0.7–0.8), great (0.8–0.9), and superb (above 0.9) (Hutcheson and Sofroniou, 1999). KMO test is shown in Section 6.6 in Table 6.31 in Chapter 6.

3.3 Summary

This chapter discusses the methodology employed in conducting this thesis. This study employed pragmatic paradigm by deploying a mixed method; qualitative and quantitative approach. The methodology part covered the research design of this study. The methodology chapter explains how the research is carried out from the literature review phase, preliminary study phase, model development phase, and model evaluation phase. This chapter explains how the research problem was addressed; how the research questions are answered and how the research objectives are achieved. Furthermore, this chapter discussed on how the proposed Green IT/IS assessment model is developed based on belief-action-outcome framework. This chapter also explains on how the data was collected using case study by interview to confirm the model independent variables and Green IT/IS practices. The chapter further discuss how the author collected data using survey to validate the developed Green IT/IS assessment model. In addition, this chapter describes how the survey data was analysed using SPSS and SmartPLS. Lastly, this chapter highlights how the author utilized the implemented GAT to also validate the developed Green IT/IS assessment model based on a focus-group questionnaire to test the applicability of the tool.

CHAPTER 4

PRELIMINARY STUDY

4.1 Introduction

This chapter discusses the qualitative data collection and analysis in confirming the Green IT/IS practice and independent variables derived from the literatures as presented in Section 2.6.1 and 2.6.2 in Chapter 2. The chapter begins with a discussion of the purpose and informants involved in the case study by interview. This chapter then move to discuss the findings based on data obtained from the case studies, conducted in four CE based in Malaysia with a total of fifteen informants as stated in Section 3.2.4.1 in Chapter 3. This chapter further discusses the quality in qualitative study showing how the data was verified in the reporting finding from the interview transcript. The last section states the summary of the chapter.

4.2 Findings from Case Studies

The enterprise selected for the case study were chosen because they were considered frontrunners in Green IT/IS practices in Malaysia as proven through the receipt of recognition towards sustainability attainment (see Section 3.2.4.1 in Chapter 3). Accordingly, semi-structured interviews was used to collect data, the semi-structured interview consists of open-ended questions that focused on the informants' perceptions of the independent variables that influence Green IT/IS practice and Green IT/IS practice implemented in their enterprise. Moreover, participants (see Table 4.1) are IT practitioners who had in-depth understanding of issues surrounding Green IT/IS practice. Table 4.2 shows the characteristics, difference and similarities of all case studies. The interview data were supplemented with data from Green IT/IS documents

included those publicly available at the organizations websites, and those provided by the informants after the interview session. The interview was conducted in English and face-to-face and was recorded manually by the author who is the interviewer. As seen in Table 4.1, a total of fifteen interviewees were interviewed together and separately in some cases for about 30-45 minutes in their enterprise at their own convenience.

Table 4.1 Selected informants for the case studies interview

Case Studies	Type	Informants	Education	Working Experience	InformantsPosition	Total
Case study A, Universiti Malaysia Pahang (UMP)	Government based Institution (Mygreenump, 2016)	1	Bachelor's Degree	0-5	IT Officer	4
		2	Master's degree	0-5	Sustainability Officers	
		1	PhD	>20	Head of Sustainability	
		1	PhD	6-10	Head of ICT	
Case study B, Universiti Teknologi Malaysia (UTM)	Government based Institution (Sustainable_utm, 2016)	1	PhD	0-5	Corporate Strategy Officer	3
		1	PhD	16-20	Industry and Community Relations Officer	
Case study C, Ministry of Energy, Green Technology and Water (Kettha)	Government based Organization (Kettha, 2010)	2	Master's degree	0-5	IT Officers	4
		1	Master's degree	0-5	Sustainability Officer	
		1	Master's degree	11-15	Sustainability Technical Officer	
		1	PhD	>20	Director of Sustainability	
Case study D, Malaysia Green Technology Corporation (GreenTech Malaysia)	Government based Organization (Greentech.my, 2016)	1	Master's degree	0-5	Project Officer	4
		1	Master's degree	0-5	Senior Administrative Assistant	
		1	Master's degree	11-15	IT Officer	

Table 4.2 Selected enterprise characteristics

Characteristics	Case Study A	Case Study B	Case Study C	Case Study D
Enterprise sector	Education Research and human development.	Education Research and human development.	Government and Administration.	ICT, engineering and construction.
Enterprise size (employees)	Above 1000 employees.	Above 1000 employees.	251- 1000 employees.	51-250 employees.
Enterprise founding date (time)	Between 1991-2000.	Between 1967-1980.	Between 2001-2010.	Between 1991-2000.
Enterprise revenue (annually)	RM 4, 500,000 to RM 9, 000,000.	RM 9,000,000 or above.	RM 4, 500,000 to RM 9, 000,000.	RM 2,700,000 to RM 4,500,000.
Key Product and Services	Training and educational services.	Training and educational services.	Sustainable development products and services.	Sustainable development products and services.
Market Served	International	International	National	National
Determinants of sustainability	Normative pressure (pressure from management and stakeholders).	Normative and mimetic pressure (pressure to imitate operationally similar successful enterprise).	Coercive pressure (pressure from government).	Normative pressure (pressure from management and stakeholders).
The need for Green IT/IS	Support enterprise.	Improvement influencer.	Primary enterprise services and as enabler for enterprise operations.	Enabler for facilitating enterprise operations and also core enterprise service.
Main objective of Green IT/IS	Mostly waste minimization and end of life management.	Mainly energy utilization reduction.	Geared towards CO2 decrease and minimal natural resource usage.	Aimed at achieving cost lessening alongside CO2 decrease.
Motivation of Green IT/IS	Supporting enterprise daily operations.	Facilitating enterprise day-to-day activities.	To attain sustainable development towards Malaysia being a carbon free city come 2020.	Infusing Green culture to society and enterprise towards Malaysia being a Green city.
Management method for IT department	Social and environmental centered.	Social and environmental centered.	Synergies within economic, social, environmental goals.	Concerned about economic, social and environmental.
Start date of Green IT/IS practice	1st May 2011.	16th March 2011.	9th April 2009.	12th May 1998.

4.2.1 Independent Variables that Influences Green IT/IS Practice in CE

This section present finding based on data from the case studies to confirm the independent variables that influence Green IT/IS practice in CE. Accordingly, Table 4.3 presents a summary of the findings from the case study based on independent variables that influence Green IT/IS practice in the selected enterprises. Based on the summarized findings presented in Table 4.3, each of the independent variables are further described below in relation to how the four enterprise are influenced by the independent variables in implementing Green IT/IS practice to achieve sustainability.

Table 4.3 Summarized independent variables findings from case studies

Independent Variables	Case Study 1	Case Study 2	Case Study 3	Case Study 4
IT practitioners	-Headed by the center of excellence which research sustainability strategies.	-Comprises of committee members headed by office of campus sustainability.	-Has steering committee and working committee.	-Comprises nine committee members.
IT governance	-Allocates 7% of the enterprise' budget for Green IT/IS.	-Top management support and encouragement has been an important success factor	-Inaugurated a Green technology council to manage the enterprise.	-Integrates Green plan to reduce carbon emission by 40% by 2020.
Technologies and systems	-Installed renewable energy using solar and wind turbines for generation energy.	-Implements a sustainable energy management program to save electricity.	- Deploys solar panel to provide energy to the enterprise.	-Utilize solar energy, deploys a building energy management system.
Motivating forces	-Aimed to reduce the high cost from power usgae and allocates annual budget to support Green IT/IS practice.	-Gets motivational support from the top management and also reinvest money to promote Green energy initiatives.	-Provides financial incentives for staffs to pursue Green technology related training and businesses.	-Provides Green technology financing scheme to generate Green jobs and Green market.
IT strategy	-Aims to lessen CO and CO_2 emission and also create awareness on Green IT/IS practice.	- Aims to facilitate low carbon induced practices.	-Involves Green energy attainment and also support efficient electricity utilization.	-Provides policies and funding to promote Green IT/IS practices.
Information availability	-Provides information on how to promote Green IT/IS practice across the enterprise.	-Carries out energy reduction and saving awareness within the enterprise.	-Carryout awareness programs and demonstrations on Green IT/IS practices.	-Deploys promotion and public awareness program to create awareness.

4.2.1.1 IT Practitioners

According to the informants from all case studies IT practitioners influence Green IT/IS practice. The IT officer mentioned that case study A has many practitioners mainly in Green IT/IS practices initiatives headed by the Center of Excellence where research sustainability strategies that contribute to environmental protection are carried out by the enterprise' sustainability practitioners. Moreover, in Case Study A, the enterprise community is leading economic, environmental and social dimensions of sustainability in the enterprise operational day-to-day practices. Similarly, in Case Study B, the corporate strategy officer made mentioned that Green IT/IS practice is headed by the "Office of Campus Sustainability". As stated by the corporate strategy officer, Green IT/IS practice for sustainability in Case Study B incorporates the collective involvement of enterprise staff, departments and nearby neighbouring community.

Case study B comprises of sustainability council members and sustainability technical committee that encompasses experts from energy, water, environment, social and economy domain. Likewise, Case Study C has two committees, the steering committee and the working committee. The steering committee helps to create coordination and cooperation between several government agencies, enhance the fiscal and also provides support mechanisms for the Green technology council. Whereas the working committee comprises eight members that works under the steering committee to assist stakeholders in private agencies and organization towards Green technology implementation. In Case Study D the project officer stated that Green practice is headed by nine committee members.

4.2.1.2 IT Governance

According to the informants from all case studies IT governance polices set by the management influences Green IT/IS practice. The head of sustainability in Case Study A highlighted that the enterprise governance policy is committed towards achieving a sustainable and judicious consumption of natural resources and energy, as well as protecting the natural environment with the definitive aim of contributing to domestic and international agenda on sustainability. According to the sustainability officers 7% of the enterprise' budget is allocated to promote Green IT/IS practice.

The head of ICT in Case Study B added that the governance policy extends to ensure that the enterprise functions as a sustainable institutional community through optimized and responsible resource management, pioneering environmental and ecological system administration, efficient energy governance and governance commitment alongside institutional wide participation. According to sustainability committee member teamwork and top management support and encouragement has been an important success factor in developing the enterprise society culture towards Green IT/IS practice for reduced energy consumption and enterprise cost reduction.

Case Study C IT governance policy was established with the inauguration of a Green Technology Council to manage the organization of Government based agencies, private sector and key stakeholders for effective implementation of Green IT/IS initiatives. The sustainability officer claimed that Case Study C was established to outline Malaysian governments' commitment towards showing that Green and clean is the way forward for realizing an economy that is based on sustainable alternatives. In addition, the director of sustainability stated that Case Study D IT governance is based on environmental plan to decrease carbon emission by 40% by 2020 whereas the economic plan aims to contribute RM 22.4 billion which is about 1.2 per cent of the country's Gross Domestic Product (GDP) and also attract RM 26 billion in Green investment by 2020. Lastly, the social aims to create 144,590 Green jobs by 2020.

4.2.1.3 Technologies and Systems

According to the informants from all case studies the technologies and system utilized influences how Green IT/IS practices are implemented. The head of sustainability stated that case study A installed renewable energy sources using solar in 2015. Case Study A is located near coastal area that provides windy condition which facilitates the rotating of the turbine that converts kinetic energy into electricity. The IT officer mentioned that in 2012, case study A deployed wind turbines comprises of four windmills which produced energy of about 10 kilowatts (kw). According to the head of ICT in 2009 Case Study B implemented a Sustainable Energy Management Program (SEMP) and through the usage of SEMP from October 2010, Case Study B attained an energy efficiency index decrease of 3.7 per cent in 2010, 11.5 % in 2011, 12.2 % in 2012 and 15.3 % in September 2013 as compared to 2009. It was pointed out that a total cost saving amounting to RM 6.1 million or 19.6 million kilo watts. The sustainability

technical officer mentioned that Case Study C also utilized energy utilization by applying demand side control management by deploying solar panel to provide energy to the enterprise car parks and a few offices.

Case Study D enterprise buildings runs on solar energy powered by an integrated photovoltaic system incorporated into the building's design to provide renewable energy source for some section within the enterprise. The IT officer stated that the solar energy systems provide up to 50 per cent of the enterprise's energy requirements, which sums to about 120,000 kWh each year. The enterprise building (Case Study D) was built based on advanced Green technologies using Green energy solutions for rainwater harvesting alongside an innovative electricity controlling systems. Moreover, Case Study D currently deploys a building electricity management system that helps to optimize the enterprise energy utilization.

4.2.1.4 Motivating Forces

According to the informants from all case studies internal motivating forces and external pressures influences Green IT/IS practice. Electricity savings and usage reduction was identified as one of the motivating forces that pressured Case Study A towards Green IT/IS practices intended towards economic sustainability. Hence, Case Study A aimed to reduce the high cost generated by wasteful power consumption. Also, Case Study A continuously provides annual budget allocated to support Green IT/IS practices within the enterprise. Based on the strong motivational support from the top management, Case Study B has been able to attain 10 per cent decrease in its energy consumption index for the year 2011 and 2012 in comparison to the year 2009. In addition, the corporate strategy officer mentioned that since 2013 Case Study B has been committed to increase their efforts towards energy savings as such the enterprise allocated RM100,000 amount incentives to department within the enterprise that achieved energy saving. Case Study B also re-invested RM 500,000 of the cost savings in 2013 in badges to promote Green energy initiatives.

Case Study C provides fiscal financial incentives for staffs and students to pursue Green technology related training. Case Study C provides financial grants and assistance to other enterprise from both private and public sector. The sustainability officer claimed that Case Study C partners with governmental bodies, industries and

research institutions in regards to Green IT/IS advancement. Likewise, Case Study D is motivated by the Green technology financing scheme which aims to offers a 60 per cent guarantee of the funding amount and a refund of 2 per cent on the interest rate charged by other financial institutions. The financial scheme aimed at accelerating the growth of Green related technologies by offering easier access to funding from either commercial or private financial institutions. The financial scheme facilitates the growth of domestic based Green enterprises to generate more Green jobs and also promote the current Green markets.

4.2.1.5 IT Strategy

According to the informants from all case studies the IT strategy initiated by management influences Green IT/IS practice. The IT officer mentioned that Case Study A strategies includes encouraging students to use bicycle and also walk in short distances. This strategy will not only diminish the emission of carbon monoxide (CO) and CO_2 but also progress the health and quality of enterprise community. According to sustainability officers Case Study A has been creating awareness on environmental protection and also plant trees within the year since 2015 through several participations among the enterprise community. Case Study A has developed engagement and networking with external collaborators and partners such as stakeholders in state and federal government, in addition to non-governmental associations in order to transform the enterprise into a Green organization.

According to the corporate strategy officer, strategies implemented by Case Study B aims to facilitate low carbon induced practices. Furthermore, in Case Study C IT strategy as stated by the sustainability officer comprises of Green energy usage alongside environmental, economy and social considerations. Green energy seeks to attain independence in energy and also support efficient electricity utilization; whereas the environmental aims to safeguard and diminish negative impact on the natural environment. The economic promotes the country's economic progress through the use of Green technology and lastly social aims to progress the quality of life for all citizens. Case Study D presently provides support policies and funding programs towards promoting Green IT/IS by creating awareness on the benefits of Green IT/IS. Case Study D IT strategies according to the project officer are based on sustainable living, Green procurement, electric mobility and the Green Malaysia plan.

4.2.1.6 Information Availability

According to the informants from all case studies, the availability of information on how sustainability can be attained by the implementation of Green IT/IS practice is important. Case Study A provides information on how Green IT/IS practices by providing information on Green IT/IS initiatives in the enterprise main website that provides information on how the enterprise can promote Green IT/IS practice across the enterprise and the society at large. Case Study A also promotes the dissemination of Green practices initiatives across the enterprise by providing Green posters and banners posted across the enterprise to increase awareness of Green IT/IS initiatives. According to the head of sustainability Case Study A encourage the enterprise community to only print when it necessary to reduce paper usage. This message is attached to all email sent internally and externally from the enterprise.

Case Study B frequently carries out energy reduction and saving awareness within the enterprise. Various stickers and posters are also been put around the enterprise. In addition, Case Study B uses an in-house internal web based energy billing and monitoring system that provide up-to-date information among practitioners, management and stakeholders in the enterprise. According to the sustainability officer Case Study C deploys effective involvement of the media, non-governmental organizations and individual stakeholders in enhancing Green IT/IS. Case Study C also carry out a demonstration of programs that shows the effective application of Green IT/IS practices in all governmental based facilities within the country.

Lastly, the sustainability technical officer mentioned that Case Study C believes that an effective promotion and public awareness are needed to influence the successful implementation of Green IT/IS practices. Hence, Case Study C aims to change the mind-set of the general public by carrying out effective continuous information dissemination through comprehensive educational programs to increase public awareness on Green IT/IS practice. The senior administrative assistant stated that Case Study D propagates the county's Green technology policy initiated by the government in July 2009 mentioning that Green technology shall be a motivator to accelerate Malaysia economy and also promote sustainable development.

4.2.2 Green IT/IS Practice Implemented in CE

This section present finding based on data from the case studies to confirm the Green IT/IS practice implemented in CE. Accordingly, Table 4.4 presents a summary of the findings from the case study based on Green IT/IS practice being implemented in the selected enterprises.

Table 4.4 Summarized Green IT/IS practice findings from case studies

Green IT/IS Practice	Case Study 1	Case Study 2	Case Study 3	Case Study 4
Green creation	-Uses video conferencing systems, digital power depletion meters and developed Green building built mainly from recycled materials.	-Deployed lighting retrofits and installed T5 bulbs and adheres to no polystyrene, no plastic bag.	-Switches off lights at unoccupied areas and sets PCs to automatically switch to sleep mode when not in use.	-Installed T5 bulbs and an advanced lighting management system.
Green distribution	-Equipped with the modern ICT infrastructures such as e-meeting and e-billing to reduce paper usage and also carryout rain water harvesting.	-Deploys a comprehensive energy management information system and also carryout rain water harvesting.	- Encourage staffs to switch off all electrical equipment and use of public transport or practice car-pooling	- Carries out rain water harvesting.
Green sourcing	-Purchase only IT equipment that is needed and also purchase recycled items such as bottles and rechargeable batteries.	-Lessens the use and disposal of IT resources to decrease purchasing.	-Encourages the buying of Green IT products.	-Buys IT products that take into account environmental protection.
Green usage	-Replaced old light bulbs with LED light bulbs. -Installed motion sensors and smart metering to save energy and encourages dual printing.	- Retrofitting firm air-conditioning and switch off equipment when not in use. -Reduce use of paper by using electronic mediums.	-Encourages the reuse of paper.	-Utilized energy efficient office equipment and power efficient server system.
End of life	-Implements a waste management strategy that comprises of the 3R aimed to reduce, reuse and recycle based on EPA guidelines.	-Contributes to recycling initiatives, lessening generated solid waste and cut cost needed for collecting wastes.	-Currently reduce, reuse and recycling, and a mobile recycling buyback program that purchase out-dated reusable IT equipment.	- Aims to reduce CO2 emission by implementing recycling and recovery of waste.

In respect to the summarized findings presented in Table 4.4, each of the Green IT/IS practice are further described below in relation to how the four enterprise implements Green IT/IS practice to achieve sustainability.

4.2.2.1 Green Creation

Based on the response from the informants from all case studies, Green creation is important in implementing Green IT/IS practice in their enterprise. Accordingly, the head of sustainability stated that Case Study A uses video conferencing systems within their enterprise to reduce transporting thereby decreasing carbon footprint emission. Case study A also installed digital power depletion meters in few buildings to automatically record electricity utilization for every fifteen minutes. Case Study A further developed an environment friendly building that was built mainly from recycled material and ecological friendly bricks. The building is made of previously used resources that has been reformed and upgraded. The fully constructed environment friendly building comprises of 72 rooms for practitioners and experts in the enterprise.

The corporate strategy officer indicated that Case Study B deployed lighting retrofits, which encompassed de-lamping and replacement of super T8 lights and high proficiency T5 bulbs for better performance and less energy utilization. The sustainability officer in Case Study C revealed that the organization switches off lights at unoccupied areas in the organizations offices, configures and sets Personal Computers (PCs) to automatically switch to sleep mode when not in use. The project officer specified that Case Study D also installs an advanced lighting management system to control efficient power usage. In case study D all light fixtures in departments are fitted with high energy effective T5 small fluorescent tubes that consume less energy.

4.2.2.2 Green Distribution

Based on the response from the informants from all case studies, Green distribution is required in implementing Green IT/IS practice. The head of sustainability emphasized that Case Study A is fully equipped with the modern ICT infrastructures such as wireless broadband internet connections to support the enterprise's electronic based operation that reduces paper based activities. The sustainability officers mentioned that Case Study A utilized e-meeting and e-billing to reduce paper usage.

Moreover, data are electronically distributed and the enterprise community uses the e-community web portal for administrative purposes this helps Case Study A to become a paperless enterprise. The head of sustainability indicated that Case Study A harvest rainwater for flushing and other related needs within the enterprise. The corporate strategy officer specified that Case Study B deploys a comprehensive energy management information system to support the power consumption monitoring, computes energy savings measures and lastly suggesting budget expenditure tracking. The corporate strategy officer further indicated that Case Study B implements water management and rain water harvesting towards sustainable water utilization for the enterprise community. This initiative has resulted to a 10 per cent decrease of total water consumption in Case Study B.

Case Study C enforces policies that encourage staffs to switch off all electrical equipment at the end of office hours. Besides, Case Study C encourages the use of public transport or practice car-pooling for Green transportation. Moreover, Case Study C also promotes the park and ride facility to avoid congestions during parking. The director of sustainability declared that Case Study D implements rainwater harvesting to help conserve water in the building and decrease the use of treated water from the water utility provider. Correspondingly, through the usage of rainwater harvesting system, the dependence on piped water is significantly reduced, which results to third of the whole volume of water utilized in the enterprise building.

4.2.2.3 Green Sourcing

The informants from all case studies highlighted that Green sourcing is an integral initiative for implementing Green IT/IS practice. As mentioned by the sustainability officers in 2011 Case Study A initiated a strategic plan aimed at achieving one per cent reduction of enterprise operational IT cost saving incurred yearly by the organization. Hence, in Case Study A the enterprise community are encouraged to pre-plan their purchase and procure only IT equipment that is needed. The IT officer in Case Study A stated that the enterprise procures multipurpose items that decrease waste and material use. For Green sourcing case study B has reduced the number of paper purchase.

According to the sustainability officer, Case Study C encourages the buying of Green technology based products as the preferred choice in enterprise procurement. Besides, other Green procurement initiatives include creating a widespread recognition and availability of Green practices in terms of products, equipment, system and appliances in domestic market through standard rating and labelling initiatives. The senior administrative assistant stated that Case Study D selects and buys IT products that take into account the conservation of the natural resources and the environment.

4.2.2.4 Green Usage

The informants from all case studies stated that Green usage is necessary when implementing Green IT/IS practice. The head of sustainability made mentioned that Case Study A replaced old light bulbs with Light Emission Diodes (LED) light bulbs in enterprise buildings, deployed T8 tubes to replace T5 tubes, installed motion sensors in the enterprise' departments office lavatories and also installed intelligent metering in offices. The internal intelligent meters record enterprise real time power consumption in enterprise facilities, where the data are saved and monitored thorough a web-based system 24/7. Case Study A also replaced all sodium lamps used in street lighting to LED lights.

According to the head of ICT, since 2013 Case Study B has fully operated Green offices in some department which has helped to reduce the use of paper, recycling of out-dated computer, uses of recycled ink cartridge/toner and sourcing of electrical appliances that utilize less energy. Case Study B aims to reduce the use of paper by using emails for meetings invitations and using Universal Serial Bus (USB) drive to disseminate information instead of paper. Furthermore, Case Study B practice double side printing, reduce, reuse and recycle papers. In Case Study B, the staffs switch off computers, air conditioners and lights when not in use and maximize natural lights to enhance staff office awareness for energy savings.

The sustainability officer maintained that Case Study C encourages the reuse of paper for printing and drafting informal documents, the organization encourages the judicious use of office supplies by printing or making copies only when needed, printing or making copies on both sides of the paper for all formal documents. In addition, Case Study C promotes the use of bio-degradable substances in the enterprise.

The senior administrative assistant and the IT officer in Case Study D both mentioned that the enterprise utilized energy efficient office equipment for all IT systems such as laptops, by using only desktops with LCD screens, deploying shared network printers, utilizing wireless computer network system and power efficient server system.

4.2.2.5 End of Life

The informants from all case studies specified that end of life initiatives is necessary in implementing Green IT/IS practice. Case Study A has an efficient waste management strategy that comprises of the 3R aimed to reduce, reuse and recycle. In addition, to supporting Green waste management, case study A adopts Environmental Protection Agency (EPA) hierarchy guidelines on waste management (EPA, 2009) which includes waste reduction and reuse, recycling and composting, energy recovery and lastly treatment and disposal. End of life practice in Case Study B contributes to Green recycling initiatives, lessening generated solid waste and decrease cost needed to collecting solid waste from aluminium cans, glass, plastics and papers.

Case study B complies with Malaysia Environmental Quality Regulation 2005 (Khalil et al., 2018) in regards to e-wastes disposal in designated bins. The e-wastes include electrical and electronic wastes such as light bulbs, battery, hand phones etc. According to the corporate strategy officer, Case Study B currently implements a mobile recycling buyback program where include aluminium can, glass, paper, plastic, etc. are recycled. Case Study B mobile buyback center initiative purchases any material that could be reused or used as parts. In the buyback center initiative cash rewards are given to people that sell their old recyclable materials. Likewise, Case Study C end of life is based on the 3R, reduce, reuse and recycling practice which includes recycling of used envelops and files and considering the environment before disposal of wastes. For waste management Case Study D implements water and solid waste management by deploying waste water treatment, sanitary solid waste landfills.

4.2.3 Quality Criteria in Qualitative Study

Morris (2006); Creswell (2009); Yan and Barbara (2009) to ensure the validity and reliability (trustworthiness) of qualitative data, the credibility, transferability, dependability and confirmability are qualitative terms used to validate findings from qualitative data as explained in Section 3.2.4.3 in Chapter 3. Thus, for credibility this

thesis presented a transparent procedure for drawing conclusions from the raw data from the interview transcript. The credibility of the research findings was also verified by the independent variables and Green IT/IS practices which were all confirmed by more than one informant from the case study (see Table 4.3 and 4.4).

The transferability refers to the degree to which this study can be applied to another context. Hence, detailed documentation of the independent variables and Green IT/IS practice description in Section 2.6.1 and 2.6.2 in Chapter 2 makes it easier for other researchers to adapt in other domain. Furthermore, the transferability of the identified independent variables and Green IT/IS practice identified in this thesis are widely documented in prior studies. Moreover, the dependability of this study was made possible by detailed documentation of the data collection and analysis procedures as described in Section 3.2.4 in Chapter 3 and Section 4.3 in this chapter.

Confirmability which measures the extent to which the characteristics of the data, presented in this thesis can be confirmed by other researchers. Thus, in this thesis confirmability was determined by checking the findings of this study. The interview findings are also similar to previous research carried out by Karanasios et al., 2010; Seidel et al., 2010; Schmidt and Kolbe, 2011; Savita et al., 2014; Opitz et al., 2014; Dolci et al., 2015. Meanwhile, detailed documentation of how the qualitative data was analysed also provides means for confirmability checking as presented in Section 3.2.4.

4.3 Summary

This chapter discuss on how the preliminary study was carried out. Qualitative data was collected using case study by interview and Green IT/IS document utilized by the selected CE in implementing Green IT/IS practices. The case study was carried out in two Malaysia universities and another two Malaysia organizations using open ended interview question. Fifteen informants were interviewed to confirm the independent variables and Green IT/IS practice derived from the literatures. The qualitative data was analysed using descriptive and narrative analysis. The case study was also useful in answering the first and second research questions in Section 1.4 and first research objectives in Section 1.6 in Chapter 1. Thus, the first research objective has been accomplished, which is to identify the Green IT/IS practice to be implemented and independent variables that influences Green IT/IS practice in CE. Furthermore, findings

from the case studies reveal that all the Green IT/IS practice are important and should be implemented in CE. Besides, findings also indicate that the identified independent variables influences Green IT/IS practice in CE. Lastly, findings from the case study did not reveal any new Green IT/IS practice or independent variable.

CHAPTER 5

GREEN IT/IS ASSESSMENT MODEL DEVELOPMENT

5.1 Introduction

This chapter accomplishes the second research objective by presenting the developed Green IT/IS assessment model. Hence, the next section of this chapter discusses belief-action-outcome framework. Additionally, the conceptualization of Green IT/IS assessment model was presented to show how belief-action-outcome framework is theorized for Green IT/IS assessment. The next section presents the proposed Green IT/IS assessment model based on belief-action-outcome framework. The developed Green IT/IS assessment model comprises of independent variables, Green IT/IS practice, enterprise characteristics, socio-demographic determinants, and sustainability attainment goals. In addition, the Green IT/IS assessment model description and hypotheses development was presented. Lastly, the summary of the chapter is discussed.

5.2 Belief-Action-Outcome Framework

Many studies have examined the link between beliefs, intentions, and behaviour in IT implementation and use cognitive based models and frameworks such as theory of reasoned action, theory of planned behaviour, technology acceptance model perspective and norm activation theory as reviewed in Section 2.8 and Figure 2.8 in Chapter 2. Similarly, a number of theories such as motivational theory, institutional theory, technology-organization-environment framework, and upper echelon theory (Chen et al., 2011; Lei and Ngai, 2012; Molla and Abareshi, 2012; Zheng, 2014; Dalvi-Esfahani et al., 2017a) as presented in Section 2.8 and Figure 2.8 in Chapter 2 have been utilized to help understand the independent variables or factors that influence organizational

Green IT/IS initiatives. While, these theories are valuable in understanding the independent variables that influences Green IT/IS practice, they are less applicable in explaining the outcome assessment of Green IT/IS practice implementation.

In choosing the theoretical framework for this thesis, the author sought a framework that can both help in understanding the independent variables that influences Green IT/IS practice and can also accommodate Green IT/IS practice implementation. The author found that Melville's Belief-Action-Outcome (BAO) framework was suitable for this study as previously utilized by prior studies Gholami et al. (2013); Molla et al. (2014); Recker (2016); Loeser et al. (2017) who researched on Green IT and Green IS. Accordingly, the Green IT/IS assessment model is proposed based on BAO framework designed by Melvin (2010). Melville (2010) argued that sustainability involves human behaviour and the broader social, economic, and environmental context; it therefore covers both IT manager and IT practitioners.

Therefore, this section discusses BAO framework as previously stated in Section 3.2.5 in Chapter 3. Accordingly, Melville (2010) drew from Coleman's (1986) micro-macro-model to propose links between the influence of social and enterprise sustainability contexts (macro-level issues) on IT practitioners and IT manager's beliefs about the environment (micro-level) and the influence of their beliefs on sustainability actions and subsequent outcomes (at both macro-and micro-levels). Melville (2010) further developed the BAO framework to help explore how sustainability can be attained in organizations based on how beliefs of IT practitioners and IT managers influences their action towards implementing Green IT/IS practice for attaining sustainability as seen in Figure 5.1.

Figure 5.1 Belief-action-outcome framework
Source: Melville (2010); Recker (2016).

Figure 5.1 depicts the BAO framework as belief formation, action formation and lastly outcome assessment. Each of the constructs is discussed below;

5.2.1 Belief Formation

Congruent with Melville's (2010) framework belief capture how psychic states (opinions, desires, orientations, etc.) related to the natural environment is formed. On the organizational level (for IT managers), these states include how CE coordinates and divides labour and defines its environment-related expectations (Gholami et al., 2013). These expectations could include the managerial interpretation of environmental issues in light of corporate identity (Loeser et al., 2017). On the individual level (for IT practitioners), beliefs capture environment-related attitudes in the form of norms and beliefs. For instance, individual environmentalism depends on ecological worldviews, awareness of consequences, and ascription of responsibility (Recker, 2016).

5.2.2 Action Formation

Actions describe how psychic states related to the natural environment translate into actions. For IT managers, these actions include how CE deploys actions for environmental protection. For instance, CE implements Green IT/IS to allow for sense making of environmental issues and use the enterprise's social networks to democratize sustainability information and its employees' critical environmental decisions. On the other hand for IT practitioners, actions describe what individuals do to improve behavioural environmentalism. For instance, IT practititoners may choose to use web portals that minimize energy consumption by setting individual goals or to delocalize work practices by relying on file-sharing and conferencing systems rather than physical travel.

5.2.3 Outcome Assessment

Outcomes describe the consequences of the actions on IT managers and/or IT practitioners, as a measure of CE sustainability attainment (Loeser et al., 2017). Outcomes in BAO framework can be as both positive and negative for both enterprise and the environment. For example, they could include environmental impacts on the behaviour of organizations or such systems' environmental performance. Outcomes may also be environmentally negative, e.g., IT investments in server farms that increase electricity demand and, thus, Greenhouse gas emissions (Molla et al., 2014).

Correspondingly, BAO framework helps not only to understand the independent variables that influence Green IT/IS beliefs but also to theorize on how these can influence Green IT/IS implementation. Besides, BAO framework provides insight that IT practitioner personal capabilities can contribute toward their formation of environmental beliefs and attitudes. The framework therefore links macro-level (IT managers) with micro-level (IT practitioners) to study the role of Green IT/IS for sustainability attainment. This implies that IT practitioners and IT managers' beliefs and commitments lead to CE action that eventually results to outcomes. In essence, the author argues that IT practitioners and IT managers' attitudes and beliefs about the natural environment motivate CE action to intensify Green IT/IS implementation. The consequences of this can result in a better environment. This argument resulted in the conceptualization of the proposed Green IT/IS assessment model based on BAO framework as seen in this next section.

5.3 Conceptualization of Green IT/IS Assessment Model

The proposed Green IT/IS assessment model is conceptualized based on BAO framework as shown in Figure 5.2.

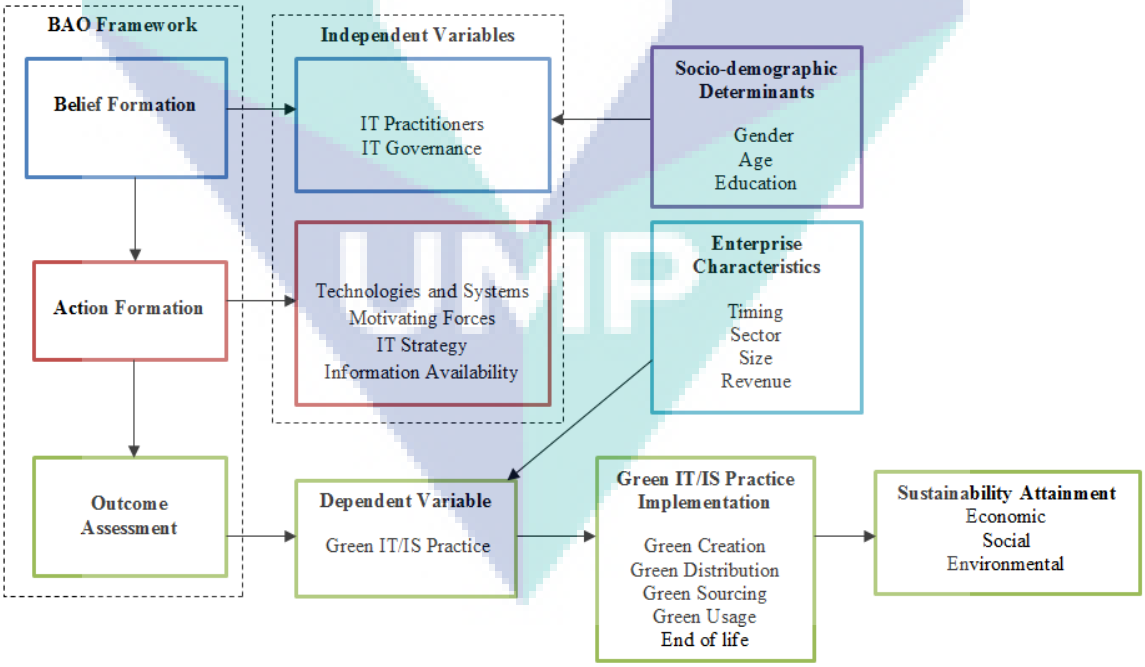


Figure 5.2 Conceptualization of Green IT/IS assessment model based on BAO framework

Figure 5.2 depicts the conceptualized Green IT/IS assessment based on BAO framework. The belief formation links to independent variables IT practitioners and IT

governance, which are the IT staffs and IT managers in CE as presented in Section 2.6.2, Table 2.3 and Figure 2.6 in Chapter 2. Followed by action formation which comprises of technologies and system deployed in the enterprise, motivating forces from governmental and non-governmental associations. The IT strategy deployed in the enterprise daily operation and lastly the availability of information on how Green IT/IS practices can be implemented in the enterprise as presented in Section 2.6.2, Table 2.3 and Figure 2.6 in Chapter 2. Moreover, outcome assessment is the results of the influence of independent variables from belief and action on the dependent variable which is practiced based on the identified Green IT/IS practice derived in Section 2.6.1 and Figure 2.5 in Chapter 2. The association to the social, economic and environmental goal of sustainability was presented in Table 2.4 in Chapter 2. Furthermore, each of the independent variables and Green IT/IS practice derived from the literature has been confirmed in the case study that was conducted in four CE based in Malaysia as seen in Table 4.3 and 4.4 as well as in Section 4.2.1 and 4.2.2 respectively.

The author included the social demographic determinants which comprises of gender, age and education as described in Section 2.6.4 in Chapter 2 as moderating variables that may influence IT practitioners and IT governance belief towards Green IT/IS practice. Likewise, enterprise characteristics which entail timing, sector, size and revenue are included as factors that may influence the outcome of Green IT/IS practice in CE as reviewed in Section 2.6.3 in Chapter 2 as control variables.

5.4 Proposed Green IT/IS Assessment Model Development

This section accomplishes the second research objective which is to propose a Green IT/IS assessment model based on BAO framework. In this study qualitative data has been employed using case study by interview as presented in Chapter 4, this section presents the Green IT/IS assessment model proposed based on the confirmed derived independent variables and Green IT/IS practice in Chapter 4 and moderating variables (socio-demographic determinants), control variable (enterprise characteristics) derived from the literatures as mentioned in Chapter 2 and sustainability constructs as seen in Figure 5.2. The Green IT/IS assessment model is proposed based on BAO framework developed by Melville (2010).

Figure 5.3 shows the developed Green IT/IS assessment model based on BAO framework. Where the belief formation of independent variables IT practitioners and IT governance and action formation from independent variables technologies and systems, motivating forces, IT strategy and information availability influences the outcome assessment of Green IT/IS practice which is a reflection of Green creation, Green distribution, Green sourcing, Green usage and end of life practice currently implemented in CE. In addition, Figure 5.3 shows the control variables which include the timing, sector, size and revenue which may also influences Green IT/IS practice. In addition, the moderating variables age, gender and education of IT practitioners and IT governance (IT managers) which may influence Green IT/IS practice implementation in CE. Lastly, Figure 5.3 depicts how the current Green IT/IS practice implemented in CE results in attaining the economic, social and environmental goal of sustainability.

