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A Generic Study on Green IT/IS Practice Development in Collaborative Enterprise: Insights from a Developing Country

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Abstract

This study investigates the perception of Information Technology (IT) professionals and IT managers towards deployment of environmental-friendly practices in Collaborative Enterprise (CE). Through literature review this study develops a model based on Perceived Organizational e-Readiness Theory (POER) and Process-Virtualization-Theory (PVT) to investigate the factors that influence IT professionals' and IT managers intention to deploy Green IT/IS practices which are based on the current environmental-friendly initiatives deployed in CE. Data was collected using questionnaire and results indicate that the POER factors influence CE's perception towards Green IT/IS. Moreover, results also reveal that PVT initiatives are influenced by the current environmental-friendly initiatives.

Keywords: Technology management; Environmental sustainability; Green IT/IS practice; Perceived organizational e-readiness theory; Process virtualization theory.

1 Introduction

The increased deployment of Information Technology (IT) over the years in Collaborative Enterprise (CE) has contributed to additional energy utilization, CO_2 emission, waste generation, increased cost incurred, as well as the consumption of natural resources calls for the sustainability of IT termed as Green IT and Green Information Systems (IS) (Gholami et al., 2013). According to Anthony et al. (2020) IT deployment in CE has resulted to environmental impacts produced by physical activities implemented from the design, use and disposal of IT hardware. Hence, CEs are trying to decrease CO_2 emissions and adopt resource efficient initiatives for sustainability attainment (Chen et al., 2011). Simultaneously, CEs are striving to conform to new environmental protection laws such as those relating to sustainable procurement and cleaner production by encouraging environmental-friendly initiatives (Ardito et al., 2019a).

Due to the impact of IT deployment on the environment, Green IT/IS practice emerged as an initiative deployed in CE towards utilizing IT infrastructures to change enterprise operations to improve energy proficiency, lessen environmental effects, and reduce e-waste generation (Ardito et al., 2019b). It was maintained that Green IT/IS practice in CE possess the prospective to decrease 3% of the total global CO_2 emission by 2020 by encouraging non-wasteful initiatives as well as the efficient use of IT infrastructures. Accordingly, this study focuses on CEs in Malaysia, due to the fact that CEs in Malaysia are deploying environmental-friendly initiatives in an attempt to achieve sustainability towards reducing Greenhouse gases emission by 40 percent by 2030 (Anthony Jnr et al., 2018). Moreover, Malaysian CEs are committed to contribute towards the

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reduction of negative effects imposed on the natural environment caused by societal daily activities by implementing environmental management standards such as ISO 14001 (Jr al., 2017a). ISO 14001 supports Malaysia CEs in attaining environmental targets (Jr et al., 2017b).

According to Molla et al. (2014); Anthony et al. (2020) CEs claim that they deploy Green IT/IS practices by only implementing recycling operation. This is mainly due to the fact that recycling concept is synonymous with environmental-friendly practices. Hence, Gholami et al. (2013) mentioned that there is need to provide environmental-friendly initiatives to be implemented in CE based on an easy-to-use but comprehensive model that assess the current environmental-friendly initiatives implemented. Similarly, prior Green IT/IS models only raise awareness on the potential of Green IT/IS (Chen et al., 2011; Akman and Mishra, 2015). Likewise, existing models offer little practical guidelines on environmental-friendly initiatives to be deployed in enterprise current operations to improve sustainability attainment (Loeser et al., 2017). Furthermore, findings from Molla et al. (2011) indicated that IT firms in Australia are implementing environmental-friendly initiatives, but their capability to measure the current practice is relatively less developed.

Accordingly, CEs needs to make decision based on their current environmental-friendly initiatives to assess if their present practice considers the economic, environment, and societal issues (Fargnoli et al., 2014; Ngai et al., 2014; Ardito et al., 2016). Besides, there are variables that influence Green IT/IS practice in CE. Hence, there is a need for a model that can be utilized by CE to ensure that IT professionals and IT managers considers these variables when implementing Green IT/IS practices in their enterprise operations (Nedbal et al., 2011; Gholami et al., 2013). Thus, the objective of this study is to investigate the variables that influence IT professionals and IT managers' perception towards Green IT and Green IS (termed as Green IT/IS) and environmental-friendly initiatives to be deployed in CE. To achieve the objective of the study we explore the following research questions;

- What are the variables that influences IT professionals' and IT managers' perception towards deploying Green IT/IS practices?
- Which environmental-friendly initiatives are deployed to improve Green IT/IS practices in CE?

To answer the research questions, we derived the variables and environmental-friendly initiatives through an extensive literature review based on perceived organizational e-readiness (POER) theory and process-virtualization-theory (PVT). Both POER and PVT theories were employed because PVT offer a theoretical base for investigating process to be adopted that influences environmental-friendly initiatives in enterprises. Accordingly, PVT was employed in this study to explicate if the environmental-friendly initiatives are responsive or resilient to being deployed. Similarly, POER theory was adopted as an assessment model to examine variables that may influence changes of Green IT/IS practice in CEs. Additionally, POER theory was employed to provide a model to investigate CE's capability to transform towards a Greener enterprise. PVT and POER and has been employed by prior Green IT studies (Bose and Luo, 2011; Molla et al., 2011; Nedbal et al., 2011). Next, a model is proposed to specify the variables for CEs to consider in improving their environmental responsibility. Furthermore, the model is validated based on a questionnaire analyzed using Partial Least Square-Structural Equation Modeling (PLS-SEM). Results from this study suggest that the identified variables (IT human infrastructure, IT governance, technologies and systems, motivating forces, IT strategy, and information availability) significantly influences IT professionals' and IT managers' perception towards Green IT/IS deployment. Results also indicate that the environmental-friendly initiatives (Green creation, Green distribution, Green sourcing, Green usage and end of life) are significant and should be deployed in CE towards sustainability attainment.

The organization of this paper is as follows. The conceptual background and model development are presented in section 2. Research methodology is discussed in section 3. The results of the study are presented in section 4. Section 5 is the discussion. Implications and limitations of the study are presented in section 6. Conclusion is discussed in section 7.

1.1 Culture, Standards and Governmental Policy on Environmental Protection in Malaysia

In December 2009, a climatic change conference on was held in Denmark termed "United Nations Climate Change Conference 2009", in the program induction, the former Prime Minister of Malaysia obliged that Malaysia would play its part to decrease of up to 40 percent of CO_2 emissions before the year 2030 (MESTECC, 2020). Undeniably, this was a moral and motivated pledge made by the then Prime Minister of Malaysia to the international community and since then CEs in Malaysia supports the prime minister pledge to the international community by deploying Green IT/IS practice contributing to CO_2 reduction. Furthermore, the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) formerly known as Kettha was established by the Prime Minister of Malaysia to help provide a strategic role of achieving autonomy and mitigating environmental changes.

MESTECC vision is "Energy sustainability, wealth formation through science and technology and environmental sustainability". Since 2009 MESTECC has supported the country towards deploying Green technology as one of the emerging influencers of economic growth. MESTECC 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 (Junior et al., 2018). MESTECC acknowledges the need and prominence of implementing Green IT/IS practice. MESTECC believes that enterprise day-to-day operations may possess indirect or direct impact on the natural environment nationally or internationally (MESTECC, 2020).

MESTECC further aims to champion a Green future for the continued wellbeing of the planet. In implementing Green practices, MESTECC's objectives are directed towards decreasing harm to the natural environment caused by enterprise daily operations. Consequently, aspiring to promote Green value and norms among CEs in Malaysia, by planning to be a leader in disseminating Green practice strategies to Malaysian public/private sectors. MESTECC also provides funding to CEs willing to adopt and implement Green IT/IS practice that directly contributes to protect the natural environment (Anthony Jnr et al., 2018). Presently, CEs in Malaysia adopt ISO 14001 standard which is a practical tool widely used to achieve sustainability by guiding CEs in controlling the impact of their operations and activities on environment and acquiring external certifications for environmental-friendly initiatives.

2 Conceptual Background and Model Development

This section discusses on Green IT/IS practice, overview of CE, and the adopted theories.