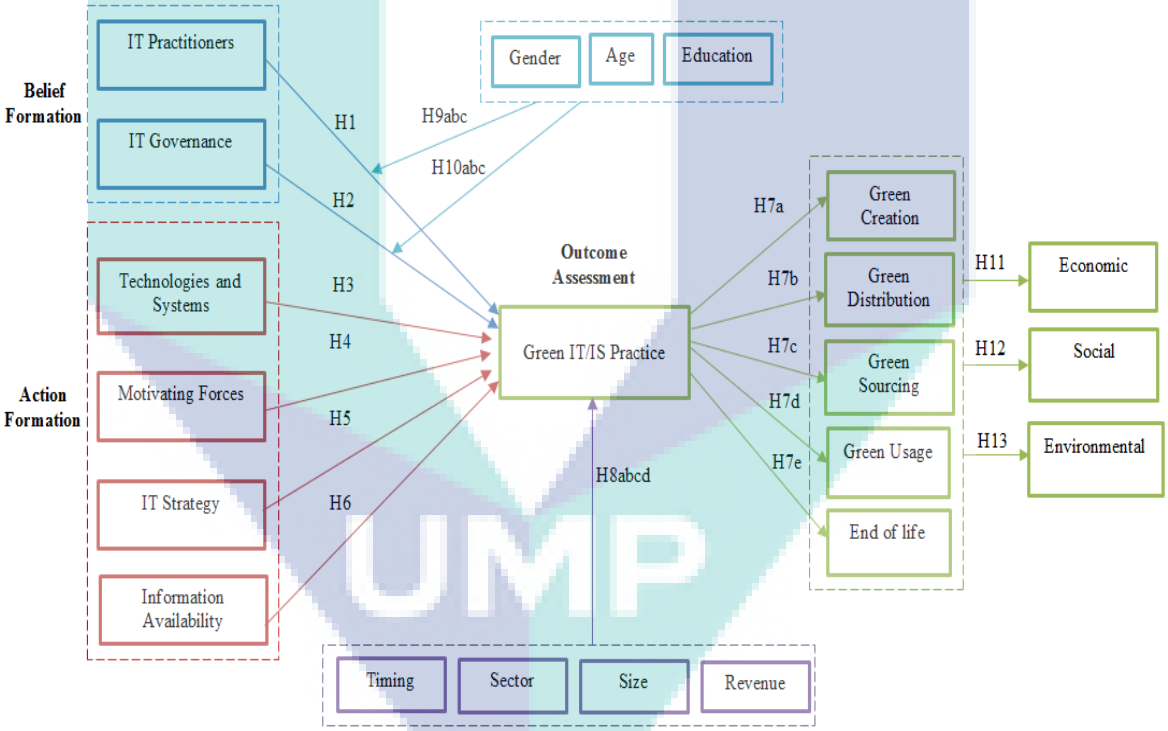


Figure 5.3 Developed Green IT/IS assessment model

Figure 5.3 depicts the developed Green IT/IS assessment model proposed based on belief formation, action formation and outcome assessment. The Green IT/IS assessment model is developed based on the conceptualization of Green IT/IS assessment presented in Figure 5.2 which shows how each of the variables and Green IT practice to be implemented are linked in attaining sustainability. Respectively, the model constructs and hypotheses are further described in the next section.

5.5 Green IT/IS Assessment Model Description and Hypotheses Development

5.5.1 Belief Formation for Green IT/IS Assessment

The belief formation entail two independent variables which comprises of IT practitioners and IT governance as seen in Figure 5.2 and 5.3. Thus, each of the independent variables and the derived hypotheses are described below;

5.5.1.1 IT Practitioners

IT practitioners are the humans that possess the skills and knowledge to implement Green IT initiatives. This independent variable comprises the staffs, practitioners and stakeholders involved in CE operation. Hence, IT practitioners' attitude towards the environment will affect the outcome of Green IT/IS practice implementation. Therefore, CE should develop and train their staffs to achieve the state of rational knowledge headed for sustainability attainment. Besides, CE should not only see their staffs as a means to attaining profit, but need also emphasis on the welfare of the staffs. Based on the proceeding arguments, the following hypothesis is made:

H1: IT practitioner's personality will positively influence his/her action toward Green IT/IS practice implementation.

5.5.1.2 IT Governance

IT governance comprises the managerial rules and regulation that governs the institutions daily processes. IT governance is policies that support CE in their decision making. Hence, IT governance policies increases enterprise's awareness on issues pertaining to sustainability and also provide an agenda for employee in the organization to achieve sustainability. In general, IT governance policies are drafted by the management board who initiates rules and regulation for their employee. These policies facilitate provision of resources for Green IT/ARE practice. Thus, in implementing Green IT/IS practices, IT governance policies captures an organization's intent to fully attaining sustainability by defining metrics needed to assess the effect of Green IT/IS initiatives implemented in the enterprise. Therefore, the author proposes that:

H2: IT governance structure will have a positive effect on the implementation of Green IT/IS practice.

5.5.2 Action Formation for Green IT/IS Assessment

The action formation entails four independent variables which comprises of technologies and system, motivating forces, IT strategy and information availability as seen in Figure 5.2 and 5.3. Thus, each of the independent variables and the derived hypotheses are described below;

5.5.2.1 Technologies and Systems

Technologies and systems consist of both IT infrastructures such as servers, networks, software and hardware utilized by CE for organizational day to day operations. Hence, enterprise acquiring, deploying eco-friendly technologies and systems can facilitate the attainment of sustainability. Moreover, technologies and systems explore the technical perspective that influences the implementation of Green IT/IS practices. These technologies and systems aims to decrease energy depletion of running facilities. They also reduce power consumed in cooling of IT infrastructures by enhancing the energy competence of IT infrastructure, thereby lessening Greenhouse gas emissions. Therefore, the author proposes the following:

H3: Green IT/IS practice implementation is positively influenced by deployed technologies and systems.

5.5.2.2 Motivating Forces

Motivating forces or pressure is independent variable that influences CE's decision to implement Green IT/IS practice in attaining sustainability. These pressure results from rising energy costs of energy utilization in the enterprise, thus resulting to the need for enterprise to lessen energy consumption. Furthermore, CEs are under pressure by governmental and non-governmental bodies to implement Green IT/IS practices by imposing environmental regulations. Besides, other motivational pressure includes social pressure which influence enterprise's mission to implement Green IT/IS practices. On the basis of the above the following hypothesis is proposed;

H4: Pressure from management, governmental and non-governmental organizations will have a positive effect on Green IT/IS practice implementation.

5.5.2.3 IT Strategy

This independent variable comprises the activities and procedures carried out in CE. Besides, IT strategy is an important factor that can influence corporate growth and also promotes the enterprise bids to reduce operating costs in the long term. In addition, IT strategy also involves description of the enterprise scope and activities carried out in the organization towards Green IT/IS practice implementation. Furthermore, IT strategy can also be established when enterprise deploy initiatives to support their staffs by putting in place procedures that simplify Green IT/IS practice. IT strategies may also involve actions enterprise innovate to support Green IT/IS oriented services. Based on the above, the author proposes that:

H5: Collaborative enterprises with well defined IT strategies are more likely to implement Green IT/IS practices.

5.5.2.4 Information Availability

The need for information regarding Green IT/IS practice implementation by staffs in CE aims to provide data on how enterprise can implement Green IT/IS practice. Information usage can assist CE decrease energy consumption, which is one of the aims of Green IT/IS as there is a definite cost saving that can be derived with the use of less energy which leads to the reduction of CO_2 emitted through enterprise operations. Based on these arguments, the following hypothesis is made:

H6: Green IT/IS implementation will emerges if there exist a shared enterprise Green repository in enterprise to provide Green information.

5.5.3 Outcome Assessment for Green IT/IS Assessment

Outcome assessment comprises of Green IT/IS practice which is being assessed in the enterprise based on Green IT/IS practice implementation that comprises of Green creation, Green distribution, Green sourcing, Green usage and end of life as seen in Figure 5.2 and 5.3. The Green IT/IS practice aims to facilitate CE attain economic, social and environmental sustainability as presented in Table 2.4 in Chapter 2. Each of the Green IT/IS practices and associated hypotheses are further described below;

5.5.3.1 Green Creation

Green creation aims to analyse, create and synthesize ecological friendly products with better efficiency. CE usually disregarded environmental effects during design and as such hazardous wastes were discarded without the ecological issues being considered as mentioned in Section 2.6.1.1 in Chapter 2. Therefore, Green creation in CE consider energy proficient and deployment of ecologically sound servers, cooling equipment and computer components such as LED monitor, etc. Furthermore, Green creation for Green IT/IS practice implementation includes installation of replaced or new IT systems, data management, air-flow control, cooling control and assessment of power consumption. Thus, the author proposes that;

H7a: The current Green IT/IS practice implemented will have a positive effect on Green creation.

5.5.3.2 Green Distribution

This practice in CE involves steps taken toward applying Greener prospect by increasing the reutilizing and reusability rate of the existing infrastructures deployed in the CE as discussed in Section 2.6.1.2 in Chapter 2. Furthermore, Green distribution in CE includes deployment of lead-free integrated circuit technology and utilization of electronic components, computers and other related subsystems that has a low or no effect on the natural environment. Hence, in Green distribution equipment which has negligible impact or no effect on the environment should only be installed. Thus, the author proposes that;

H7b: The current Green IT/IS practice implemented will have a positive effect on Green distribution.

5.5.3.3 Green Sourcing

This practice involves CE moving towards Green procurement by buying and utilized electronic products that have Green labels such as Blue Angel from Germany, TCO 95 from Sweden and Environmental Protection agency (EPA) Energy Star form the United States as stated in Section 2.6.1.3 in Chapter 2. IT infrastructures with Greener labels, utilizes less energy thereby emits less CO_2 to the environment.

Moreover, Green sourcing comprises ecologically considerations that promotes economically viability of the enterprise towards selecting and acquiring services and products that reduces environmental pollution. Thus, the author proposes that;

H7c: The current Green IT/IS practice implemented will have a positive effect on Green sourcing.

5.5.3.4 Green Usage

This process aims to save energy which leads to less emission of CO_2 to the atmosphere when CE IT infrastructures are being deployed. Furthermore, Green usage also aims to enhance power performance of enterprise assets towards decreasing energy utilization of cooling and powering enterprise data centers assets, optimizing energy performance of data centers, reducing data centers induced CO_2 emissions, practicing low carbon emitting corporate practices and lastly assessing enterprise total environmental footprint as mentioned in Section 2.6.1.4 in Chapter 2. Green usage to be applied in CE may include virtualization, turning off axillary data centers systems at the end of working hours, etc. Thus, the author proposes that;

H7d: The current Green IT/IS practice implemented will have a positive effect on Green usage.

5.5.3.5 End of Life

End of life provides CE with a flexible and audit policy solution for gathering; re-processing and recycling of end-of-life redundant IT associated equipment as stated in Section 2.6.1.5 in Chapter 2. End of life involves Green disposal that helps to actively decrease waste, diminish CO_2 emissions and also lessens processing costs incurred in disposal IT generated wastes in landfills, providing a medium to generate revenue return since some disposed equipment may still be functional and as such can be refurbished and be used in other enterprises. Hence, in end of life CE can plan to refurbish and reuse old IT hardware components, while other unwanted electronics components can be prepared for recycling operations. Thus, the author proposes that;

H7e: The current Green IT/IS practice implemented will have a positive effect on end of life.

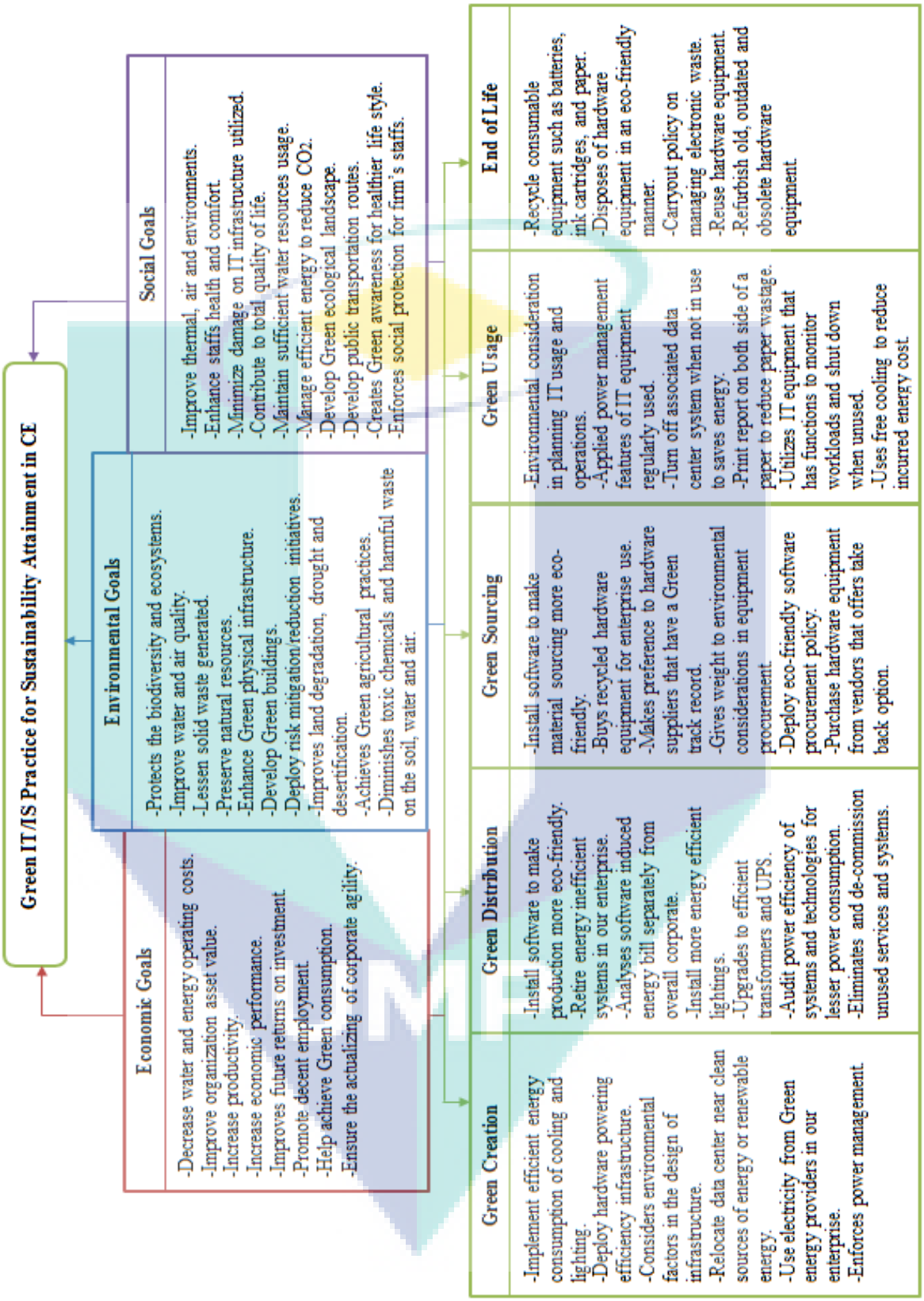


Figure 5.4 Green IT/IS practice for sustainability attainment in CE

Figure 5.4 shows how Green IT/IS practice aims to address societal, economic and environmental goals of sustainability in CE. Accordingly, Green creation, Green distribution, Green sourcing, Green usage, and end of life help to achieve economic,

social, and environmental goal of sustainability. Figure 5.4 depicts how Green IT/IS practice can help CE in attaining sustainability. In addition, Figure 5.4 is derived from the literature in Table 2.4 in Chapter 2 and findings from the case study findings in Table 4.4 in Chapter 4.

Thus, as presented in Figure 5.4, Table 2.4 in Chapter 2, Table 4.4 in Chapter 4, and based on the developed Green IT/IS assessment model in Figure 5.3 the author proposes the following ;

H11: The current Green IT/IS practice implemented will have a positive effect on CE attaining economic sustainability.

H12: The current Green IT/IS practice implemented will have a positive effect on CE attaining social sustainability.

H13: The current Green IT/IS practice implemented will have a positive effect on CE attaining environmental sustainability.

5.5.4 Enterprise Characteristics (Control Variables)

The enterprise characteristics as presented in Figure 5.2 and 5.3 comprise of timing, sector, size and revenue. Hence, the time an enterprise was founded may influence if the enterprise will be willing or be interested in implementing Green IT/IS practice as mentioned in Section 2.6.3.3 in Chapter 2. Thus, this thesis includes timing as a control variable to recognize when the enterprise was established. Similarly, CE in different industry sectors may perform differently in terms of Green IT/IS practice implementation in their enterprise. Enterprises such as end users service industries for instance IT based industries (dell, HP, Toshiba etc.) which tend to have more information content in their products and services are more likely to implement Green IT/IS practice for reasonable advantage than those in engineering sector as stated in Section 2.6.3.2 in Chapter 2. Hence, enterprise sector is a regarded as a control variable in this thesis.

As discussed in Section 2.6.3.1 in Chapter 2, the enterprise size may affect CE implementing Green IT/IS practices. Thus, this present study includes enterprise size as a control variable and is measured based on enterprise's total physical assets. Likewise,

the annual revenue is added in this thesis as a control variable as described in Section 2.6.3.4 in Chapter 2 based on the fact that enterprises with more financial resources are able to examine new practices and cope with implementation failures. Hence, the income acquired by an enterprise over a period of time will influence if CE will implements Green IT/IS practices in its enterprise operations. Therefore, CE supporting Green IT/IS practices in their organizational process may be influenced by their annual revenue. Thus, the discussion above leads to;

H8a: How long the enterprise has existed positively influences Green IT/IS practice.

H8b: The sector the enterprise belongs to positively influences Green IT/IS practice.

H8c: The enterprise size positively influences Green IT/IS practice.

H8d: The annual revenue generated by the enterprise positively influences Green IT/IS practice.

5.5.5 Socio-demographic Determinants (Moderating Variables)

The socio-demographic determinants as presented in Figure 5.2 and 5.3 comprises of age, gender and education. Accordingly, the relationship between gender of IT practitioners and IT managers towards the implementation of Green IT/IS practices has produced diversified results as reviewed in Section 2.6.4.1 in Chapter 2. Where, IT practitioner and IT manager's gender does forecast Green attitude. Further, gender differences have been found not to have an effect on IT practitioners implementing Green IT/IS practices in their enterprise. Where women have more favourable attitudes toward the environment and are more involved in recycling activities.

In regards to age, Green IT/IS practice implementation awareness is higher and more stable among IT practitioners and IT managers aged 55-60 years, those aged between 25-35 years have strong but unstable concern, and middle-aged citizens manifest a stable subset of concerns for the environment as mentioned in Section 2.6.4.2 in Chapter 2. As the age of individuals 'increases, their engagement with reuse, reduce; recycle activities increases. Similarly, this study explores on the educational levels of IT practitioners and IT managers in relation to Green IT/IS practice in CE as

discussed in Section 2.6.4.3 in Chapter 2. Based on the preceding arguments above the following hypotheses are made:

H9a: The gender of IT practitioners positively moderates Green IT/IS practice.

H9b: The age of IT practitioners positively moderates Green IT/IS practice.

H9c: The educational level of IT practitioners positively moderates Green IT/IS practice.

H10a: The gender of IT manager positively moderates Green IT/IS practice.

H10b: The age of IT manager positively moderates Green IT/IS practice.

H10c: The educational level of IT manager positively moderates Green IT/IS practice.

5.6 Summary

This chapter aims to provide answer to the last research question presenting how to assess the current Green IT/IS practice being implemented in collaborative enterprise and to also provide answer to the second research objective which is to propose a Green IT/IS assessment model based on belief-action-outcome framework. Accordingly, the proposed Green IT/IS assessment model developed based on belief-action-outcome framework was presented in this chapter. The proposed Green IT/IS assessment model independent variables, Green IT/IS practice, sustainability attainment constructs, enterprise characteristics and socio-demographic determinants and associated hypotheses were further discussed in this chapter. In addition, this chapter depicts how Green IT/IS practice can help CE attain the social, economic and environmental goals of sustainability. Lastly, the summary of the chapter was presented.

CHAPTER 6

RESULTS AND DISCUSSION

6.1 Introduction

This chapter accomplish research objective three and four by discussing the findings based on data obtained from online survey and focus-group questionnaire session. The online survey data is used to validate the developed Green IT/IS assessment model as presented in Section 5.4 in Chapter 5 which was confirmed in Section 4.2 in Chapter 4 whereas the focus-group questionnaire is utilized to evaluate the implemented Green IT/IS assessment tool in validating the Green IT/IS assessment model as stated in Section 3.2.6 and 3.2.6.8 in Chapter 3. To this end, data from the survey is analysed using SPSS and PLS-SEM. Normality, reliability and test of validity are carried out. After which regression, partial correlation, multiple regression moderating analysis and one-way Anova was carried out to validate the developed Green IT/IS assessment model. In addition, bootstrapping, moderating and multiple group analysis statistical tests were carried out using Smart PLS 3 to confirm the analysed results from SPSS. Furthermore, the applicability of the implemented Green IT/IS assessment tool was evaluated by using SPSS to analyse the focus-group questionnaire data. Lastly, the summary of this chapter is presented.

6.2 Survey Items and Demographic Characteristics

The survey (for actual survey see Appendix B) was conducted in selected CE across Malaysia as mentioned in Section 3.2.6.1 in Chapter 3. The survey questionnaire items are based on independent variables and Green IT/IS practice presented in Figure 5.3 as shown in Table 3.3 and Table 3.4 in Chapter 3.

Table 6.1 Characteristic of the survey respondents

Demographic Profile	Options	Frequency	Response
Gender	Male	76	57.1 %
	Female	57	42.9 %
Age	< 25	1	0.8 %
	25-34	55	41.4 %
	35-44	59	44.4 %
	45-55	17	12.8 %
	>55	1	0.8 %
Education	High School	4	3.0 %
	Diploma	30	22.6 %
	Bachelor's Degree	43	32.3 %
	Master's Degree	37	27.8 %
	PhD	19	14.3 %
Enterprise Sector	ICT, Communication and Media	49	36.8 %
	Education and Research	66	49.6 %
	Health and Community Services	2	1.5 %
	Engineering and Construction	2	1.5 %
	Government, Administration and Defence	11	8.3 %
	Personal, Professional	1	0.8 %
	Other_Services	2	1.5 %
Job Title	Business and Systems Analysts and Programmers	37	27.8 %
	IT Managers	26	19.5 %
	IT Network and Support Professionals	20	15.0 %
	Non IT Specialist Managers	6	4.5 %
	Tertiary Education Lecturers	13	9.8 %
	Database Systems Administrators, and IT Security Specialists	7	5.3 %
	Others	24	18.0 %
Working Experience	0-5	42	31.6 %
	6-10	31	23.3 %
	11-15	35	26.3 %
	16-20	15	11.3 %
	>20	10	7.5 %
Enterprise Size	Below 50 employees	14	10.5 %
	51-250 employees	23	17.3 %
	251- 1000 employees	25	18.8 %
	Above 1000 employees	71	53.4 %
Enterprise Founded Date	Before 1967	10	7.5 %
	Between 1967-1980	26	19.5 %
	Between 1991-2000	52	39.1 %
	Between 2001- 2010	37	27.8 %
	From 2011- Till date	8	6.0 %
Enterprise Annual Revenue	RM 90,000 or below	19	14.3 %
	RM 90,000 to RM 900, 000	14	10.5 %
	RM 900,000 to RM 2, 700,000	32	24.1 %
	RM 2,700,000 to RM 4,500,000	15	11.3 %
	RM 4, 500,000 to RM 9, 000,000	12	9.0 %
	RM 9,000,000 or above	41	30.8 %

The demographic characteristic of the survey respondents from CE in Malaysia are presented in Table 6.1. Based on the results presented in Table 6.1, 57.1% of the respondents are male and 42.9% are female. In regards to the age of respondents, 44.4% of the respondents were between the age of 35-44, where 41.4% were between the age of 25-35, 12.8% of the respondents were around the age of 45-55 and last 0.8% are either less than 25 years and another 0.8% are above 55 years. Considering the educational qualification of our respondents, 32.3% are bachelor's degree, 22.6% are diploma, 27.8% possesses master's degree, 14.3% are PhD holder and lastly only 3.0% are high school certificate holders. By considering the enterprise sector, more respondents were received (IT practitioners, IT professionals and IT staffs) from education and research sector that implements Green IT/IS practices with a total of 49.6 %, followed by respondents from IT, communication and media industries with 36.8 %, next is the government, administration and Defence based enterprise with respondents of 8.3 %. 1.5% of respondents were from engineering and construction based enterprise, health, community services, and other services respectively.

Lastly, another 0.8% of respondents were from personal, professional based enterprise. Looking at working experience 31.6% of the respondents possess working experience of 0-5 years, 23.3% had experience in between 6-10 years, followed by 26.3% between 11-15 years, 11.3% had experience for 16-20 years and lastly 7.5% had experience of more than 20 years. Considering job title of the respondents, Table 6.1 reveal that 27.8% are currently business and systems analysts and programmers, 19.5% are IT manager, 15% are IT network and system support professionals, 4.5% are non IT specialist managers, whereas 9.8% are tertiary education lecturers. Moreover, 5.3% are database systems administrators and IT security specialists and lastly 1.5% currently holds other positions. In terms of enterprise size, 53.4% had above 1000 employees, whereas 17.3% had currently has 51-250 employees, 10.5% had below 50 employees and lastly 18.8% had 251-1000 employees. Regarding enterprise founding date, 39.1% of the respondents enterprise was established between the year 1991-2000, whereas 27.8% of the respondents enterprise was founded between the year 2001- 2010. Next, 19.5% of the respondents enterprise was founded between 1967-1980 another 6.0% were founded between from 2011- Till date (2017). Lastly, 7.5% was established before 1967.

Investigating enterprise annual revenue, 30.8% claimed their enterprise had annual revenue ranging from RM 9,000,000 or above. 14.3% had annual revenue of RM 90,000 or below, whereas 10.5% had annual revenue of RM 90,000 to RM 900, 000 and another 24.1% had annual revenue of RM 900,000 to RM 2, 700,000. 11.3% of the respondents' enterprise had annual revenue of RM 2,700,000 to RM 4,500,000 and lastly 9.0% respondents' enterprise had annual revenue ranging from RM 4, 500,000 to RM 9, 000,000.

6.3 Explorative and Descriptive Analysis

This phase helps to check if the data is normally distributed. Hence, out of the received 133 survey responses, 82% where complete answer and 18% had missing values. Based on sample size utilized in prior studies (see Table 3.5) the survey size is acceptable. However, the missing data values were treated by applying mean value replacement using (SPSS) as stated in Section 3.2.6.2 in Chapter 3. Accordingly, the author proceed to search for multivariate outliers using boxplots and also calculating the Mahalanobis d-squared values which should be lesser than 0.01 (Fields, 2009) for all response. Results found that most of the responses were all within a satisfactory range (<0.01), resulting in a final sample of 133 valid datasets, after which the normality, reliability and construct validity test of dataset was carried out.

Table 6.2 Explorative and descriptive analysis

Independent Variables, Green IT/IS Practice and Sustainability	**Normality**		**Descriptive**		**Reliability**
	Skewness	**Kurtosis**	**Mean**	**SD**	**Cronbach's Alpha**
IT Practitioners	-0.071	-1.416	3.93	0.736	0.951
IT Governance	-0.131	-1.519	3.98	0.773	0.949
Technologies and Systems	0.071	-1.087	3.79	0.771	0.947
Motivating Forces	0.226	-0.983	3.60	0.706	0.945
IT Strategy	0.163	-1.138	3.77	0.774	0.946
Information Availability	0.164	-1.398	3.80	0.819	0.945
Green Creation	0.013	-0.078	3.46	0.812	0.944
Green Distribution	-0.282	-0.041	3.35	0.910	0.947
Green Sourcing	-0.277	-0.080	3.25	0.967	0.949
Green Usage	-0.087	-0.048	3.51	0.836	0.942
End of Life	-0.079	0.163	3.49	0.846	0.945
Green IT/IS Practice	0.058	-0.507	3.41	0.807	0.943
Economic Sustainability	-0.277	-0.080	3.25	0.967	0.985
Social Sustainability	-.0.087	-0.283	3.37	0.856	0.965
Environmental Sustainability	0.137	-0.602	3.47	0.771	0.982
Valid N sample (listwise)	133	Kaiser-Meyer-Olkin Measure of Sampling Adequacy = 0.902, Bartlett's Test of Sphericity = 925.954, df= 21, Sig. = 0.000.			

Additionally, mean and Standard Deviation (SD) of the independent variables, Green IT/IS practice, dependent variable and sustainability attainment are shown in Table 6.2. Table 6.2 shows the explorative and descriptive analysis, outlining the normality test of the dataset using Skewness and Kurtosis computed using SPSS, where the Skewness and Kurtosis values between ±2 are considered valid as suggested by George and Mallery (2005) (see Section 3.2.6.4). Hence, all Skewness and Kurtosis values are between the required ranges as seen in Table 6.2. Besides, all mean values are greater than 2.5 and the SD is less than 1 showing that the response from the respondents are close and not widely dispersed. Next, the consistency of the survey instrument is checked using Cronbach's α (CA) as suggested by Shelby (2011). Where, the Cronbach's α reliability coefficient should be greater than or equal to 0.7 (Hair et al., 2006) (see Section 3.2.6.4).

Thus, all items are reliable and acceptable based on the individual Cronbach's alpha of all independent variables, Green IT/IS practice, dependent variable and sustainability attainment constructs are greater than 0.7 as presented in Table 6.2. This indicate that the instruments (survey) used in this study has good reliability and appropriate for this study. Additionally, the reliability can be examined using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Field, 2009) as described in Section 3.2.6.8 in Chapter 3. Thus, Table 6.2 depicts the KMO and Barlett's test value derived from the factor analysis test in SPSS which showing that the KMO is = 0.902 which is higher than the 0.5 limit. Hence, suggesting that the survey instruments scales are valid at a significance of 0.000. Furthermore, the Bartlett's test of sphericity $\chi 2$ (21) = 925.954, p < 0.000, indicated that correlations between items were sufficiently large for exploratory analysis.

6.3.1 Test of Validity

The construct validity test is shown in Table 6.3. Results from Tables 6.3 shows that the Pearson's correlation (r) and factor analysis value was above 0.3 to 0.9 as suggested in Table 3.6 in Chapter 3, representing a medium and strong positive correlation, that are statistically significant at p = 0.000, thus confirming the quality or validity of the survey data.

Table 6.3 Correlation analysis

Independent Variables, Green IT/IS Practice and Sustainability Attainment	Green IT/IS Practice (DV)	
	Pearson Correlation	**Factor Analysis**
IT Practitioners	0.323**	0.323
IT Governance	0.409**	0.409
Technologies & Systems	0.511**	0.511
Motivating Forces	0.587**	0.587
IT Strategy	0.536**	0.536
Information Availability	0.547**	0.547
Green Creation	0.903**	0.903
Green Distribution	0.935**	0.935
Green Sourcing	0.932**	0.932
Green Usage	0.943**	0.943
End of Life	0.901**	0.901
Economic Sustainability	0.932**	0.932
Social Sustainability	0.989**	0.989
Environmental Sustainability	0.968**	0.968
**. Correlation is significant at the 0.01 level (2-tailed), N =133, Sig. (2-tailed) =0.000		

6.3.2 Non-Bias Test

To check for non-bias, since this thesis employed a purposive sampling method non-response bias test by comparing the non-respondents and respondents was not applicable to this study (Ryoo and Koo, 2013). This research followed the recommendation proposed by Lambert and Harrington (1990), an approach to check for non-response bias by comparing the first and second rounds of respondents by confirming that non-response bias is non-existent if no differences exist on the survey items. Thus, non-bias was measured by confirming that responses on enterprise sector variables did not differ significantly between the early responses "first 25 per cent, 20 samples" and the last responses "last 25 per cent, 20 samples" similar to Ryoo and Koo (2013).

Table 6.4 One-way ANOVA test for non-bias

	ANOVA Test For First Participants				
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.011	2	2.006	0.052	0.950
Within Groups	660.989	17	38.882		
	ANOVA Test For Last Participants				
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	170.273	3	56.758	1.836	0.181
Within Groups	494.727	16	30.920		
**. Significant at the 0.05 level (2-tailed), N =20, Sig. (2-tailed) =0.000					

First participants were categorized by choosing those that replied in January 2017 and the last respondents are those that responded in April 2017. Next One-Way Anova test was carried out prior to previous study (Meacham et al., 2013). Results from the test revealed no significance differences at a 0.05 level, signifying that non-response bias was low as seen in Table 6.4.

6.4 Hypothesis Testing and Results from SPSS

There are twenty four hypotheses testing that have been developed in this thesis.

Table 6.5 Proposed model relationship hypotheses and tests

Hypotheses	Description	Test to Carryout
H1	IT Practitioners ->> Green IT/IS Practice	Regression
H2	IT Governance ->> Green IT/IS Practice	Regression
H3	Technologies &Systems ->> Green IT/IS Practice	Regression
H4	Motivating forces ->> Green IT/IS Practice	Regression
H5	IT Strategy ->> Green IT Practice	Regression
H6	Information Availability ->> Green IT/IS Practice	Regression
H7a	Green IT/IS Practice ->> Green Creation	Regression
H7b	Green IT/IS Practice ->> Green Distribution	Regression
H7c	Green IT/IS Practice ->> Green Sourcing	Regression
H7d	Green IT/IS Practice ->> Green Usage	Regression
H7e	Green IT/IS Practice ->> End of Life	Regression
H8a	Timing->> Green IT/IS Practice	Partial Correlation
H8b	Sector->> Green IT/IS Practice	Partial Correlation
H8c	Size->> Green IT/IS Practice	Partial Correlation
H8d	Revenue->> Green IT/IS Practice	Partial Correlation
H9a	Gender ->> IT Practitioners	Multiple Regression Moderation
H9b	Age ->> IT Practitioners	Multiple Regression Moderation
H9c	Education ->> IT Practitioners	Multiple Regression Moderation
H10a	Gender ->> IT Governance	Multiple Regression Moderation
H10b	Age ->> IT Governance	Multiple Regression Moderation
H10c	Education ->> IT Governance	Multiple Regression Moderation
H11	Green IT/IS Practice ->> Economic	Regression
H12	Green IT/IS Practice ->> Social	Regression
H13	Green IT/IS Practice ->> Environmental	Regression

Table 6.5 shows the relationship between variables and hypotheses for explanation of the test to be carried out in validating the developed Green IT/IS assessment model as seen in Figure 5.3, Section 5.4 of Chapter 5 using survey data.

6.4.1 Regression Analysis to Validate H1-H6

From Section 5.5.1-5.5.2 the following hypotheses (H1 to H6) were proposed;

H1: IT practitioner's personality will positively influence his/her action toward Green IT/IS practice implementation.

H2: IT governance structure will have a positive effect on Green IT/IS practice implementation.

H3: Green IT/IS practice implementation is positively influenced by deployed technologies and systems.

H4: Pressure from management, governmental and non-governmental organizations will have a positive effect on Green IT/IS practice implementation.

H5: CEs with well defined IT strategies are more likely to implement Green IT/IS practices.

H6: Green IT/IS practice implementation will emerges if there exist a shared enterprise Green repository in enterprise to provide Green information.

Thus, Table 6.6 shows the regression analysis test carried out to validate the hypothesized relationships H1 to H6 as seen in Figure 5.3 (Chapter 5). Where;

H_0: There is no significant relationship between each independent variables and dependent variable.

H_A: There is a significant relationship between each independent variables and dependent variable.

Table 6.6 Regression analysis to validate H1-H6

Dependent Variable: Green IT/IS Practice	**Collinearity Statistics**	**Regression Analysis**					
Independent Variables	**Tolerance**	***F*-Tests**	R^2	**Beta**	**Std. Error**	***t*-test**	***P*-value (Sig.)**
IT Practitioners	0.276	15.271	0.104	0.323	0.091	3.908	0.000
IT Governance	0.188	26.315	0.167	0.409	0.083	5.130	0.000
Technologies & Systems	0.293	46.213	0.261	0.511	0.079	6.798	0.000
Motivating Forces	0.225	69.018	0.345	0.587	0.081	8.308	0.000
IT Strategy	0.133	52.742	0.287	0.536	0.077	7.262	0.000
Information Availability	0.159	56.012	0.300	0.547	0.072	7.484	0.000

Table 6.6 shows the result of inferential test using regression analysis test between independent variables and dependent variable where the results outlines the goodness of fit relationship test, namely; *F*-test for the variables given as 15.271, 26.315, 46.213, 69.018, 52.742 and 56.012 with *p*-value 0.000 showing that the test is highly significant for all independent variables. Since *p*-value of *F*-test is less than significance level α=0.05, therefore conclude that there is a significant relationship between the independent variables and dependent variable. The strength of relationships is measured by examining R^2 of all the variables where R^2 = 0.104 for IT practitioners shows that IT practitioners variable has been interpreted at 10.4% of the variance, next is IT governance with R^2 =0.167 interpreting at 16.7% of the variance.

Technologies and systems has an R^2 =0.261 interpreting at 26.1% of the variance, next is motivating forces which has the highest R^2 =0.345 interpreting at 34.5% of the variance, followed by IT strategy with R^2=0.287 interpreting at 28.7% of the variance and lastly is information availability with R^2=0.300 interpreting 30% of the variance in Green IT/IS practice. Additionally, all the independent variables has a direct effect on the Green IT/IS practice (as shown in positive beta result (β = 0.323, 0.409, 0.511, 0.587, 0.536, 0.547)), which express the relative importance of the variables where the tolerance value is greater than 0.01 for all independent variables (showing that collinearity is not an issue) (Brace et al., 2003).

In terms of improvement (β value), increase 1 unit in all independent variables, Green IT/IS practice will increase by 0.32 (32%) unit for IT practitioners, 0.409 (40.9%) unit for IT governance, 0.511(51.1%) unit for technologies and systems, 0.587 (58.7%) units for motivating forces, 0.536 (53.6%) units for IT strategy, and lastly 0.547 (54.7%) units for information availability. Lastly, considering the *t*-test value all the independent variables (3.908, 5.130, 6.798, 8.308, 7.262, 7.484) are higher than 1.96 benchmark recommended by Hair et al. (2010), showing that all independent variables are very significant, with motivating forces being the most important independent variables at t = 8.308, p = 0.000 and IT practitioners being the least important variable at t = 3.908, p = 0.000.

6.4.2 Regression Analysis to Validate H7a-H7d

From Section 5.5.3 in Chapter 5, the following hypotheses H7a-H7e were proposed;

H7a: The current Green IT/IS practice implemented will have a positive effect on Green creation.

H7b: The current Green IT/IS practice implemented will have a positive effect on Green distribution.

H7c: The current Green IT/IS practice implemented will have a positive effect on Green sourcing.

H7d: The current Green IT/IS practice implemented will have a positive effect on Green usage.

H7e: The current Green IT/IS practice implemented will have a positive effect on end of life.

Where;

H_0: There is no significant relationship between Green IT/IS practice and Green creation, Green distribution, Green sourcing, Green usage and end of life.

H_A: There is a significant relationship between Green IT/IS practice and Green creation, Green distribution, Green sourcing, Green usage and end of life.

Table 6.7 Regression analysis to validate H7a-H7e

Dependent Variable: Green IT/IS Practice	**Collinearity Statistics**	**Regression Analysis**				
Green IT/IS Practice	**Tolerance**	**R^2**	**Beta**	**Std. Error**	**t-test**	**P-value (Sig.)**
Green Creation	0.253	0.815	0.903	0.037	24.025	0.000
Green Distribution	0.174	0.875	0.935	0.027	30.299	0.000
Green Sourcing	0.206	0.868	0.932	0.026	29.395	0.000
Green Usage	0.150	0.888	0.943	0.028	32.281	0.000
End of Life	0.221	0.811	0.901	0.036	23.703	0.000

Table 6.7 depicts the regression analysis test carried out to validate the hypothesized relationships H7abcde as seen in Figure 5.3 (Chapter 5) using SPSS showing that the *p*-value of all Green IT/IS practice equals to 0.000. Since *p*-value is less than significance level α=0.05, conclude that there is significant relationship between dependent variable and Green IT/IS practice. The strength of relationship is measured by examining R^2 = 0.815, 0.875, 0.868, 0.888, 0.811 is >0 <1 Hair et al.

(2006) and beta value β = 0.903, 0.935, 0.932, 0.943, 0.901 showing a strong relationship. Additionally, Table 6.7 shows an encouraging *t*-test value which is greater than 1.96 as stated by Hair et al. (2006). Based on this result, this study concludes that the dependent variable is a reflection of the Green IT/IS practice implemented in CE. Additionally, the Green IT/IS practice were also tested for multicollinearity and it was found that the tolerance value was above 0.10 (Brace et al., 2003) illustrating that multicollinearity is not a problem.

6.4.3 Regression Analysis to Validate H11-H13

From Section 5.5.3 in Chapter 5, the following hypotheses H11-H13 were proposed;

H11: The current Green IT/IS practice implemented will have a positive effect on CE attaining economic sustainability.

H12: The current Green IT/IS practice implemented will have a positive effect on CE attaining social sustainability.

H13: The current Green IT/IS practice implemented will have a positive effect on CE attaining environmental sustainability.

Where;

H_0: There is no significant relationship between Green IT/IS practice and economic, social and environmental sustainability.

H_A: There is a significant relationship between Green IT/IS practice and economic, social and environmental sustainability.

Table 6.8 Regression analysis to validate H11-H13

Dependent Variable: Green IT/IS Practice	**Collinearity Statistics**	**Regression Analysis**				
Sustainability	**Tolerance**	**R^2**	**Beta**	**Standard Error**	**t-test**	**P-value (Sig.)**
Economic	0.100	0.868	0.932	0.026	29.395	0.000
Social	0.100	0.978	0.989	0.012	75.479	0.000
Environmental	0.150	0.937	0.968	0.023	44.246	0.000

Table 6.8 depicts the regression analysis test carried out to validate the hypothesized relationships H11-H13 as seen in Figure 5.3 (Chapter 5) using SPSS showing that the *p*-value of economic, social and environmental sustainability equals to

0.000. Next, R^2 = 0.868, 0.978, 0.937 with beta value β = 0.932, 0.989, 0.968 showing a strong relationship. Additionally, Table 6.8 shows an encouraging *t*-test value which is greater than 1.96 indicating that the Green IT/IS practice implementation leads to economic, social and environmental sustainability attainment in CE. Moreover, the sustainability constructs were also tested for multicollinearity and it was found that the tolerance value was equal to or above 0.10.

6.4.4 Partial Correlation Analysis to Validate H8a-H8d

Next from Section 5.5.4 in Chapter 5 the following hypotheses H8a-H8e were proposed and are tested using partial correlation as seen in Table 6.9.

H8a: How long the enterprise has existed positively influences Green IT/IS practice.

H8b: The sector the enterprise belongs to positively influences Green IT/IS practice.

H8c: The enterprise size positively influences Green IT/IS practice.

H8d: The annual revenue generated by the enterprise positively influences Green IT/IS practice.

H_0: There is no significant relationship between the enterprise duration, sector, size, revenue and Green IT/IS practice.

H_A: There is a positive significant relationship between the enterprise duration, sector, size, revenue and Green IT/IS practice.

Table 6.9 shows the partial correlation for independent variables and dependent variable as recommended by Field (2009) while controlling for enterprise timing, sector, size and revenue. Four different analyses were carried out by introducing each of the control variables into the model. Data was collected in two pairs as seen in Table 6.9 when the control was not introduce into the test and another when the control is introduce into the test.

Table 6.9 Partial correlations for testing control variables H8a-H8d

Control Variables	Independent and Dependent Variables	Partial Correlation Test	Results
-none-a	Analysis 1a	Correlation	0.539
		Significance (2-tailed)	0.000
		df	131
Enterprise Founding Date	Analysis 1b	Correlation	0.541
		Significance (2-tailed)	0.000
		df	130
-none-a	Analysis 2a	Correlation	0.539
		Significance (2-tailed)	0.000
		df	131
Enterprise Sector	Analysis 2b	Correlation	0.539
		Significance (2-tailed)	0.000
		df	130
-none-a	Analysis 3a	Correlation	0.539
		Significance (2-tailed)	0.000
		df	131
Enterprise Size	Analysis 3b	Correlation	0.540
		Significance (2-tailed)	0.000
		df	130
-none-a	Analysis 4a	Correlation	0.539
		Significance (2-tailed)	0.000
		df	131
Enterprise Revenue	Analysis 4b	Correlation	0.545
		Significance (2-tailed)	0.000
		df	130

a. Cells contain zero-order (Pearson) correlations.

Test from partial correlation analysis results reveal that there was a moderate, positive partial correlation between independent variables and dependent variable whilst controlling for enterprise founding date, which was statistically significant, when the control was introduce into the test at $r(130) = 0.541$, $p = 0.000$ and $r(131) = 0.539$, $p = 0.000$ when the control was excluded from the test. The variation in correlations indicates that enterprise founding date had positively influence with a significant difference of 0.541-0.539 =0.002 (0.2%).

Table 6.9 additionally shows that there was no positive partial correlation between independent variables and dependent variable whilst controlling for enterprise sector, which was statistically significant, $r(131) = 0.539$, $p = 0.000$ before considering the control variable and $r(130) = 0.539$, $p = 0.000$, after introducing the control variable into the test indicating that enterprise sector had no influence in controlling for the relationship between independent variables and dependent variable. Furthermore, there was a positive partial correlation between independent variables and dependent variable

whilst controlling for enterprise size, which was statistically significant, $r(131) = 0.539$, $p = 0.000$ before considering the control variable and $r(130) = 0.540$, $p = 0.000$, after introducing the control variable into the test indicating that enterprise size had a significant influence of 0.540-0.539 =0.001 (0.1%) in controlling for the relationship between independent variables and dependent variable.

The results (see Table 6.9) suggest there was a significant difference of 0.540-0.539 =0.001 (0.1%). Also, there was a positive partial correlation between independent variables and dependent variable whilst controlling for enterprise revenue, which was statistically significant, $r(131) = 0.539$, $p = 0.000$ before considering the control variable and $r(130) = 0.545$, $p = 0.000$, after introducing the control variable into the test indicating that enterprise revenue had a significant influence in controlling for the relationship between independent variables and dependent variable. Furthermore, it can be seen there was a moderate significant difference of 0.545-0.539 =0.006 (0.6%).

6.4.5 Multiple Regression Moderation Analysis to Validate H9a-H9c/H10a-H10c

From Section 5.5.5 in Chapter 5 on social-demographic determinants, the following hypotheses are to be tested using multiple regression moderation analysis.

H9a: The gender of IT practitioners positively moderates Green IT/IS practice.

H9b: The age of IT practitioners positively moderates Green IT/IS practice.

H9c: The educational level of IT practitioners positively moderates Green IT/IS practice.

H10a: The gender of IT manager positively moderates Green IT/IS practice.

H10b: The age of IT manager positively moderates Green IT/IS practice.

H10c: The educational level of IT manager positively moderates Green IT/IS practice.

H_0: There is no significant relationship between the moderating effects of gender, age, education of IT practitioners and IT manager on Green IT/IS practice.

H_A: There is a positive significant relationship between the moderating effects of gender, age, education of IT practitioners and IT manager on Green IT/IS practice.

The following hypotheses (H9a-H9c and H10a-H10c) were proposed and are tested using multiple regression moderating analysis.

Table 6.10 Multiple regression moderation analysis for H9a-H9c

Gender	Dependent Variable: Green IT/IS Practice	Multiple Regression Analysis		
Test 1	Independent Variables: IT Practitioner Moderating Variable: Gender *F*-Tests =9.043, *P*-value (Sig.) = 0.000, R^2= 0.122	Beta	Standard Error	*t*-test
		0.333	0.090	4.037
Test 2	Dependent Variable: Green IT/IS Practice Independent Variables: IT Practitioner; Moderating Variable: Gender; Moderator: Gender_Moderator_ITP *F*-Tests =6.005, *P*-value (Sig.) = 0.001, R^2= 0.123	Multiple Regression Moderating Analysis for Gender Moderating IT Practitioners		
		Beta	Standard Error	*t*-test
		0.335	0.091	4.025
Age	Dependent Variable: Green IT/IS Practice	Multiple Regression Analysis		
Test 1	Independent Variables: IT Practitioner Moderating Variable: Age *F*-Tests =18.042, *P*-value (Sig.) = 0.000, R^2= 0.217	Beta	Standard Error	*t*-test
		0.300	0.085	3.860
Test 2	Dependent Variable: Green IT/IS Practice Independent Variables: IT Practitioner; Moderating Variable: Age; Moderator: Age_Moderator_ITP *F*-Tests =14.167, *P*-value (Sig.) = 0.000, R^2= 0.248	Multiple Regression Moderating Analysis for Age Moderating IT Practitioners		
		Beta	Standard Error	*t*-test
		0.322	0.085	4.175
Educati-on	Dependent Variable: Green IT/IS Practice	Multiple Regression Analysis		
Test 1	Independent Variables: IT Practitioner Moderating Variable: Education *F*-Tests =8.042, *P*-value (Sig.) = 0.001, R^2= 0.122	Beta	Standard Error	t-test
		0.309	0.092	3.679
Test 2	Dependent Variable: Green IT/IS Practice Independent Variables: IT Practitioners; Moderating Variable: Education; Moderator: Education _Moderator_ITP *F*-Tests =5.500, *P*-value (Sig.) = 0.001, R^2= 0.113	Multiple Regression Moderating Analysis for Education Moderating IT Practitioners		
		Beta	Standard Error	*t*-test
		0.302	0.093	3.548

The multiple regression moderating analysis is presented in Table 6.10 and 6.11 as suggested by Aiken and West (1991) to predict the moderating effect of gender, age and education on IT practitioner and IT governance which influences Green IT/IS practice as displayed on Table 6.10 and Table 6.11. In which two tests was carried out each for each moderators (gender, age and education). Accordingly, Table 6.10, for gender test 1, multiple regression of the variables (gender, IT practitioner and Green

IT/IS practice) was statistically significantly predicted Green IT/IS practice, F= 9.043, p < 0.0000, R^2 = 0.122, (β = 0.333, std.error=0.090, t=4.037) showing that all three variables added statistically significantly to the prediction, p < 0.05.

Next, test 2, multiple regression moderating analysis comprising of (gender, IT practitioner, gender_moderator_IT_practitioner and Green IT/IS practice) with results, F= 6.005, p < 0.001, R^2 = 0.123, (β = 0.335, std.error=0.091, t=4.025), this shows a significant increase in R^2, std.error and β value but a decrease in the t and p value. Based on the results in Table 6.10 it is concluded that gender does not moderate IT practitioner effect on Green IT/IS practice.

From Table 6.10, for age test 1, multiple regression of the variables (age, IT practitioner and Green IT/IS practice) which was statistically significantly predicted Green IT/IS practice, F= 18.042, p < 0.0000, R^2 = 0.217, (β = 0.300, std.error=0.085, t=3.860) showing that all three variables added statistically significantly to the prediction, p < 0.05. Next test 2, multiple regression moderating analysis comprising of (age, IT practitioner, age_moderator_IT_practitioner and Green IT/IS practice) was also carried out and the result outlines that F= 14.167, p < 0.0000, R^2 = 0.248, (β = 0.322, std.error=0.085, t=4.175), this shows a significant increase in R^2, β and t value but same std.error of 0.085. Based on the results in Table 6.10, it is concluded that age positively moderates IT practitioner effect on Green IT/IS practice.

From Table 6.10, for education test 1, multiple regression of the variables (education, IT practitioner and Green IT/IS practice) which was statistically significantly predicted Green IT/IS practice, F= 8.042, p < 0.0001, R^2= 0.122, (β = 0.309, std.error=0.092, t=3.679) showing that all three variables added statistically significant to the prediction, p < 0.05. Next test 2, multiple regression moderating analysis comprising of (education, IT practitioner, education_moderator_IT_practitioner and Green IT/IS practice) was also carried out and the results reveal that F= 5.500, p < 0.001, R^2= 0.113, (β = 0.302, std.error=0.093, t=3.448), this shows a null significant, decrease in R^2, β, t and p statistics value. Based on the results in Table 6.10 it is concluded that education does not moderate IT practitioner effect on Green IT/IS practice.

Table 6.11 Multiple regression moderation analysis for H10a-H10c

Gender	Dependent Variable: Green IT/IS Practice	Multiple Regression Analysis		
Test 1	Independent Variables: IT Governance; Moderating Variable: Gender *F*-Tests =14.036, *P*-value (Sig.) = 0.000, R^2= 0.178	Beta	Standard Error	*t*-test
		0.407	0.083	5.215
Test 2	Dependent Variable: Green IT/IS Practice Independent Variables: IT Governance; Moderating Variable: Gender, Moderator: Gender_Moderator_ITG *F*-Tests =9.813, *P*-value (Sig.) = 0.000, R^2= 0.186	Multiple Regression Moderating Analysis for Gender Moderating IT Governance		
		Beta	Standard Error	t-test
		0.412	0.083	5.173
Age	Dependent Variable: Green IT/IS Practice	Multiple Regression Analysis		
Test 1	Independent Variables: IT Governance Moderating Variable: Age *F*-Tests =22.260, *P*-value (Sig.) = 0.000, R^2= 0.255	Beta	Standard Error	*t*-test
		0.362	0.080	4.718
Test 2	Dependent Variable: Green IT/IS Practice Independent Variables: IT Governance, Moderating Variable: Age, Moderator: Age_Moderator_ITG *F*-Tests =18.596, *P*-value (Sig.) = 0.000, R^2= 0.302	Multiple Regression Moderating Analysis for Age Moderating IT Governance		
		Beta	Standard Error	*t*-test
		0.375	0.078	5.020
Educati-on	Dependent Variable: Green IT/IS Practice	Multiple Regression Analysis		
Test 1	Independent Variables: IT Governance; Moderating Variable: Education *F*-Tests =13.168, *P*-value (Sig.) = 0.000, R^2= 0.168	Beta	Standard Error	*t*-test
		0.400	0.086	4.859
Test 2	Dependent Variable: Green IT/IS Practice Independent Variables: IT Governance; Moderating Variable: Education; Moderator: Education _Moderator_ITG *F*-Tests =8.809, *P*-value (Sig.) = 0.000, R^2= 0.170	Multiple Regression Moderating Analysis for Education Moderating IT Governance		
		Beta	Standard Error	*t*-test
		0.398	0.086	4.805

From Table 6.11, for gender test 1 multiple regression of the variables (gender, IT governance and Green IT/IS practice) which was statistically significantly predicted Green IT/IS practice, F= 14.036, $p < 0.0000$, R^2 = 0.178, (β = 0.407, std.error=0.083, t=5.215) showing that all three variables added statistically significantly to the prediction, $p < 0.05$. Next test 2, multiple regression moderating analysis comprising of

(gender, IT governance, gender_moderator_IT_governence and Green IT/IS practice) was also carried out and the result outlines that F= 9.813, p < 0.000, R^2 = 0.186, (β = 0.412, std.error=0.083, t=5.173), this shows a significant increase in R^2 and β value but a decrease in t-test and F-test and same value for p statistics and std.error value. The results conclude that gender does not moderates IT manager effect on implementing Green IT/IS practice in CE.

From Table 6.11, for age test 1, multiple regression of the variables (age, IT governance and Green IT/IS practice) which was statistically significantly predicted Green IT/IS practice, F= 22.260, p < 0.0000, R^2 = 0.255, (β = 0.362, std.error=0.080, t=4.718) showing that all three variables added statistically significantly to the prediction, p < 0.05. Next test 2, multiple regression moderating analysis comprising of (gender, IT governance, age_moderator_IT_governence and Green IT/IS practice) was also carried out and the results outline that F= 18.596, p < 0.0000, R^2= 0.302, (β = 0.375, std.error=0.078, t=5.020), this shows a significant increase in R^2, β and t value but a reduced F and std.error value. The results conclude that age positively moderates IT manager effect on implementing Green IT/IS practice in CE.

From Table 6.11, for education test 1, multiple regression of the variables (education, IT governance and Green IT/IS practice) which was statistically significantly predicted Green IT/IS practice, F= 13.168, p < 0.0000, R^2 = 0.168, (β = 0.400, std.error=0.086, t=4.859) showing that all three variables added statistically significantly to the prediction, p < 0.05. Next test 2, multiple regression moderating analysis comprising of (education, IT governance, education_moderator_IT_governance and Green IT/IS practice) was also carried out and the result reveals that F= 8.809, p < 0.000, R^2= 0.170, (β = 0.398, std.error=0.086, t=4.805), this shows a negative significant, decrease in β and t-test value. The results conclude that education does not moderate IT manager effect on Green IT/IS practice.

6.5 Confirmatory Test from PLS-SEM

This section carries out confirmatory test using Smart PLS 3 to also validate the developed Green IT/IS assessment model. Hence, results from PLS-SEM corroborate results from SPSS. The confirmatory tests are carried out based on Table 6.12.

Table 6.12 The hypotheses, relationship and inferential test in PLS-SEM

Hypotheses	Description	Inferential Test to Carryout
H1	IT Practitioners ->> Green IT/IS Practice	PLS Algorithm and Bootstrapping
H2	IT Governance ->> Green IT/IS Practice	PLS Algorithm and Bootstrapping
H3	Technologies & Systems ->> Green IT/IS Practice	PLS Algorithm and Bootstrapping
H4	Motivating forces ->> Green IT/IS Practice	PLS Algorithm and Bootstrapping
H5	IT Strategy ->> Green IT/IS Practice	PLS Algorithm and Bootstrapping
H6	Information Availability ->> Green IT/IS Practice	PLS Algorithm and Bootstrapping
H7a	Green IT/IS Practice ->> Green Creation	PLS Algorithm and Bootstrapping
H7b	Green IT/IS Practice ->> Green Distribution	PLS Algorithm and Bootstrapping
H7c	Green IT/IS Practice ->> Green Sourcing	PLS Algorithm and Bootstrapping
H7d	Green IT/IS Practice ->> Green Usage	PLS Algorithm and Bootstrapping
H7e	Green IT/IS Practice ->> End of Life	PLS Algorithm and Bootstrapping
H8a	Timing->> Green IT/IS Practice	Multiple Group Analysis
H8b	Sector->> Green IT/IS Practice	Multiple Group Analysis
H8c	Size->> Green IT/IS Practice	Multiple Group Analysis
H8d	Revenue->> Green IT/IS Practice	Multiple Group Analysis
H9a	Gender ->> IT Practitioners	Interaction Mediation Analysis
H9b	Age ->> IT Practitioners	Interaction Mediation Analysis
H9c	Education ->> IT Practitioners	Interaction Mediation Analysis
H10a	Gender ->> IT Governance	Interaction Mediation Analysis
H10b	Age ->> IT Governance	Interaction Mediation Analysis
H10c	Education ->> IT Governance	Interaction Mediation Analysis
H11	Green IT/IS Practice ->> Economic	PLS Algorithm and Bootstrapping
H12	Green IT/IS Practice ->> Social	PLS Algorithm and Bootstrapping
H13	Green IT/IS Practice ->> Environmental	PLS Algorithm and Bootstrapping

6.5.1 Measurement of Developed Green IT/IS Assessment Model

The measurement was carried using 5000 sample bootstrapping technique as suggested by (Henseler, 2010) to determine the significance levels of the path coefficients, weights and loadings for model validation. All statistical tests were measured with reflective measurement using two-tailed *t*-tests at p=0.05 significance. The developed Green IT/IS assessment model (see Figure 5.3) is divided into three measurement model to shows the interactions between the independent variables and dependent variable as structural model 1, whereas dependent variable and Green IT/IS practice is represented as structural model 2, and sustainability attainment as structural model 3 (see Table 6.13). Structural model 1 is used to confirm hypotheses H1-H6,

whereas structural model 2 is used to confirm hypotheses H7a-H7e. Lastly, structural model 3 is used to confirm hypotheses H11-H13.

Table 6.13 Measurement of structural model 1-3

Models	Relationship	R^2 (Percentage of Variance)	Path Coefficient
Structural Model 1	IT Practitioner -> Green IT/IS Practice	0.132	0.363
	IT Governance -> Green IT/IS Practice	0.194	0.441
	Technologies and Systems -> Green IT/IS Practice	0.294	0.542
	Motivating Forces -> Green IT/IS Practice	0.387	0.622
	IT Strategy -> Green IT/IS Practice	0.318	0.564
	Information Availability -> Green IT/IS Practice	0.331	0.575
Structural Model 2	Green IT/IS Practice -> End of Life	0.839	0.916
	Green IT/IS Practice -> Green Creation	0.842	0.917
	Green IT/IS Practice -> Green Distribution	0.886	0.941
	Green IT/IS Practice -> Green Sourcing	0.876	0.936
	Green IT/IS Practice -> Green Usage	0.907	0.953
Structural Model 3	Green IT/IS Practice ->> Economic	0.862	0.929
	Green IT/IS Practice ->> Social	0.955	0.977
	Green IT/IS Practice ->> Environmental	0.941	0.970

Table 6.13 show the measurement of structural model 1 (H1-H6) results presenting the R^2 value (see Table 6.13), that show how much the variance of the dependent variable is being explained by independent variables, where path coefficients (standardized regression weights) represents the weight outlines different ranking of their relative statistical importance. Results from Table 6.13 suggest that the coefficient of determination R^2 (percentage of variance) should be > 0<1 (Henseler, 2010; Hair et al., 2011), where R^2 between IT practitioner and Green IT/IS practice (H1) is 0.132, signifying that IT practitioners moderately explain 13.2% of the variance in Green IT/IS practice. (H2) R^2 is 0.194 (19.4%) for IT governance, (H3) R^2 is 0.294 (29.4%) for technologies and systems, (H4) R^2 is 0.387 (38.7%) for motivating forces, (H5) R^2 is 0.318 (32.8%) for IT strategy and lastly (H6) R^2 is 0.331 (33.1%) for information availability of the variance in Green IT/IS practice.

Results from Table 6.13 also reveal that for the path coefficient, motivating forces has the strongest effect on Green IT/IS practice with a value of 0.622, followed

by information availability with 0.575 then IT strategy with 0.564, technologies and systems with 0.542, then IT governance with 0.441 and lastly IT practitioner with a value of 0.363. Accordingly, the hypothesized path relationship between the independent variables and dependent variable (H1-H6) is statistically significant since all the values are greater than 0.1 (Hair et al., 2013). Thus, the author concluded that all independent variables are reasonably strong predictors of dependent variable (Green IT/IS practice).

Results from Table 6.13 also shows the measurement of structural model 2 (H7a-H7e) results showing R^2 value that indicates how much the variance of Green IT/IS practice are being explained by the dependent variable. Where (H7a) R^2 between Green IT/IS practice and Green creation is 0.842, signifying that Green IT/IS practice moderately explain 84.2% of the variance in Green creation. (H7b) R^2 is given as 0.886 (88.6%) for Green distribution, (H7c) R^2 is given as 0.876 (87.6%) for Green sourcing, (H7b) R^2 is given as 0.907 (90.7%) for Green usage and lastly 0.839 (83.9%) for end of life variance being affected by Green IT/IS practice. Moreover, results from Table 6.13 regarding the path coefficient indicate that Green IT/IS practice has the strongest effect on Green usage with a value of 0.953, next is Green distribution with 0.941, followed by Green sourcing with 0.936, Green creation is next with 0.917 and end of life with 0.916 with the least effect on Green IT/IS practice.

Results from Table 6.13 also show the measurement of sustainability (H11-H13) where (H7a) R^2 between Green IT/IS practice for economic is 0.862 (86.2%), social is 0.955 (95.5%) and lastly environmental is 0.941 (94.1%). Considering the path coefficient, Green IT/IS practice has the strongest effect on social with a value of 0.977, followed by environmental with 0.970 and economic with 0.929.

6.5.2 Loading, Reliability and Convergent Validity

The individual item reliability was assessed by examining the loading of respective item path based on the independent variables, dependent variable, Green IT/IS practice, and sustainability. Respectively where, the loading is the correlations between the independent variables, Green IT/IS practice, and sustainability items.

Table 6.14 Assessment measurement of structural model 1

Independent Variables & DV	Code	Loadings	Composite Reliability (CR)	Cronbach 's Alpha	Average Variance Extracted (AVE)	Mean	SD
IT Practitioners	ITP1	0.876	0.963	0.956	0.764	3.93	0.736
	ITP2	0.887					
	ITP3	0.886					
	ITP4	0.873					
	ITP5	0.871					
	ITP6	0.863					
	ITP7	0.815					
	ITP8	0.922					
IT Governance	ITG1	0.894	0.977	0.973	0.843	3.98	0.773
	ITG2	0.938					
	ITG3	0.938					
	ITG4	0.933					
	ITG5	0.836					
	ITG6	0.947					
	ITG7	0.958					
	ITG8	0.893					
Technologies and Systems	TS1	0.901	0.960	0.952	0.750	3.79	0.771
	TS2	0.823					
	TS3	0.823					
	TS4	0.834					
	TS5	0.904					
	TS6	0.903					
	TS7	0.886					
	TS8	0.851					
Motivating Forces	MF1	0.805	0.945	0.932	0.709	3.60	0.706
	MF2	0.789					
	MF3	0.814					
	MF4	0.867					
	MF5	0.869					
	MF6	0.899					
	MF7	0.845					
IT Strategy	ITS1	0.910	0.975	0.970	0.849	3.77	0.774
	ITS2	0.911					
	ITS3	0.885					
	ITS4	0.961					
	ITS5	0.948					
	ITS6	0.957					
	ITS7	0.871					
Information Availability	IA1	0.954	0.977	0.969	0.915	3.80	0.819
	IA2	0.959					
	IA3	0.960					
	IA4	0.955					
Green IT/IS Practice	GP1	0.901	0.966	0.956	0.851	3.41	0.807
	GP2	0.914					
	GP3	0.931					
	GP4	0.918					
	GP5	0.947					

Table 6.14 and 6.15 shows the survey items loading values which should be between 0.5 to 1 (Hair et al., 2006; Henseler, 2010), as seen in Table 6.14 and 6.15 the independent variables, dependent variable, Green IT/IS practice, and sustainability item loading values are above 0.5 and below 1, where the higher loading implies that there is a shared variance among the variables.

Table 6.15 Assessment measurement of structural model 2 and 3

Green IT/IS & Sustainability	Code	Loadings	CR	Cronbach's Alpha	AVE	Mean	SD
Green Creation	GC1	0.795	0.942	0.927	0.731	3.46	0.812
	GC2	0.872					
	GC3	0.867					
	GC4	0.870					
	GC5	0.864					
	GC6	0.863					
Green Distribution	GD1	0.854	0.964	0.957	0.771	3.35	0.910
	GD2	0.918					
	GD3	0.821					
	GD4	0.813					
	GD5	0.878					
	GD6	0.908					
	GD7	0.910					
	GD8	0.913					
Green Sourcing	GS1	0.879	0.967	0.959	0.829	3.25	0.967
	GS2	0.894					
	GS3	0.932					
	GS4	0.917					
	GS5	0.932					
	GS6	0.907					
Green Usage	GU1	0.922	0.950	0.937	0.761	3.51	0.836
	GU2	0.939					
	GU3	0.854					
	GU4	0.761					
	GU5	0.875					
	GU6	0.872					
End of Life	EOL1	0.885	0.942	0.923	0.764	3.49	0.846
	EOL2	0.886					
	EOL3	0.868					
	EOL4	0.885					
	EOL5	0.844					
Economic	GS	0.929	0.967	0.959	0.829	3.25	0.967
Social	GD	0.961	0.960	0.917	0.924	3.37	0.856
	GU	0.962					
Environmental	GC	0.931	0.929	0.846	0.867	3.41	0.807
	EOL	0.931					

Table 6.14 and 6.15 also show the Composite Reliability (CR), Cronbach's Alpha, and Average Variance Extracted (AVE) of each independent variable, Green

IT/IS practice and dependent variable. Hence the Cronbach's Alpha which is the items or indicator reliability (i.e., loadings square) should be 0.70 or higher is preferred (Hulland, 1999). Additionally, the composite reliability should be 0.7 or higher (Bagozzi and Yi, 1988) and the convergent validity value given as AVE should be 0.5 or higher (Bagozzi and Yi, 1988). From Table 6.14 and 6.15, the values are shown to be greater than 0.7, so high levels of internal consistency reliability have been verified for independent variables, Green IT/IS practice, sustainability and dependent variable items. Similarly, evidence of convergent validity was assessed by inspecting the variance extracted for each item, where the convergent validity if established, is the variance-extracted value exceed 0.50 variables (Fornell and Larcker, 1981). Thus, to check convergent validity, each variable's Average Variance Extracted (AVE) is assessed. Again from Table 6.14 and 6.15, it is found that all of the AVE values are greater than the acceptable threshold of 0.5, so convergent validity is confirmed.

6.5.3 Discriminant Validity for Structural Model 1 and Model 2

Discriminant validity was assessed in this study by following Fornell and Larcker (1981) recommendations as discussed in Section 3.2.6.7 in Chapter 3.

Table 6.16 Discriminate validity of structural model 1

	Green IT/IS Practice	**1**	**2**	**3**	**4**	**5**	**6**
Green IT/IS Practice	**0.922**						
IT Governance	0.429	**0.918**					
IT Practitioner	0.350	0.851	**0.874**				
IT Strategy	0.557	0.788	0.712	**0.921**			
Information Availability	0.569	0.796	0.717	0.904	**0.957**		
Motivating Forces	0.621	0.69	0.647	0.853	0.819	**0.842**	
Technologies and Systems	0.536	0.773	0.693	0.800	0.772	0.750	**0.866**

The discriminant validity is thus acceptable when variable have an AVE value greater than 0.5 meaning that at least 50% of measurement variance was attributed to that variable. Therefore, results for discriminate validity of structural model 1-3 are shown in Table 6.16-6.18 respectively. Table 6.16-6.18 show the Fornell-Larcker

criterion analysis for checking discriminant validity using the square root of AVE on the diagonal of Table 6.16-6.18, where all the values are larger than 0.5%. The result indicates that discriminant validity is well established.

Table 6.17 Discriminate validity of structural model 2

	1	2	3	4	5
End of Life	**0.874**				
Green Creation	0.742	**0.855**			
Green Distribution	0.768	0.843	**0.878**		
Green Sourcing	0.796	0.802	0.862	**0.910**	
Green Usage	0.871	0.817	0.856	0.839	**0.872**

Table 6.18 Discriminate validity of structural model 3

	1	2	3
Economic Sustainability	**0.910**		
Environmental Sustainability	0.855	**0.931**	
Social Sustainability	0.877	0.917	**0.961**

6.5.4 Structural Path Significance and Total Effect

Next to finally confirm H1-H6, H7a-H7e, and H11-H13 in PLS-SEM as done in SPSS as seen in Table 6.6, 6.7 and 6.8, SmartPLS3 is used to generate *t*-statistics value for significance testing using bootstrapping procedure.

Table 6.19 Confirmatory results of hypotheses (H1-H6 and H7a-H7e)

Models	Relationship	Hypotheses	Path Coefficient	R^2	*t*-Value	P-value	At p =>0.05
Structural Model 1	IT Practitioner -> Green IT/IS Practice	H1	0.363	0.132	5.960	0.000	Accept
	IT Governance -> Green IT/IS Practice	H2	0.441	0.194	6.427	0.000	Accept
	Technologies and Systems -> Green IT/IS Practice	H3	0.542	0.294	7.710	0.000	Accept
	Motivating Forces -> Green IT/IS Practice	H4	0.622	0.387	9.699	0.000	Accept
	IT Strategy -> Green IT/IS Practice	H5	0.564	0.318	7.882	0.000	Accept
	Information Availability -> Green IT/IS Practice	H6	0.575	0.331	9.395	0.000	Accept

Table 6.19 Continued.

Models	Relationship	Hypotheses	Path Coefficient	R^2	*t*-Value	P-value	At p =>0.05
Structural Model 2	Green IT/IS Practice -> End of Life	H7a	0.916	0.839	41.669	0.000	Accept
	Green IT/IS Practice -> Green Creation	H7b	0.917	0.842	44.89	0.000	Accept
	Green IT/IS Practice -> Green Distribution	H7c	0.941	0.886	71.509	0.000	Accept
	Green IT/IS Practice -> Green Sourcing	H7d	0.936	0.876	64.708	0.000	Accept
	Green IT/IS Practice -> Green Usage	H7e	0.953	0.907	106.88	0.000	Accept
Structural Model 3	Green IT/IS Practice -> Economic Sustainability	H11	0.929	0.862	65.714	0.000	Accept
	Green IT/IS Practice -> Social Sustainability	H12	0.977	0.955	180.98	0.000	Accept
	Green IT/IS Practice -> Environmental Sustainability	H13	0.970	0.941	101.94	0.000	Accept

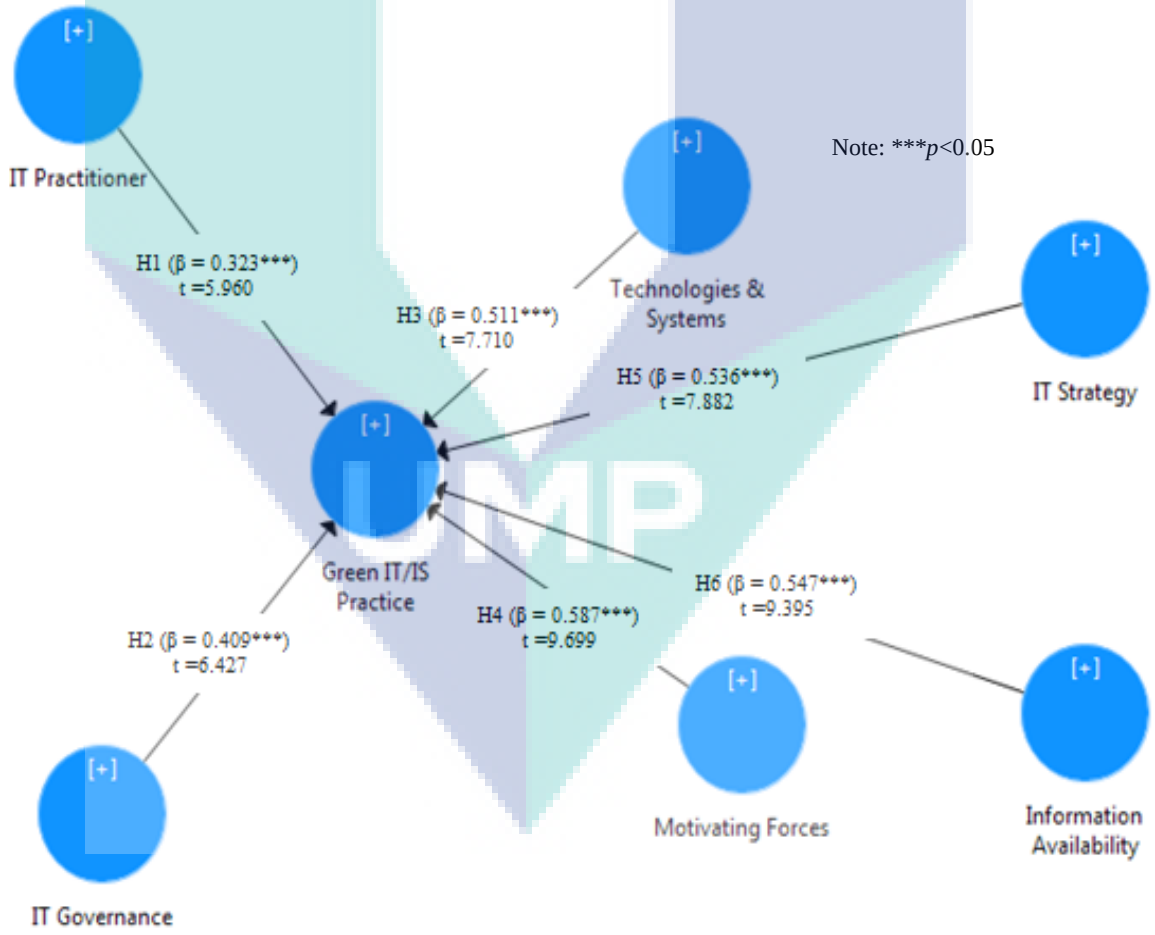


Figure 6.1 Results of structural model 1

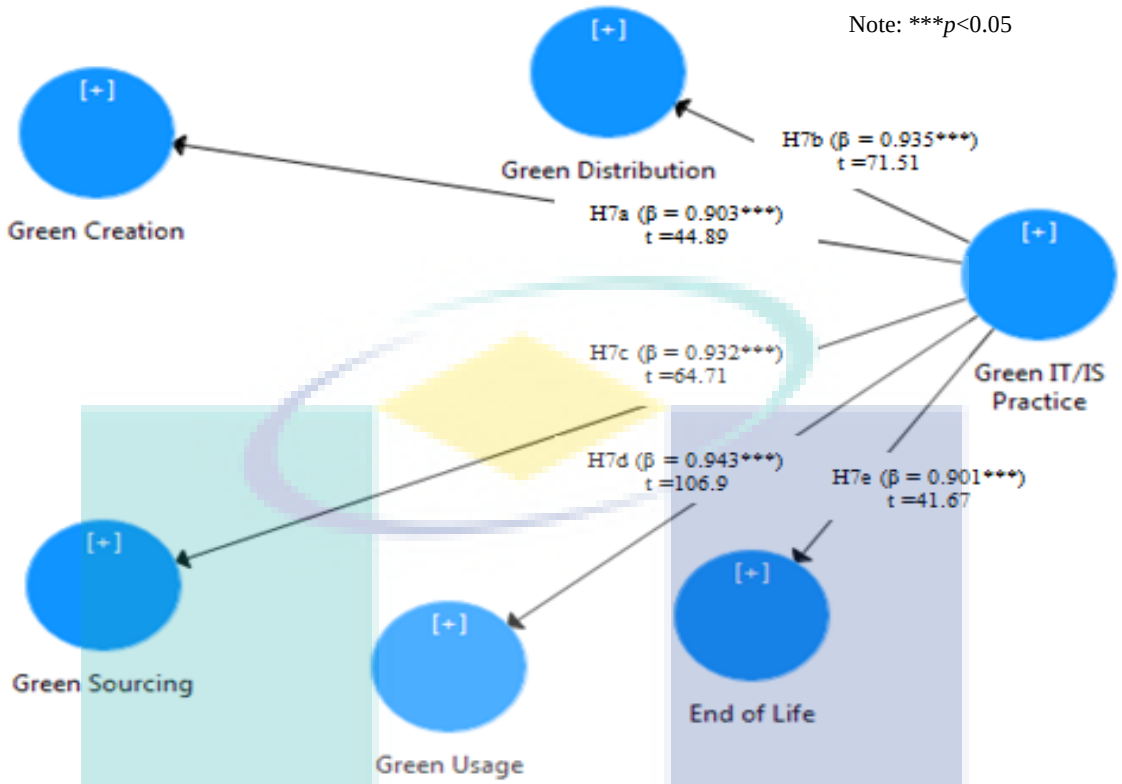


Figure 6.2 Results of structural model 2

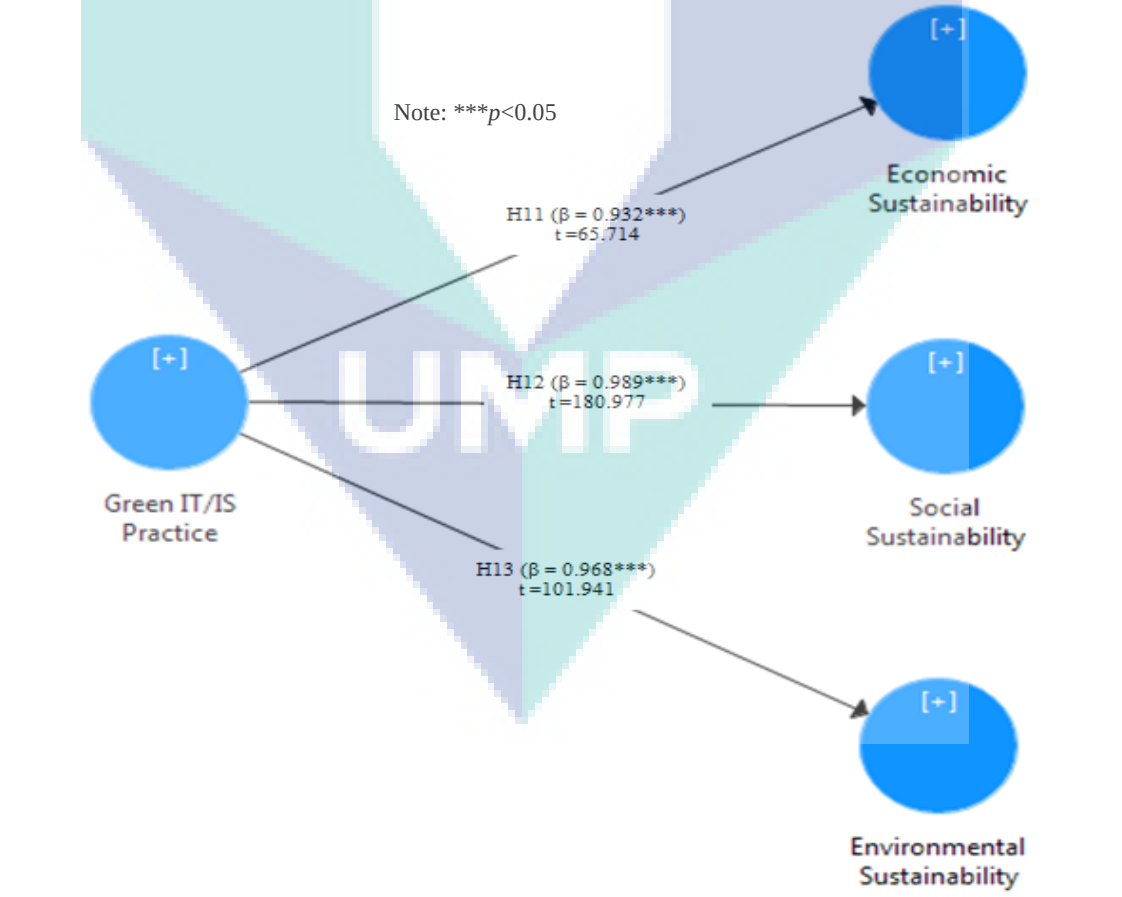


Figure 6.3 Results of structural model 3

Table 6.19 shows the hypotheses test using a two-tailed *t*-test with a significance level of 5%, the path coefficient will be significant if the *t*-value is larger than 1.96. As seen all values are greater than the 1.96 threshold. Hence, all hypotheses are highly significant and are supported similar to results from SPSS in Table 6.6 to 6.8. Likewise, Figure 6.1, 6.2 and 6.3 shows the PLS-SEM modelling result validation for hypotheses (H1-H6, H7a-H7e, and H11-H13).