2.1 Background of Green IT/IS Practice

Enterprises are progressively being concerned about sustainability issues because it is widely presumed that the future of the earth depends on our communal capability to reduce or, preferably, reverse social instigated environmental deprivation. Watson et al. (2010) argued that IS have contributed to improving organizational productivity since the last decades, and as such IS deployed systems can also support and provide solutions to environmental related issues. IT infrastructures used for enterprise operations consumes vast quantities of energy, thereby contributing to CO_2 emissions (Jenkin et al., 2011). Respectively, environmental issues caused by IT deployment in CEs, can be categorized as Green IT and Green IS (Gholami et al., 2013; Loeser et al., 2017). Green IT is the research and practice of modeling, producing, operating, and discarding of IT hardware effectively and efficiently with negligible or no effect on the natural environment (Zheng, 2014). Whereas Green IS refers to IS enabled enterprise initiatives that promotes economic, environmental and social performance (Anthony Jr et al., 2018).

Researchers such as Watson et al. (2010) maintained that Green IT has a limited scope of technical related issues whereas Green IS is more systemic and includes humans, procedures, and know-hows that address sustainability issues. Besides, Watson et al. (2010) stated that Green IT only encompasses the capability of IT deployed facilities to decrease CO_2 emissions. The main conjecture here is that, in as much as IT creates negative ecological effects due to energy consumption and disposal of outdated hardware (Anthony Jr, 2019). IS based programs can be utilized to lessen environmental issues by changing CEs current practices (Zheng, 2014; Anthony et al., 2018). Where IS can contribute in supporting IT professionals and IT managers in making decisions that facilitate environmental-friendly practices (Jr et al., 2017a). Moreover, researchers such as Loeser et al. (2017) suggested that CEs attempting to reduce their environmental footprint should adopt both Green IS and Green IT because Green IT initiatives are limited to only IT capabilities and do not include the potentials of IS to lessen environmental effects. Therefore, this study incorporates the concept of Green IT and Green IS as Green IT/IS to address sustainability related issues in Malaysia CEs similar to previous studies carried out by Jenkin et al. (2011); Chen et al. (2011); Zheng (2014) in other countries.

2.2 Overview of Collaboration Enterprise

Collaborative enterprise is derived from the word collaboration which is an activity that comprises of two or more stakeholders (Tolomett and Saunders, 1998), working collectively to achieving a shared goal towards the organizations vision (Halal, 2001; Kim, 2008). CE is any establishments that carries out activities where two or more people contribute distinct resources and know-how to facilitate the development of the establishment (Hale and White, 2014). According to Tencati and Zsolnai (2008) the goal of CEs is multidimensional hence different from other traditional enterprise and aims to provide end users and stakeholders with social, economic and environmental values which are mainly not considered by traditional enterprises. Currently, the increasing attention towards sustainability is forcing CEs to change their business models. But, despite these growing interest towards the integration of environmental issues into enterprise process, little attention has been devoted in the literature, specifically by means of quantitative research, on how inter- and intra-enterprise collaboration known as CE influence the deployment of Green IT/IS practice, and on their successful variables (Messeni Petruzzelli et al., 2011).

Thus, it would be relevant to understand technological and organizational variables of Green IT/IS practice, as well as the environmental-friendly initiatives to be adopted (Messeni Petruzzelli et al., 2011). Moreover, it is important to study environmental-friendly initiatives adopted in CEs because they presently carryout their organizational services by utilizing IT infrastructures (Anthony et al., 2018) which consumes electricity thereby emitting CO_2 to the atmosphere that contributes to climatic changes, global warming and environmental degradation. Hence, there is need to identify the environmental-friendly initiatives to be deploy in CEs for cost saving reduction, improved energy efficacy, ethical waste management, natural resource usage reduction, and CO_2 emission decrease for sustainability attainment.

2.3 Review on Theoretical Models

A number of theories have been adopted to investigate variables that influence the attitude of IT professionals and/or IT managers towards deploying Green IT and Green IS practices such as theory of reasoned action (Mishra et al., 2014), theory of planned behaviour (Akman and Mishra, 2014), technology acceptance model (Akman and Mishra, 2015), norm activation theory (Lei and Ngai, 2014), resource-based view (Chen et al., 2011; Deng and Ji, 2015), institutional theory (Butler, 2011a; Chen et al., 2011), technology-organization-environment framework (Nedbal et al., 2011; Zheng, 2014), diffusion of innovation theory (Bose and Luo, 2011; Nedbal et al., 2011), belief-action-outcome (Gholami et al., 2013; Molla et al., 2014; Loeser et al., 2017). While, these theories are valuable in examining the factors that influence Green IT/IS deployment, they do not address the complete environmental-friendly initiatives to be deployed in CEs (Chen et al., 2011;

Akman and Mishra, 2015). Respectively, in choosing the theory for this paper, the authors sought theories that can both help in understanding the variables that influences IT professionals and IT managers perception towards Green IT/IS practice, and also explore on the environmental-friendly initiatives to be deployed in CE (Bose and Luo, 2011; Molla et al., 2011; Nedbal et al., 2011). To this end, perceived organizational e-readiness theory and process-virtualization-theory were selected as suitable theories. This is because POER is more concerned about variables that influence behaviour of IT professional in adopting new technological invention. Likewise, PVT, supports the capturing of environmental-friendly initiatives to be deployed. Thus, each of the theories are discussed below;

2.3.1 Perceived Organizational e-Readiness Theory

POER theory was developed by Molla and Licker (2005) to examine changes in organizations and can be utilized to investigate the level of maturity of innovation such as Green IT/IS practice at a particular point in time. POER theory offers a solid structure to investigate firm capability to transform towards a Greener enterprise and also aids in identifying the significant variables essential for such change. Accordingly, POER theory comprises of constructs (awareness, governance, commitment, and resources) that are required to transform traditional enterprise in to an e-enterprise (Molla et al., 2011). In the context of this study awareness entails CE’s perception, understanding, and plan of the benefits and risks of deploying Green IT/IS practice (Molla and Licker, 2005). Besides, governance relates to the tactical, strategic, and operative strategy that defines the firms’ structure to assign resources and make decisions.

Governance also influences how well an enterprise manages the transition to deploying environmental-friendly practices from traditional operational process previously adopted (Molla and Licker, 2005). Similarly, commitment relates to support by stakeholders, particularly the Chief Executive Officer (CEO), who is required to champion Green IT/IS practice. Thus, top executive’s commitment towards the deployment of Green IT/IS practice is an important successful component (Molla and Licker, 2005). Lastly, resources relate to the level of business, human, technological resources of an enterprise. Thus, the resource available in any business influences the capacity of the firm to respond to opportunities and challenges of deploying Green IT/IS practice (Molla and Licker, 2005).

2.3.2 Process-Virtualization-Theory

PVT was proposed by Overby (2008) to offer a conceptual theory for examining if a process is responsive or resilient to being deployed virtually. PVT helps investigate how progress in IT is enabling a new generation of virtual practices. This symbolizes a substantial trend in recent IS developments such as the adoption of cloud computing services to support enterprise communication. PVT constructs include synchronism requirements, sensory requirement, identification and control requirements, and relationship requirements (Deng and Ji, 2015). The dependent construct, process virtualizability, describe how easy a process is being deployed without physical interaction between people or/and objects. However, there are three moderating variables which include representation, reach, and monitoring capability (Bose and Luo, 2011). Therefore, this study is grounded on a theory-based method to connect perceived organizational e-readiness theory with process virtualization theory to investigate IT professionals and IT manager perception towards Green IT/IS practice. Respectively, to conceptualize a broad scope, the model is proposed on POER theory and also extends PVT to incorporate environmental-friendly practices into the model as shown in Figure 1.