In addition to checking the hypotheses, there is need to check each model's effect size which shows how much the individual independent variable influences the dependent variable's R^2 value in structural model 1 and how the dependent variable influences the individual Green IT/IS practice R^2 in structural model 2. The effect size is utilized to determine the strength of relationship between the independent variables and dependent variable. Correspondingly, Chin et al. (1996) clearly pointed out that researchers should not only indicate whether the relationship between variables is significant or not, but also report the effect size between the variables in the model.

Table 6.20 Variables total effect and performance important measurement

Variables Relationship	Total Effect	Performances
IT Governance -> Green IT/IS Practice	-0.027	54.189
IT Practitioner -> Green IT/IS Practice	-0.227	55.792
IT Strategy -> Green IT/IS Practice	-0.087	61.525
Information Availability -> Green IT/IS Practice	0.266	59.992
Motivating Forces -> Green IT/IS Practice	0.524	60.683
Technologies and Systems -> Green IT/IS Practice	0.213	68.910

Results from Importance-Performance Map Analysis (IPMA) (as discussed in Section 3.2.6.7 in Chapter 3) in SmartPLS3 was deployed as seen in Table 6.20 to test for total effect for structural model 1 and results indicate that motivating forces is the most influencing independent variable with total effect of 0.524 in relation to Green IT/IS practice in CE and technologies and systems is the most performing independent variable with value of 68.910 in relation to Green IT/IS practice implementation in CE as seen in Table 6.20. Similarly, to assess the total effect for structural model 2, blindfolding analysis test was deployed in SmartPLS3, where blindfolding is samples re-use technique. It allows calculating Stone-Geisser's Q^2 value, which represents an evaluation criterion for the cross-validated predictive relevance of the PLS path model as discussed in Section 3.2.6.7 in Chapter 3.

Table 6.21 Green IT/IS practice construct crossvalidated redundancy for model 2

Green IT/IS Practice	Sum of Square of the Observation (SSO)	Sum of Square in Predicting Errors (SSE)	Q^2 (=1-SSE/SSO)
End of Life	665	278.235	0.582
Green Creation	798	349.428	0.562
Green Distribution	1,064.00	390.787	0.633
Green Sourcing	798	258.125	0.677
Green Usage	798	284.201	0.644

The Q^2 value of Green IT/IS practice in the PLS path model is obtained by using the blindfolding procedure (Hair et al., 2013). Consequently, blindfolding is employed in this thesis to check for the path coefficient of each Green IT/IS practice in structural model 2 and the R^2 percentage variance of each Green IT/IS practice, where each value should be greater than "0" as discussed in Section 3.2.6.7 in Chapter 3. Results from blindfolding (Q^2 value) as seen in Table 6.21 suggest that Green IT/IS practice has more effect on Green sourcing in CE with a value of 0.677 (67.7%).

6.5.5 Test for Enterprise Characteristics (Control Variables)

Next test is carried out to ascertain if the control variables (duration, sector, size and revenue) influences Green IT/IS practice in CE by conducting Partial Least Square-Multi-Group Analyses (PLS-MGA) (as discussed in Section 3.2.6.7 in Chapter 3) in SmartPLS3 as suggested by Keil et al. (2000), to accept or reject the hypotheses H8a-H8e. Therefore, multi-group analysis previously carried out by Molla et al. (2014) in their research on Green IT practice among IT professionals and Dalvi-Esfahani et al. (2017b) in their research on Green IS practice among managers was carried out in this study to establish whether the structural relationships among the independent variables and dependent variable is influenced by the control variables.

The control variables or enterprise characteristics are duration, sector, size and revenue. Each of the control variables was tested independently. A dichotomization procedure was followed as previously carried out by Molla et al. (2014). The results from the multi-group analyses as shown in Table 6.22 to 6.25 reveal that duration, size and revenue of the enterprise significantly influences Green IT/IS practice based on *p*-values lower than 0.05, thus accept hypothesis H8acd, whereas sector of the enterprise

does not influences Green IT/IS practice, thus reject hypothesis H8b based on *p*-values higher than 0.05 analogous to results from SPSS as seen in Section 6.4.4.

Table 6.22 PLS-MGA for enterprise timing

	Path Coefficients-diff (|TimingTime(1.0)—TimingTime(2.0)|)	***p*-Value (TimingTime(1.0) vs. TimingTime(2.0))**
IT Governance -> Green IT/IS Practice	0.304	0.039
IT Practitioner -> Green IT/IS Practice	0.364	0.009
IT Strategy -> Green IT/IS Practice	1.144	0.026
Information Availability -> Green IT/IS Practice	0.084	0.014
Motivating Forces -> Green IT/IS Practice	0.758	0.007
Technologies & Systems -> Green IT/IS Practice	0.188	0.048

Table 6.23 PLS-MGA for enterprise sector

	Path Coefficients-diff (|Sector1—Sector2|)	***p*-Value (Sector1 vs. Sector2)**
IT Governance -> Green IT/IS Practice	1.064	0.985
IT Practitioner -> Green IT/IS Practice	0.041	0.449
IT Strategy -> Green IT/IS Practice	0.019	0.516
Information Availability -> Green IT/IS Practice	0.810	0.039
Motivating Forces -> Green IT/IS Practice	0.090	0.412
Technologies & Systems -> Green IT/IS Practice	0.304	0.139

Table 6.24 PLS-MGA for enterprise size

	Path Coefficients-diff (|Size1—Size2|)	***p*-Value (Size1 vs. Size2)**
IT Governance -> Green IT/IS Practice	0.479	0.011
IT Practitioner -> Green IT/IS Practice	0.319	0.020
IT Strategy -> Green IT/IS Practice	0.376	0.029
Information Availability -> Green IT/IS Practice	0.410	0.040
Motivating Forces -> Green IT/IS Practice	0.618	0.046
Technologies & Systems -> Green IT/IS Practice	0.107	0.030

Table 6.25 PLS-MGA for enterprise annual revenue

	Path Coefficients-diff (|Revenue1—Revenue2|)	***p*-Value (Revenue1 vs. Revenue2)**
IT Governance -> Green IT/IS Practice	0.269	0.027
IT Practitioner -> Green IT/IS Practice	0.157	0.017
IT Strategy -> Green IT/IS Practice	1.083	0.024
Information Availability -> Green IT/IS Practice	0.151	0.014
Motivating Forces -> Green IT/IS Practice	0.718	0.034
Technologies & Systems -> Green IT/IS Practice	0.249	0.017

6.5.6 Test for Social-demographic Determinants (Moderating Variables)

For socio-demographic determinants, this thesis test for the moderating variables using interaction mediation analyses in SmartPLS3 as suggested by Hair et al. (2013) for gender, age and education individually on IT practitioners and IT governance (IT manager) in relation to Green IT/IS practice to verify hypotheses H9a-H9c for IT practitioners and H10a-H10c for IT governance (IT manager).

SmartPLS 3 (moderating effect functionality) was used to create a new moderators based on the existing moderator being tested and the independent variable in the model in relation to the dependent variable. The analysis was undertaken to investigate whether the independent variable (IT practitioners and IT governance) were sensitive to differences in the values of moderating variables. As introduced previously, the moderating variables gender, age and education were analysed independently using bootstrapping procedure. Therefore, results of the interaction mediation analysis are shown in Figure 6.4 and 6.5 respectively.

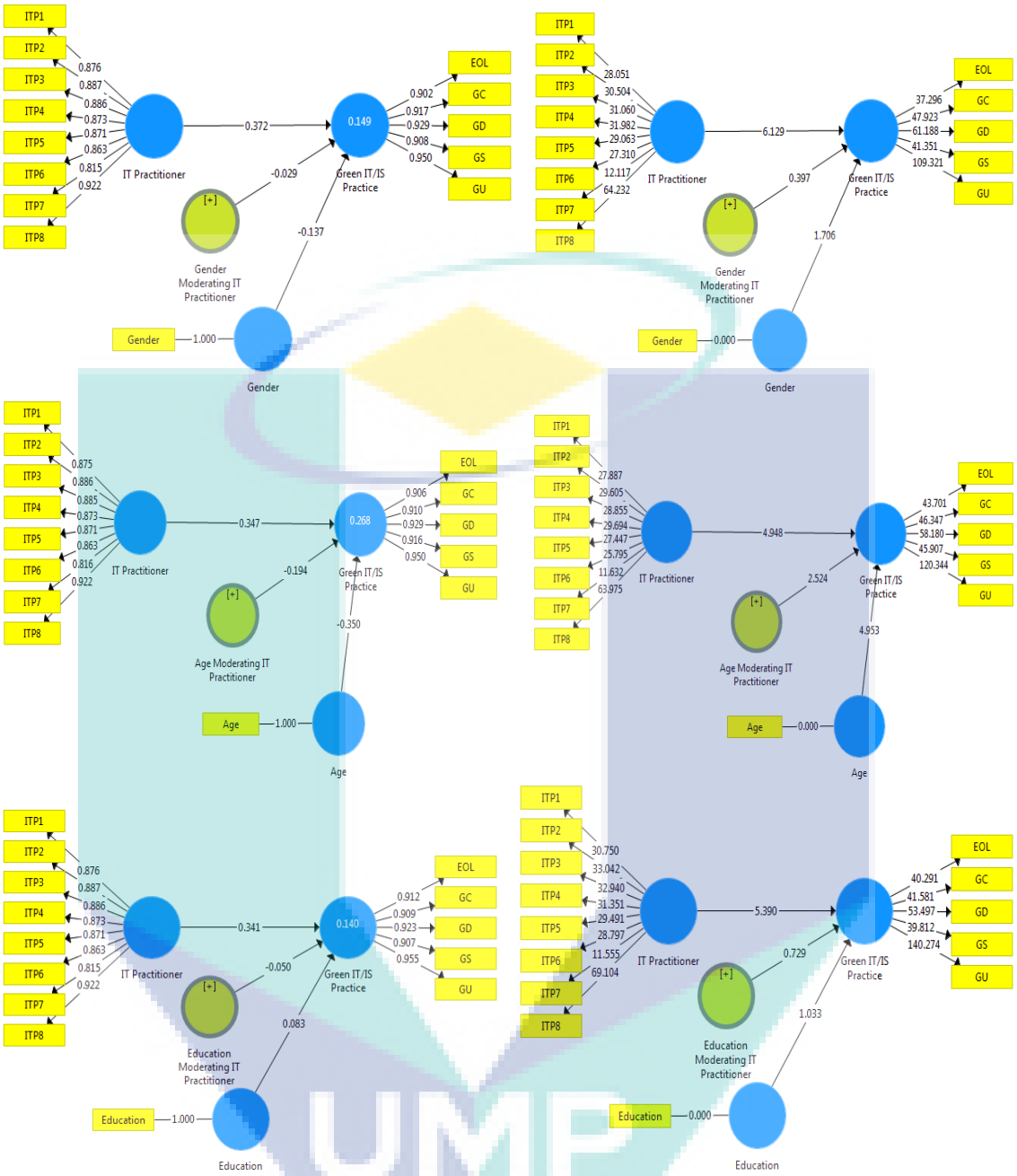


Figure 6.4 Results of moderating influences of age, gender, education and experience on IT practitioner

The moderating effect path coefficient of gender on IT practitioners is given as -0.029 (see Figure 6.4), whereas the *p*-value= 0.683; *t*-value is given as 0.397 which is lower than 1.96. Thus, indicating that gender (either male or female) does not positively mediate IT practitioner's intention to implement Green IT/IS practice in CE. Hence, reject H9a, since no significant was observed. Results of the moderating effect path coefficient of age on IT practitioners is given as -0.194 (see Figure 6.4), whereas the *p*-value= 0.09; *t*-value is given as 2.524 which is higher than 1.96, thus showing that age moderates IT practitioner's intention to implement Green IT/IS practice in CE, thus

support H8b. In addition, to confirm which age results from One way-Anova in Table 6.26 for age distribution show that the younger age below 25 are more concerned about Green IT/IS practice. Likewise, the moderating effect path coefficient of education on IT practitioner is given as -0.050 (see Figure 6.4), whereas the *p*-value= 0.452; *t*-value is given as 0.729 which is lower than 1.96. Thus, suggesting that any level of education does not moderate IT practitioner's intention to implement Green IT/IS practice in CE, hence reject H9c, similar to results from SPSS (see Table 6.10 in Section 6.4.5).

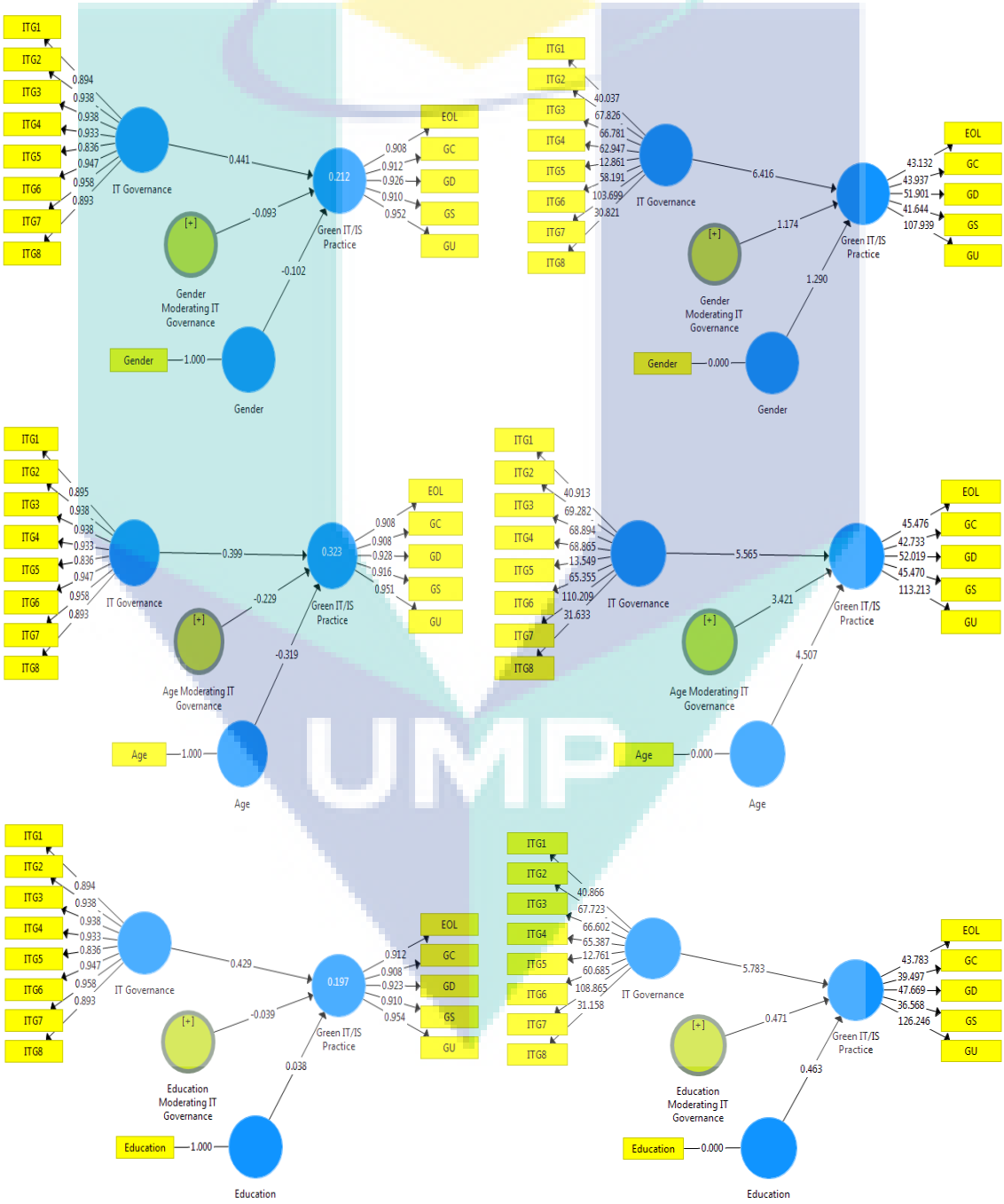


Figure 6.5 Results of moderating influences of age, gender, education and experience on IT governance

The moderating effect path coefficient of gender on IT governance is given as -0.093 (see Figure 6.5), whereas the *p*-value= 0.210; *t*-value is given as 1.174 which is lower than 1.96. Thus, indicating that gender (either male or female) does not positively mediate IT manager's intention to implement Green IT/IS practice in CE. Hence, reject H10a, since no significant was observed. Similarly, the moderating effect path coefficient of age on IT governance is given as -0.229 (see Figure 6.5), whereas the *p*-value= 0.001; *t*-value is given as 3.421 which is higher than 1.96. Thus, revealing that age moderates IT manager's intention to implement Green IT/IS practice in CE. To confirm which age results from One way-Anova (Table 6.27) for age distribution shows that the age between 25 to 34 are more concerned about Green IT/IS practice, thus support H10b. Equally, the moderating effect path coefficient of education on IT governance is given as -0.039 (see Figure 6.5), whereas the *p*-value= 0.639; *t*-value is given as 0.471 which is lower than 1.96. Thus, suggesting that any level of education does not moderate IT manager's intention to implement Green IT/IS practice in CE, hence reject H10c, similar to results from SPSS (see Table 6.11 in Section 6.4.5).

Table 6.26 One way-Anova test for age moderating IT practitioners

Age	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
<25	1	4.00					4	4
25–34	55	3.98	0.665	0.090	3.80	4.16	3	5
35–44	59	3.91	0.815	0.106	3.70	4.12	3	5
45–55	17	3.92	0.711	0.172	3.55	4.28	3	5
>55	1	3.00					3	3

Table 6.27 One way-Anova test for age moderating IT governance (IT manager)

Age	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
<25	1	4.00					4	4
25–34	55	4.11	0.732	0.099	3.91	4.31	3	5
35–44	59	3.90	0.810	0.105	3.69	4.12	3	5
45–55	17	3.85	0.762	0.185	3.45	4.24	3	5
>55	1	3.00				3.00	3	5

6.6 Evaluation of Green IT/IS Assessment Tool

To accomplish the fourth research objective which aims to further validate the developed Green IT/IS assessment model using the implemented Green IT/IS assessment tool as stated in Section 1.6 in Chapter 1. Likewise, as stated in Section 3.2.6.8 in Chapter 3, the implemented GAT is also used to validate the developed Green IT/IS assessment model by testing the applicability of the implemented tool (see Appendix D). Thus, SPSS was employed to analyse the collect questionnaire data as used in previous studies, where Kwon et al. (2007) deployed SPSS to evaluate their multi-agent-Case Based Reasoning (CBR) prototype system and Chang et al. (2016) where, the researchers utilized SPSS to evaluate their agent and CBR online bookstore.

Table 6.28 Characteristic of the focus group questionnaire respondents

Profile	Options	Frequency	Percentage
Gender	Male	22	62.9 %
	Female	13	37.1 %
Age	< 25	4	10.4%
	25-34	14	41.0%
	35-44	13	39.0%
	45-55	3	5.7%
	>55	1	3.8%
Education	Diploma	2	5.7%
	Bachelor's Degree	14	40.0%
	Master's Degree	13	37.1%
	PhD	6	17.1%
Job Title	IT Practitioner	18	51.4%
	IT Administrator	4	11.4%
	Environmental Practitioners	7	20.0%
	IT Manager	4	11.4%
	IT Staff	1	2.9%
	Others	1	2.9%
Working Experience	0-5	8	22.9%
	6-10	18	51.4%
	11-15	6	17.1%
	16-20	3	8.6%

Table 6.28 shows the demographic characteristic of the respondents involved in the focus-group to test the applicability of GAT in validating the developed Green IT/IS assessment model. The questionnaire items (see Appendix C) were all measured with a 5 point Likert scale ranging from not important as "1" and very important as "5", completely dissatisfied as "1" and completely satisfied as "5", whereas the demographic items gender, age, education, experience and job title all measured using ordinal measurement.

Table 6.29 Frequency and descriptive analysis results for GAT

#	Items	Frequency Response and Percentage					Descriptive Analysis	
		1	2	3	4	5	Mean	SD
1	User friendly	0 0.00%	0 0.00%	10 28.6%	17 48.6%	8 22.9%	3.94	0.718
2	Provide enough information	0 0.00%	0 0.00%	10 28.6%	16 45.7%	9 45.7%	3.97	0.740
3	Easy to navigate	0 0.00%	0 0.00%	21 60.0%	8 22.9%	6 17.1%	3.57	0.770
4	Easy to learn	0 0.00%	0 0.00%	11 31.4%	10 28.6%	14 40.0%	4.09	0.845
5	Encounter problems	0 0.00%	0 0.00%	13 37.1%	10 28.6%	312 34.3%	3.97	0.849
6	Sufficient to assess Green creation	0 0.00%	0 0.00%	11 31.4%	10 26.3%	14 33.1%	4.09	0.845
7	Sufficient to assess Green distribution	0 0.00%	0 0.00%	5 14.3%	14 40.0%	16 45.7%	4.31	0.711
8	Sufficient to assess Green sourcing	0 0.00%	0 0.00%	13 37.1%	13 37.1%	9 25.7%	3.89	0.788
9	Sufficient to assess Green usage	0 0.00%	0 0.00%	6 17.1%	23 65.7%	6 17.1%	4.00	0.588
10	Sufficient to assess end of life	0 0.00%	0 0.00%	6 17.1%	17 48.6%	12 4.3%	4.17	0.700
11	Sufficient to manage knowledge	0 0.00%	0 0.00%	10 28.6%	7 20.0%	18 51.4%	4.23	0.869
12	Best practice suggestion importance	0 0.00%	0 0.00%	9 23.8%	21 61.9%	5 14.3%	3.90	0.613
13	Assessment enrolment importance	0 0.00%	0 0.00%	10 28.6%	9 25.7%	16 45.7%	4.17	0.849
14	Result certification generation importance	0 0.00%	0 0.00%	9 25.7%	14 40.0%	12 34.3%	4.09	0.774
15	Efficiency of the tool	0 0.00%	0 0.00%	9 20.0%	13 37.1%	15 42.9%	4.23	0.763
16	Overall performance of the tool	0 0.00%	0 0.00%	15 42.9%	7 20.0%	13 37.1%	3.94	0.897
17	Information retrieval response time	0 0.00%	0 0.00%	20 57.1%	6 17.1%	9 27.1%	3.69	0.858
18	Consistency of data provided	0 0.00%	0 0.00%	20 57.1%	10 28.6%	5 14.3%	3.57	0.732
19	Satisfaction in terms of tool evaluation	0 0.00%	0 0.00%	15 42.9%	15 42.9%	5 14.3%	3.71	0.703
20	Satisfaction in terms of tool benchmark	0 0.00%	0 0.00%	16 45.7%	11 31.4%	8 22.9%	3.77	0.800
21	Satisfaction in terms of tool rating	0 0.00%	0 0.00%	23 64.8%	8 23.8%	4 11.4%	3.47	0.694

Scoring Guide for Mean: 0.00-2.49 = low, 2.50-3.49 = moderate, 3.50-5.00 = high as suggested by Isa (2016).

The questionnaire items were derived from prior studies on tool evaluation; this confirms content validity of the instrument (as stated in Section 3.2.6.8). The reliability

of the measured 21 items based on Cronbach's alpha was given as $\alpha = 0.70$ from SPSS. This reveals that the items have an acceptable reliability and appropriate for testing the tool based on recommendations from Section 3.2.6.4. Then, descriptive analysis was employed to provide an overview of the participants' perception of the applicability of GAT in relation to the questionnaire questions. Hence, Table 6.29 presents the questionnaire items scores presented in percentages and frequency to depict the distribution of relies in relation to the applicability of the tool.

Table 6.30 Factor analysis (principal component analysis) for GAT

#	Factors/Questionnaire Items	Factor Loading	Eigenvalues	% of Variance
1	User Friendly	0.711	4.190	19.954
2	Provide Enough Information	0.782	3.163	15.062
3	Easy to Navigate	0.805	2.327	11.083
4	Easy to Learn	0.617	1.848	8.801
5	Encounter Problems	0.825	1.547	7.368
6	Sufficient to Assess Green Creation	0.531	1.215	5.788
7	Sufficient to Assess Green Distribution	0.679	1.012	4.817
8	Sufficient to Assess Green Sourcing	0.816	0.890	4.238
9	Sufficient to Assess Green Usage	0.616	0.817	3.889
10	Sufficient to Assess End of Life	0.654	0.737	3.510
11	Sufficient to Manage Knowledge	0.604	0.636	3.030
12	Best Practice Suggestion Importance	0.778	0.525	2.501
13	Assessment Enrolment Importance	0.845	0.462	2.198
14	Certification Generation Importance	0.780	0.386	1.836
15	Efficiency of the Tool	0.841	0.315	1.498
16	Overall Performance of the Tool	0.667	0.236	1.125
17	Information Retrieval Response Time	0.752	0.212	1.011
18	Consistency of Data Provided	0.782	0.198	0.943
19	Satisfaction in Terms of Tool Evaluation	0.677	0.162	0.772
20	Satisfaction in Terms of Tool Benchmark	0.743	0.074	0.354
21	Satisfaction in Terms of Tool Rating	0.800	0.047	0.224

The percentages and frequency result responses shows moderate and high acceptance of GAT, where the means and SD value of the item are displayed in Table 6.29. Overall, based on the scoring guide 0.00-2.49 = low 2.50-3.49 = moderate 3.50-5.00 = high as suggested by Isa (2016), the descriptive analysis results reveal that the mean value for items are ranging from as below as 3.47 for satisfaction in terms of tool assessment rating as moderate level to the highest of 4.31 for sufficient to assess Green distribution as highest level and no low level of mean value was observed. Besides, SD is less than 1 for all items showing that the response from the respondents are close and

not widely dispersed, this implicates that all items are accepted by the participants in terms of the applicability of GAT. Next, the questionnaire items were subjected to principal component analysis as previously carried out by Molla (2009b); Ahmad et al. (2014); Ismail et al. (2016); Zakaria et al. (2016) to ascertain the underlying items that influences respondents' perception towards GAT (see Table 6.30).

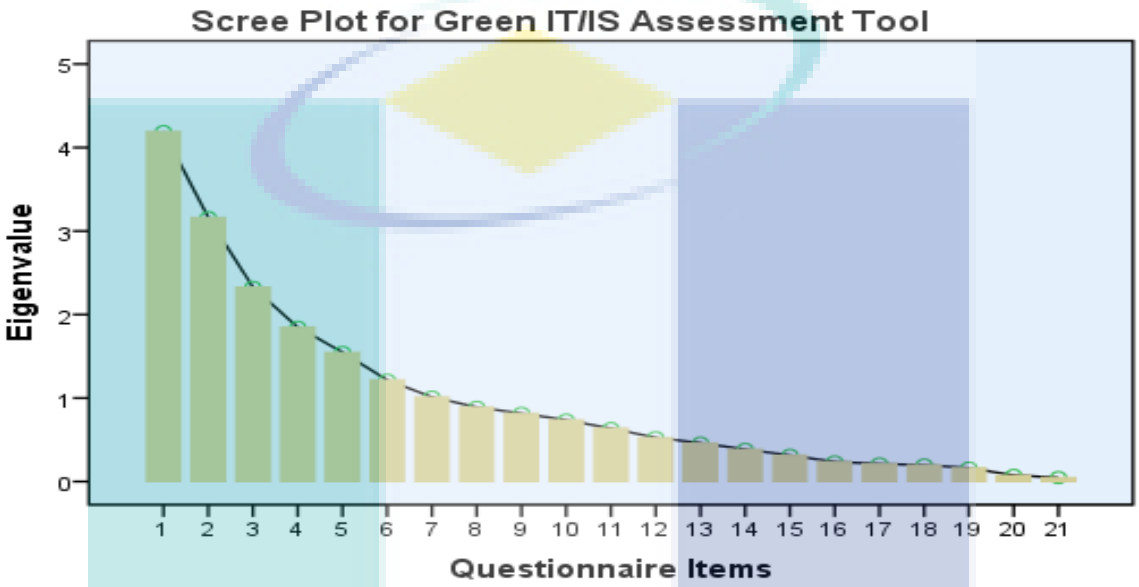


Figure 6.6 Scree plot of principal component analysis for GAT

Figure 6.6 shows the Scree plot of the questionnaire item used to test the applicability of GAT, where item 1 has the highest Eigen value. In addition, factor analysis helps to explain the item that best confirms the tool, where the applicability criteria of all twenty-one items has been reflected based on a extraction method utilized to best describe overall contribute towards confirming the applicability of GAT. Hence, the items factor loadings, eigenvalues, percentage of variance that best define the applicability criteria of GAT are shown in Table 6.30. The principal component analysis shown in Table 6.30 show the factor loadings or communality of each item, where the loadings indicate a significance level that should be greater than 0.50, as recommended by Hair et al. (2006); Ahmad et al. (2014). Hence, results from Table 6.30 reveal that all the questionnaire item loading ranges from item 6 which measures the sufficient of GAT to assess Green creation practice in CE with a value of 0.531 to the importance of the assessment enrolment functionality with a value of 0.845.

User friendly item is the most influential item with a value of 19.154 explaining (19.2%) of the variance and satisfaction of the tool rating capabilities with a value of 0.224 explaining (0.22%) of the variance where item 1 has the highest eigenvalue and

item 21 has the least eigenvalue as seen in Figure 6.4. Furthermore, the percentage of variance explained for all items was greater than 0.1, as recommended by Straub et al. (2004) as seen in Table 6.30. In addition, this thesis also examined the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy as suggested by Field (2009) as shown in Table 6.31. Where KMO values around 0.5 are barely acceptable, higher KMO (KMO) values are ordered as average (0.5–0.7), good (0.7–0.8), great (0.8–0.9), and superb (above 0.9) (Field, 2009) as discussed in Section 3.2.6.8 in Chapter 3.

Table 6.31 KMO and Bartlett's Test for GAT

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.			0.50
Bartlett's Test of Sphericity		Approx. Chi-Square	1154.224
		df	210
		Sig.	0.000

In conclusion, results from Table 6.31 show the KMO and Barlett's test value derived from the principal component analysis test in SPSS confirms that the KMO is = 0.50 which is within the 0.5 limit. Therefore, showing that GAT is accepted by the respondents, hence applicable for Green IT/IS practice assessment at a significance of 0.000. Congruently, the Bartlett's test of sphericity $\chi 2$ (210) = 1154.224, $p < 0.000$, indicated the acceptance of GAT based on KMO and Bartlett's test results.

6.7 Discussion of Green IT/IS Assessment Model Validation

This thesis develops a Green IT/IS assessment model to facilitate sustainability attainment. The model was validated based on survey question (see Appendix B) and analysed using SPSS and SmartPLS. Findings from regression analysis in SPSS and coefficient size, and structural path significance test in SmartPLS indicate ample supports for hypotheses (H1-H7) revealing that IT practitioner commitment is mandatory for CE in initiating Green IT/IS practices. This result is consistent with results of prior studies (Deng and Ji, 2015), the data implies that IT practitioners' cooperation is based on their shared interest and stakes in fulfilling the objectives of the enterprise with a *t*-value of 3.908 and R^2 of 0.104, where this can be seen as part of the environmental ethics or stewards in CE similar to Gholami et al. (2013) where the authors got a *t*-value of 3.040 and R^2 of 0.120.

This study found that IT governance rules to have a positive influence on Green IT/IS practice by suggesting that the regulation initiated by management influences how staffs implement Green IT/IS practices in CE with a *t*-value of 5.130; R^2 of 0.167. This finding has also been supported by other studies in the literature such as Dalvi-Esfahani et al. (2017b) with *t*-value of 3.273; R^2 of 0.534 where the authors stressed that management must provide guidelines and campaigns to inform employee on how techniques such as telematics which can improve Green IT/IS practice, in detail, the findings lead to the conclusion that the commitment of CE to governance policies is essential in promoting Green IT/IS practice.

The results of this study support that there is a positive relationship between technologies and systems and Green IT/IS practice with *t*-value of 6.798; R^2 of 0.261. The outcomes of previous research (Cooper and Molla, 2014) confirm the result of this current study with *t*-value of 4.500; R^2 of 0.590. Conversely, Molla et al (2014) revealed that technology and systems which refers to infrastructures enable sustainable related operations in CE, this is reasonable since these technology and systems are utilized by IT practitioners processing the knowledge and skills to implement Green IT/IS practices in their enterprise. The outcome of this research also support the hypothesis that there is positive relationship between motivating forces and Green IT/IS practice with a value of with *t*-value of 8.308; R^2 of 0.345. This result is consistent with findings of previous research (Vykoukal et al., 2011; Gholami et al., 2013) with a value of *t*-value = 7.016; R^2 of 0.354 and *t*-value = 3.040; R^2 of 0.120 respectively. This study data indicate that CE are influenced by internal and external pressure that controls how they conducts business in relation to Green IT/IS practices based on standard set mostly by government and external environmental associations such as Greenpeace. The results suggest that strategy deployed by CE to accomplish their objectives significantly influences Green IT/IS practices with *t*-value = 7.262; R^2 of 0.287. This is in line with findings of prior studies conducted in other countries such as (Loeser et al. (2017) with a value of *t*-value = 2.420; R^2 of 0.410. So, it is recommended that IT strategy should support CE in reducing their day-to-day operating costs.

This study indicates that information availability influences Green IT/IS practice in CE with *t*-value = 7.484; R^2 of 0.300, this is similar to findings presented by Cooper and Molla (2014) with *t*-value = 2.500; R^2 of 0.580. In addition, Butler (2011a);

Meacham et al. (2013) mentioned that information usage through IT/IS can assist to reduce energy consumption, which is one of the aims of CE as there is a clear cost saving that comes with the use of less energy as energy prices increases. Further results from regression analysis and coefficient sizes, and structural path significance test revealed that the Green IT/IS practice hypotheses (H7a-H7e) for Green creation, Green distribution, Green sourcing, Green usage, and end of life are based on the current Green IT/IS practice being implemented in the enterprise.

The results show that the current Green IT/IS practice significantly influence Green creation with mean value = 3.46; SD of 0.812, as previously stated by Molla et al. (2009a); Ninlawan et al. (2010) with mean value = 4.20; SD of 1.24 where the researchers mentioned that Green creation involves the utilization of information systems for enterprise operations, environmental management and carbon foot print assessment in CE design activities. The results also imply that the current Green IT/IS practice significantly influence Green distribution in CE with mean value = 3.35; SD of 0.910. This results is analogous to the statement proposed by Molla et al. (2009b); Raza et al. (2012) with mean value = 2.72; SD of 1.27 where the researchers mentioned that Green distribution emboldens operative procedures that increases the reutilization and reuse of raw materials to encourage minimal unwanted materialization thereby lowering resource consumption. The results also showed that Green IT/IS practice influences Green sourcing which reflects on environmentally preferable IT infrastructure procuring in CE with mean value = 3.25; SD of 0.967. This result is consistent with previous results presented by Molla et al. (2009ab); Pichetpongsa and Campeanu, (2011) with mean value = 3.88; SD of 1.58, where the authors found out that Green sourcing initiative in CE includes social concerns such as the presence of harmful materials in IT operations as well as in Green procurement decisions.

An intriguing finding of the study is that Green usage is a reflection of Green IT/IS practice implemented in CE with mean value = 3.51; SD of 0.832 by enhancing power efficiency in powering and cooling enterprise IT infrastructures and also decreasing IT induced CO_2 emissions. Accordingly, it can be interpreted from the result that Green usage aims to bring about energy consumption reduction similar to findings presented by Molla et al. (2009b); Karanasios et al. (2010) with mean value = 4.36; SD of 1.38 in their studies. Furthermore, results from this study indicate that end of life

management towards Green disposal with mean value = 3.49; SD of 0.846 is also influenced by Green IT/IS practice similar to results presented by Molla et al. (2009a) with mean value = 5.14; SD of 1.27 in their case study research conducted in Dell and Toshiba corporations, where Pichetpongsa and Campeanu, (2011) suggested that end of life entails the practices of refurbishing, reusing, recycling and disposing of IT equipment in an ethical environmental friendly manner. Similarly, results from this study reveal that Green IT/IS practice positively influence economic, social and environmental sustainability in CE (see Figure 6.3).

Results from partial correlation test in SPSS and multi-group analysis test in SmartPLS for (H8a-H8d) reveal that the timing, size and revenue of the enterprise influence Green IT/IS practice implementation with *p*-values < 0.05 similar to findings presented by Opitz et al. (2014) on size influencing Green IT practice in German based CE where *p*-values < 0.05 but not consistent with findings presented by Vykoukal et al. (2011); Molla and Abareshi (2011); Ainin et al. (2015) on size not influencing Green IT practice with *p*-values > 0.05. Conversely, sector of the enterprise does not influence Green IT/IS practice with *p*-values > 0.05 similar to findings presented by Vykoukal et al. (2011); Molla and Abareshi (2011); Lintukangas et al., 2014; Mishra et al. (2014); Ainin et al. (2015) where *p*-values > 0.05.

Results from multiple regression-moderating test in SPSS and interaction mediation analyses tests in SmartPLS for (H9a-H9c and H10a-H10c) shows that the moderating role of gender of IT practitioners and IT governance does not influence Green IT/IS practice in CE with *p*-value = 0.683 for gender of IT practitioners and *p*-value = 0.210 for IT governance. Where this result is analogous with previous results presented by Molla et al. (2014) with *p*-value = 0.110; Mishra et al. (2014); Akman and Mishra (2015) with *p*-value = 0.338, where all *p*-values > 0.05. Additionally, results reveal that the age of IT practitioners influences Green IT/IS practice in CE. Similarly an equivalent results in relation to IT governance was derived showing that the moderating role of age of IT governance influences their orientation towards Green IT/IS deployment with *p*-value = 0.009 for age of IT practitioners and with *p*-value = 0.001 for IT governance respectively consistent with results presented by Molla et al. (2014) with *p*-value = 0.018; Mishra et al. (2014) with *p*-value = 0.037; Akman and Mishra (2015) with *p*-value = 0.023, where all *p*-values are < 0.05.

The education level of IT practitioners and IT governance does not have any effects on their intention to implement Green IT/IS with *p*-value = 0.452 for IT practitioners and *p*-value = 0.639 for IT governance respectively. Moreover, this results is consistent with finding presented by Molla et al. (2014) where the authors found non-significant relationships between education level and Green IT practice implementation by IT professionals with *p*-value = 0.264 where all *p*-values are > 0.05. Finally, according to the analysis in SmartPLS for total effect using constructs performance important for structural model 1 (see Table 6.20) results from this thesis provides strong support and also reveal that motivating forces is the most influencing independent variable as predicted with total effect of 0.524 in relation to Green IT/IS practice implementation in CE.

An obvious explanation for this finding is that over the years there has been pressure on CE to go Green from end users, governmental and non-governmental bodies. Interestingly, technologies and systems is the most performing independent variable with value of 68.910 in relation to Green IT/IS practice in CE, where this is in line with a recent study by Dalvi-Esfahani et al. (2017b) where the authors also concluded that the technologies and systems installed in the organization influences sustainability. Lastly, results from blindfolding test for structural model 2 (see Table 6.21) shows that Green IT/IS practice has more effect on Green sourcing with a value of 0.677 as compared to other Green IT/IS practice.

6.8 Discussion of Green IT/IS Assessment Tool Evaluation

In summary, findings from this focus-group questionnaire verifies the implemented Green IT/IS assessment tool, where results from descriptive analysis (see Section 6.6) confirms that the tool contributes to sustainability attainment in CE through assessment of CE current Green IT/IS practice and provision of initiatives for attainment of sustainability. This was confirmed from the mean value (see Table 6.29) of tool being user friendly, providing enough information in assessing Green IT/IS practice, easy to navigate, easy to learn without encountering any problems with mean value ranging from 3.57 to 4.09. In relation to the tool sufficiency in assessing Green creation, Green distribution, Green sourcing, Green usage and end of life, the mean value was 3.89 to 4.31 showing that the tool is highly accepted by the focus group participants.

Results from the focus-group questionnaire (see Table 6.29) showed some interesting findings regarding the tool providing suggestion, important in assessment enrolment, performs well in generating result certification, better efficiency, overall performance and acceptable response time in information retrieval with mean value ranging from 3.69 to 4.23. In addition, result from questionnaire provided a clear understanding on the tool being able to provide consistent data, acceptable in tool evaluation, benchmark and rating Green IT/IS practice implemented in CE with mean value ranging from 3.47 to 3.77.

6.9 Summary

This chapter accomplished the third and fourth research objective which aims to validate the proposed Green IT/IS assessment model using survey data and to further validate the proposed Green IT/IS assessment model using the implemented Green IT/IS assessment tool. Thus, this chapter presented the findings of the study based on the research survey where SPSS version 22 and SmartPLS 3 software was used to analyses collected survey data for validating the developed Green IT/IS assessment model. Based on the results, the dataset from the survey is normal, reliable, and are not highly correlated with each other, and possess no multicollinearity problem. In addition, all hypotheses related to the independent variables, Green IT/IS practice and social, economic and environmental sustainability in the developed Green IT/IS assessment model were proved to be significant, whereas there was variation in the control and mediating variables in relation to Green IT/IS practice implementation. Interestingly, results presented by SPSS analysis were analogous with the results derived from SmartPLS. Furthermore, the implemented GAT was evaluated by testing the applicability of the tool based on data collected from respondents in a focus-group questionnaire. The data was further analysed using descriptive and principal component analysis in validating the developed Green IT/IS assessment model.

CHAPTER 7

CONCLUSION, IMPLICATIONS AND FUTURE WORK

7.1 Overview

This thesis contributes to the body of knowledge by developing a Green IT/IS assessment model that comprises the independent variables that influences Green IT/IS practice and Green IT/IS practice to be implemented in collaborative enterprise towards attaining sustainability. In addition, the developed Green IT/IS assessment model helps to assess IT practitioners current Green IT/IS practice implemented in collaborative enterprise, as well as provide information on the Green IT/IS practice initiatives that can be implemented by collaborative enterprise in improving their current Green IT/IS practice for attaining sustainability. Accordingly, this chapter summarizes this thesis by describing the overall research objective accomplished. Then, this chapter discusses on the theoretical and practical implication, limitations and lastly future works.

7.2 Summary

Sustainability has progressively become significant to research and practice in collaborative enterprise over the year as a result of rapid reduction of natural resources and sudden climatic changes. The fast changing global weather requires IT practitioners in CE to respond to these changes and implement Green IT/IS practices. Thus, IT practitioners are beginning to implement Green IT/IS practice by initiating environmental friendly guidelines such as ISO 14001 standards. Nevertheless, since 2007/2008 Green IT/IS has become an important concept in various domain, as such CE are beginning to implement Green IT/IS practices in their organizational operations. Accordingly, the term “Green” is used to describe a practice that is more environmental

friendly has given rise to an overuse and often a misuse of the term. Thus CE claims of "Green IT/IS" practice must be assessed against some standard, but a few CE claim they implement Green IT/IS practices by only implementing recycling operation and ignoring other Green IT/IS practices.

Consequently, there is need to provide the Green IT/IS practice to be implemented in CE. But, one of the main challenges confronting CE today is defining and achieving sustainability goals which includes identifying and developing Green IT/IS practices based on economic, social and environmental goals of sustainability and most significantly, assessing the current Green IT/IS practices against the goals of sustainability. Nevertheless, over the decade, the trend towards Green IT/IS practices has infiltrated CE daily operations. Conversely, without an enterprise based accepted Green IT/IS assessment model, the burden of assessing Green IT/IS practice in CE lies with each individual enterprise, which has resulted to issues for Green IT/IS assessment in CE. Moreover, there are independent variables that influence Green IT/IS practice implementation in CE.

Therefore, there is a need for a Green IT/IS assessment model that can be utilized by CE to ensure that IT practitioners considers these independent variables when implementing Green IT/IS practices in their enterprise operations. Furthermore, CE needs to make decision based on their current Green IT/IS practice to assess if their present practice aims to attain the environmental, social and economic goals of sustainability. But at the moment IT practitioners in CE utilizes manual paper self-assessment methods based on checklists mainly because they are inexpensive and practical for use. Hence, there is need for Green IT/IS assessment model to aid IT practitioners in assessing their current Green IT/IS practice towards attaining sustainability. Accordingly, the research objectives of this thesis included;

i. To identify the Green IT/IS practice to be implemented and independent variables that influences Green IT/IS practice in CE.

ii. To propose a Green IT/IS assessment model based on belief-action-outcome framework.

iii. To validate the proposed Green IT/IS assessment model using survey data.

iv. To validate the applicability of the proposed Green IT/IS assessment model using the implemented Green IT/IS assessment tool.

The four objectives were achieved successfully by employing a pragmatic research paradigm which incorporates mixed research approaches (qualitative and quantitative method). In order to achieve the first objective, the independent variables that influence Green IT/IS practices and Green IT/IS practice to be implemented by IT practitioners in CE was derived by the author by reviewing existing literatures on Green IT/IS as seen in Section 2.6.1 and 2.6.2 (Chapter 2). Thus, the author carried out a document study, making use of secondary data from various papers such as journals articles and conference proceeding to find out the independent variables as IT practitioners, IT governance, technologies and systems, motivating forces, IT strategy and information availability (see Table 2.3). Similarly, the Green IT/IS practices to be implemented were identified from various literatures as Green creation, Green distribution, Green sourcing, Green usage and end of life. A preliminary study was carried out by employing qualitative method, case study by interview to verify or confirm the derived independent variables and Green IT/IS practice by collecting data from four selected enterprise in Malaysia (Table 4.2), where fifteen informants (see Table 4.1) were interviewed and the interview data and Green IT/IS documents were reported using descriptive and narrative analysis based on independent variables and Green IT/IS practice as stated in Section 4.3.1 and 4.3.2 in Chapter 4.

To accomplish the second objective, which is to propose a Green IT/IS assessment model based on belief-action-outcome framework. Accordingly, the Green IT/IS assessment model was conceptualized and developed based on belief-action-outcome framework, where the model comprises of the independent variables, Green IT/IS practice, sustainability constructs, social-demographic determinants (moderating variables), and enterprise characteristics (control variables) (see Figure 5.3). Similarly, the developed Green IT/IS assessment model hypotheses was presented. In addition, Green IT/IS practice for sustainability attainment in CE was designed in Figure 5.4 in Chapter 5 to present the Green IT/IS practice initiatives to be implemented in achieving the social, economic and environmental goals of sustainability.

To accomplish research objective three which include validating the proposed Green IT/IS assessment model using survey data. Survey data was collected from one

hundred and thirty-three respondents from selected collaborative enterprise in Malaysia to validate the developed Green IT/IS assessment model. The collected data was analysed using descriptive (mean and standard deviation), explorative (normality, reliability, and validity) and inferential statistics using SPSS by conducting regression test to validate the independent variables hypotheses (H1-H6) (see Table 6.8), Green IT/IS practice hypotheses (H7a-H7e) and sustainability hypotheses (H11-H13) (see Table 6.9).

Partial correlation was applied to validate the control variables hypotheses (H8a-H8d) (see Table 6.10). Then multiple regression moderation was applied to validate the moderating variables hypotheses (H9abc-H10abc) (see Table 6.10 and 6.11) in the developed Green IT/IS assessment model. Similarly, PLS-SEM using SmartPLS was also employed to analyse the survey data to corroborate the results presented by SPPS analysis by conducting PLS algorithm and bootstrapping, multiple group analysis and interaction mediation analysis to validate the proposed Green IT/IS model. Lastly, to accomplish the fourth research objective, the developed Green IT/IS assessment model was further validated using the implemented Green IT/IS assessment tool by testing the applicability of the tool by utilizing focus-group questionnaire to collect data from thirty-five IT practitioners. Furthermore, descriptive (see Table 6.29) and principal component analysis (see Table 6.30) was carried using SPPS to analyse the questionnaire data in confirming the applicability of Green IT/IS assessment tool.

7.3 Implication of Study

This thesis has important theoretical and practical implications for academicians, IT practitioners and IT managers.

7.3.1 Theoretical Implication

This thesis proposed a Green IT/IS assessment model that comprises of identified Green IT/IS practice to be implemented by IT practitioners in CE. Furthermore, the Green IT/IS assessment model also comprises of independent variables that influences IT practitioners in implementing Green IT/IS practice and the constructs for sustainability attainment. Moreover, the model encompasses socio-demographic determinants (moderating variables) and enterprise characteristics (control variables). In addition, the developed Green IT/IS assessment model aids to assess the

current sustainability performance levels in CE. The model can further be applied to identify actions for Green IT/IS practice improvement. Furthermore, the model can be utilized by IT practitioners to check their own Green IT/IS objectives. Besides, by utilizing the model CE will also be able to track significant progress in Green IT/IS practice towards promoting corporate sustainability attainment. The model is also useful in planning and supporting Green IT/IS initiatives. Hence, the model provides a baseline for CE to assess the development of their Green IT/IS practice. This helps as it offers a basis to prioritize CE Green IT/IS practice thus providing a roadmap for future improvement.

Coming in the wake of global warming, climate change and environmental degradation, this thesis is both timely and relevant, therefore, embodies one of the few empirical studies regarding how Green IT/IS deployment among IT practitioners in CE can help address the aforementioned issues. Hence, IT managers can draw upon the developed Green IT/IS assessment model in measuring conditions for positive deployment of Green IT/IS in their enterprise operation towards address sustainability concerns. Therefore, this thesis provides a grounded lens for CE to better understand the independent variables which comprises of factors that influences the perception of IT practitioners towards implementing Green IT/IS practices in their enterprise processes. Likewise, this study provides an agenda for CE to incorporate Green IT/IS practice into their current enterprise operations.

At the moment, CEs are under pressure (motivating forces) from end users, society, competitors, governmental associations, and regulators bodies to implement sustainable business practices. Hence, balancing societal, environmental and economic dimensions is a tactical issue; as a result, IT practitioners can refer to developed Green IT/IS assessment model in this thesis in identifying the Green IT/IS practice required for successful implementation of Green IT/IS practices. Therefore, IT practitioners need not to only think Green but as well as act Green by deploying Green creation, Green distribution, Green sourcing, Green usage and end of life, hence this thesis provides insights on Green IT/IS practice initiatives in collaborative enterprise.

The developed Green IT/IS assessment model provide a road map on sustainability attainment towards Green IT/IS implementation for IT practitioners and IT managers in CE as seen in Table 2.4 in Chapter 2 and Figure 5.4 in Chapter 5.

Besides, the Green IT/IS assessment model also provides a set of guidelines for determining each Green IT/IS practice based on several indicators to assist IT practitioners in reviewing, managing and improving their sustainability performance as seen in Table 3.4 in Chapter 3. Moreover, the Green IT/IS assessment model can help ascertain the progress being made with the development level reached to ensure that IT practitioners remains fully engaged with Green IT/IS practices implementation.

7.3.2 Practical Implication

Findings from this thesis have practical implications for the capability of Green IT/IS to support enterprise' sustainability goal and also for the deployment of Green IT/IS practices by suggesting Green creation, Green distribution, Green sourcing, Green usage and end of life as best practices to address the direct impact (first order impact) caused by IT being a problem and contributor to global warming, climatic changes and environmental degradation. Additionally, this thesis also enriches the theory on sustainability by assessing IT practitioners' action on implementing Green IT/IS practices. The proposed Green IT/IS assessment model presented in this thesis aims to motivate the perception and mind-set shift of IT practitioners' decision-makings in CE towards economic, social and environmental protection. Practically, the Green IT/IS practice in this thesis can help CE apprehend the potential benefits associated with Green IT/IS practices implementation, in understanding the weakness and strength of their current Green IT/IS practices initiatives.

Results of this study thus provide practical implications for CE wishing to implement or maintain high levels of environmental responsiveness. This thesis therefore demonstrates the applicability of the Green IT/IS practice in CE and also highlight that Green IT/IS practices are being implemented in a few CE in Malaysia to lessen energy consumption of IT infrastructure in enterprise office environments and data centers, decreasing deployment costs incurred and decrease CO_2 emission. Empirically, this thesis adds original and pertinent knowledge to the emergent field of Green IT/IS research towards sustainability attainment. Practically, this thesis provides both Green IT/IS assessment model with scope, content, and initiatives for the implementation of Green IT/IS practices in CE.

This study also provides practical implications for CE wishing to implement or enhance their current sustainability responsiveness. The Green IT/IS assessment model provides a step further towards promoting enterprise efforts to resolve social problems without trading off ecological and cost reduction concerns of CE. Moreover, this thesis provides implication for IT practitioners to choose from the Green IT/IS practice metrics as seen in Table 2.4 in Chapter 2 and Figure 5.4 in Chapter 5 towards improving their current Green IT/IS practices, based on sustainability goal they want to attain. The findings from this study helps to guide future Green IT/IS research and practical implementations in the domain of collaborative enterprise toward contributing to social as well as economic and environmental sustainability thereby assisting to decrease the negative first order impact of IT in CE.

The developed Green IT/IS assessment model aids CE to measure their currently implemented Green IT/IS practice. The model can further be applied to identify actions for Green IT/IS practice improvement. Besides, by utilizing the model IT practitioners will also be able to track significant progress in Green IT/IS practice that will influence their corporate sustainability attainment. Moreover, the Green IT/IS assessment model provides a tool for enhancing Green IT/IS practice initiatives. The Green IT/IS assessment model also provides a baseline for CE to assess the maturity of their Green IT/IS practice. This helps as it offers a basis to prioritize IT practitioners Green IT/IS practice thus providing a medium to rate CE Green IT/IS practice thereby providing a guide or roadmap for future improvement.

As a final point, the Green IT/IS assessment model can be used to compare and contrast CE's efforts towards sustainability performance. Additionally, it can be used for internally comparing CE departments Green IT/IS practices and externally with other CE locally and globally. In addition, Green IT/IS assessment model can help CE towards reorienting their current corporate performance for a sustainable future and assist IT practitioners to explicitly acknowledge enterprise areas to be recognized, resolved and further improve.

7.4 Limitations

This thesis possesses a few limitations. First, the limitation of this thesis related to the sample size which was limited based on the medium response from invited

participants. Although, the author does not claim that the sample in this research is a representative of all CE in Malaysia, this thesis still provides useful insights on current Green IT/IS practice initiatives being implemented in CE based in Malaysia. Additionally, since this research was intended to examine Green IT/IS practice initiatives in most cases IT departments of CE, the author only invited IT practitioners and IT managers in IT departments of CE that implements Green IT/IS practices by getting their detail from their enterprise web portals.

Secondly, another limitation is that the author examined CE based in Malaysia. The results might differ for other CE based in other countries. Hence findings from this study can only relate to countries which Green IT/IS practices are similar to Malaysia culture and cannot be generalized to other countries with different background. Thirdly, an additional limitation is the use of respondents who are either IT practitioners or IT managers as participants for our study as stated previously. A multiple-respondents method that included both staffs and experts and professionals from other domains would be fruitful and may offer different findings in relation to the independent variables and Green IT/IS practice being investigated.

7.5 Future work

Accordingly, further research would be necessary to carry out a longitudinal data collection to get more data from multiple respondents based in more than one country to increase sample size. Therefore, an extension to Green IT/IS practice implementataion in other enterprises from different countries would also be of interest. In this respect, the independent variables that influences these other enterprises to go Green would be analysed, as well as the items regarding sustainability attainment in these other enterprises, may also provide other interesting results. Another area of fruitful exploration would be to look into how social and economic dimension influence CE into deploying Green IT/IS practices. Future research could profitably look into getting more samples. Besides, given the significant role played by Green IT/IS practices in CE, future research will examine the third order impact of IT deployment from the societal view point such as Green practices in domestic homes and energy informatics since Green IT/IS practices are critical in supporting the society towards developing sustainability proficiencies such as smart cities deployment.

REFERENCES

Abareshi, A. and Molla, A., 2013. Greening logistics and its impact on environmental performance: an absorptive capacity perspective. *International Journal of Logistics Research and Applications*, *16*(3), 209-226.

Accenture .2008. Data Center Energy Forecast Final Report, www.accenture.com.

Adom, D., and Ankrah, A. Y. A. K. 2016. Constructivism philosophical paradigm: Implication for research, teaching and learning. *Global Journal of Arts Humanities and Social Sciences*, 4(10), 1-9.

Ahmad, T. B. T., Bello, A. and Nordin, M. S. 2014. Exploring Malaysian university students' awareness of green computing. *GSTF Journal on Education (JEd)*, *1*(2).

Aiken, L. and West, S., 1991. Multiple Regression: Testing and Interpreting Interactions. Newbury Park: Sage Publications.

Ainin, S., Naqshbandi, M.M. and Dezdar, S., 2016. Impact of adoption of Green IT practices on organizational performance. *Quality and Quantity*, *50*(5), 1929-1948.

Ajzen, I. 1991. The theory of planned behavior. *Organizational behavior and human decision processes*, 50(2), 179-211.

Ajzen, I. and Fishbein, M. 1980. Understanding attitudes and predicting social behavior. Englewood Cliffs, NJ: Prentice-Hall.

Akman, I. and Mishra, A. 2014. Green information technology practices among IT professionals: Theory of planned behavior perspective. *Problemy Ekorozwoju – Problems Of Sustainable Development*. 9(2), 47-54.

Akman, I. and Mishra, A. 2015. Sector diversity in green information technology practices: technology acceptance model perspective. *Computers in human behavior*, *49*, 477-486.

Alghamdi, N., Alghamdi, N., den Heijer, A., den Heijer, A., de Jonge, H. and de Jonge, H. 2017. Assessment tools' indicators for sustainability in universities: an analytical overview. *International Journal of Sustainability in Higher Education*, *18*(1), 84-115.

Amran, A., Nabiha Abdul Khalid, S., Abdul Razak, D. and Haron, H. 2010. Development of MBA with specialisation in sustainable development: the experience of Universiti Sains Malaysia. *International Journal of Sustainability in Higher Education*, 11(3), 260–273.

Armitage, A. 2007. Mutual research designs: Redefining mixed methods research design. The *British Educational Research Association Annual Conference*, p. 8.

Asabere, N.Y., Acakpovi, A. and Quaynor, N. 2016. Encouraging Green ICT Implementation Strategies in Polytechnic Education in Ghana. *International Journal of Applied Information Systems*, 10(6), 14-21.

Aziz, N. S. and Kamaludin, A. 2014. Assessing website usability attributes using partial least squares. *International Journal of Information and Electronics Engineering*, 4(2), 137.

Azlin, A. Z. B., Er, A. C., Rahman, N. B. A. and Alam, A. F. 2016. Consumers' roles and practices towards sustainable UKM campus. *International Journal of Advanced and Applied Sciences*. 3(2), 30-34.

Baggia, A., Brezavšček, A., Maletič, M., Šparl, P., Raharjo, H. and Žnidaršič, A., 2016. Awareness and Attitude Towards Green IS in Slovenian Enterprises. *Organizacija*, *49*(1), 15-27.

Bagozzi, R. P., and Yi, Y. 1988. On the evaluation of structural equation models. *Journal of the Academy of Marketing Science*, 16(1), 74–94.

Barney, J. 1991. Firm resources and sustained competitive advantage. *Journal of management*, 17(1), 99-120.

Belady, C., Rawson, A., Pfleuger, J. and Cader, T. 2008. Green grid data center power efficiency metrics: PUE and DCIE. Technical report, Green Grid.

Belecheanu, R., Pawar, K.S., Barson, R.J., Bredehorst, B. and Weber, F. 2003. The application of case based reasoning to decision support in new product development. *Integrated Manufacturing Systems*, *14*(1), 36-45.

Benbasat, I., Goldstein, D. K. and Mead, M. 1987. The case research strategy in studies of information systems. *MIS quarterly*, 369-386.

Benitez-Amado, J., Perez-Arostegui, M.N. and Tamayo-Torres, J., 2010. Information technology-enabled innovativeness and green capabilities. *Journal of Computer Information Systems*, *51*(2), 87-96.

Bergold, J., and Thomas, S. 2012. Participatory research methods: A methodological approach in motion. *Historical Social Research/Historische Sozialforschung*, 191-222.

Berkhout, F. and Hertin, J. 2001. Impacts of information and communication technologies on environmental sustainability: Speculations and evidence. *Report to the OECD*.

Bose, R. and Luo, X. 2011. Integrative framework for assessing firms' potential to undertake Green IT initiatives via virtualization—A theoretical perspective. *The Journal of Strategic Information Systems*, 20(1), 38–54.

Boudreau, M.C., Chen, A. and Huber, M., 2008. Green IS: Building sustainable business practices. *Information systems: A global text*, 1-17.

Brace, N., Kemp, R. and Snelgar, R. 2003. SPSS for Psychologists: A Guide to Data Analysis Using SPSS for Windows ed. New York: Palgrave Macmillan.

Brocke, J.V., Watson, R.T., Dwyer, C., Elliot, S. and Melville, N., 2012. Green information systems: directives for the IS discipline. *CAIS*, 33(1), 509-520.

Brooks, S., Wang, X. and Sarker, S. 2012. Unpacking green IS: a review of the existing literature and directions for the future. *Green business process management*, 15-37.

Brundtland, G.H. 1985. World commission on environment and development. *Environmental policy and law*, *14*(1), 26-30.

Butler, T. 2011a. Compliance with institutional imperatives on environmental sustainability: Building theory on the role of Green IS. *The Journal of Strategic Information Systems*, *20*(1), 6-26.

Butler, T. 2011b. Towards a practice-oriented green IS framework. *ECIS*, p. 102.

Butler, T. and Daly, M. 2009. Environmental responsibilty and green IT: An institutional perspective. *ECIS*, 1855-1866.

Cai, S., Chen, X. and Bose, I. 2013. Exploring the role of IT for environmental sustainability in China: An empirical analysis. *International Journal of Production Economics*, 146(2), 491-500.

Cardoso, A.C. and Carvalho, J. 2010. Green information systems: the use of information systems to enhance sustainable development. *MIS Quarterly*, *34*(1), 23-38.

Cater-Steel, A. and Tan, W.G. 2011. The role of IT service management in green IT. *Australasian Journal of Information Systems*, *17*(1), 5-23.

CFO. 2009. The Next Wave of Green IT: IT's Role in the Future of Enterprise Sustainability, www.CFO.com.

Chang, J. W., Lee, M. C. and Wang, T. I. 2016. Integrating a semantic-based retrieval agent into case-based reasoning systems: A case study of an online bookstore. *Computers in Industry*, *78*, 29-42.

Chen, A.J., Boudreau, M.C. and Watson, R.T. 2008. Information systems and ecological sustainability. *Journal of Systems and Information Technology*, *10*(3), 186-201.

Chen, A.J., Watson, R.T., Boudreau, M.C. and Karahanna, E. 2011. An institutional perspective on the adoption of Green IS & IT. *Australasian Journal of Information Systems*, 17(1), 23-45.

Chen, H.M. and Kazman, R., 2012. Architecting ultra-large-scale green information systems. *Proceedings of the First International Workshop on Green and Sustainable Software*, 69-75.

Cheng, J. C. and Ma, L. J. 2015. A non-linear case-based reasoning approach for retrieval of similar cases and selection of target credits in LEED projects. *Building and Environment*, *93*, 349-361.

Chin, W. W., Marcolin, B. L., and Newsted, P. R. 1996. A partial least squares latent variable
modelling approach for measuring interaction effects: Results from a Monte Carlo

simulation study and voice mail emotion/adoption study. *17th International Conference on Information Systems*, Cleveland, OH.

Chou, D.C., 2013. Risk identification in Green IT practice. *Computer Standards and Interfaces*, *35*(2), 231-237.

Claudiaflowers. 2017. Hierarchical Multiple Regression. Available online: http://www.claudiaflowers.net/rsch8120/hierarchical_multiple_regression.htm (accessed 22 July 2017).

Cohen, J., Cohen, P., West, S. G. and Aiken, L. S. 2013. Applied multiple regression/correlation analysis for the behavioral sciences, Routledge.

Coleman, J.S. 1986. Social theory, social research, and a theory of action, *American Journal of Sociology*, 91(6), 1309-1335.

Cooper and Schindler 2008. Surveys in Social Research. (5th ed.) Australia: Crows Nest, NSW.

Cooper, V. A. and Molla, A. 2014. Absorptive capacity and contextual factors that influence green IT assimilation. *Australasian Journal of Information Systems*, 18(3), 271-288.

Cooper, V. and Molla, A., 2013. Green IT assimilation: comparing the influence of contextual and absorptive capacity based models. *24th Australasian Conference on Information System*, 1-11.

Cooper, V.A. and Molla, A., 2012. Developing Green IT Capability: An Absorptive Capacity Perspective. *PACIS*, p. 46.

Creswell, J. 2009. *Research Design: Qualitative, quantitative, and mixed methods approaches.* SGE Publications, Los Angeles, Inc.

Curet, O., Jackson, M. and Tarar, A. 1996. Designing and evaluating a case-based learning and reasoning agent in unstructured decision making. *International Conference on Systems, Man, and Cybernetics*, 2487-2492

Curry, E., Hasan, S., ul Hassan, U., Herstand, M. and O'Riain, S., 2011. An entity-centric approach to green information systems. *ECIS*, p. 194.

Curwin, J. and Slater, R. 1991, Qualitative Methods for Business Decisions. London: Chapman and Hall.

Dalvi-Esfahani, M. and Rahman, A.A., 2016. An Integrative Framework to Understand The Influence of Morality on Green IS Adoption: A Theoretical Perspective. *Journal of Theoretical and Applied Information Technology*, *88*(2), p.337.

Dalvi-Esfahani, M., Ramayah, T. and Rahman, A. A. 2017b. Moderating role of personal values on managers' intention to adopt Green IS: Examining norm activation theory. *Industrial Management and Data Systems*, *117*(3), 582-604.

Dalvi-Esfahani, M., Ramayah, T., and Nilashi, M. 2017a. Modelling upper echelons' behavioural drivers of Green IT/IS adoption using an integrated Interpretive

Structural Modelling–Analytic Network Process approach. *Telematics and Informatics*, *34*(2), 583-603.

Daly, M., and Butler, T. 2009. Environmental Responsibility and Green IT: An Institutional Perspective. *17th European Conference on Information Systems* Verona, Italy.

Dao, V., Langella, I. and Carbo, J., 2011. From green to sustainability: Information Technology and an integrated sustainability framework. *The Journal of Strategic Information Systems*, *20*(1), 63-79.

Davis, F. D. 1989. Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–339.

Dedrick, J.L. 2010. Green IS: Concepts and issues for information systems research. *CAIS*, p.11.

Deng, Q. and Ji, S., 2015. Organizational Green IT Adoption: Concept and Evidence. *Sustainability*, *7*(12), 16737-16755.

Denzin, N.K. and Lincoln, Y.S. 2000. Handbook of qualitative research. 2nd ed. Thousand Oaks: Sage Publications.

Dezdar, S. 2017. Green information technology adoption: influencing factors and extension of theory of planned behavior. *Social Responsibility Journal*, 13(2), 292-306.

Dick, M., Drangmeister, J., Kern, E. and Naumann, S., 2013. Green software engineering with agile methods. *2nd International Workshop on Green and Sustainable Software*, 78-85.

DiMaggio, P. and Powell, W. 1983. The iron cage revisited: Institutional isomorphism and collective rationality in organizational fields. *American Sociological Review*, 48(2), 147-160.

Dolci, D.B., Lunardi, G.L., Salles, A.C. and Alves, A.P.F., 2015. Implementation of green IT in organizations: A structurational view. *Revista de Administração de Empresas*, *55*(5), 486-497.

Dubé, L. and Paré, G. 2003. Rigor in Information Systems Positivist Case Research: Current Practices,Trends, and Recommendations. *MIS Quarterly*, 27(4), 597–635.

Eklim, S. and Rahim, M. M. 2015. A qualitative evaluation of an instrument to measure organisational motivations for inter-organisational systems adoption. *International Journal of Business and Information*, *3*(1), 53-85.

Elkington, J., 1997. Cannibals with forks. *The triple bottom line of 21st century*, p.73.

Elkington, J., 1998. Partnerships from cannibals with forks: The triple bottom line of 21st-century business. *Environmental Quality Management*, *8*(1), 37-51.

Elliot, S. and Binney, D. 2008. Environmentally Sustainable ICT: Developing Corporate Capabilities and an Industry Relevant IS Research Agenda, *Pacific Asia Conference Information Systems*, Suzhou, China, 4-7.

Environmental Protection Agency (EPA). 2009. EPA ENERGY STAR Program Requirements for Computer Systems - Draft 4, Environmental Protection Agency, Washington, DC.

Erek, K., Loeser, F. and Zarnekow, R. 2012. Reference Model for Sustainable Information Systems Management: Establishing a Holistic Research Agenda.

Esfahani, M.D., Nilashi, M., Rahman, A.A., Ghapanchi, A.H. and Zakaria, N.H., 2015a. Psychological Factors Influencing the Managers' Intention to Adopt Green IS: A Review-Based Comprehensive Framework and Ranking the Factors. *International Journal of Strategic Decision Sciences (IJSDS)*, *6*(2), 28-56.

Esfahani, M.D., Rahman, A.A. and Zakaria, N.H., 2015b. The status quo and the prospect of green IT and green IS: a systematic literature review. *Journal of Soft Computing and Decision Support Systems*, *2*(1), 18-34.

Fang, F., and Wong, T. N. 2010. Applying hybrid case-based reasoning in agent-based negotiations for supply chain management. *Expert Systems with Applications*, *37*(12), 8322-8332.

Fishbein, M. and Ajzen, I. 1975. Belief, attitude, intention and behavior: An introduction to theory and research, reading. Addison-Wesley Publishing Company.

Foo, K. Y. 2013. A vision on the role of environmental higher education contributing to the sustainable development in Malaysia. *Journal of Cleaner Production*, 61(1), 6-12.

Foogooa, R. and Dookhitram, K. 2014. A self green ICT maturity assessment tool for SMEs. In *IST-Africa Conference Proceedings*, 1-9.

Fornell, C. and Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39-50.

Galbraith, J. R. 1974. Organization design: An information processing view. *Interfaces*, 4(3), 28-36.

Gartner. 2008. Going Green: The CIO's Role in Enterprise-wide Environmental Sustainability, Gartner EXP Premier.

Gartner. 2013. Introducing the gartner green and sustainable it infrastructure and operations maturity model.

Gawali, R. D. and Meshram, B. B. 2009. Agent-based autonomous examination systems. in *International Conference on Intelligent Agent and Multi-Agent Systems*, 1-7.

George, D and Mallery, P. 2005. SPSS for Windows Step-by-step: A Simple Guide and Reference. Boston: Allyn and Bacon.

Ghazalli, Z. and Murata, A., 2011. Development of an AHP–CBR evaluation system for remanufacturing: end-of-life selection strategy. *International Journal of Sustainable Engineering*, *4*(01), 2-15.

Gholami, R., Sulaiman, A.B., Ramayah, T. and Molla, A., 2013. Senior managers' perception on green information systems (IS) adoption and environmental performance: Results from a field survey. *Information and Management*, *50*(7), 431-438.

Gholami, R., Watson, R.T., Molla, A., Hasan, H. and Bjørn-Andersen, N., 2016. Information systems solutions for environmental sustainability: How can we do more?. *Journal of the Association for Information Systems*, *17*(8), p.521.

Gholami, R., Molla, A., Goswami, S., & Brewster, C. 2017. Green information systems use in social enterprise: the case of a community-led eco-localization website in the West Midlands region of the UK. *Information Systems Frontiers*, 1-17.

Grant, N. and Marshburn, D., 2014. Understanding the Enablers and Inhibitors of Decision to Implement Green Information Systems: A Theoretical Triangulation Approach.

Greentech.my. 2016. http://www.greentechmalaysia.my/ (accessed 27 July 2017).

Gu, Q., Lago, P. and Bozzelli, P. 2015. A Decision-Making Model for Adopting Green ICT Strategies. *Green in Software Engineering*, 285-300.

Guba, E.G. 1990. The Paradigm Dialog. London: Sage.

Guba, E.G. and Lincoln, Y.S. 1994. Competing paradigms in qualitative research. *Handbook of Qualitative Research*, 2(1), 163-194.

Hair, J. F., Anderson, R. E., Tatham, R. L. and Black, W. C. 2006. Multivariate Data Analysis. Prentice-Hall International, Inc.

Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. 2013. A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Thousand Oaks: Sage.

Hair, J. F., Ringle, C. M., and Sarstedt, M. 2011. PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice*, 19(2), 139-151.

Hair, J.F., Sarstedt, M., Ringle, C.M. and Mena, J.A., 2012. An assessment of the use of partial least squares structural equation modeling in marketing research. Journal of the Academy of Marketing Science, 40(3), 414-433.

Hallie, P. and Darlene, R. E. 2005. Building Evaluation Capacity Evaluation Models, Approaches, and Designs, SAGE Publications, Inc. City: Thousand Oaks.

Hambrick, D.C. and Mason, P.A., 1984. Upper echelons: the organization as a reflection of its top managers. *Acad. Manage. Rev.* 9 (2), 193–206.

Hambrick, D.C., 2007. Upper echelons theory: an update. Acad. Manage. Rev. 32 (2), 334–343.

Hankel, A. and Lago, P. 2016. How organisations can assess and improve their green ICT activities in a standard and efficient way. *ITU Kaleidoscope: ICTs for a Sustainable World*, 1-6.

Hankel, A., Heimeriks, G. and Lago, P. 2016. Green ICT Assessment for Organisations. *Journal of ICT Standardization*, 4(2), 87-110.

Harmon, R.R. and Auseklis, N., 2009. Sustainable IT services: Assessing the impact of green computing practices. *Portland International Conference on Management of Engineering and Technology*, 1707-1717.

Hart, S.L. 1995. A Natural Resource Based View of the Firm. *Academy of Management Review* (20) 4, 986– 1014.

Hart, S.L. and Milstein, M.B., 2003. Creating sustainable value. *The Academy of Management Executive*, *17*(2), 56-67.

Hart, S.L., 1997. Beyond greening: strategies for a sustainable world. *Harvard business review*, *75*(1), 66-77.

Hasan, H., Molla, A. and Cooper, V., 2012. Towards a green IS taxonomy, *Proceedings of SIGGreen Workshop. Sprouts: Working Papers on Information Systems*, 12(25), 1-22.

Helms, J. E., Henze, K. T., Sass, T. L. and Mifsud, V. A. 2006. Treating Cronbach's Alpha Reliability Coefficients As Data In Counseling Research. *The Counseling Psychologist*, 34, 630-660.

Henriques, A. and Richardson, J. eds., 2013. *The triple bottom line: Does it all add up*. Routledge.

Henseler, J. 2010. On the convergence of the partial least squares path modeling algorithm. *Computational Statistics*, 25(1), 107–120.

Henseler, J., Ringle, C. M., and Sarstedt, M. 2015. A New Criterion for Assessing Discriminant Validity in Variance-based Structural Equation Modeling., *Journal of the Academy of Marketing Science*, 43(1), 115-135.

Hilty, L. M., and Aebischer, B. 2015. ICT for sustainability: An emerging research field. *ICT Innovations for Sustainability*, 3-36.

Hock, Y.M., Molla, A. and Cooper, V., 2012. Framework for a residential energy information system (REMIS) to promote energy efficient behaviour in residential energy end users. *Proceedings of the 23rd Australasian Conference on Information Systems*, 1-11.

Howard, G.R. and Lubbe, S., 2012. Synthesis of green is frameworks for achieving strong environmental sustainability in organisations. In *Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference*, 306-315.

Huang, A.H., 2009. A model for environmentally sustainable information systems development. *Journal of Computer Information Systems*, *49*(4), 114-121.

Hulland, J. 1999. Use of partial least squares (PLS) in strategic management research: a review of four recent studies. *Strategic Management Journal*, *20*(2), 195–204.

Husin, M. H., Loghmani, N. and Zainal Abidin, S. S. 2017. Increasing e-government adoption in Malaysia: MyEG case study. *Journal of Systems and Information Technology*, 19(3/4), 202-227.

Hutcheson, G. and Sofroniou, N., 1999. The Multivariate Social Scientist, Sage, London, England.

Ijab, M.T. and Molla, A., 2012. The Study Of Green Information Systems From The Theory of Practice Perspective. *Mediterranean Conference on Information System (MCIS)*, 1-12.

Ijab, M.T., Molla, A. and Cooper, V., 2012. Green information systems (green IS) practice in organisation: tracing its emergence and recurrent use.

Ijab, M.T., Molla, A. and Cooper, V.A., 2011. A theory of practice-based analysis of Green Information Systems (Green IS) use. *Proc of ACIS*.

Ijab, M.T., Molla, A., Kassahun, A.E. and Teoh, S.Y., 2010. Seeking the" Green" in" Green IS": A Spirit, Practice and Impact Perspective. *PACIS*, p. 46.

Info~Tech. 2007. 11 Green Initiatives Your Peers Are Cultivating, Info~Tech Research Group, 1–14.

Info~Tech. 2008. North America Underperforms in Green IT Attitudes and Actions‖, Info~Tech Research Group (January), 1–15.

Ingram, D. L., and Fernandez, R. T. 2012. Life cycle assessment: a tool for determining the environmental impact of horticultural crop production. *HortTechnology*, *22*(3), 275-279.