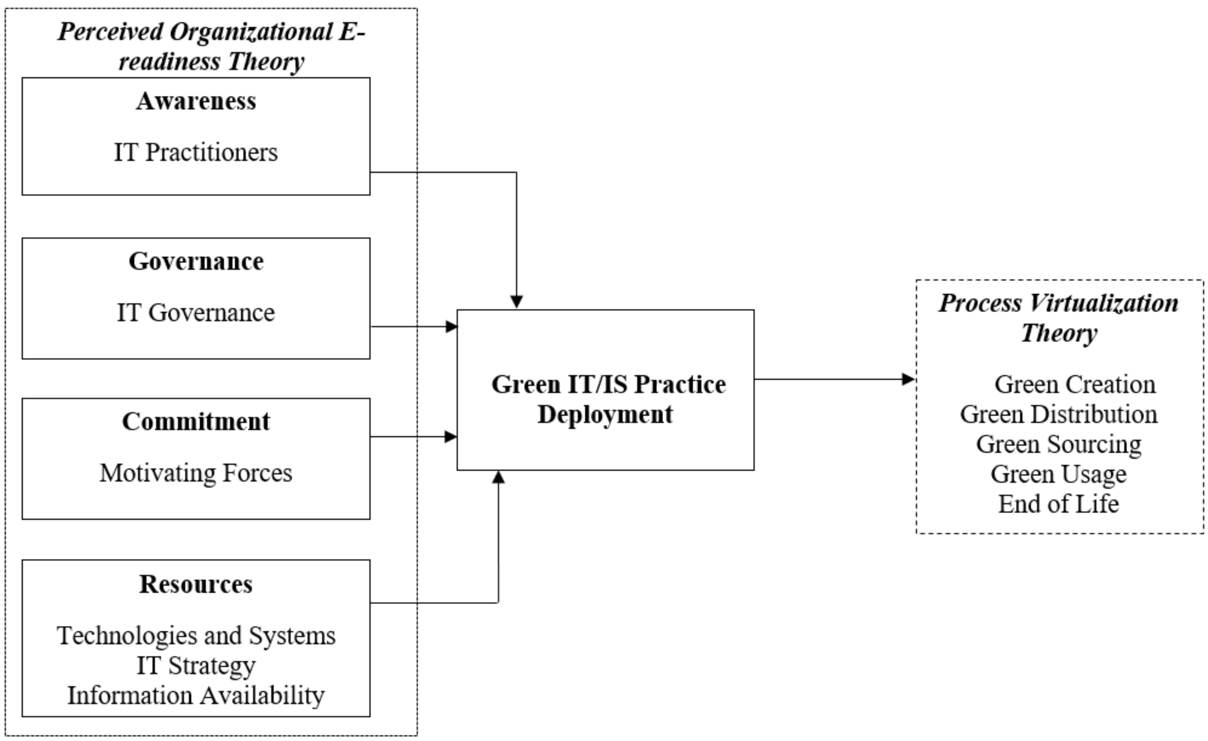

Figure 1 Model development based on POER theory and PVT

Figure 1 depicts the development of the model grounded on POER theory and PVT. The POER theory constructs includes the awareness of IT practitioners, governance presented as IT governance, commitment relating to enterprise willingness to adhere to internal and external pressure and lastly resources which involves the technologies and system, IT strategy and information availability. Additionally, since the independent and moderating variables of PVT are not the main focus of this study, we do not consider the independent and moderating variables of PVT but only consider the dependent variable of PVT which is the "virtualization process" involved for environmental-friendly initiatives as shown in Figure 1. Because virtualization process aids in describing how applicable a process is deployed using information system and technologies in replacing physical procedure carried out in traditional approach.

Although, Green IT includes human-technology interaction, such as telecommuting, virtualization, teleconferencing, etc. But, since IT hardware virtualization is not the main focus of this study, we do not consider the independent and moderating variables which are more aligned to hardware component of Green IT. Thus, in this study we assume that the Green IT/IS deployment will be IT driven. Also, our model therefore assumes that the aforementioned independent and moderating factors will always influence positively to the virtualizability of the greening process as argued by Bose and Luo (2011). Hence, we include only dependent variable virtualization process which is more aligned to the software (IS) component analogous to prior study (Nedbal et al., 2011), and similarly Bose and Luo (2011) where the researchers did not examine the moderating variables of PVT. Hence, the derived virtualization process to address environmental-friendly initiatives in CEs comprises of Green creation, Green distribution, Green sourcing, Green usage, and end of life.

2.4 Model Development

2.4.1 Variables that Influences Green IT/IS Practice

This sub-section investigates the first research question by identifying the variables that influences IT professionals' and IT managers' perception towards deploying Green IT/IS practices in CE based on POER theory each of the variables are discussed below;

a. Awareness (IT Practitioners)

IT practitioners are the humans that possess the skills and knowledge to deploy Green IT/IS practices (Anthony et al., 2018). This variable comprises of the staffs, professionals and experts involved in enterprise operation (Sahu and Singh, 2016). In addition, IT practitioners' attitude towards the environment will impact the success of Green IT/IS practice and this in turn influence other IT professionals and IT managers in deploying Green IT/IS practices (Loeser et al., 2017). Hence, it is important to empower staffs by developing their expertise through training on sustainability, so that they can utilize the knowledge and skills obtained to advance enterprise sustainability goals (Ainin et al., 2016). Thus, CE should not see their employee as a means to generate income only but need to be concerned about the wellbeing of the staffs (Deng and Ji, 2015). On the same vein, findings from Ardito et al. (2016) suggested that enterprises are more involved in innovating to solve environmental or social supporting environmental stewardship. This shows that CEs present a better capability to turn competencies related to the natural environment into pioneering outcomes, as also established by the fact that they better comply with environmental policies. Likewise, although the transition towards environmental-friendly initiatives is perceived too risky and expensive by CEs, Ardito et al. (2019a) found that their long-term alignment is mainly accountable for the ultimate impetus towards more environmentally-friendly oriented behaviors, which may be reflected into Green IT/IS practice of higher value (Ardito et al., 2019a). Therefore, we propose:

H1: IT practitioners' personality will positively influence his/her action toward Green IT/IS deployment.

b. Governance (IT Governance)

IT governance comprises the administrative rules and regulation that administers enterprise daily processes (Ainin et al., 2016). These policies are procedures to direct Green IT/IS practice towards achieving sustainability (Zheng, 2014). Moreover, IT governance increases CE's responsiveness on issues relating to environmental performance at the management level and also provides an outline for staffs in the organization to attain sustainability (Butler, 2011a). Therefore, management support is an important attribute for any organization's success (Messeni Petruzzelli et al., 2011). In general, IT governance policies are drafted by the management board or committee who initiates rules and regulation for their employees (McGibbon and Van Belle, 2013). Additionally, IT governance policies capture business's interest in specifying metrics required to evaluate the impact of Green IT/IS practices in CE (Deng and Ji, 2015). Besides, Green IT/IS practice in CE is further exacerbated by the fact that environmental issues do not usually represent main competencies for most enterprises and yields of Green IT/IS practice are more uncertain and riskier (Messeni Petruzzelli et al., 2011). But CEs are pushed to adopt or implement environmentally responsible initiatives because they are closely associated and more responsive to the increasing environmental concerns of local community, as result of their inclination to listen to stakeholders. Therefore, we propose:

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

c. Commitment (Motivating Forces)

Motivating forces is a factor that influences business's perception to deploy Green IT/IS initiatives in achieving sustainability (Jr et al., 2017a). These forces are due to increased energy costs incurred when enterprise consumes energy for business operations (Howard and Lubbe, 2012). Furthermore, CEs are being motivated by non-governmental, social, external, and governmental associations to implement environmental-friendly practices by initiating environmental protection policies. Likewise, CEs are influenced by consumer right groups that consumes goods and services produce by organizations (Anthony Jr et al., 2018). Similarly, CEs are committed to deploy Green IT/IS practices due to the persuasion by public concern for environmental-friendly products to help conserve the natural environment (Ainin et al., 2016). Therefore, we propose the following:

H3: Pressure from internal, external, and social bodies will have a significant effect on Green IT/IS deployment.

d. Resources (Technologies and Systems)

Technologies and systems consist of both IT infrastructures such as communication networks equipment, software, and hardware utilized by IT professionals to accomplish enterprise goals (Jenkin et al., 2011). Hence, enterprise acquiring, deploying environmental-friendly technologies and systems can facilitate the attainment of sustainability (Karanasios et al., 2010; Akman and

Mishra, 2014). This variable also explores the physical facilities that are deployed to promote Green IT/IS practices, although these technologies also contributes to environmental pollution and can also be a possible solution to these pollution (Molla et al., 2009). Renewable energy technologies generated from solar or wind can be used as a substitute to replace coal-based energy stations that provides energy, since coal emits CO_2 which contributes to global warming (Mishra et al. 2014; Deng and Ji, 2015). Furthermore, in order to achieve this win-win outcome, the development of technological solutions that supports the creation of and at the same time address environmental issues has become of primary importance. The deployment of Green IT/IS practice should therefore be at the core of a sustainability transition in order to replace existing dirtier technologies, boost the economy, and improve environmental protection (Ardito et al., 2019b). Therefore, we propose the following:

H4: Green IT/IS practice deployment is significantly influenced by installed technical infrastructures.