Isa, N. K. M. 2016. Sustainable campus and academic staffs awareness and behaviour in Malaysia's institutions of higher learning: A case study of UPSI. *Malaysian Journal of Society and Space*, 12(6), 89–99.

Ismail, F. D., Hamsa, A. A. K. and Mohamed, M. Z. 2016. Factors Influencing the Stated Preference of University Employees towards Telecommuting in International Islamic University Malaysia. *Transportation Research Procedia*, *17*, 478-487.

ISO. 2004. ISO/IEC 15504 Information Technology Process assessment, ISO.

Jain, R., Benbunan-Fich, R., and Mohan, K. 2011. Assessing green IT initiatives using the balanced scorecard, *IT professional*, 13(1), 26-32.

Jenkin, T. A., Webster, J. and McShane, L. 2011. An agenda for 'Green'information technology and systems research. *Information and Organization*, *21*(1), 17-40.

Jenkin, T. and McShane. L. 2009. Green Information Technologies and Systems in Organizations: The State of Practice, *Academy of Management Annual Meeting*, Chicago, IL, 7–11.

Jia, X. and Bai, L., 2009. The enterprise application information system integration based on the green supply chain management. *International Conference on Information Technology and Computer Science*, 433-435.

Jung, H.S., Kim, Y. and An, J.A., 2011. Effects of the Internal and External Factors of Small and Mediumsized Corporations on Green Management Performances through the Establishment and Utilization of Information Systems and Building Relationships for Information and Knowledge. *Proceedings of the Seventeenth Americas Conference on Information Systems*, Detroit, Michigan, 1-11.

Kant, K. 2009. Data Center Evolution: A Tutorial on State of the Art, Issues, and Challenges. *Computer Networks*, 53(17), 2939-2965.

Karanasios, S., Cooper, V., Deng, H., Molla, A. and Pittayachawan, S., 2010. Antecedents to greening data centres: A conceptual framework and exploratory case study. *Proceedings of the 21st Australasian Conference on Information Systems.*

Keil, M., Tan, B.C., Wei, K.-K., Saarinen, T., Tuunainen, V. and Wassenaar, A. 2000. A cross-cultural study on escalation of commitment behavior in software projects. *MIS Quarterly*, 24(2), 299-325.

KeTTHA: Ministry of Energy, Green Technology and Water. 2010. Kettha's Green Practice. Ministry of Energy, Green Technology and Water (KeTTHA), 1-19.

Khalil, N., Husin, H. N. and Nawawi, A. H. 2018. Evaluation and Concept of Building Performance Towards Sustainability in Malaysian Higher Institutions. *Asian Journal of Environment-Behaviour Studies*, 3(6), 91-99.

Kim, S. Y. 2008. Modeling and Analysis of a Web-based Collaborative Enterprise using Petri nets. *International Conference on Information Reuse and Integration*, 422-428.

Klör, B., 2016. Understanding the Role of Decision Support Systems in Green is Research: literature Review and Research Agenda. *PACIS*, p. 378.

Kotze, C., Van Belle, J.P. and McGibbon, C., 2014. Key Drivers of Green Information Systems in South African Listed Companies. *5th International Conference-Confluence the Next Generation Information Technology Summit (Confluence)*, 935-940.

Krishnadas, N. and Radhakrishna, R. 2014. Green Information Technology: Literature and Research Domains. *Journal of Management Systems*, 24(1), 57-79.

Kwon, O., Im, G. P., and Lee, K. C. 2007. MACE-SCM: A multi-agent and case-based reasoning collaboration mechanism for supply chain management under supply and demand uncertainties. *Expert Systems with Applications*, *33*(3), 690-705.

Lago, P., Kazman, R., Meyer, N., Morisio, M., Müller, H.A. and Paulisch, F., 2013. Exploring initial challenges for green software engineering: summary of the first GREENS workshop, at ICSE 2012. *ACM SIGSOFT Software Engineering Notes*, *38*(1), 31-33.

Lai, R.S., Hsu, L.L., Chen, J.C. and Chang, M.D., 2012. A Case Study on Green Information System. *ASBBS Proceedings*, *19*(1), p.512.

Lambert, D. M., and Harrington, T. C. 1990. Measuring nonresponse bias in customer service mail surveys. *Journal of Business Logistics*, 11(2), 5.

Lei, C. F., and Ngai, E. W. T. 2012. Green IS assimilation: A theoretical framework and research agenda. AMCIS Proceedings, Paper 2

Lei, C.F. and Ngai, E.W.T., 2013. Green Information Technologies Adoption: A Managerial Perspective. *PACIS*, p. 274.

Lei, C.F. and Ngai, E.W.T., 2014. A Research Agenda on Managerial Intention to Green IT Adoption: from norm activation Perspective. *PACIS*, p. 242.

Lintukangas, K., Kähkönen, A. K. and Ritala, P. 2014. Supply risks as drivers of green supply management adoption. *Journal of Cleaner Production*, 112, 1901-1909.

Loeser, F., 2013. Green IT and Green IS: Definition of constructs and overview of current practices. *Proceedings of the Nineteenth Americas Conference on Information Systems*, 1-13.

Loeser, F., Erek, K., and Zarnekow, R. 2012. Towards a typology of green IS strategies: insights from case study research. *33rd International Conferences on Information Systems*, pp.1-19.

Loeser, F., Erek, K., Limbach, F. and Zarnekow, R., 2013. Shared domain knowledge in strategic green IS alignment: an analysis from the knowledge-based view. *46th Hawaii International Conference on System Sciences (HICSS)*, 3515-3524.

Loeser, F., Recker, J., Brocke, J. V., Molla, A., and Zarnekow, R. 2017. How IT executives create organizational benefits by translating environmental strategies into Green IS initiatives. *Information Systems Journal*, 27(4), 503-553.

Loper, J, and Parr, S. 2007. Energy Efficiency in Data Centers: A New Policy Frontier. *Environmental Quality Management*, 16(4), 83-97.

Lowry, P. B., and Gaskin, J. 2014. Partial least squares (PLS) structural equation modeling (SEM) for building and testing behavioral causal theory: When to choose it and how to use it. *IEEE Transactions on Professional Communication*, 57(2), 123-146.

Luan, C.J., Tien, C. and Chen, W.L., 2016. Which "green" is better? An empirical study of the impact of green activities on firm performance. *Asia Pacific Management Review*, *21*(2), 102-110.

Lundfall, K., Grosso, P., Lago, P. and Procaccianti, G. 2015. The green practitioner: A Decision-Making tool for green ICT. 29th International Conference on Informatics for Environmental Protection (EnviroInfo 2015), 74-81.

Mangla, S.K., Kumar, P. and Barua, M.K., 2015. Risk analysis in green supply chain using fuzzy AHP approach: a case study. *Resources, Conservation and Recycling*, *104*, 375-390.

Mat, S.O.H.I.F., Sopian, K., Mokhtar, M., Ali, B., Hashim, H.S., Rashid, A.K.A. and Zain, M.F.M. 2011. Managing sustainability in Universiti Kebangsaan Malaysia, *Environmental Problems and Development*, 1(1) , 33–38.

McGibbon, C. and Van Belle, J.P. 2013. Integrating green information systems into the curriculum using a carbon footprinting case. *European Conference on Information Management and Evaluation*, p. 104.

McGibbon, C. and Van Belle, J.P., 2015. Integrating environmental sustainability issues into the curriculum through problem-based and project-based learning: a case study at the University of Cape Town. *Current Opinion in Environmental Sustainability*, 16(1), 81-88.

Meacham, J., Toms, L., Green Jr, K.W. and Bhadauria, V.S., 2013. Impact of information sharing and green information systems. *Management Research Review*, *36*(5), 478-494.

Melville, N.P., 2010. Information systems innovation for environmental sustainability. *MIS quarterly*, *34*(1), 1-21.

Meyer, J. W. and Rowan, B. 1977. Institutionalized organizations: Formal structure as myth and ceremony. *American journal of sociology*, 83(2), 340-363.

Mickoleit, A. 2010. *Greener and smarter: ICTs, the environment and climate change* (No. 2010/1). OECD Publishing.

Miles, M. B. and Huberman, A.M. 1994. An Expanded Sourcebook Qualitative Data Analysis, Sage Publication, London.

Mines, C. 2008. The Dawn of Green IT Services‖, Forrester Research, http://www.accenture.com/NR/rdonlyres/24ABF590-558E-42E6-B78B 143AFCF81A23/0/TheDawnOfGreenITServices.pdf

Mishra, A., Yazici, A. and Mishra, D., 2012. Green information technology/information system education: Curriculum views. *TTEM*, *7*(3), 679-686.

Mishra, D., Akman, I. and Mishra, A., 2014. Theory of reasoned action application for green information technology acceptance. *Computers in human behavior*, *36*, 29-40.

Mohankumar, M. and Anand, M.K., 2015. A Green IT Star Model Approach for Software Development Life Cycle. *International Journal of Advanced Technology in Engineering and Science*, *3*(1), 548-559.

Molla, A. and Abareshi, A. 2012. Organizational green motivations for information technology: empirical study. *Journal of Computer Information Systems*, 52(3), 92-102.

Molla, A. and Abareshi, A., 2011. Green IT Adoption: A Motivational Perspective. *PACIS*, p. 137.

Molla, A. and Cooper, V. 2009. Green IT readiness: A framework and preliminary proof of concept. *Australasian journal of information systems*, 16(2), 5-23.

Molla, A. and Cooper, V., 2010. Green IT readiness: A framework and preliminary proof of concept. *Australasian journal of information systems*, *16*(2), 5-23.

Molla, A. and Cooper, V., 2014. Greening data centres: The motivation, expectancy and ability drivers. *Proceedings of the European Conference on Information Systems, Tel Aviv*.

Molla, A., 2008. GITAM: A Model for the Adoption of Green IT. *ACIS Proceedings*, p.64.

Molla, A., 2009a. Organizational motivations for Green IT: Exploring Green IT matrix and motivation models. *PACIS 2009 Proceedings*, p.13.

Molla, A., 2009b. The reach and richness of green it: a principal component analysis. *Australian Conference on Information Systems (ACIS)*, 754-764.

Molla, A., 2013. Identifying IT sustainability performance drivers: Instrument development and validation. *Information Systems Frontiers*, *15*(5), 705-723.

Molla, A., Abareshi, A. and Cooper, V., 2014. Green IT beliefs and pro-environmental IT practices among IT professionals. *Information Technology and People*, *27*(2), 129-154.

Molla, A., Cooper, V., Corbitt, B., Deng, H., Peszynski, K., Pittayachawan, S. and Teoh, S.Y., 2008. E-readiness to G-readiness: Developing a green information technology readiness framework. *ACIS 2008 Proceedings*, p.35.

Molla, A., Cooper, V.A. and Pittayachawan, S., 2011. The Green IT Readiness (G-Readiness) of Organizations: An Exploratory Analysis of a Construct and Instrument. *CAIS*, *29*, p.4.

Molla, A., Deng, H. and Corbitt, B., 2010. IT for green: a framework for assessing the capability of the IT industry. *Green IT Work. Pap. Ser,(5)*.

Molla, A., Pittayachawan, S., and Corbitt, B. 2009a. Green IT diffusion: an international comparison. *School of Business Information Technology*.

Molla, A., Pittayachawan, S., Corbitt, B. and Deng, H., 2009b. An international comparison of Green IT diffusion. *International Journal of e-Business Management*, *3*(2), p.3.

Morris, T. 2006. *Social Work Research Methods: Four alternative paradigms*. Thousand Oaks, SAGE Publication.

Mouette, D. and Fernandes, J. F. R. 1996. Evaluating goals and impacts of two metro alternatives by the AHP. *Journal of Advanced Transportation*, 30(1), 23-35.

Muladi, N., and Surendro, K. 2014. The readiness self-assessment model for green IT implementation in organizations. *International Conference of Advanced Informatics: Concept, Theory and Application*, 146-151.

Murugesan, S. 2008. Harnessing Green IT: Principles and Practices, *IT Professional* (10)1, 24-33.

Myers, M. D. 1997. "Qualitative Research in Information Systems". MIS Quarterly, 21(2): 241-242.

Mygreenump. 2016. http://www. mygreen.ump.edu.my (accessed 20 December 2016).

Nathalia, D. W., Minsani, M. and Karen, I. 2011. IT Professionals Awareness: Green IT International Comparison Study. *Communications of the IBIMA*, 20(11), 1-15.

Nchise, A. C. 2012. An Empirical Analysis of the Theory of Planned Behavior: A Review of Its Application on E-democracy Adoption Using the Partial Least Squares Algorithm. *JeDEM-eJournal of eDemocracy and Open Government*, 4(2), 171-182.

Nedbal, D., Wetzlinger, W., Auinger, A. and Wagner, G., 2011. Sustainable IS Initialization Through Outsourcing: A Theory-Based Approach. In *AMCIS*.

Negulescu, O. and Doval, E., 2014. Managers' Position Against Risk, Uncertainty and Efficiency within the Green Industry: Ten Questions. *Procedia-Social and Behavioral Sciences*, *124*, 339-343.

Nifa, F. A. A., Rahim, S. A., Rani, W. N. M. W. M., and Ismail, M. N. 2016. Collaborative procurement for developing a sustainable campus. *AIP Conference Proceedings*.

Nikkheslat, M., Zohoori, M., Bekheirnia, N. and Mehrafshar, M., 2012. The important theories in term of applying green technologies and green processes in organizations: A study of Malaysian Universities. *Interdisciplinary Journal of Contemporary Research in Business*, *4*(7), 88-89.

Ninlawan, C., Seksan, P., Tossapol, K. and Pilada, W., 2010. The implementation of green supply chain management practices in electronics industry. *Proceedings of the international multiconference of engineers and computer scientists*, 17-19.

Nunn, S. 2007. Green IT: Beyond the Data Centre How IT can contribute to the Environmental Agenda Across and Beyond the Business‖, Accenture, http://www.accenture.com/SiteCollectionDocuments/PDF/126677_ATC_GreenIt_USUK_8_A4.pdf

Odeh, K. and Meszaros, J. 2012. SustainaBits: A framework and rating system for sustainable IT. International Green Computing Conference, 1-9.

O'Keefe, R. M., and O'Leary, D. E. 1993. Expert system verification and validation: a survey and tutorial. *Artificial Intelligence Review*, 7(1), 3-42.

Opitz, N., Krüp, H. and Kolbe, L.M., 2014. How to Govern your Green IT?-Validating a Contingency Theory Based Governance Model. *PACIS*, p. 333.

Overby, E., 2008. Process virtualization theory and the impact of information technology. *Organization Science*, 19 (2), 277–291.

Pallant, J. 2007. SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS for Windows (Version 10). St Leonards, N.S.W: Allen and Unwin

Park, S. H., Eo, J. and Lee, J. J. 2012. Assessing and Managing an Organization's Green IT Maturity. *MIS Quarterly Executive*, *11*(3), 127-140.

Penzenstadler, B., 2014. Infusing Green: Requirements Engineering for Green In and Through Software Systems. In *RE4SuSy@ RE*, 44-53.

Pernici, B., Aiello, M., vom Brocke, J., Donnellan, B., Gelenbe, E. and Kretsis, M., 2012. What IS Can Do for Environmental Sustainability: A Report from CAiSE'11 Panel on Green and Sustainable IS. *CAIS*, *30*, p.18.

Petzer, C., McGibbon, C. and Brown, I., 2011. Adoption of Green IS in South Africa: an exploratory study. *Conference on Knowledge, Innovation and Leadership in a Diverse, Multidisciplinary Environment*, 330-333.

Pichetpongsa, N. and Campeanu, G., 2011. Analysis of Green Information Technology in Dell and Toshiba Companies. *Research article*.

Pitt, L.F., Parent, M., Junglas, I., Chan, A. and Spyropoulou, S., 2011. Integrating the smartphone into a sound environmental information systems strategy: Principles, practices and a research agenda. *The Journal of Strategic Information Systems*, *20*(1), 27-37.

Radu, L.D., 2016. Determinants of Green ICT Adoption in Organizations: A Theoretical Perspective. *Sustainability*, *8*(8), p.731.

Rahim, M. M., Shanks, G., Johnston, R. and Sarker, P. 2007. Organizational motivation and interorganizational systems adoption process: Empirical evaluation in the Australian automotive industry, *Journal of electronic commerce in organizations*, *5*(3), 1-16.

Rahim, R. E. A, and Rahman, A. A. 2013. Applicability of resource-based environmental studies in Green IT. *Journal of Systems and Information Technology*, 15(3), 269-286.

Raza, K., Patle, V.K. and Arya, S., 2012. A review on green computing for eco-friendly and sustainable IT. *Journal of Computational Intelligence and Electronic Systems*, *1*(1), 3-16.

Recker, J. 2016. Toward a design theory for green information systems. *49th Hawaii International Conference on System Sciences*, 4474-4483.

Rogers, E. M. 1995. Diffusion of Innovation. New York, U.S.A, The Free Press.

Roscia, M., Longo, M. and Lazaroiu, G.C., 2013. Smart City by multi-agent systems. *International Conference on Renewable Energy Research and Applications*, 371-376.

Roscoe, J.T. 1975. Fundamental Research Statistics for the Behavioural Sciences, (2nd Ed.). New York: Holt Rinehart and Winston.

Ryoo, S.Y. and Koo, C., 2013. Green practices-IS alignment and environmental performance: The mediating effects of coordination. *Information Systems Frontiers*, *15*(5), 799-814.

Sacchero, S.D. and Molla, A., 2009. Environmental considerations in ICT infrastructure decision making. *ACIS 2009 Proceedings*.

Saha, B., 2014. Green computing. *International Journal of Computer Trends and Technology (IJCTT)*, *14*(2), 46-50.

Sahu, G. P. and Singh, M. 2016. Green Information System Adoption and Sustainability: A Case Study of Select Indian Banks. *Conference on e-Business, e-Services and e-Society*, 292-304.

Sakas, D. and Kutsikos, K., 2014. An adaptable decision making model for sustainable enterprise interoperability. *Procedia-Social and Behavioral Sciences*, *148*, 611-618.

Sarkar, P. and Young, L. 2009. Managerial attitudes towards Green IT: an explorative study of policy drivers. *PACIS 2009 Proceedings*.

Sarkis, J., Koo, C. and Watson, R.T., 2013. Green information systems and technologies–this generation and beyond: Introduction to the special issue. *Information Systems Frontiers*, *15*(5), 695-704.

Savita, K.S., Dominic, P.D.D. and Ramayah, T., 2014. The adoption of green information technologies and systems as a driver within green SCM. *International Conference on Computer and Information Sciences*, 1-6.

Schmidt, N.H. and Kolbe, L.M., 2011. Towards a contingency model for green IT governance. *ECIS*, p. 105.

Schmidt, N.H., Erek, K., Kolbe, L.M. and Zarnekow, R., 2009. Towards a procedural model for sustainable information systems management. *42nd Hawaii International Conference on System Sciences, HICSS'09*, 1-10.

Schmidt, N.H., Erek, K., Kolbe, L.M. and Zarnekow, R., 2010. Predictors of Green IT Adoption: Implications from an Empirical Investigation. *AMCIS*, p. 367.

Schultz, P. W., Gouveia, V. V., Cameron, L. D., Tankha, G., Schmuck, P. and Franěk, M. 2005. Values and their relationship to environmental concern and conservation behavior. *Journal of cross-cultural psychology*, 36(4), 457-475.

Schulz, G. 2009. The Green and Virtual Data Center. FL: CRC Press, Taylor & Francis

Schwartz, S. H. 1974. Awareness of interpersonal consequences, responsibility denial, and volunteering. *Journal of Personality and Social Psychology*, 30(1), 57-63.

Seidel, S., Recker, J.C., Pimmer, C. and vom Brocke, J., 2010. Enablers and barriers to the organizational adoption of sustainable business practices. *16th Americas conference on information systems: sustainable IT collaboration around the globe*.

Sharma, C. and Jain, A., 2015. PV Based Green Computing System for ICT Sustainable Development. *Second International Conference on Advances in Computing and Communication Engineering (ICACCE)*, 240-244.

Shen, Y., Colloc, J., Jacquet-Andrieu, A. and Lei, K. 2015. Emerging medical informatics with case-based reasoning for aiding clinical decision in multi-agent system. *Journal of biomedical informatics*, 56, 307-317.

Shriberg, M. 2002. Institutional assessment tools for sustainability in higher education: strengths, weaknesses, and implications for practice and theory. *International Journal of Sustainability in Higher Education*, *3*(3), 254-270.

Simmonds, D. and Bhattacherjee, A., 2014. Green IT adoption and sustainable value creation. *Twentieth Americas Conference on Information Systems*, Savannah, 1-16.

Standing, C. and Jackson, P., 2007. An approach to sustainability for information systems. *Journal of Systems and Information Technology*, *9*(2), 167-176.

Statistics.laerd, 2017a. Multiple Regression Analysis using SPSS Statistics. Available online: https://statistics.laerd.com/spss-tutorials/multiple-regression-using-spss-statistics.php (accessed 22 July 2017).

Statistics.laerd, 2017b. Partial Correlation using SPSS Statistics. Available online: https://statistics.laerd.com/spss-tutorials/partial-correlation-using-spss-statistics.php (accessed 22 July 2017).

Statisticssolutions. 2017. Exploratory Factor Analysis. http://www.statisticssolutions.com/factor-analysis-sem-exploratory-factor-analysis// (accessed 29 July 2017).

Straub, D., Boudreau, M. and Gefen, D. 2004. Validation guidelines for IS positivist research. *Communications of the Association for Information Systems*, 13(1), 380–427

Sustainable_utm. 2016. http://www.utm.my/sustainable/our-policy/ (accessed 20 December 2016).

Tashakkori, A. and Teddlie, C. 2003. Handbook of mixed methods in social and behavioural research. Thousand Oaks: Sage Publications.

Tashakkori, A., Teddlie, C., & Teddlie, C. B. 1998. Mixed methodology: Combining qualitative and quantitative approaches (Vol. 46). Sage.

Tedre, M., Chachage, B. and Faida, J., 2009, October. Integrating environmental issues in IT education in Tanzania. *39th IEEE Frontiers in Education Conference*, 1-7.

Tencati, A., and Zsolnai, L. 2009. The collaborative enterprise. *Journal of Business Ethics*, *85*(3), 367-376.

Tornatzky, L. G. and Fleischer, M. 1990. The Processes of Technological Innovation, Lexington Books, Massachusetts, USA.

Uddin, M., Hindu, R.C., Alsaqour, R., Shah, A., Abubakar, A. and Saba, T., 2015. Knowledge management framework using green IT to implement sustainable entrepreneur ecosystem. *Applied Mathematics and Information Sciences*, *9*(5), p.2703.

UI Green Metric. 2016. UI GreenMetric Overall Ranking 2016. http//greenmetric.ui.ac.id/overall-ranking-2016/ (accessed 20 March 2017).

Vela, F. G., Montes, J. I., Rodríguez, P. P., Román, M. S., and Valverde, B. J. 2007. An architecture for access control management in collaborative enterprise systems based on organization models. *Science of Computer Programming*, *66*(1), 44-59.

Velte, T.J., Velte, A.T. and Elsenpeter R. 2008. Green IT: Reduce Your Information System's Environmental Impact While Adding to the Bottom Line, New York, NY: McGraw Hill.

Vykoukal, J., Beck, R. and Wolf, M., 2011. Impact of pressure for environmental sustainability on grid assimilation–empirical results from the financial services industry. *Australasian Journal of Information Systems*, *17*(1), 5-28.

Wade, M. and Hulland, J. 2004. The resource-based view and information systems research: Review, extension, and suggestions for future research. *MIS quarterly*, 28(1), 107-142.

Wati, Y. and Koo, C., 2012. Toward green IS adoption behaviors: A self-determination perspective. *45th Hawaii International Conference on System Science,* 1207-1216.

Watson, R.T., Boudreau, M.C. and Chen, A.J., 2010. Information systems and environmentally sustainable development: energy informatics and new directions for the IS community. *MIS quarterly*, 23-38.

Watson, R.T., Boudreau, M.C., Chen, A.J. and Sepúlveda, H.H., 2011. Green projects: An information drives analysis of four cases. *The Journal of Strategic Information Systems*, *20*(1), 55-62.

Wernerfelt, B. 1984. A resource-based view of the firm. Strategic management journal, 5(2), 171-180.

Widjaja, N. D., Mariani, M. and Imam, K. 2011. IT Professionals Awareness: Green IT International Comparison Study. *Communications of the IBIMA*, 1-15.

Wong, K. K. K. 2013. Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS. *Marketing Bulletin*, 24(1), 1-32.

Yan, Z. and Barbara, M. W. 2007. Qualitative Analysis of Content, Sage Publications.

Yang, S. Y. 2012. Developing a Cloud Energy-Saving and Case-Based Reasoning Information Agent with Web Service Techniques. *Fifth International Symposium on Parallel Architectures, Algorithms and Programming*, 178-185.

Yin, K.R., 2004. Case Study Methods, Complementary Methods for Research in Education, Cosmos Corporation. *American Education Research Association*.

Yin, R. K. 2011. Applications of case study research. Sage.

York, P.T. et al. 2009. Green IS: Using Information Systems to Encourage Green Behavior, *Academy of Management Annual Meeting*, Chicago, IL, 7-11.

Zakaria, R., Alqaifi, G., Hamid, A. R. A., Mansur, S. A., Resang, A., Zen, I. S., ... and Khalid, M. S. 2016. UTM sustainable living laboratory campus; Are the implementations effective?. *Regional Conference in Engineering Education*, 1-6.

Zaman, B. and Sedera, D., 2016. Green information technology as administrative innovation-Organizational factors for successful implementation: Literature review. *Australasian Conference on Information Systems*, Adelaide.

Zeng, S. X., Tam, C. M., Tam, V. W. and Deng, Z. M. 2005. Towards implementation of ISO 14001 environmental management systems in selected industries in China. *Journal of Cleaner Production*, 13(7), 645-656.

Zhang, D. and Adipat, B. 2005. Challenges, methodologies, and issues in the usability testing of mobile applications. *International journal of human-computer interaction*, 18(3), 293-308.

Zheng, D. 2014. The Adoption of Green Information Technology and Information Systems: an Evidence from Corporate Social Responsibility. *PACIS*, p. 237.

Zouhair, A., Amami, B., Boukachour, H., Person, P. and Bertelle, C. 2014. Modelisation and implementation of our system incremental dynamic case based reasoning founded In the MAS under JADE plate-form. *ICMCS*, 1031-1036.

APPENDIX A

Interview Overview

- The purpose of this interview is to investigate Green IT/IS practices implementation in Malaysia collaborative enterprise.
- This interview hopefully can contribute to the research objective which is to develop a Green IT/IS assessment model.
- The interview question aimed at verifying or confirming the Green IT/IS practice to be implemented and independent variables that influences Green IT/IS practice.
- Therefore this work is for academic purpose only and the details of the interviewee and the enterprise will not be published or displayed to the public.

Definition of Terms

- IT- Information Technology refers to computer software, hardware and peripheral infrastructures.
- IS- Information Systems involves the human activities and technology components related to the running and management process of technology across enterprise.
- Sustainability- Sustainability is defined as development that meets the needs of the present without affecting the ability of future generations to meet their needs.
- Green IT/IS - Green IT/IS refers to the development and utilization of information systems technologies to support or enable environmental sustainability initiatives.
- Collaborative Enterprise- this is an organizations that comprises of two or more than two people that working together to accomplish a particular aims or objectives.
- Green IT/IS Practice- these are the eco-friendly initiatives carried out in collaborative enterprise daily operations.
- Independent Variables- these are the factors that influences eco-friendly practices being carried out in collaborative enterprise daily operations.
    - Designation/ Skills: _____
    - Experience (years): _____
    - Age: [16-30], [31-40], [40-50], [50-Above]
    - Date: _____
    - Time: _____
    - Enterprise: _____
    - Gender: _____
    - Education _____

A. Green IT/IS Practice Implementation

Is it important for your enterprise to implement the following Green IT/IS practice?

1. Section A

Green Creation is implemented when practitioner's utilizes information systems such as telecommuting, IP telephony, thin client, web based business services, videoconferencing and virtual collaboration in their enterpise.

i. Is Green creation important in implementing Green IT/IS practice in your organization?
ii. If no please give reasons why.
iii. If yes how does your organization implement Green creation?

2. Section B

Green Distribution- invloves deploying information systems and other auxiliary subsystems with limited impact on the environment by using sterile delivery systems to encourage minimal unwanted pollution to the environment and lowering resource consumption.

i. Is Green distribution required in implementing Green IT/IS practice in your organization?
ii. If yes what initiatives does your organization used for implementing Green distribution?
iii. If no please give reasons why.

3. Section C

Green Sourcing implies the practice of purchasing IT infrastructure that posses Green labels of certifications.

i. Is Green sourcing an integral initiative for implementing Green IT/IS practice in your organization?
ii. If yes what measures are implemented in Green sourcing?
iii. If no please give reasons why.

4. Section D

Green Usage aims to bring about energy consumption reduction and reducing IT induced CO_2 emissions by optimizing of energy utilization without reducing the installed power base, structural avoidance results in reduction installed power capacity.

i. Is Green usage necessary when implementing Green IT/IS practice in your organization?
ii. If yes what initiatives does your organization carryout in implementing Green usage?
iii. If no please give reasons why.

5. **Section E**

End of Life- refers to practices in refurbishing, recycling reusing and disposing IT hardware in an ethical eco-friendly manner.

iv. Is end of life necessary when implementing Green IT/IS practice in your organization?
v. If yes what activities does your organization carryout in implementing end of life strategies?
vi. If no please give reasons why.

In your opinion is there any other Green IT/IS practice that is implemented in your enterprise that is supposed to be included?

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B. Green IT/IS Variables that Influence Green IT/IS Practice Implementation

1. **Section A**
   i. Are the IT practitioners important in implementing Green IT/IS practice?
   ii. If no please give reasons why.
   iii. If yes why are they important, who and which department(s) performs Green IT/IS practice implemention in your organization?

2. **Section B**
   i. Does the enterprise governance policies, rules or standards determines Green IT/IS practice?
   ii. If no please give reasons why.
   iii. If yes what governance policies, rules or standards are currently implemented in your organization?
   iv. If you apply more than one standard, which is the most useful for Green IT/IS practice?

3. **Section C**
   i. Does the technologies and systems used influence Green IT/IS practice?
   ii. If no please give reasons why.
   iii. If yes what technologies and systems does your organization use for Green IT/IS practice implementation?
   iv. How long has the technologies and systems been used?
   v. Do the technologies and systems meet your expectation?
   vi. Is there any problem encountered in using the technologies and systems?

4. **Section D**
   i. Is your organization influenced or pressured by industrial, government or non-governmental associations in implementing Green IT/IS practices?
   ii. If no why is your organization not influenced by these associations?
   iii. If yes which industrial, government or non-governmental bodies influences your organization in implementing Green IT/IS practice?

5. **Section E**
   i. Do you agree that the IT strategy such as the routine, activities and procedures carried out by the organization influences the implementation of Green IT/IS practices?
   ii. If no why?
   iii. If Yes why?

6. **Section F**
   i. Do you agree that the availability of information influences the implementation of Green IT/IS practices in an organization?
   ii. If no why?
   iii. If yes why?

In your opinion is there any other independent variable(s) that influence collaborative enterprise in implementing Green IT/IS practice?

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Thanks for your time and response to further this research

APPENDIX B

A SURVEY TO EVALUATE GREEN IT/IS IMPLEMENTATION IN MALAYSIA COLLABORATIVE ENTERPRISE

Research Overview

The aim of this research is to propose a Green IT/IS assessment model for sustainability attainment in Malaysia collaborative enterprise.

Survey Overview

- This survey hopefully can contribute to the research objective by validating the proposed Green IT/IS assessment model.
- Therefore this work is for academic purpose only, thus the name of the respondents and their respective enterprise will not be published or displayed to the public.

Definition of Terms

- IT- Information Technology refers to computer software, hardware and peripheral infrastructures.
- IS- Information Systems involves the human activities and technology components related to the running and management process of technology across enterprise.
- Sustainability- Sustainability is defined as development that meets the needs of the present without affecting the ability of future generations to meet their needs.
- Green IT/IS - Green IT/IS refers to the development and utilization of information systems technologies to support or enable environmental sustainability initiatives.
- Collaborative Enterprise- this is an organization that comprises of two or more than two people working together to accomplish a particular aims or objectives.
- Green IT/IS Practice- these are the eco-friendly initiatives carried out in collaborative enterprise daily operations.
- Independent Variables- these are the factors that influences eco-friendly practices being carried out in collaborative enterprise daily operations.

Survey Directions:

This questionnaire is divided into three sections:

- Section A: Respondent's and enterprise information.

- Section B: Measures independent variables that influence Green IT/IS practice implementation in collaborative enterprise.
- Section C: Measures Green IT/IS practice implemented in collaborative enterprise.

Section A (Respondents/Enterprise Information)

Please answer all questions in this section. Please tick (√) in relation to your current position and enterprise

Gender: Male ○	Female ○
Age:	< 25 25-34 35-44 45-55 >55
Education:	High School Diploma Bachelor's Degree Master's degree PhD
Enterprise Country:	Malaysia Others
Enterprise Sector:	ICT, Communication and Media Education and Research Health and Community Services Engineering and Construction Finance, Banking and Insurance Government, Administration and Defence Manufacturing Business, Wholesale and Retail Personal, Professional Others Services
Job Title:	Business and Systems Analysts and Programmers ICT Managers ICT Network and Support Professionals Non ICT Specialist Managers Chief Executives, General Managers and Legislators Tertiary Education Lecturers Database and Systems Administrators, and ICT Security Specialists Others

Working Experience:
0-5
6-10
11-15
16-20
>20

Enterprise Size (Employees):
Below 50 employees
51-250 employees
251- 1000 employees
Above 1000 employees

Enterprise Founding Date (Time):
Before 1967
Between 1967-1980
Between 1991-2000
Between 2001- 2010
From 2011- Till date

Enterprise Revenue (Annually):
RM 90,000 or below
RM 90,000 to RM 900, 000
RM 900,000 to RM 2, 700,000
RM 2,700,000 to RM 4,500,000
RM 4, 500,000 to RM 9, 000,000
RM 9,000,000 or above

Section B (Independent Variables that Influence Green IT/IS Practice)

Please answer all questions in this section.

Please tick (√ or CIRCLE your selection) to give the degree of how the independent variables influence Green IT/IS practice implementation in your enterprise.

How important are the following in driving your firm towards implementing Green IT/IS.

Not Important ⟷ **Very Important**

	1	2	3	4	5
IT Practitioners	**Degree Response**				
1. Positive attitude of IT practitioners.					
2. Ethical consideration of IT practitioners.					
3. Social-Culture of IT practitioners.					
4. General capabilities of IT practitioners.					
5. Beliefs of IT practitioners in relation to climate and environment.					
6. Knowledge of IT practitioners in relation to climate and environment.					
7. Experience of IT practitioners in the enterprise.					
8. IT practitioners' commitment.					

How important are the following in driving your firm towards implementingGreen IT/IS.

Not Important ⟷ Very Important

IT Governance	1	2	3	4	5
	Degree Response				
1. Formal organisational structures.					
2. Management playing leading role.					
3. Management support.					
4. Management investigation on ways to reduce IT's power consumption.					
5. Management advocates the use of technology and systems by potential IT suppliers.					
6. Management policy for the use of IT to reduce overall wastes.					
7. Management policy on employee's use of IT in an energy efficient manner.					
8. Allocated budgets and other resources by management.					

How relevant is the following to your firm implementing Green IT/IS.

Not Relevant ⟷ Very Relevant

Technologies and Systems	1	2	3	4	5
	Degree Response				
1. Transforming its business process to be paperless.					
2. Server/Storage virtualization and consolidation to reduce energy usage.					
3. Use of teleconferencing for enterprise meetings.					
4. Use of video conferencing for daily activities.					
5. Use of telecommuting by employees transporting around the organization.					
6. Use of on-line collaboration tools for enterprise day-to-day activities.					
7. Installation of software to reduce overall emissions and wastes.					
8. Installation of software to reduce overall use of hazardous and toxic materials.					

How the following does influences your firm in implementing Green IT/IS.

Not Influential ⟷ Very Influential

Motivating Forces	1	2	3	4	5
	Degree Response				
1. The pressure from government and non-governmental bodies.					
2. Management involvement influences Green IT/IS implementation.					
3. Provision of government incentives and other resources.					
4. The actions of other competitors.					
5. Pressure from clients, consumers and ICT vendors.					
6. Encouragement from industry associations.					
7. Future consequences of enterprise actions.					

How important are the following in driving your firm towards implementing Green IT/IS.

Not Important ⟷ Very Important

IT Strategy	1	2	3	4	5
	Degree Response				
1. Tackling the carbon foot print of IT systems.					
2. Own corporate strategy.					
3. Financial returns (cost saving) on investment.					
4. Plan initiatives on how to achieve environmental goals.					
5. Effective routines to facilitate the combination of newly acquired knowledge.					
6. Refine procedures to facilitate the combination of newly acquired knowledge.					
7. Develop business opportunities based on sustainability perspective.					

How important are the following in driving your firm towards implementing Green IT/IS.

Not Important ⟷ Very Important

Information Availability	1	2	3	4	5
	Degree Response				
1. Providing latest information relating to the environment and climate.					
2. Usage of information to communicate and have access to information unconstrained.					
3. Providing precise and unique information.					
4. Providing same and consistent information.					

Section C (Green IT/IS Practice Implementation)

Please answer all questions in this section.

Please tick (√ or **CIRCLE** your selection) to give the degree of how your organizational initiatives relate to the implementation of Green IT/IS practices.

To what extent has your organization implemented the following.

Not Implemented ⟷ Fully Implemented

Green Creation- is implemented when practitioner's utilizes information systems such as telecommuting, IP telephony, thin client, web based business services, videoconferencing and virtual collaboration in their enterprise.	1	2	3	4	5
	Degree Response				
1. Concerned about the energy consumption of cooling and lighting in our data centres.					
2. Concerned about the efficiency of powering our IT infrastructure (storage, servers and network).					
3. Considers environmental factors in the design of the enterprise infrastructure (lighting, power delivery, cooling systems) and IT infrastructure (servers, storage and network) of data centres					
4. Relocate enterprise data centre near clean sources of energy/renewable energy (solar, wind, hydro, etc.).					
5. Use electricity supplied by Green energy providers.					
6. Enforces PC power management.					

To what extent has your organization implemented the following.

Not Implemented ⟷ Fully Implemented

	1	2	3	4	5
Green Distribution- involves deploying information systems and other auxiliary subsystems with limited impact on the environment by using sterile delivery systems to encourage minimal unwanted pollution to the environment and lowering resource consumption.	**Degree Response**				
1. Install software to make the product distribution and delivery more eco-friendly.					
2. Retire energy inefficient systems.					
3. Analyses IT's energy bill separately from overall corporate bill.					
4. Engaging the service of a professional service provider.					
5. Install more energy efficient lightings.					
6. Upgrades to efficient transformers and UPS.					
7. Auditing the power efficiency of systems for lesser power consumption.					
8. Eliminates and di-commission unused services and systems.					

To what extent has your organization implemented the following.

Not Implemented ⟷ Fully Implemented

	1	2	3	4	5
Green Sourcing- implies the practice of purchasing IT infrastructure that possesses Green labels of certifications.	**Degree Response**				
1. Install software to make material sourcing more environmentally friendly.					
2. Buys recycled IT equipment for enterprise use.					
3. Makes preference to IT hardware suppliers that have a green track record.					
4. Gives weight to environmental considerations in IT procurement.					
5. Deploy environment-friendly IT procurement policy.					
6. Purchase IT infrastructures from vendors that offers take back option.					

To what extent has your organization implemented the following.

Not Implemented ⟷ Fully Implemented

	1	2	3	4	5
Green Usage- aims to bring about energy consumption reduction and reducing IT induced CO_2 emissions by optimizing of energy utilization without reducing the installed power base, structural avoidance results in reduction installed power capacity.	**Degree Response**				
1. Environmental consideration in planning IT usage and operations.					
2. Applied power management features of IT we regularly use.					
3. Turn off computers when not in use to saves energy.					
4. Print on both side of a paper to reduce paper wastage thus saving the environment.					
5. Utilizes computers that have functions to monitor workloads and to shut down components when unused.					
6. Uses free cooling in data centres to reduces incurred energy cost.					

To what extent has your organization implemented the following.

Not Implemented ⟷ **Fully Implemented**

	1	2	3	4	5
End of Life- refers to practices in refurbishing, recycling reusing and disposing IT hardware in an ethical eco-friendly manner.	**Degree Response**				
1. Recycle consumable equipment (e.g. batteries, ink cartridges, and paper).					
2. Disposes of IT equipment in an environmentally friendly manner.					
3. Carryout policy on managing electronic waste.					
4. Reuse IT equipment.					
5. Refurbish old, out-dated and obsolete IT equipment.					

Thank you for participating in this survey.

Your response is invaluable for this research.

Please submit or return the completed survey to the person in charge. The data will only be used for research purposes. The names of your organization and position will be treated as **CONFIDENTIAL**.

For any enquiry, please contact at **016-234-9489**

or e-mail me
at ***bkanjr@gmail.com***
End of Survey

APPENDIX C

Focus-Group Questionnaire

- The purpose of this questionnaire is to evaluate the implemented Green IT/IS Assessment Tool (GAT) among IT practitioners in collaborative enterprise that implement Green IT/IS practice in Malaysia.
- This survey hopefully can contribute to test the applicability of the GAT.
- Therefore this work is for academic purpose only and the details of the participants will not be published or displayed to the public.

Section A (Respondents Information)

Please answer all questions in this section.

Please tick (√) in relation to your current position

1. **Gender:** Male ○ Female ○
2. **Age:**
   - < 25
   - 25-34
   - 35-44
   - 45-55
   - >55
3. **Education:**
   - High School
   - Diploma
   - Bachelor's Degree
   - Master's Degree
   - PhD
4. **Job Title:**
   - IT Practitioner
   - IT Administrator
   - Environmental Practitioners
   - IT Manager
   - IT Staff
   - Others
5. **Working Experience:**
   - 0-5
   - 6-10
   - 11-15
   - 16-20
   - >20

Section B (Questions to Test the Applicability of GAT)

#	Questions and associated scale
1	Is the tool user friendly, understandable enough in terms of its icons, buttons, table, lists captures, menus, graphic, and colours? 0 = Completely unfriendly ⟷ 5= Completely Friendly **0 1 2 3 4 5**
2	Does the tool provide enough information regarding Green IT/IS practice? 0 = Not enough ⟷ 5= Very enough **0 1 2 3 4 5**
3	Is it easy to navigate around the tool? 0 = Very Difficult ⟷ 5= Very easy **0 1 2 3 4 5**
4	Was it easy to learn how to use the tool? 0= Very difficult ⟷ 5= Very easy **0 1 2 3 4 5**
5	Did you encounter problems in using the tool? 0= Always ⟷ 5= No Problem **0 1 2 3 4 5**
6	Regarding the Green IT/IS practice and provision of information, is the tool sufficient to assess the following? **Green Creation** 0 = Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5** **Green Distribution** 0 = Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5**

	Green Sourcing 0 = Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5** **Green Usage** 0 = Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5** **End of Life** 0 = Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5** **Information Provision** 0 = Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5**
7	Some other features have been introduced by the tool. Could you please weigh them? **Green IT/IS Best Practice Suggestion** 0= Not important ⟷ 5= Very important **0 1 2 3 4 5** **Green IT/IS Assessment Enrolment** 0= Not important ⟷5= Very important **0 1 2 3 4 5** **Green IT/IS Assessment Result Certification Generation** 0= Not important ⟷ 5= Very important **0 1 2 3 4 5**
8	How efficient do you think the tool would be in the real use for Green IT/IS assessment? 0= Very inefficient ⟷ 5= Very efficient **0 1 2 3 4 5**

9	How satisfied are you with the tool in terms of: **Its overall performance** 0= Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5** **Information retrieval response time** 0= Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5** **Consistency of data provided** 0= Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5**
10	How satisfied are you with the tool in terms of Green IT/IS practice evaluations? 0= Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5**
11	How satisfied are you with the tool in terms of Green IT/IS practice benchmarking? 0= Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5**
12	How satisfied are you with the tool in terms of Green IT/IS practice rating? 0= Completely dissatisfied ⟷ 5= Completely satisfied **0 1 2 3 4 5**

Is there any other functionality you think should be added to the Green IT/IS Assessment Tool? Please give your suggestion here.

……
……

Thank You for Participating

APPENDIX D

APPLICATION OF SOFTWARE AGENTS AND CASE BASED REASONING

D1. Software Agents for Green IT/IS Practice Assessment

In computer science, an agent is software that acts or brings about a certain result; it is one which is empowered to act for another. Hence agent can be defined as a software entity, which is autonomous to accomplish its designed objectives. Accordingly, agents are defined as a software entity, which is independent to complete its design objectives, considered as a part of a complete objective. Furthermore, software agents cooperate and collaborate with other agents in order to solve problems beyond their individual knowledge or expertise.

D2. Case Based Reasoning for Green IT/IS Practice Recommendation

Case Based Reasoning (CBR) is the method of solving new problems based on the solutions of similar past problems, by retrieving similar cases from a case base. Hence, practitioners can reuse and revise solutions from similar cases and obtain the final confirmed solution for the new problem. CBR is a problem-solving and continuous learning methodology. The CBR technique can be explained as a four-step process as seen in Figure D1. Thus, Figure D1 show how CBR is carried out, in retrieving the most similar cases from the case base and reusing them in present circumstances to solve new problems. Figure D1 also shows how CBR is deployed by retrieving the most similar cases from the case base and reusing the retrieved case resolving current problems. CBR technique comprises of four main steps: retrieve, reuse, revise and retain, which are termed by many researchers as the CBR cycle.

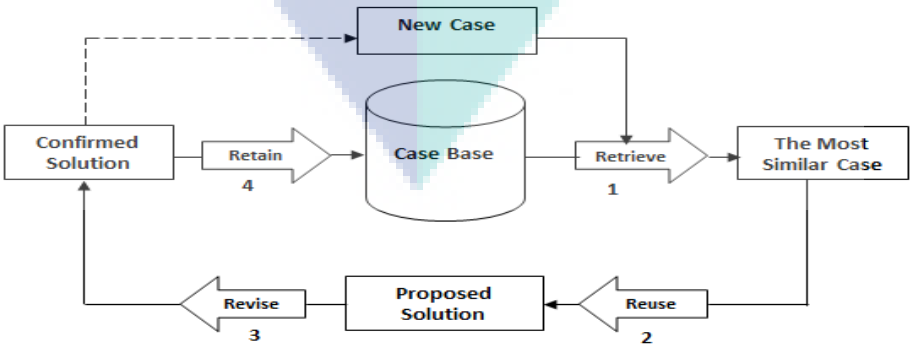

Figure D1 Case based reasoning cycle

D3. Software Agents and CBR Application For Green IT/IS Assessment

This section comprises of software agents and CBR which are the two techniques integrated in this thesis to implement the Green IT/IS Assessment Tool (GAT). Therefore, this section describes how software agents assess the current Green IT/IS practice implemented by IT practitioners in CE and how CBR provides best Green practice to IT practitioners in CE. Hence, Figure D2 shows the software agents' system architecture deployed to evaluate benchmark and rate IT practitioners current Green IT/IS practice in CE.

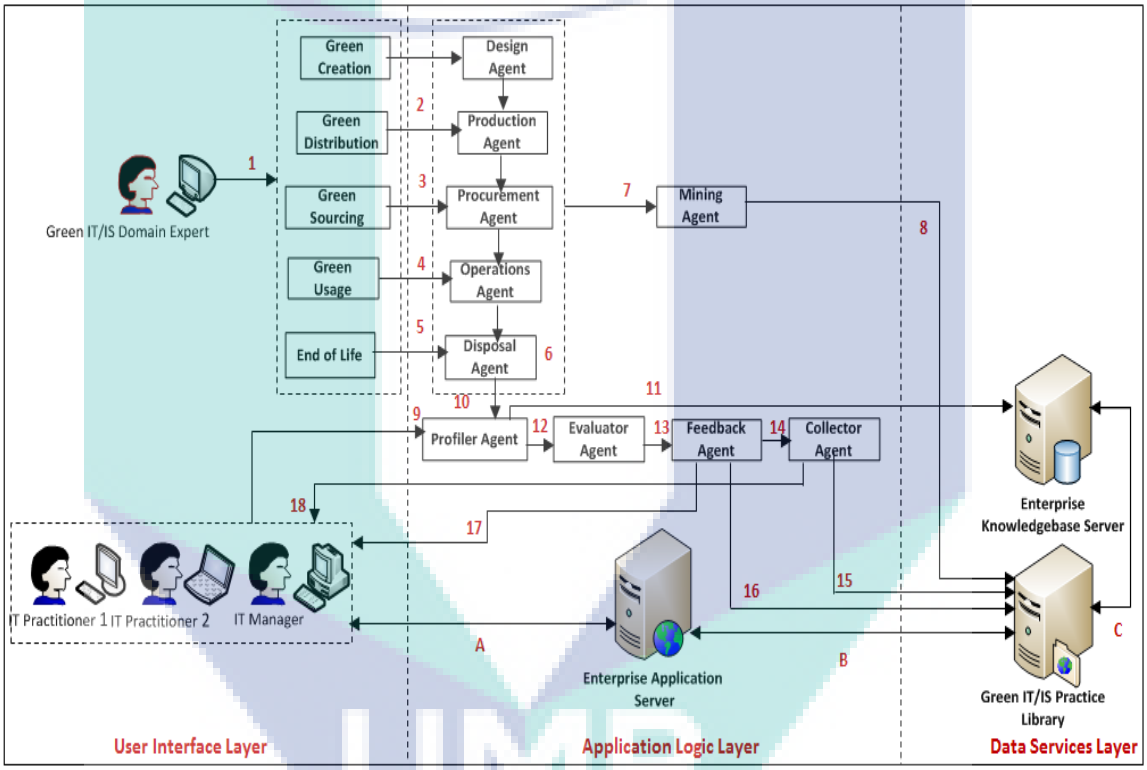

Figure D2 Software agents' system architecture

Accordingly, Figure D2 comprises of the domain experts who adds in the best practice assessment questions into the Green IT/IS practice library. In addition, Figure D2 also show IT practitioners that are been assessed and the enterprise web application server which stores all the ten agents, evaluation/grading algorithm and lastly the enterprise knowledge base that contains information of IT practitioners in the enterprise. Similarly, the Green IT/IS practice library retains all the Green IT/IS implementation questions, answered and recommendations. Moreover, Figure D2 also depicts that the domain experts, IT practitioners and IT managers are in the user interface layer, whereas all the ten agents are deployed in the application logic layer and

the enterprise knowledge base and Green IT/IS practice library are situated in the data service layer. The pseudo code for the software agent system architecture is shown below based on the numbers in Figure D2.

Begin

(1) Start the agent by Green IT/IS domain experts adding Green IT/IS practice assessment category, question and answers,
(2) Calls the design agent to receive questions and answers on Green creation,
(3) Calls the production agent to collect questions and answers on Green distribution,
(4) Calls the procurement agent to collect questions and answers on Green sourcing,
(5) Calls the operation agent to collect questions and answers on Green usage,
(6) Disposal agent collect questions and answers on end of life,
(7) Mining agent integrates Green creation, Green distribution, Green sourcing, Green usage and end of life,
(8) Then saves in Green IT/IS practice library,
(9) While IT practitioner or IT manager request to login;

If either IT practitioner or IT manager login details are invalid; Then deny login; Else profiler agent confirms corresponding user (IT practitioner or IT manager) details from the enterprise knowledge server base and redirects user to users profile page;

(10) Retrieves assessment questions based on selected Green IT/IS practice category;
(11) Profiler agent saves user Green IT/IS practice assessment session in the enterprise knowledgebase server;
(12) Profiler agent transmits the sessions' Green IT/IS practice assessment question and selected answers to the evaluator agent;
(13) The evaluator agent benchmarks, scores the user and also generates required information of the Green IT/IS practice assessment based on pre-defined formula 0-15% = Not sustainable, >15%-50% = Not sustainable, >50%-85% = Sustainable and >85%-100% = Highly sustainable) as suggested by ISO (2004), and then calls the feedback agent;
(14) Feedback agent begins to communicate the benchmarking and rating of the Green IT/IS practice assessment results to the user;
(15) Collector agent saves the details of the user's Green IT/IS practice assessment session in the Green IT/IS practice library;
(16) Feedback agent requests the Green IT/IS assessment results of the user;
(17) Feedback agent displays the Green IT/IS assessment practice results to user;
(18) Collector agent displays valid answers as Green IT/IS best practices as recommendation and also generates Green IT/IS assessment certification result based on assessment(s) taken;

End

Furthermore, "A" in Figure D2 shows the interaction between the users' and software agents through the enterprise web application server. "B" is the connection

between the application logic layer and the data service layer, whereas “C” denoted the connection between the enterprise knowledgebase server and the Green IT/IS practice library. Next the algorithms for each software agent are presented.

D3.1 Green IT/IS Practice Agents Algorithm

The algorithm comprises Green IT/IS practice question formulation from the Green IT/IS domain experts represented with a single algorithm for design agent (Green creation), production agent (Green distribution), procurement agent (Green sourcing), operations agent (Green usage) and disposal agent (end of life). The algorithm is show below;

Start
Function Green IT/IS_practice ( )
Step 1:
Green IT/IS _domain expert is responsible to provide data on the structure and index the content of Green IT/IS practice.
Let

1. DE = {d | d is the Green IT/IS domain experts data}
2. GP = {gp | gp is the Green IT/IS practice that is been added by d’s and is given as, d ∈GP}
3. d∈GP= {Green creation, Green distribution, Green sourcing, Green usage, end of life}
4. GA = {design agent, production agent, procurement agent, operations agent, disposal agent}
5. Indexing the added Green IT/IS practice to the Green IT/IS practice library’ is the enabler for assessment as show in Figure D2. One element in the set GP is a set of individual practices (P1, P2, P3, P4, P5) that are saved in the Green IT/IS practice library.
6. The mining agents {GA} collects data on each of the practice (d∈GP) are programmed to collect Green IT/IS best practices only and avoid tuple duplicates.

Step 2:

1. “GA” are programmed to discover and retrieve Green IT/IS practice assessment questions, previously saved by the Green IT/IS domain experts in Step 1 from the Green IT/IS practice library.
2. Where GA inspects Green IT/IS practice library structure stored in case base tables gpi ∈ GP. From the Green IT/IS practice library table, the GA searches the individual gpi accessible through query search and locates the GP.
3. GA search may include: {“Green creation”, “Green distribution”, “Green sourcing”, “Green usage”, “end of life”}in order to decide whether the current Green IT/IS practices implemented by user is sustainable, GA retrieves questions from each of the practice in d∈GP. If a search of (P1, P2, P3, P4, P5)

does not lead to any Green IT/IS assessment questions, the search can be executed again. This may occurs if there is limited codified knowledge on Green IT/IS practice from Green IT/IS domain experts.

4. Let us consider the Green IT/IS practice set (GPS) identified in step 2 based on d∈GP; the agents GA stores Green IT/IS items values in the Green IT/IS practice library "GreenIT/ISImplementationTable" that stores in its columns the Green IT/IS practice best practice and the corresponding valid answers of each Green IT/IS items values.

Step 3:

For the d∈GP, the agents GA runs the algorithm described below;

1. d∈GP= {Green creation, Green distribution, Green sourcing, Green usage, end of life}
2. For each value (P1, P2, P3, P4, P5) in the gpi Green IT/IS practice library
3. Store the values for the d∈GP items in the table "GreenIT/ISImplementationTable",
4. Using (di, gpi, Value_of_ d∈GP [n])
5. Where n is the id number of each best practice added by the Green IT/IS domain expert; n = 1, | d∈GP | (n equal 1 of every Green IT/IS practice added to the Green IT/IS practice library)

End

D3.2 Collector Agent Algorithm

Collects assessment data from feedback agent and retrieves best practice recommendations to IT practitioners as shown below;

Input: Green assessment evaluation data from feedback agent
Output: retrieves and maps Green IT/IS practice implementation recommendations to users
Function recommendation_report ( )

1. Begin
2. For every user [assessment user]
3. {
4. Collects users' assessment evaluation session;
5. Computes number of success and failed Green IT/IS implementation;
6. }
7. If the Green IT/IS assessment question is focus on objective computation [a, b, c, d, e] then
8. Retrieves and display recommendations from Green IT/IS practice library in objective format;
9. Else
10. If
11. Green IT/IS assessment question focus on subjective computation then;
12. Sort recommendation with the same subjective instance
13. Implement pair wise comparison;

14. Retrieves and display recommendations from Green IT/IS practice library in subjective format;
15. Return Green IT/IS recommendation;
16. End

D3.3 Profiler Agent Algorithm

This agent mainly executes three main functions which includes user login, Green assessment session and lastly Green IT/IS assessment questions randomization, thus each function algorithm is presented;

Users' Login Algorithm

This algorithm authenticates IT practitioner that intend to take the Green IT/IS practice assessment as a participant.

Input:
Uname, username of participant
Pword, password of participant
Output:
Authentication of participant
Selection of assessment category
Function participant_authentication ( )
Start
1. Get uname and pword of participant
2. Profiler agent sends inputted uname, pword to enterprise knowledgebase server for authentication

msg.setArg ("uname",uname);
msg.setArg ("pword",pword);

3. Profiler agent retrieves uname, pword from enterprise knowledgebase server
   Using the statement
   String query = Select * from users where uname = "username" and pword="password";
4. if
   (uname, pword received from participant == uname, pword in enterprise knowledgebase server);
   Then

Participant is valid user;
Else
Participant is not a valid user and profiler agent display error message "login is failed";

5. If
   (login access is granted and Green IT/IS practice category selected = Green IT/IS practice category from options provided);

Start Green IT/IS practice assessment session ()
Go to Green IT/IS practice assessment ()
Else
Select assessment category from Green IT/IS assessment option provided;
Return to participants profile ()
End

Green IT/IS Assessment Session Algorithm

This algorithm presents how the assessment session is deployed and executed by the profiler agent.

Input:
Assessment category, assessment category chosen by participant
Assessment questions, Green IT/IS assessment questions for assessment category selected
Answers alternatives, assessment alternatives to be selected as preferred answer
Session timer, to keep track of time elapsed during each assessment session
Assessment_question_count, counter to compute Green IT/IS assessment questions
Participant, IT practitioner or IT manager taking the assessment
d∈GP= {Green creation, Green distribution, Green sourcing, Green usage, end of life}
Output:
Assessment alternatives_selected as answer by participant
Begin
Function assessment_session ( )
1. If (participant choses to start the Green IT/IS practice assessment)
Then
Invokes the profiler agents and create a connection with the Green IT/IS practice library
2. If (Green IT/IS practice library connectivity is successful)
Then
Profiler agent retrieves Green IT/IS practice questions randomly from Green IT/IS practice library based on the assessment category selected by participant
Using the command below
String query = Select * from assessment_questions where cat_id= "sel_category";
&& -int rnd = rand.next_int{no_of_records in Green IT/IS ImplementationTable);
rand_ d∈GP.add_Items{""+rnd);
Else
No retrieval of Green IT/IS assessment questions and answers
3. If (all required random Green IT/IS assessment questions are retrieved)
Then
Set session_timer = zero
Set Green_assessment_question_count = one
Else
Retrieve remaining Green IT/IS assessment questions
4. Initiate
Start incrementing session_timer (session_timer = session_timer + 1)
Profiler agent retrieves and displays Green IT/IS assessment questions and answers available to participant systematically

While (Green IT/IS_assessment_question_count <= total Green IT/IS _assessment_questions or timer <= pre-defined allocated time)
5. Stop user from providing answers to Green IT/IS assessment questions
6. Call evaluator agent to initiate calculate_session_result ( )
Return ()
End

Green IT/IS Assessment Questions Randomization Algorithm

This algorithm helps the profiler agent to selects random questions for the participant taking the Green IT/IS practice assessment. This algorithm works with the Green IT/IS practice assessment algorithm.

d∈GP= {Green creation, Green distribution, Green sourcing, Green usage, end of life}
i= {Items} = Each Green IT/IS practice items
Function Random_ Green IT/IS_assessment_Questioning ()
Start
1. For
Green assessment question "q" = 1 to max_no_of_ q;
q = false;
2. While (q==false);
3. q = true
If
max_no_of_ d∈GP [q] = rand ( ) %no_of_i;
4. For
q=1 to max_no_of_ d∈GP;
5. rand_no[q] == rand_no[i]
6. Return rand_ d∈GP () && rand_[i]
End

D3.4 Evaluator Agent Algorithm

This algorithm is responsible to evaluate, score and rate IT practitioner based on the Green IT/IS practice assessment session that has been taken.

Input:
Assessment_question_count, counter to count Green IT/IS assessment questions
Answers, alternative answers selected by participants
Correct answer, correct pre-defined answer of a particular Green IT/IS assessment question
Green_score, marks allocated to a participant for valid answers provided during the Green IT/IS practice assessment session
Output:
Displays uname of participant
Total number of Green IT/IS assessment questions attempted
Final assessment score of the participant
Function calculated_assessment_result ( )

Start

1. While (session_timer <= pre-defined allocated time);

Set answered_value = false;
Set Green_score = zero;

2. For
   (Green IT/IS assessment question "q" = 1,
   q <= GreenIT/IS_assessment_question_count, next Green IT/IS assessment question);
3. If
   (Answer selected = valid answer);

Then
Set answered_value = true;
Else
No change in answered_value status;

4. If (answered_value is set to true);

Then
Increment Green_score by 1 (Green_score = Green_score + 1);
Else
No change in Green_score;
Call and sends evaluation data to Feedback agent;
Return Green_score ()
End

The evaluator agents communicates with the profiler agents who performs procedures which includes selecting assessment category, retrieving assessment questions for selected assessment category with its alternatives/answer and valid pre-defined answer. Besides, the retrieval of possible answers is task of regaining answers that are relevant to Green IT/IS domain experts' questions. This evaluator agent used probabilistic pairwise comparison to map the inputted answer of the participant with the correct answer in the Green IT/IS practice library is gives as "P (R = true | A, GQ) " Where "P' is the probabilistic pairwise comparison, "R" is the Boolean random value (True for correct answer entered or false for incorrect answer answered), "A" is the answer entered and "GQ" is the assessment question presented by the profiler agent.

The probabilistic pairwise comparison can be expressed as "P (r | A, GQ) = P (A, GQ | r) P (r) | P (A, GQ)" Where "r" is the answered alternative "R" = true. The equation is used to by the evaluator agent to determine if the entered answer is valid for a given Green IT/IS assessment question as seen in the evaluator agent algorithm. Once the evaluator agent completes the evaluation by calculating the marks score obtained by the participant for correct answers selected is sent to the feedback agent.

D3.5 Feedback Agent Algorithm

This algorithm is deployed by the feedback agent who is responsible for retrieving assessment results from the Green IT/IS practice library and displays the assessment result to the participant as shown by the algorithm below;

Begin
Function final_assessment_result ( )

1. Select Participant.PID, Participant.Name,
2. Participant.Evaluation, Participant.Score, Evaluation.EID,
3. Evidence.Detail
4. From
   Participant INNER JOIN Evaluation ON Participant.PID = Evaluation.PID;
5. Display Participant.Evaluation
6. Return ()

End

The feedback agent retrieves and displays the session result using deployed Structured Query Language (SQL) statement which is embedded inside the feedback agent. The feedback agent simply collects the participants ID and evaluation session ID and gathers information using embedded SQL statements and finally produces the Green IT/IS practice assessment session results in form of report to the participants.

D3.6 Mining Agent Algorithm

This algorithm is responsible to collect Green IT/IS practice implementation codified data from Green IT/IS domain expert. The mining agent retrieves data added in the Green IT/IS practice library collected by the design agent, production agent, procurement agent, operations agent and disposal agent from the Green IT/IS domain expert. The mining agent then saves all mined data in the Green IT/IS practice library as shown by the algorithm presented below;

d∈GP= {Green creation, Green distribution, Green sourcing, Green usage, end of life,}
GA = {design agent, production agent, procurement agent, operations agent, disposal agent}
i= {Items} = Each Green IT/IS practice items
Begin
Function GreenIT/IS_practice_mining ( )

1. Initiates mining agents and communicates with GA;
2. Collects Green IT/IS practice based on GA and i;
3. Start with each GA to dispatch and collect all the Green IT/IS practice items from the Green IT/IS domain expert host machine;
4. Validate Green IT/IS practice content;
5. After validation mining agent proceeds with execution;

6. If (execution is paused) {
   Mining agent displays error message;
   If (errors have been resolved)
7. Saves to GreenIT/ISImplementationTable;
   Else Re-directs to Step 4

Return ("display success message to Green IT/IS domain expert")
End

Next Figure D3 shows the case based reasoning system architecture that provides best practice to IT practitioners in CE.

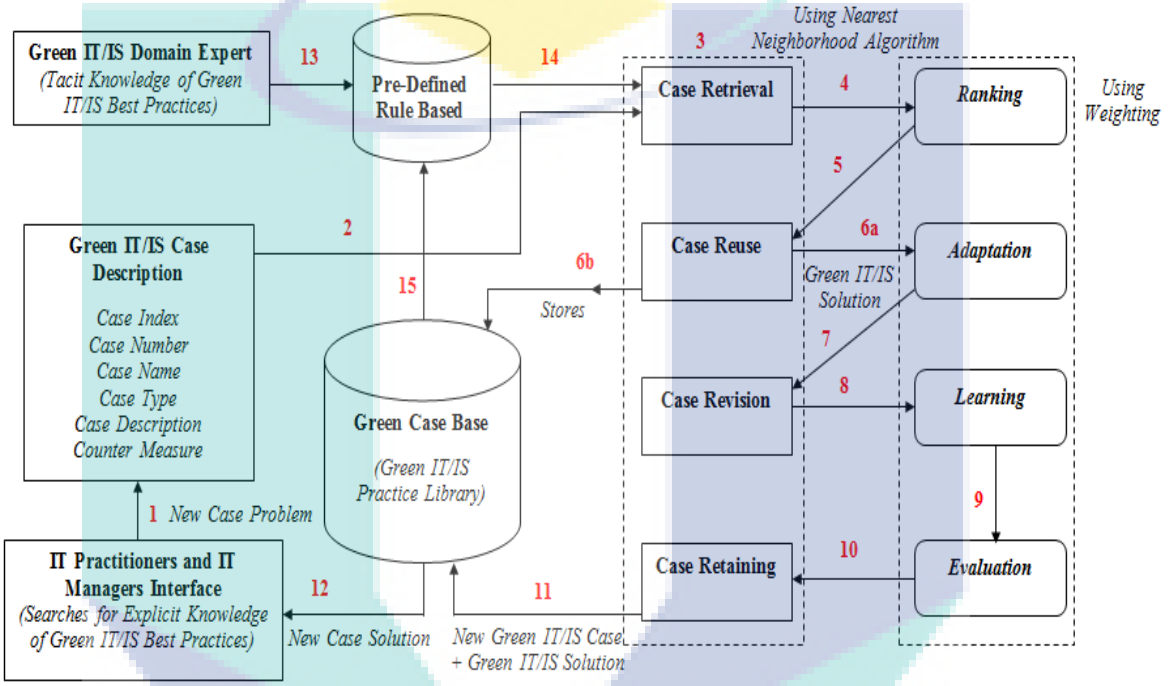

Figure D3 Case based reasoning system architecture

The numbers in Figure D3 are described below;

1-Case requester describes a Green IT/IS resource specification (Green IT/IS problem) via user interface.

2-Generates Green IT/IS case request message query via SQL.

3-Executes search similarity using Nearest Neighbourhood (NN) algorithm.

4-Rate the retrieved Green IT/IS case results based on specified case weighting rules.

5-Implements similar Green IT/IS case in relation to the retrieved case description.

6ab-If retrieved case solution is not similar to current case problem add new case description.

7-Update or modify available Green IT/IS case description if needed.

8-System learns of new Green IT/IS case corrections and applies new rules.

9-System proceeds to save the new Green IT/IS case or modified Green IT/IS case in the Green case base.

10-System evaluates and verifies if the new Green IT/IS case description is to be saved to modify existing Green IT/IS case or retain previous case.

11-System proceeds to save new Green IT/IS case and Green solution in the Green case base via SQL.

12-Case requester view similar Green IT/IS solution based on requested Green is problem. Thus expert knowledge (explicit knowledge) has been codified to explicit knowledge for IT practitioners and IT managers towards implementing Green IT/IS practice in CE operations. The retrieved explicit knowledge comprises of how IT practitioners and IT managers can implement Green IT/IS practices based on the case problem being requested for by either an IT practitioner or IT manager.

13-Green IT/IS domain experts adds pre-defined rule base to generate Green IT/IS case solutions, but if searched Green IT/IS case solution is not found in case base.

14-The rule base is used to aid the Green IT/IS case retrieval phase.

15-If similar Green IT/IS case cannot be found, system use case from the pre-defined rule base developed grounded on a function to generate case solutions via SQL.

Therefore, Figure D3 supports IT practitioners and IT managers in the retrieval and reuse of similar Green IT/IS successful case to solve new problems relating to sustainability attainment in CE. Accordingly, each of the components in the developed CBR system architecture is discussed below;

D3.7 Description of CBR Architecture

A. IT Practitioner Interface (Green IT/IS Case Requester)

Currently, CE deploys manual based assessment (Hankel et al., 2016) by utilizing questionnaire checklist assessment tools. Such methods usually are not fully automated and also do not provide features such as assessment report. Hence, to execute proper case retrieval, it is mandatory for new cases to be effectively described.

$$C(C = \{cncp = 1,2,3, \ldots., total_c\}) \quad (1)$$

The past Green IT/IS practice knowledge are stored in the Green case base as shown in equ. 1. Where *cn* is the *n-th* prior Green case, *cp* is the case parameters and *totalc* is the total sum of past Green cases. Each Green case consists of five parameters

which include case number, case index, case category, problem description and recommended solution (see Table D1).

B. Green IT/IS Case Description

In the developed CBR system architecture CBR checks if an old case is applicable to a new problem by comparing the similarities between parameters of the problem and data in the Green case base. If the new problem is applicably similar to a previous solution description, the case(s) is selected. The case solution part provides suggestion or practical steps that can be implemented by IT practitioners. Further, a case number is assigned to every case. The case number is always a numerical value assigned to all cases and can range from 1 to *nth* value. After which is the case index which specifies the essential content of a case. The case is retrieved from the Green case based by IT practitioners based on searched keyword(s).

Table D1 Case structure and content

Parameter No	Case Parameter	Parameter Value
1	Case number	Integer, from 1 to n.
2	Case index	Vector, {keyword1, keyword n}.
3	Case category	Binary value, private or public.
4	Problem description	Text, including problem domain and problem definition.
5	Recommended solution	Text, including possible solution and recommendation steps.

$$Ci = \sum_{1=1}^{i} j\ Pij = (Pi1, Pi2, Pi3, \ldots\ldots\ldots Pin) \ldots \quad (2)$$

In relation to Green IT/IS case description in equ. 2, *C* represents a case and each parameter *Pij* represents each case index parameter.

C. Case Retrieval

CBR usually depends on this step, as such once IT practitioners search for a case the CBR procedure recovers similar Green cases from the case base. The phase aims to discover the best analogous case by comparing similarity between the new searched case and existing case. Comparison metrics such as Euclidean distance, city block distance, geometric similarity metrics, probabilistic similarity measure, Mahalanobis distance or NN algorithm are used by CBR to execute case comparison. However, this thesis applies NN algorithm for measuring the similarity of the problem case and solution cases as shown in equ. 3

$$\mathrm{sim}(\mathrm{NC}, \mathrm{RC}) = \sum_{1=1}^{n} \mathrm{w_i} * \mathrm{sim}(\mathrm{NC_i}, \mathrm{RC_i}) / \sum_{1=1}^{n} \mathrm{w_i} \ldots \quad (3)$$

$$\mathrm{sim}(\mathrm{NC_i}, \mathrm{RC_i}) = 1 \frac{|\,\mathrm{NC_i} - \mathrm{RC_i}|}{|\mathrm{NC_i}| + |\mathrm{RC_i}|} \ldots \quad (4)$$

Where, *NC* is new Green case, *RC* is retrieved Green case, *NCi* and *RCi* are the parameter *i* of the new Green case *NC* and *RC* correspondingly, *wi* is the weight of case parameter *i*, and *sim (NCi, RCi)* is the similarity value of case parameter *i*. In addition the value of *sim (NCi, RCi)* is computed as shown in equ. 4.

D. Ranking

The similarity check detects how similar is a case parameters searched to existing case in the Green case base. Accordingly, there are three procedures utilizes for this step and they include inductive, nearest neighbour and knowledge guided. Knowledge guided is not usually used because it involves a lot of data to be available to be effective. Inductive method uses a large number of cases to create an induction trees, but often criticize for not deploying efficient case retrieval. Moreover, NN algorithm is usually used to identify similarity between two or more cases when the retrieval parameters are not well defined or when the cases available are few.

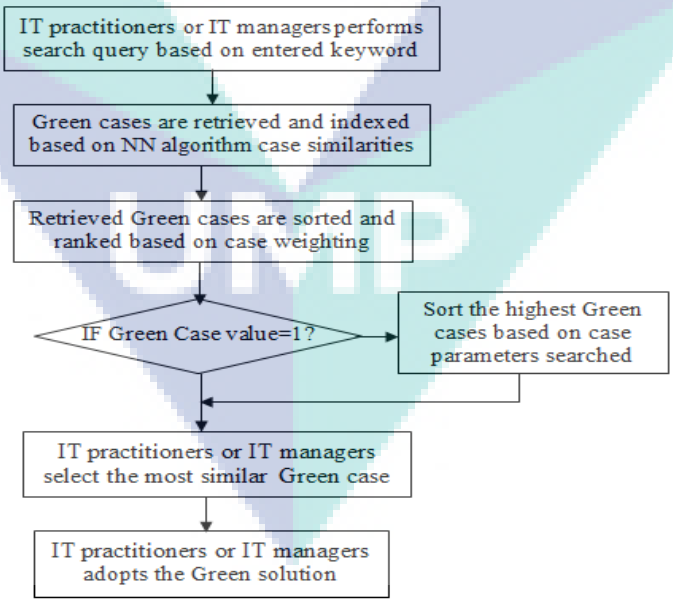

Figure D4 Chart of case retrieval (similarity check and case ranking)

Therefore, this thesis integrates NN algorithm for deploying case similarity check based on the keyword searched by the user, after which the cases are ranked and displayed as presented in Figure D4 which shows the flow chart that highlights the

method executed in deploying similarity check and case ranking. IT practitioner or IT manager searches for case solution on Green IT/IS based on case parameter weight value. The similarity check and ranking of the case is based on the weight value assigned to each case parameter as shown in equ. 5.

$$D_{ps} = \sum_{1=k}^{n} W_k |\, X_{pk} - CB_{sk}| \quad (5)$$

Where *Dps* means distance between the problem *pth* that is searched by the IT practitioners or IT managers' and *sth* solution cases with reference to the case parameters. W represents the weight assigned to the case parameters. *X* is the selected case chosen by the IT practitioners or IT manager, while *CB* is the Green case base.

E. Case Reuse

This phase involves IT practitioners selecting the most suitable solutions from the retrieved ranked Green cases. Once the most similar case is chosen by the IT practitioners, it will be directly reused as a suggested solution. The similarity between a new problem and an existing Green case retrieved to be reused by IT practitioners is calculated as follows:

$$sim(SQ, CB) = \sum_{1=1}^{n} w_i * sim(P_i, S_i) \quad (6)$$

Where, *SQ* is the search query executed by IT practitioners, *CB* is the case base and *w* indicates the weight assigned to case parameters respectively. *Pi* is the problem case and *Si* is the solution selected by the user.

F. Adaptation

In the CBR cycle the retrieved case may not be directly applicable mostly due to change of technology or requirements. In this condition, the selected solution presented is not usually applied by the user and are adapted before they can be applied to solve the current problem. This phase usually uses algorithms such as, weighted average, majority voting, arithmetic average, etc. Still, it is challenging to execute the case adaptation process as such most CBR based systems excludes this stage. In addition, case adaptation involves changing and adjusting old case parameter values to help IT practitioners implement the retrieved case recommendation. Consequently, the knowledge of the user needs to be elicited in the phase. Hence, the knowledge of the

user is needed in understanding how to apply the selected case to suits his/her own preference, CBR deploys equ. 7 to allocate the adapted case an initial value *AC(a)*:

$$\mathrm{AC(a)} = \mathrm{n}\sum_{1=1}^{\mathrm{n}} \mathrm{W_{ac}} = 1\ [\mathrm{sim(a, ac)} * \mathrm{AC(ac)}]/\mathrm{n} \qquad (7)$$

Where, *AC(ac)* is the value of the adapted case *ac*, *n* is the number of selected cases adapted and *sim(a, ac)* is the solution similarity between the initial case *c* and adapted case *ac*.

G. Case Revision

This phase encompasses modifying existing case solution based on the adapted case by verifying the adapted solution for the new problem. In addition in this phase CBR learns about revised Green cases executed by IT practitioner. Moreover, case revision usually entails replacing previous solution for a particular problem with adapted solution. Similarly, after the new case solution has be verified based on real world applicability and correctness, the validated solution is saved as a new learnt case and stored into the Green case base for future reuse. This phase is a distinctive feature of CBR technique which differentiates it from other intelligent learning techniques. The revision of a retrieved case is updated by the feedback provided by the IT practitioner. Hence, equ. 8 describe how a selected solution *si* is revised based on the survival value *PV(si)* of the Green case.

$$\mathrm{PV(new)(si)} = \mathrm{PV(new)(si)} + \Delta\mathrm{PV(si)} \qquad (8)$$

Where

$$\Delta\mathrm{PV(si)} = (\mathrm{Sat(si)} - 0.45) * \mathrm{L} \qquad (9)$$

As seen in equ. 9 *Sat(si)* represents the value of approval degree of solution selected by IT practitioner or IT manager *si*, and ‘‘*L*’’ represents the CBR learning rate, set to 0.1 for gradually modifying *Sat(si)*.

H. Learning

CBR learning is an experience activity designed for case evaluation and retaining procedures, thus if a suggested Green case is applied to solve a problem and is later specified by the IT practitioners that the recovered case is effective, CBR learns

about this. Accordingly, the recommended case chosen by most users will have higher significance when other users search for similar problems in future. Certainly, if a case was chosen to address a target problem by IT practitioners, the ranking score of the particular case would result to "+1". The higher score denotes the greater priority in case ranking. Consequently, this procedure can constantly enhance case based learning and ranking result, hence based on equ. 8 CBR identifies the survival (importance) value of a selected case solution as *ΔPV (si)* presented in equ. 9 is redefined as equ. 10.

$$\Delta PV(si) = (Sat(1) - 0.45) * sim\,(c, a) * 1 \qquad (10)$$

Likewise, Table D2 shows that 0.45 is the moderate satisfaction value for any solution case selected by the IT practitioners. Thus, CBR learning is derived based on the representation values in Table D2.