e. Resources (IT Strategy)

This variable involves activities and operations deployed in the organization (Dolci et al., 2015). The strategy is an essential component that determines business growth and also enhances enterprise efforts to deploy Green IT/IS practices towards actualizing long term environmental, society, and economic goals (Jenkin et al., 2011). The strategies infused may include supporting enterprise reduce operational cost, minimize carbon emissions thereby changing the direction towards realizing sustainability goal. Thus, CE should possess strategies with targets aimed at attaining a carbon neutral operation (Molla et al., 2008). Additionally, this variable involves establishing of enterprise scope and process deployed in the organization for Green IT/IS deployment (Ainin et al., 2016). Therefore, CE strategies can be established with activities to promote Green IT/IS awareness on the cause of environmental problems and how to promote environmental-friendly practices (Karanasios et al., 2010). Therefore, we propose:

H5: IT strategies deployed in CE significantly influences Green IT/IS practices.

f. Resources (Information Availability)

The accessibility and usage of information regarding environmental-friendly initiatives by employees in CE increase the knowledge of the enterprise community in familiarizing themselves with issues related to how environmental issues can ethically be addressed (Jr et al., 2017a). Thus, IT professionals and IT managers depending broadly on multiple knowledge sources provides CEs with valuable knowledge flows which are later transformed into actual environmental-friendly initiatives. This is particularly true for Green IT/IS practice, for which the lack of external knowledge sourcing in research and development has been found to be a barrier to subsequent deployment and exploitation (Ardito et al., 2019b). Hence, the availability of information can support businesses minimize energy consumption (Butler, 2011b), which definably leads to cost saving for CEs. Moreover, information disseminated across the enterprise can support employees to be familiar with environmental-friendly initiatives that can result to decrease CO_2 emission. Therefore, we propose:

H6: The availability of information across CE will significantly influence Green IT/IS deployment.

2.4.2 Environmental-Friendly Initiatives

This sub-section explores the second research question which identifies the environmental-friendly initiatives to be deployed in CE to improve Green IT/IS practices as presented in Figure 1. Based on PVT, the environmental-friendly initiatives include Green creation, Green distribution, Green sourcing, Green usage, and end of life. Each of the process are discussed below;

a. Green Creation

Green creation involves synthesizing, analyzing and designing environmental-friendly services as well as products with less energy (Saha, 2014). At the moment most CEs do ignore the environmental effects caused during design stage. Green creation facilitates IT practitioners to design efficient products with less costs incurred (Pichetpongsa and Campeanu, 2011). This process also encourages proficient usage of IT facilities, data resources, decreases central processing unit operation cycle, reducing power consumption, measuring Greenhouse gas emission (Molla, 2009). In Green creation, CEs are expected to deploy efficient and environmental-friendly hardware components, facilities and computer peripherals (Anthony Jr et al., 2018). Thus, we propose that;

H7a: Green creation initiatives are positively influenced by the current Green IT/IS practice deployed in CE.

b. Green Distribution

Green distribution refers to the production procedures which involve utilizing raw materials with limited or low ecological effects, which produce little or no pollution (Saha, 2014). In this process IT professionals take actions toward a Greener prospect by changing IT configurations and installation utilized by staffs in CE to achieve more efficient operations and also increases the reusability and recycling rate of IT hardware (Molla, 2009). This is accomplished by deploying environmental-friendly initiatives such as clean production and enforcing Green policies as part of enterprise governance (Pichetpongsa and Campeanu, 2011). Moreover, Green distribution initiatives in CE leads to reduced costs for resources, increase in productivity, and decrease of environmental impact of the enterprise (Molla et al., 2008). Thus, we propose that;

H7b: Green distribution initiatives are positively influenced by the current Green IT/IS practice deployed in CE.

c. Green Sourcing

Green sourcing involves deploying environmental-friendly procurement initiatives when purchasing IT infrastructures (Molla, 2009). This initiative focuses on the environmental assessment and reviewing of IT merchants when procuring IT hardware and software to ensure that vendors comply with environmental standards stated by certified environmental bodies such is ISO 14001. According to Loeser et al. (2017) in Green sourcing CEs should select IT vendors when procuring IT goods and services according to pre-defined environmental criteria. Likewise, it also involves CE moving towards Green procurement by buying electronic products that have Green labels such as Blue Angel from Germany, TCO 95 from Sweden and Environmental Protection agency (EPA) Energy Star from the United States (Reza et al., 2012; Anthony et al., 2020). IT infrastructures with Greener labels, utilizes less energy thereby emits less CO2 to the environment. Thus, we propose that;

H7c: Green sourcing initiatives are positively influenced by the current Green IT/IS practice deployed in CE.

d. Green Usage

Green usage includes environmental-friendly practices aimed at decreasing energy consumed when IT facilities are operated in CEs data centers (Molla, 2009), and departmental office (Loeser et al., 2017). This practice mainly aims to conserve energy, which in turn results to reduced pollutants and CO_2 emission into the atmosphere (Saha, 2014). Hence, IT professionals and IT managers in CE should be aware of Green usage practices that can diminish energy utilized by IT infrastructures. Besides, Green usage involves the deployment of IT equipment in an environmentally sound manner (Raza et al., 2012). Thus, we propose that;

H7d: Green usage initiatives are positively influenced by the current Green IT/IS practice deployed in CE.

e. End of Life

End of life relates to Green disposal policies that comprises of environmental-friendly initiatives that reduce electronic waste (e-waste) by re-deploying, repairing, refurbishing, retaining, reusing of obsolete IT infrastructures (Loeser et al., 2017). This initiative also offers a means for collecting and re-processing of unwanted IT hardware by recycling e-waste at a controlled handling cost (Pichetpongsa and Campeanu, 2011; Saha, 2014). According to Anthony et al. (2020) discarded IT infrastructures should be gathered for reuse or refurbished, whereas discarded out-of-date hardware should comply to relevant environmental regulations and legislations stipulated by The European Waste Electrical and Electronic Equipment (WEEE) when they are disposed. Where, WEEE levies the responsibility for electrical and electronic waste on the equipment manufacturers (Fargnoli et al., 2013). 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 (Zhao and Chen, 2019). Thus, we propose that;

H7e: End of life initiatives are positively influenced by the current Green IT/IS practice deployed in CE.

Based on the findings from the variables and environmental-friendly initiatives that influence Green IT/IS practice, the model is developed grounded on POER theory and PVT as shown in Figure 2 based on model development as seen in Figure 1. Thus, Figure 2 outlines the research model proposed in this study, the hypotheses (H1-H6) represents the variables which influences Green IT/IS practice. Similarly, the current Green IT/IS practice is based on environmental-friendly initiatives being deployed in CE, (H7a-H7e).