Table D2 Satisfaction degrees and their representation (Chang et al., 2016)

Satisfaction Degree	Representative Value
Highly satisfied	0.80
Satisfied	0.65
Moderate	0.45
Unsatisfied	0.25
Highly unsatisfied	0.10

I. Evaluation

In this phase CBR retrieved and displays ranked list of most similar cases to IT practitioners and also estimates if the case solutions suggested are able to resolve the existing problems, if the retrieved answers are able to address the present issues, the retrieved cases are perceived as effective cases, if not the user can search for more suitable Green case solutions after the revision phase. To evaluate which case is to be saved in the Green case base (previous solution case or case adapted by user) CBR take into account the similarity of the previous solution case against the case adapted by IT practitioner. As shown in equ. 11.

$$sim\,(si, ac) = |Ssi \cup Sac|/|Ssi \cap Sac| \qquad (11)$$

Where *ac* is the case adapted by IT practitioners or IT manager, *si* is the selected case solution, *Sac* is the solution part of the adapted case *ac* and *Ssi* is the solution part

of the select case solution *si* and *sim(si,ac)* measures the extent to which the selected case contributes to solving the new problem in relation to the adapted solution.

J. Case Retaining

This phase involves storing resulting new cases for future reference in the Green case base as best Green IT/IS practice, after the solution has been effectively deployed to address present problem. The case to be retained in the Green case based is saved based on inputted satisfaction value added by IT practitioners. Thus, as stated previously Table D2 shows the satisfaction degrees of users which are based on the feedback provided by IT practitioners. Although, since the selected case solution si was adapted as *AC(a*) in equ. 7. CBR does not retain the previous retrieved case shown in equ. 3, instead equ. 12 is used for case retaining. Where *sinew* is the assign a survival value to the adapted case solution and *PVave* is the averaged survival value of the case in case base.

$$\mathrm{PV}(\mathrm{si}_{\mathrm{new}}) = \mathrm{PV}_{\mathrm{ave}} * \mathrm{S}_{\mathrm{at}}(\mathrm{si}_{\mathrm{new}}) \quad (12)$$

Where

$$\mathrm{PV}_{\mathrm{ave}} = \mathrm{n} \sum_{1=1}^{\mathrm{n}} \mathrm{PV}(\mathrm{si})/\mathrm{n} \quad (13)$$

K. Green IT/IS Domain Experts

These are the users in the enterprise that are experienced (possess tacit knowledge) in Green IT/IS practice implementation. They input their experience into the Green case base and predefined rule base that can provide data on Green IT/IS practices to other less experienced staffs in CE. Moreover, Green IT/IS domain experts possess knowledge that cannot be transferred to other novice users in CE, thus they codify their tacit knowledge in the Green case base for IT practitioners or IT manager who may implement the stored Green IT/IS best practices as explicit knowledge when they utilized GAT. This is seen in Eq. (1) where IT practitioners search for solution case to solved new problems.

L. Green Case Base

This comprises all the Green cases that have been successfully implemented previously. The case base can be referred to as best Green IT/IS practice. The Green case base also contains Green assessment questions and answers used to assess IT practitioners' current Green practice as seen in Figure D2. Thus a Green case base CB containing n number of cases may be expressed as given in equ. 14.

$$CB = \sum_1^n Cn = (C1, C2, C3, \ldots \ldots Cn) \quad (14)$$

M. Pre-Define Rule Base

This phase provides Green IT/IS practice suggestion to IT practitioners if the Green case base does not have a direct solution for new problems. Thus, Green solutions can be generated to IT practitioners based on existing pre-defined rules added in the rule base by system administrator or rule experts as shown in equ. 15.

$$Si = \sum_1^n kW_{ik} * W_k / \sqrt{\sum_1^n k(W_{ik})2 \ \sum_1^n k(W_k)2} \quad (15)$$

Where *Wk* is the weight of the *nth* term in the pre-defined rule case base, however this equation is executed only if the retrieved Green cases from the case base are not able to solve the target problem searched by the IT practitioners in implementing Green IT/IS practice.

D4 UML Requirement Analysis and Design

The requirement analysis phase shows the main users and main functionalities in the Green IT/IS assessment tool. This phase encompasses the Unified Modeling Language (UML) diagrams (use case diagram, class diagram and sequence diagrams). Accordingly, use case diagram illustrates the functions that a system provides to its users and the interaction between the users and the system.

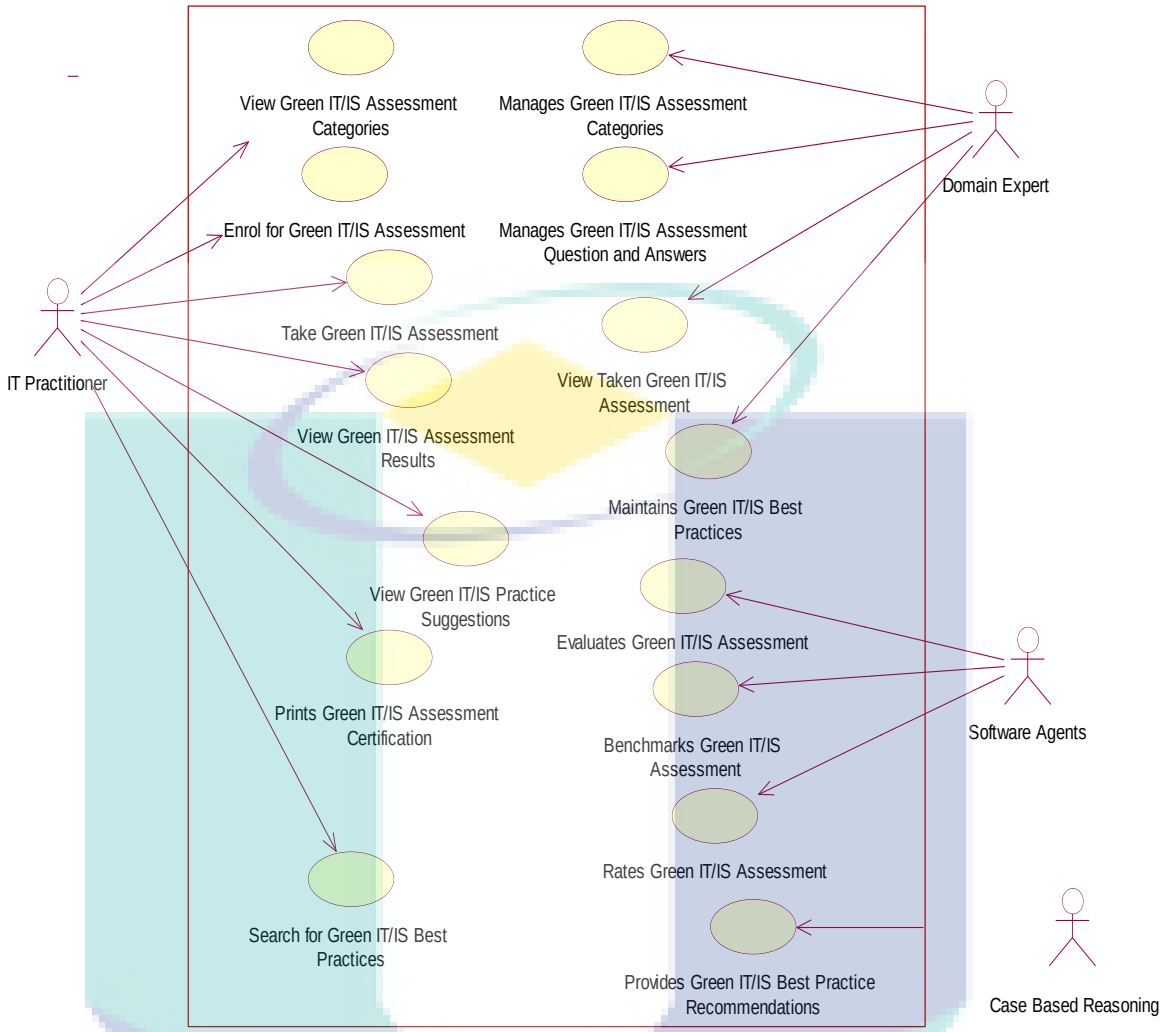

Figure D5 Use case diagram for Green IT/IS Assessment Tool

The GAT was deployed using software agents and CBR to carry out Green IT/IS practice assessment and best practice recommendation. Figure D5 shows the use case diagram for GAT, displaying the functionalities provided by GAT.

Next the UML class diagram is designed, where the class diagram is a crucial diagram in the set of modelling diagrams; it shows the relationship between classes, thereby displaying the structure of the whole environment. Class diagram is divided mainly into three sections (layers); the topmost being the class name, followed by the class attributes and lastly, the class methods.

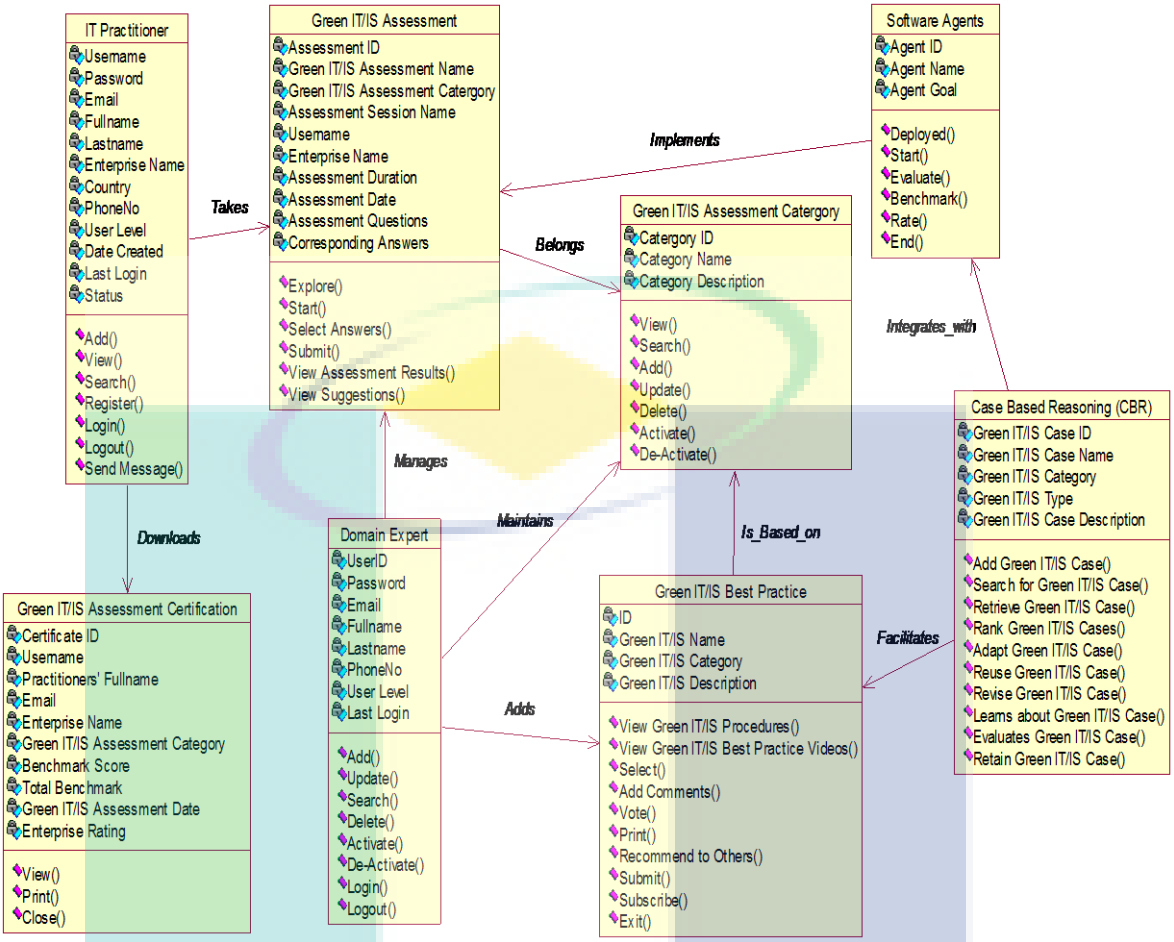

Figure D6 Class diagram for Green IT/IS Assessment Tool

Figure D6 shows the class diagram of the Green IT/IS assessment tool showing how the tool is deployed to evaluate benchmark and rate the current Green IT/IS practice implemented in CE. Next, is sequence diagram which model the flow of logic within a system in a visual manner, enabling one to both document and validate the development logic, and are commonly used for both analysis and design purposes. Thus, sequence diagrams focuses on identifying the behaviour within the system. Sequence diagrams display interactions between items as time elapses (the vertical lines in the sequence are called lifelines.

Figure D7 to Figure D10 are sequence diagrams illustrating how IT practitioners and domain experts interacts with Green IT/IS assessment tool.

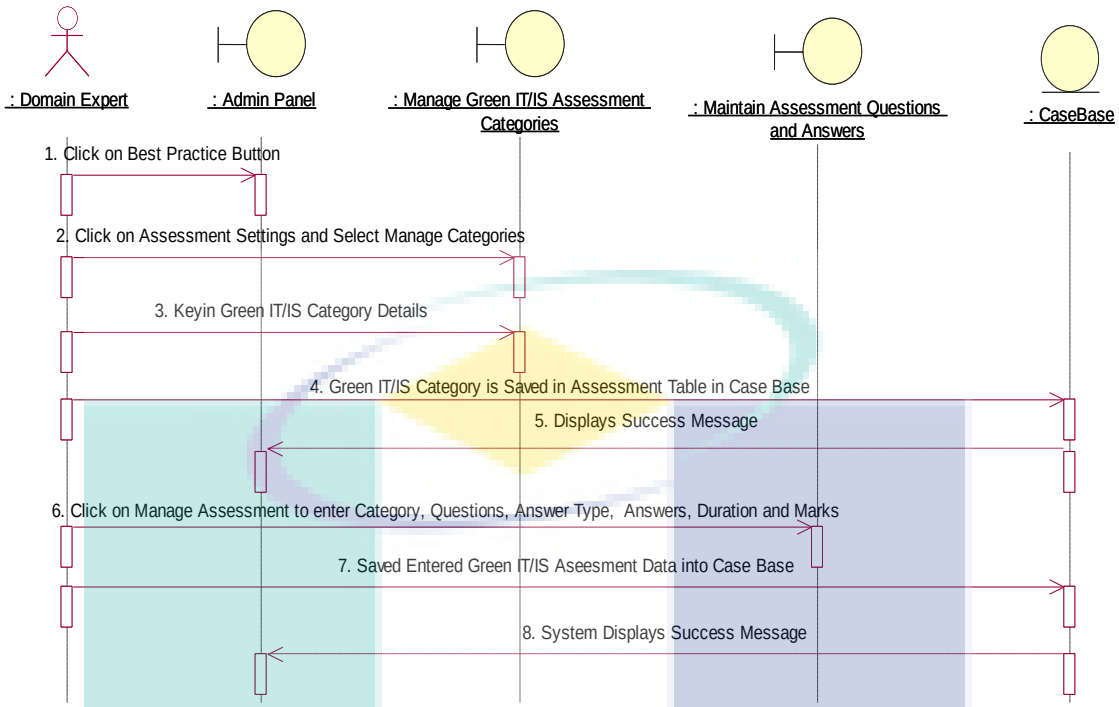

Figure D7 Sequence diagram of domain expert manage Green IT/IS assessment

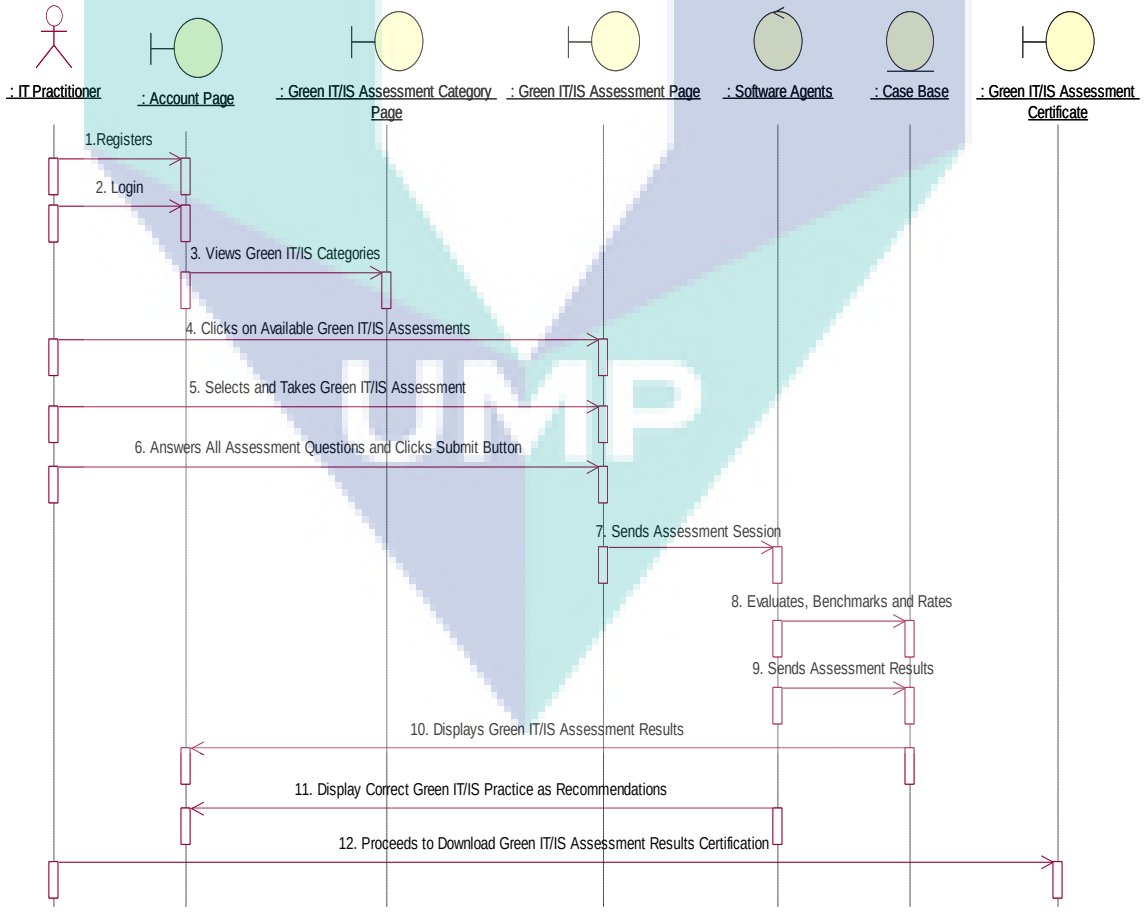

Figure D8 Sequence diagram of IT practitioner take Green IT/IS assessment

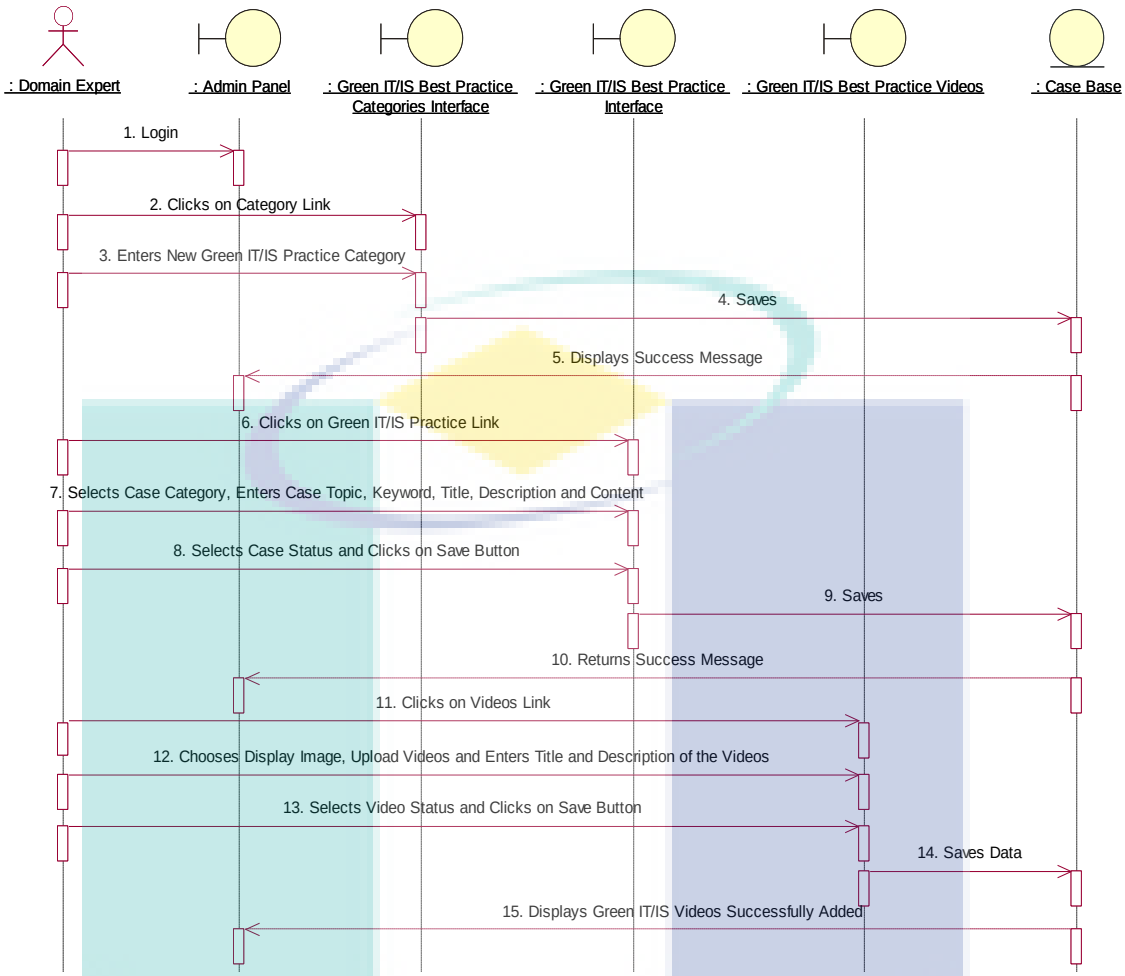

Figure D9 Sequence diagram of domain expert maintains Green IT/IS best practice

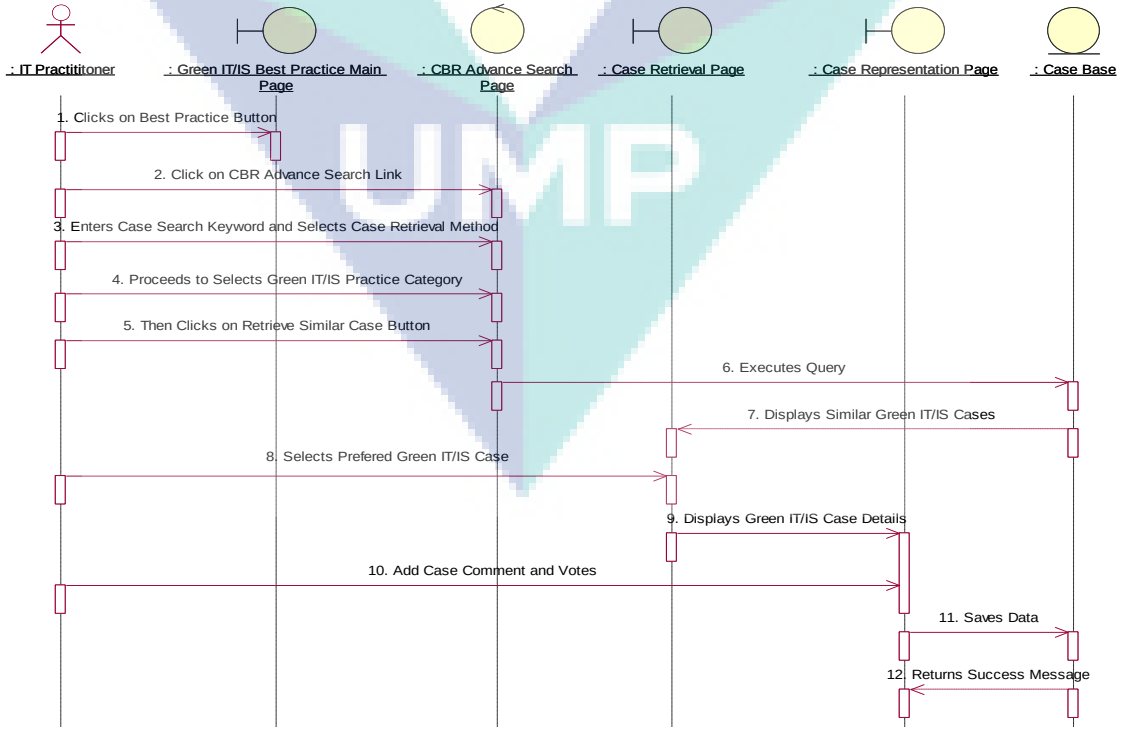

Figure D10 Sequence diagram of IT practitioner utilize Green IT/IS best practice

D4 Implemented Green IT/IS Assessment Tool Interface

The Green IT/IS assessment tool is implemented based on the application of software agent and CBR technique as a web based application in HTML, PHP and MySQL similar to prior studies (Yang, 2012; Zouhair et al., 2014) that utilized PHP to implement web based agent-CBR systems in their research. Likewise, this thesis is similar to Kwon et al. (2007); Gawali and Meshram (2009); Yang (2012); Chang et al. (2016); Chen and Ma (2015); Shen et al. (2015) where the authors implemented their agent and CBR systems based on an online platform.

Hence, a few interfaces of the implemented Green IT/IS assessment tool are shown in this section to illustrate how the software agents assess IT practitioners current Green IT/IS practice. In addition, this section shows how CBR provides best Green IT/IS practice recommendation.

Figure D11 Add new Green IT/IS practice assessment question interface

Figure D11 show the page utilized by the domain expert to add new assessment question, where the data are collected and saved by the mining agent into Green case base as shown in Figure D2.

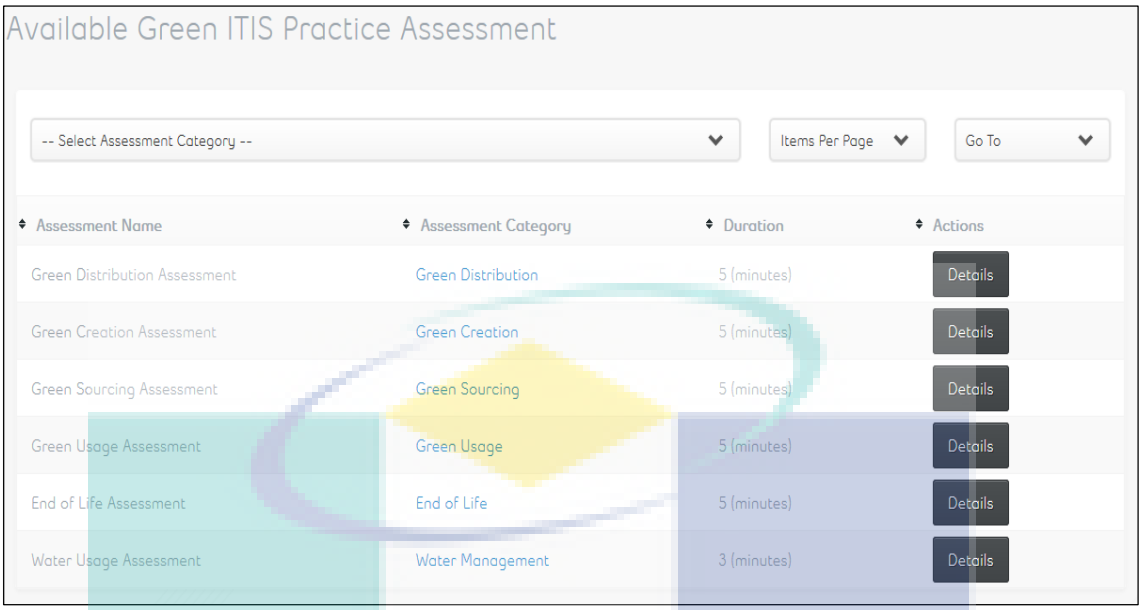

Figure D12 Available Green IT/IS practice assessment interface

Figure D12 shows the available Green IT/IS practice assessment as controlled by the profiler agent.

Figure D13 Green IT/IS practice assessment session for Green sourcing

Furthermore, information pertaining to Green IT/IS practice, total assessment question and estimated time is shown to IT practitioners or IT manager taking the assessment are displayed to the user taking the assessment by the profiler agent as shown in Figure D13. In addition, Figure D13 shows an assessment session for Green sourcing practice to ascertain if the Green sourcing practice in the enterprise is sustainable or not as controlled by the evaluator agent.

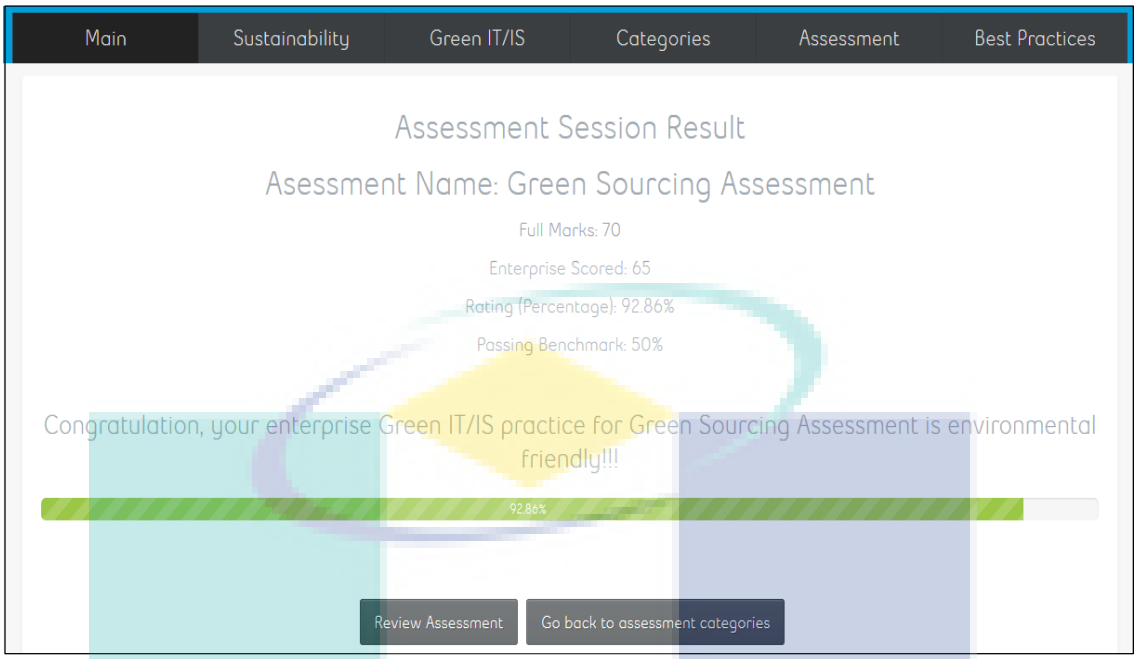

Figure D14 Available Green IT/IS practice assessment interface

Figure D14 shows the Green IT/IS practice assessment benchmark and rating result achieved by the user assessing his/her enterprise Green sourcing practice as controlled by the feedback agent and collector agent.

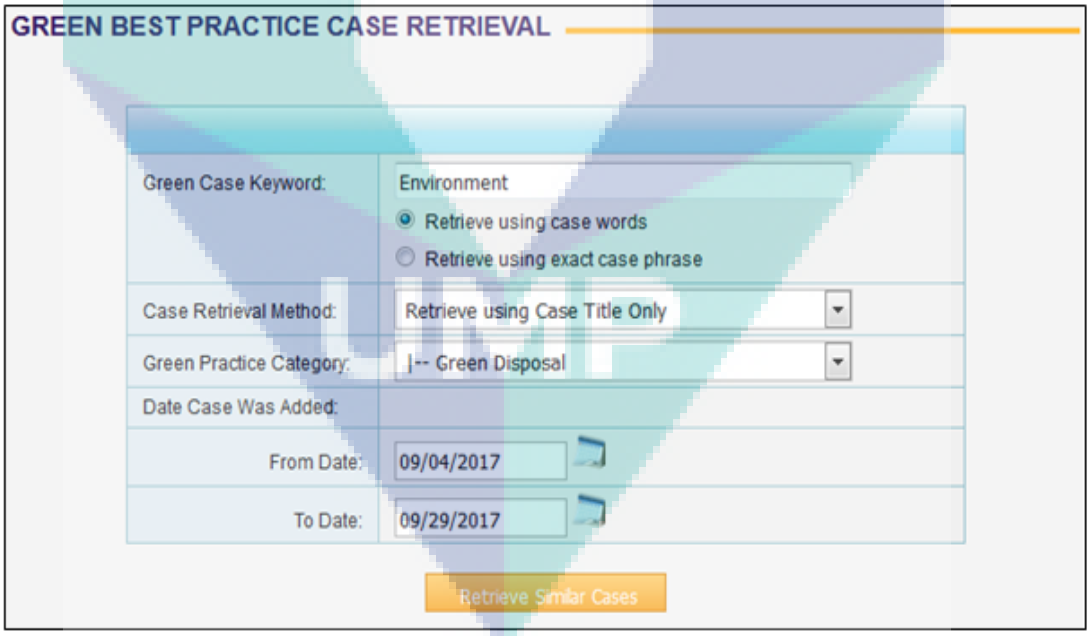

Figure D15 CBR best practice case retrieval search interface

Figure D15 shows the Green IT/IS assessment tool case retrieval search interface utilized by IT practitioners to search and retrieve Green IT/IS best practices on how they can attain sustainability in their enterprise.

Figure D16 Retrieved similar Green IT/IS practice cases

Figure D16 shows the case retrieved from the Green case base as search by either the IT practitioner search keyword "Environment". The retrieved cases are ranked as seen in Figure D16 based on the case that possesses the most similar cases (ranking and weighting) as previously explained using NN algorithm (see Figure D3). Next the case requested (IT practitioner) proceeds to click and select the most similar case from the list of retrieved cases.

Figure D17 Selected Green practice case recommendation

Lastly, Figure D17 shows the selected case details as previously added by the domain experts. The displayed case details can be mailed to other staffs in the enterprise or printed to be implemented by IT practitioners for sustainability attainment in their enterprise.

LIST OF PUBLICATIONS

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). A Collaborative Agent Based Green IS Practice Assessment Tool for Environmental Sustainability Attainment in Enterprise Data Centers. *Journal of Enterprise Information Management, Emerald Publishers,* Vol 31, No 5, 771-795, **Index by ISI Q1, Impact Factor 2.482, Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R (2018). Green IS Diffusion in Organizations: A Model and Empirical Results from Malaysia. *Environment, Development and Sustainability*, 1-42, *Springers Publisher*, **Index by ISI (Q3), Impact Factor 1.379, Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). A Proposed Model for Green Practice Adoption and Implementation in Information Technology Based Organizations. *Problemy Ekorozwoju/ Problems of Sustainable Development*, Vol. 13, No.1, 95-112. **Index by ISI (Q4), Impact Factor 1.058, Scopus. (Published).**

Bokolo, A. J. (2018) A Review on Case Based Reasoning For Green IS Infusion and Assimilation among IT Professionals in University Campuses. *SCIENTIA IRANICA: International Journal of Science and Technology*, **Index by ISI (Q4)**, **Impact Factor 0.475, Scopus. (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). Hybrid Multi-Agents and Case Based Reasoning for Aiding Green Practice in Institutions of Higher Learning, *Tehnicki vjesnik – Technical Gazette*, Vol. 25, No. 6, 1641-1649. **Index by ISI (Q4) Impact Factor 0.686**, **Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). Heterogeneous Agent Enabled Decision System for Evaluating Green IT Performance in Industrial Environments. *Journal of Decision Systems, Taylor and Francis Publisher*, Vol 27, No 1, 37-62, **Index by ISI Web of Science, Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). Green Information Technology Adoption towards a Sustainability Policy Agenda for Government Based Institutions: An Administrative Perspective. *Journal of Science and Technology Policy Management*, *Emerald Publishers*, 1-28. **Index by ISI Web of Science, Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). A Descriptive Study towards Green Computing Practice Application for Data Centres in IT Based Industries, *MATEC Web of Conferences*, Vol. 150, 1-8. **Index by ISI Web of Science, Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). An Empirical Study on Predictors of Green Sustainable Software Practices In Malaysian Electronics Industries. 1-29, *Journal of Information and Communication Technology (JICT)*, Vol. 17, No.2, 347–391. **Index by ISI Web of Science, Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). Green Information Technology Practice Implementation for Sustainability Elicitation in Government Based

Organizations: An Exploratory Case Study. *International Journal of Sustainable Society, Inderscience Publisher*, Vol 10, No 1, 20-41 **Index by Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). Exploring Green Information Technology Implementation in Collaborative Enterprise, *Advance Science Letters*, Vol 24. No.10, 7707-7715. Index by Scopus. (**Published**).

Bokolo, A. J., & Mazlina A. M. (2017). An Agent Based Green Decision Making Model for Sustainable Information Technology Governance, *Advance Science Letters*, Vol. 23, No.1 11114–11118. **Index by Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2017). Sustainable Adoption and Implementation in Collaborative Enterprise: A Systematic Literature Review. *Journal of Theoretical and Applied Information Technology*, Vol 95, No 9, pp. 1875-1915. **Index by Scopus. (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2017). A Green Information Technology Governance Framework for Eco-Environmental Risk Mitigation, *Progress in Industrial Ecology, An International Journal, Inderscience Publisher*, Vol 11, No 1, 30-48. **Index by Scopus. (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2017). Green ITIS Practice for Sustainable Collaborative Enterprise: A Structural Literature Review. *International Journal of Sustainable Society, Inderscience Publisher*, Vol 9, No 3, *243-272.* **Index by Scopus. (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2017). An Agent Based Green Assessment System Architecture for Sustainable Practice Implementation among IT Practitioners in University Campuses. *The 8th International Conference on Information Technology (ICIT 2017), May 17th-18th 2017, Amman, Jordan, 17-25,* **Index by Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2017). A Model for Adopting Sustainable Practices in Software Based Organisations. *The 8th International Conference on Information Technology (ICIT 2017), May 17th-18th 2017, Amman, Jordan, 26-35,* **Index by Scopus (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2017). Application of Intelligent Agents and Case Based Reasoning Techniques for Green Software Development. *Technics Technology Education Management* , Vol 12, No1, 30-43. **Index by Google Scholar (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2016). A Case Based Reasoning Decision Support Model for Green ITIS Diffusion in Collaborative Enterprise. *The 2016 IEEE Conference on Open Systems*, Langkawi, Malaysia 10 -12 October 2016, 1-6. **Index by Scopus. (Published).**

Bokolo, A. J., & Mazlina A. M. (2016). Development of a Green ICT Model for Sustainable Enterprise Strategy. *Journal of Soft Computing and Decision Support Systems*, 3(3), 1-12. **Index by Google Scholar (Published).**

Bokolo, A. J., & Mazlina A. M. (2016). Green IS for Sustainable Decision Making in Software Management. *Journal of Soft Computing and Decision Support Systems*, 3(3), 20-34. **Index by Google Scholar (Published).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). A Designed Multi-Software Agents Based System Architecture for Green Software Management towards Sustainable Development in Software Based Industries. 1-24, *Journal of Information and Communication Technology (JICT)*, **Index by ISI Web of Science, Scopus (Accepted).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). Emerging Case Oriented Agents Reasoning for Sustaining Educational Institutions Going Green towards Environmental Responsibility, *Journal of Systems and Information Technology*, *Emerald Publishers*, 1-29. **Index by Scopus. (Third Round Review).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). Examining the Role of Green IT/IS Practice Innovation Initiatives in Collaborative Enterprise-Implications from a Developing Country, *Sustainability Accounting, Management and Policy Journal*, *Emerald Publishers*, **Index by ISI (Q1) Impact Factor 2.200**, **Scopus (Second Round Review).**

Bokolo, A. J., Mazlina A. M. & Awanis, R. (2018). A Reactive Case Based Reasoning Green IS Practice Recommender Tool for Environmental Sustainability Attainment in Enterprise Data Centers. *Knowledge and Process Management, Wiley Publishers*, 1-36, **Index by ISI Web of Science, Scopus (Under Review).**