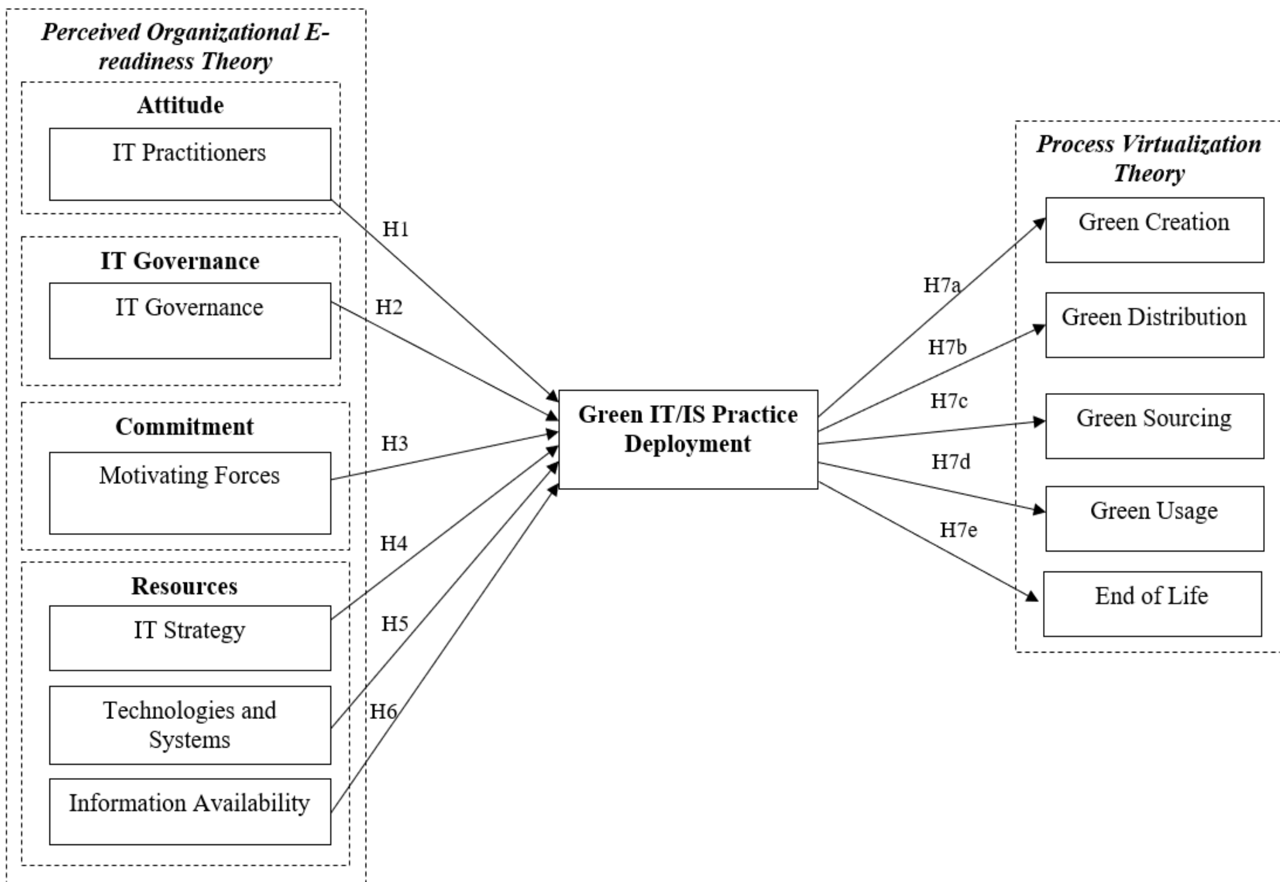

Figure 2 Proposed model for Green IT/IS practice deployment

3 Research Methodology

3.1 Design and Procedure

To evaluate the proposed model, questionnaire instrument was employed targeting IT professionals and IT managers as participants since they possess in-depth knowledge towards Green IT/IS practice in their enterprise. Hence, these respondents are selected using purposively sampling to represent the target population required to evaluate the proposed model. Additionally, in designing the questionnaire, the recommendations suggested by Fowler (2009) was adopted as employed by Loeser et al. (2017) in their study on Green IS. Next, the designed questionnaire was pre-tested by 5 domain experts who were familiar with Green IT/IS practice confirming the appropriateness of the instrument. Feedback from the pre-test sessions helped to enhance the lexical structure, readability, and understanding of the questionnaire.

The survey instrument questions were designed based on previous research studies on Green IT and Green IS practice implementation (see Appendix A1-A2). The survey question 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 second section consists of questions to measure the demographic characteristics of the respondents and their respective enterprise using ordinal scale. The third section consists of question to measure the independent variables that influence Green IT/IS practice based on item derived from the literatures. The final section comprises questions to validate the environmental-friendly initiatives derived from the literatures. The participants were asked questions to measure the level of importance of each independent variable's and Green IT/IS practice, and level of implementation of environmental-friendly initiatives attribute using Likert scale with five response categories (1-5).

The questionnaire was set up online and sent through e-mail together with a cover letter to participants that currently deploy Green IT/IS practice in their enterprise. Participants were selected based on their present role in their organization. To confirm each respondent is qualified to provide data required in validating the proposed model, each respondent's details was confirmed through their enterprise Green center website. Email invitation messages were sent to respondents to participate in the data collection at their own convenience. Invitation to partake in the survey was first sent on January 2017, after which a second round of reminder was sent on February 2017, finally the last invitations was sent in March 2017 to expedite the reply rate together with an apology for several invitations sent.

At the end of April 2017 out of the 1,190 requests sent to IT professionals and IT managers within the enterprises, a total of 133 IT professionals and IT managers responded and partake in the survey and provided complete response. Although 18 response were excluded due to incomplete responses provided by the participants. The sample is between medium ranges, since its more than 100 responses as suggested by Hair et al. (2011), hence acceptable based on sample utilized in prior studies. Where, Loeser et al. (2017) used dataset from 118 samples and Widjaja et al. (2011) utilized 105 survey responses in their research.

3.2 Statistical Tool and Techniques

Partial Least Square-Structural Equation Modeling (PLS-SEM) approach is adopted for analyzing the data to evaluate the proposed model. SEM employs a multivariate numerical data exploration method that supports modeling cause and effect interactions among variables and related items by utilizing a component based approach for analysis (Hair et al., 2011). PLS-SEM approach uses an analytical causal measurement based on variance. Accordingly, PLS-SEM was employed to analyze the questionnaire data, where PLS-SEM has previously been utilized in Green and environmental research by researchers such as Benitez-Amado et al. (2010); Gholami et al. (2013); Akman and Mishra (2014); Loeser et al. (2017). PLS-SEM is also suitable for research which low sample size (below 100) for model validation (Anthony et al., 2020). Thus, we opted for PLS-SEM as a statistical tool appropriate for validating the developed model.

PLS-SEM is based on formative and reflective relationship. Reflective measurement show that the items are a sub-set of the variable being measured (reflective relationship). In formative measurement, the items are defined by the variables (formative relationship). The reflection measure is suitable if there is a correlation among the variables. In this study, all variables were represented using a reflective model based on correlation results which suggest relationships among the variables, ranging from Pearson correlation from 0.32 to 0.90 (see Table A4 in appendix), which supports our selection of reflective measurement. Thus, PLS-SEM was employed using SmartPLS version 3 to test the model base on assessment of measurement model and structural model.

4 Results

This section presents results of assessment of measurement model and structural model.

4.1 Model Evaluation

The proposed model (see Figure 2) is divided into two model designed in Smart PLS 3 to shows the interactions between the variables and dependent variable as model 1 and dependent variable and environmental-friendly initiatives as model 2. Model 1 is used to confirm hypotheses H1-H6, whereas model 2 is used to confirm hypotheses H7a-H7e. The variables for POER are all measured using a five point Likert scale (1 to 5) which rates 1 as not important and 5 as very important. Similarly, the environmental-friendly initiatives for PVT are measured using a five point Likert scale where 1 signifies not implemented and 5 signifies fully implemented (see Table A1 and Table A2 in appendix). For characteristic of the survey respondents refer to Table A3 in Appendix. Respectively, Table 1 shows the measurement of structural model 1 (H1-H6) results presenting the R^2 value which assess the dependent variable percentage of variance which is being interpreted by the independent variables. Whereas, the standardized regression weights or path coefficients measures how strong the effect of the independent variable is to the dependent variable.

Table 1 Measurement of structural model 1 and 2

Structural Models	Relationship	R^2 (Percentage of Variance)	Standardized Regression Weights
Model 1 (Perceived Organizational e-Readiness Theory)	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
Model 2 (Process Virtualization Theory)	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

Results from Table 1 show that the coefficient of determination, R^2 (percentage variance) should be > 0<1 (Anthony et al., 2020), 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 0.387 (38.7%) for motivating forces, (H4) R^2 is 0.294 (29.4%) for technologies and systems, (H5) R^2 is 0.318 (32.8%) for IT strategy, and lastly (H6) R^2 is 0.331 (33.1%) for information availability. Additionally, results from Table 1 also reveal that for the standardized regression weights motivating forces has the highest influence on Green IT/IS practice (0.622), followed by information availability (0.575), then IT strategy (0.564), next is technologies and systems with (0.542), subsequently IT governance (0.441), and lastly IT practitioner (0.363). Hence, the hypotheses (H1-H6) is significant as all the scores are higher than 0.1 (Anthony et al., 2020). Evidently, this suggests that the independent variables are reasonably strong predictors of dependent variable.

Table 1 also shows the measurement results of structural model 2 hypotheses (H7a-H7e) showing R^2 value that assesses the percentage of variance of environmental-friendly initiatives 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, (H7d) R^2 is given as 0.907 (90.7%) for Green usage, and lastly (H7e) R^2 is given as 0.839 (83.9%) for end of life variance being influenced by Green IT/IS practice. Furthermore, results from Table 1 regarding the standardized regression weights 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 has the least effect on Green IT/IS practice.

4.2 Assessment of Measurement Model

This sub-section present results of measurement models by measuring the reliability, validity, and item loadings.

Table 2 Assessment measurement model 1

Variables	Code	Loadings	Composite Reliability (CR)	Cronbach's Alpha	Average Variance Extracted (AVE)	Mean	Standard Deviation
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					
	GP2	0.914					
	GP3	0.931					

	GP4	0.918	0.966	0.956	0.851	3.41	0.807
	GP5	0.947					

Table 3 Assessment measurement model 2

Environmental-Friendly Practices	Code	Loadings	Composite Reliability (CR)	Cronbach's Alpha	Average Variance Extracted (AVE)	Mean	Standard Deviation
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					
Green IT/IS Practice	GP1	0.902	0.966	0.956	0.852	3.41	0.807
	GP2	0.905					
	GP3	0.934					
	GP4	0.928					
	GP5	0.945					

The constructs item reliability was measured by examining the loading of all items, as depicted in Table 2 and Table 3, where the path loading value should be between 0.5 to 1 (Gholami et al., 2013). In this paper the benchmarks of 0.5 suggested by Gholami et al. (2013) is used for confirming items. Results from Table 2 and 3 indicate that the independent variables and environmental-friendly initiatives item loading values are higher than 0.5 and lesser than 1. In any research it is essential to check the validity and reliability. Respectively, results from Table 2 and Table 3 depict the Composite Reliability (CR), Cronbach's Alpha, and Average Variance Extracted (AVE) of all constructs in the model. Where, the Cronbach's alpha which measure the reliability should be equal to 0.70 or higher (Benitez-Amado et al., 2010). Likewise, the CR value should be 0.7 or greater (Akman and Mishra, 2014) and the AVE should be 0.5 or greater (Loeser et al., 2017). Results from Table 2 and Table 3 reveal that CR is higher than 0.7, thus the reliability is confirmed for all independent variables and environmental-friendly initiatives. Also, results from Table 2 and Table 3 confirm that all of the AVE scores are higher than the satisfactory benchmark of 0.5 thus convergent validity is established.

4.3 Discriminant Validity

Discriminant validity measures the percentage to which any single construct is different from other construct in the same model (Fornell and Larcker, 1981). In this paper, discriminant validity was measured based on the recommendations of Fornell and Larcker (1981) in which pair-wise relationship between indicators loading were matched with the variance extracted evaluations for the construct. The discriminant validity value is satisfactory when constructs possess an AVE value higher than 0.5 signifying that at least 50 percent of assessment variance is explained by the construct.

Table 4 Discriminate validity for model 1

	Green IT/IS Practice	IT Governance	IT Practitioner	IT Strategy	Information Availability	Motivating Forces	Technologies & Systems
Green IT/IS Practice	**0.922**						
IT Governance	0.429	**0.918**					
IT Practitioner	0.35	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 & Systems	0.536	0.773	0.693	0.8	0.772	0.75	**0.866**

Table 5 Discriminate validity for model 2

	End of Life	Green Creation	Green Distribution	Green Sourcing	Green Usage
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	0.874	0.817	0.856	0.839	**0.872**

Table 4 and Table 5 show the Fornell-Larcker benchmark results for validating discriminant validity verified by assessing the square root of AVE signified in bold on the sloping of Table 4 and Table 5. Additionally, all the values are larger than 0.5%. For instance, in Table 4 the variable IT governance's AVE is established to be 0.843 (from Table 2) therefore its square root is computed as 0.918, which is significantly higher than the correlation scores in the column of IT governance (0.429). Moreover, its higher than all values in the row of IT governance (0.851, 0.788, 0.796, 0.69, and 0.773), and also higher than 0.5% benchmark. Similar value is provided for the other constructs. The result specifies that discriminant validity is confirmed in Table 4 and Table 5.

4.4 Assessment of Structural Model

This sub-section aims to check the structural path significance and total effect by confirming hypotheses (H1-H6, H7a-H7e). Thus, SmartPLS was employed to produce t-value for hypotheses testing employing a method referred to as bootstrapping based on sub-samples of 5000 bootstraps utilized from the original sample to produce estimated t-value for testing the structural path significance of the model.

Table 6 Results of hypotheses confirmation (H1-H6 and H7a-H7e)

Relationship	**Hypotheses**	**Original Sample**	**Sample Mean**	**Standard Deviation**	**T-Value**	**P Values**	**Accept or Reject at p =<0.05**
IT Practitioner -> Green IT/IS Practice	H1	0.363	0.379	0.061	**5.960**	0.000	**Accept**
IT Governance -> Green IT/IS Practice	H2	0.441	0.448	0.069	**6.427**	0.000	**Accept**
Motivating Forces -> Green IT/IS Practice	H3	0.622	0.637	0.064	**9.699**	0.000	**Accept**
Technologies and Systems -> Green IT/IS Practice	H4	0.542	0.551	0.070	**7.710**	0.000	**Accept**
IT Strategy -> Green IT/IS Practice	H5	0.564	0.568	0.071	**7.882**	0.000	**Accept**
Information Availability -> Green IT/IS Practice	H6	0.575	0.583	0.061	**9.395**	0.000	**Accept**
Green IT/IS Practice -> End of Life	H7a	0.904	0.904	0.022	**41.67**	0.000	**Accept**
Green IT/IS Practice -> Green Creation	H7b	0.907	0.909	0.020	**44.89**	0.000	**Accept**
Green IT/IS Practice -> Green Distribution	H7c	0.936	0.937	0.013	**71.51**	0.000	**Accept**
Green IT/IS Practice -> Green Sourcing	H7d	0.930	0.930	0.014	**64.71**	0.000	**Accept**
Green IT/IS Practice -> Green Usage	H7e	0.949	0.95	0.009	**106.9**	0.000	**Accept**

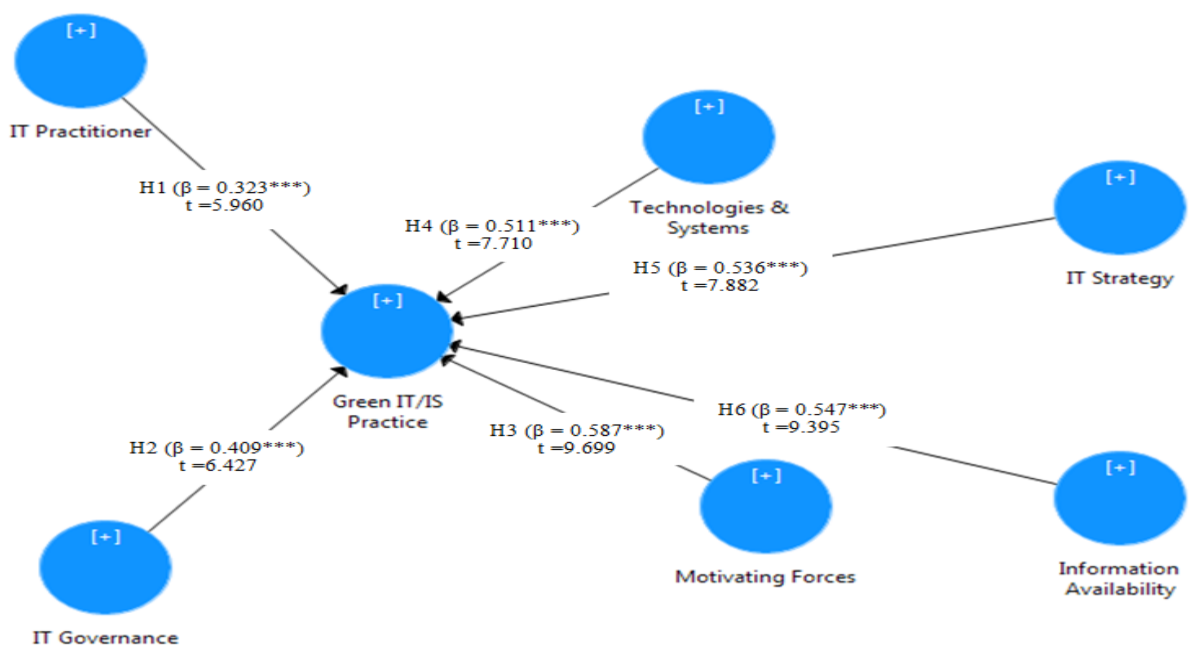

Figure 3 Results of model 1

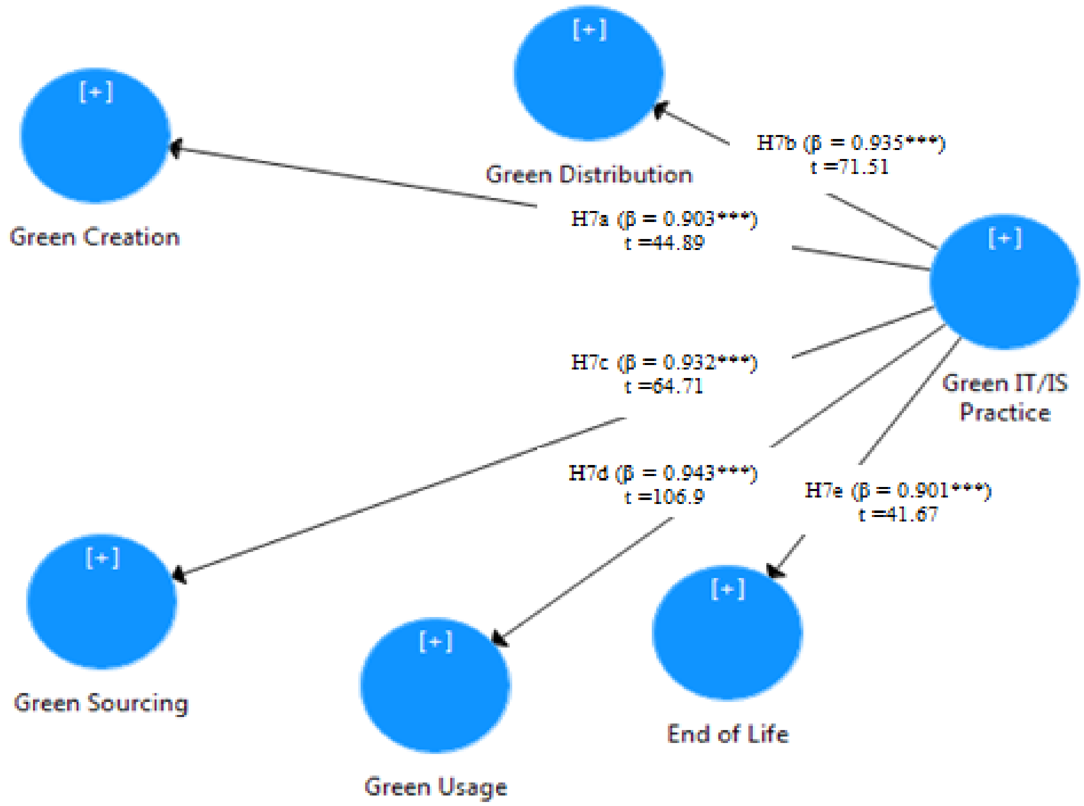

Figure 4 Results of model 2

Results from Table 6, Figure 3 and 4 show the hypotheses test using two-tailed t-test with a significance level of p=<0.05, where t-value greater than 1.96 threshold is considered significant. Results from Table 6, Figure 3 and 4 show that the t-values of all values are higher than 1.96. In addition to checking the hypotheses, there is need to check each model's effect size which measures the percentage of the individual independent variable influence on the dependent variable's R^2 value in model 1 and how the dependent variable influences individual environmental-friendly initiatives R^2 in model 2. Where, the effect size measures the strength of correlation among the constructs. This helps in confirming the complete impact of the study.

Accordingly, researchers such as Anthony et al. (2020) mentioned that researchers should not only confirm if there is a significant relationship among the variables or not, but also check the size of effect between the constructs. Hence, findings from importance-performance map test in SmartPLS3 was deployed as seen in Table 7 to test for total effect for model 1 and results show that motivating forces is the most influencing variable with total effect of 0.524 (52.4) in relation to Green IT/IS practice in CEs and technologies and systems is the most performing variable with value of 68.910 in relation to Green IT/IS practice in CEs as seen in Table 7 (based on model 1).

Table 7 Variables total effect and performance important for Green IT/IS practice

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**

To assess the total effect for model 2, the blindfolding test was deployed in SmartPLS3, where blindfolding is a technique that calculates the Stone-Geisser's Q^2 value by employing an assessment rating for cross validated predictive weight of PLS path model (Hair et al., 2013).

Table 8 Environmental-friendly initiatives construct cross-validated redundancy for model 2

Eco-Friendly Practices	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**

Accordingly, in this study Q^2 value for environmental-friendly initiatives was obtained using blindfolding procedure in SmartPLS3. Therefore, blindfolding is used in this study to check for the standardized regression weights of each variable in model 2 and the R^2 percentage variance of each variable, where each value should be higher than "0" as suggested by Hair et al. (2013). Results from blindfolding (Q^2 value) as seen in Table 8 show that Green IT/IS practice has more effect on Green sourcing with a value of 0.677 (67.7%).

5 Discussion

This study develops a model to investigate IT practitioners and IT manager's perception towards Green IT/IS practice in CE. The proposed model was evaluated based on questionnaire data. Findings from R^2 and path significance analysis confirm hypotheses (H1-H7) suggesting that IT practitioner commitment is mandatory for CE in initiating Green IT/IS practices. This result is similar with results from previous studies (Ainin et al., 2016; Sahu and Singh, 2016), implying that IT practitioners' collaboration is based on their commitment and concern in accomplishing the objectives of the enterprise. This can be regarded as part of the environmental ethics or stewards in the firm. Additionally, findings from this study indicate that IT governance policies have a positive influence on Green IT/IS deployment by suggesting that the regulation initiated by management influence how staffs deploy Green IT/IS practices in CE. This result is analogous with findings from Zheng (2014) who argued that IT executive must initiate Green policies to guide staffs on how environmental-friendly initiatives can progress Green IT/IS practice. In detail, this result leads to the conclusion that the commitment of CE to governance policies is essential in promoting Green IT/IS practice.

The outcome of this research also supports the hypothesis that there is significant relationship between motivating forces and Green IT/IS practice. This finding is analogous with results of prior study (Vykoukal et al., 2011; Ainin et al., 2016). The result reveal that CEs are motivated by social and administrative pressure that controls how they conducts business in regard to Green IT/IS practices. Moreover, our findings suggest that CEs are also influenced by environmental protection policies set mostly by governmental and external bodies for example Greenpeace. The results of this research confirm that there is a significant relationship between technologies and systems and Green IT/IS practice. The results of prior research (Mishra et al. 2014) support findings of this current research. Likewise, Karanasios et al. (2010) mentioned that technology and systems which refers to infrastructures can facilitate environmental-friendly initiatives in CE. Findings further suggest that IT strategy deployed in CE to achieve business objectives significantly influence Green IT/IS practices. This is consistent with results of prior research (Molla et al., 2008; Ainin et al., 2016). So, it is imperative that IT strategy should support CE in reducing their daily functional costs. This study indicates that information availability influences Green IT/IS practice in CEs, this is analogous to results presented by Butler (2011b). Similarly, Butler (2011a) revealed that information usage through IT/IS can help reduce energy consumption, which is one of the goals of CE as there is economic gain to be achieved with reduced energy usage.

Further results from R^2 and path significance analysis reveal that the environmental-friendly practices 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 deployed in the enterprise. The findings reveal that the current Green IT/IS practice significantly influence Green creation as previously specified by Ninlawan et al. (2010). Ninlawan et al. (2010) stated that Green creation involves the utilization of information systems for enterprise operations, environmental management, and carbon foot print assessment in CEs design activities. The results also imply that the current Green IT/IS practice significantly influence Green distribution in CE. This finding is analogous to the statement mentioned by Raza et al. (2012) where the researcher mentioned that Green distribution involves operative procedures that increases the reutilization and reuse of raw materials to encourage minimal unwanted materialization thereby lowering resource consumption. The findings showed that Green IT/IS practice influences Green sourcing which reflects on environmentally preferable IT infrastructure procuring in CE. Our findings are similar with prior results presented by Molla et al. (2009); Pichetpongsa and Campeanu (2011), where the authors found out that Green sourcing operations in CE include the purchase product having environmental labels that produce less pollutants.

An interesting finding of the research is that Green usage is based on the current Green IT/IS practice deployed in the enterprise. Hence, Green usage aims to enhance energy efficacy in operating and cooling enterprise IT infrastructures and also decreasing IT produced CO_2 emissions. Accordingly, it can be interpreted from the result that Green usage aims to achieve decrease in energy usage similar to findings presented by Karanasios et al. (2010) in their study. Furthermore, our findings specify that end of life management towards Green disposal is also influenced by Green IT/IS practice similar to results presented by Pichetpongsa and Campeanu (2011) in their case study research conducted in Dell and Toshiba corporations. Pichetpongsa and Campeanu (2011) suggested that end of life entails the practices of restoring, reusing, reprocessing, and discarding of IT equipment in an environmental-friendly manner.

Finally, according to our analysis for total effect using constructs performance important for structural model 1 our findings provide strong support and also reveals that motivating forces is the most influencing variable as predicted with total effect of 0.524 in relation to Green IT/IS deployment in CEs. Evidently, this is because over the years there has been pressure on CEs to go Green from end users, governmental and non-governmental bodies. Interestingly, technologies and systems is the most performing variable with value of 68.910 in relation to Green IT/IS practice in CEs, where this is in line with prior study by Loeser et al. (2017) where the authors concluded that the technologies and systems utilized in the organization influences environmental sustainability. Lastly, findings from blindfolding test for structural model 2 shows that Green IT/IS practice has more effect on Green sourcing with a value of 0.677 (67.7%). This result suggests that that Green sourcing is the most deployed eco-friendly practices in Malaysia CEs.

6 Implication and Limitations of Study

6.1 Theoretical Implications

Coming in the wake of global warming, climate change and environmental degradation, this research is both timely and relevant. Thus, embodies one of the few empirical studies regarding how Green IT/IS deployment among IT professionals and IT managers in CE can help address the aforementioned issues. Hence, IT managers can draw upon the model in measuring conditions for positive deployment of Green IT/IS in their organizational operation towards address sustainability concerns. Therefore, this study provides a grounded lens for CE to better understand the variables which comprises of factors that influences the perception of IT professionals and IT managers towards deploying Green IT/IS practices in their enterprise. Moreover, this study provides an agenda for CEs to incorporate environmental-friendly initiatives into their current enterprise operations.

This study further develops a model based on the identified variables grounded from perceived organizational e-readiness theory to support CE in making decision on how to attain sustainability. The model clarifies how IT professionals and IT managers would intend to deploy Green IT/IS practices in their respective enterprise for addressing environmental sustainability. At the moment, CEs are under pressure from end users, society, competitors, governmental associations, and regulators bodies to deploy environmental-friendly initiatives. Hence, addressing societal, environmental and economic performance is a tactical issue. As a result, IT professionals and IT managers can refer to the model proposed in this study to evaluate the factors required for successful deployment of Green IT/IS practices. But to successfully deploy Green IT/IS practices, it is required to better understand the behaviour of CEs towards effectively initiating environmental governance polices to accelerate Green IT/IS practice.

To this end better understanding of the behaviour of IT professionals and IT managers in CE is needed in order to initiate environmental policies to accelerate Green IT/IS deployment in CE to address sustainability issues. Therefore, this study mainly focused on the deployment of Green IT/IS practices for sustainability attainment in CE. So, IT professionals and IT managers 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. Furthermore, IT professionals and IT managers need envisage how IS can be utilized to address negative impact caused by IT by creating a sustainable organization that can move beyond Greening enterprise data center or merely installing energy monitoring programs for Personal Computers (PCs).

6.2 Practical Implications

Our results have practical implications for the capability of Green IT/IS to support enterprise' environmental sustainability goal. Findings from this study provide a model to improve Green IT and Green IS practices by suggesting Green creation, Green distribution, Green sourcing, Green usage, and end of life as best practices to address the impact caused by IT usage in CEs. Additionally, this research enriches the theory on sustainability by assessing IT professionals and IT managers' action on deploying Green IT/IS practices. The model presented in this research provide medium for future study and also inspires to motivate the perception and mind-set shift of IT professionals and IT managers' decision-makings in CE towards economic, social and environmental protection.

Practically, the environmental-friendly initiatives derived from process-virtualization-theory in this study help IT practitioners and IT managers understand the potential benefits associated with Green IT/IS practices deployment in CEs. This will help IT professionals and IT managers to understand the weakness and strength of their current environmental-friendly initiatives being implemented. Finally, this research highlights the separate roles played by traditional IT deployment and Green IT/IS deployment in CE towards the pursuit of sustainability.

This careful differentiation supports CEs to find the right positions to change their perception and deviate from the traditional use of IT to environmental-friendly use of IT (Green IT/IS) to further their enterprise goals. Furthermore, our study show that no empirical study has yet investigated Green IT/IS practice deployment in CE domain thus there is a lack of knowledge in this area. Thus, it is still unclear how IT practitioners and IT managers can deploy Green IT/IS practices for societal consideration, environmental protection and achieve economic value.

Therefore, findings from this study provide practical implications for CEs wishing to implement or retain high levels of environmental responsiveness. This study therefore validates the applicability of the Green IT/IS practice in CEs. Evidently, highlighting that environmental-friendly practices are being deployed in few CEs based in Malaysia to lessen energy usage of IT infrastructure in enterprise, decreasing deployment costs incurred, and lessen CO_2 emission. Empirically, this research is among the first study to investigate IT professionals and IT managers perception towards Green IT/IS practice in CE, by so doing, we add knowledge to the emergent field of Green IT/IS research towards sustainability attainment. Practically, this study provides both IT professionals and IT managers with scope, content, and initiatives for the deployment of Green IT/IS practices in CE.

6.3 Limitations

This study has a few limitations. First, the generalizability of the results may be restricted due to the fact that data was collected from Malaysia and the proposed model was evaluated based on 133 samples. Which was based mainly on how the respondents observe their current environmental-friendly practices and how the participants perceive the impact of the independent variables towards Green IT/IS practice deployment in Malaysian CEs. Thus, the results cannot be generalized to other developing countries. Secondly, this research mainly considered the perceptions of IT professionals and IT managers towards Green IT/IS in CE. Consequently, there is need to investigate other enterprise such as private based firms deploying Green IT/IS practices. Next, the questionnaire data were collected mainly from IT, communication and media, and education and research based enterprise. This limitation infers that the generality of the results documented in this study to other enterprises should be cautioned and requires further investigation.

7 Conclusion

The aim of this study is to investigate the variables that influence IT professionals and IT managers' perception towards Green IT/IS and environmental-friendly initiatives to be deployed in collaborative enterprise. A model was proposed based on perceived organizational e-readiness theory, and process virtualization theory. Accordingly, perceived organizational e-readiness theory was employed in this study to explicate if the environmental-friendly initiatives are responsive or resilient to being deployed. Similarly, process virtualization theory was adopted as an assessment model to examine variables that may influence changes of Green IT/IS practice in collaborative enterprise. Questionnaire was employed to validate the model. Results from this study reveal that the identified variables (IT human infrastructure, IT governance, technologies and systems, motivating forces, IT strategy, and information availability) significantly influences IT professionals' and IT managers' perception towards Green IT/IS deployment. Results also suggest that the environmental-friendly initiatives (Green creation, Green distribution, Green sourcing, Green usage, and end of life) are significant and should be deployed in collaborative enterprise towards sustainability attainment.

Future research comprising longitudinal study from other geographical location would be necessary to further examine the proposed model with data collected from IT professionals and IT manager from different cultural background. Moreover, there is need to extend this study to other enterprise that are currently deploying environmental-friendly initiatives such as private owned establishment as well as government owned institutions would also be of interest. Lastly, further research can be directed to the exploration of how social and economic dimension influence CEs into deploying Green IT/IS practices.

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Appendix

Table A1 Operationalization of variables and associated items

Variables	Code	Items	References
IT Practitioners	ITP1	Positive attitude of IT practitioners.	(York et al., 2009; Molla et al., 2011)
	ITP2	Ethical consideration of IT practitioners.	
	ITP3	Social-culture of IT practitioners.	
	ITP4	Overall competences of IT practitioners.	
	ITP5	Opinions of IT practitioners in relation to the natural environment.	
	ITP6	Awareness of IT practitioners in relation to the natural environment.	
	ITP7	Experience of IT practitioners in the industry.	
	ITP8	IT practitioners' intention to adopt eco-friendly initiatives.	
IT Governance	ITG1	Official innovativeness structures.	(Murugesan, 2008; Molla et al., 2011)
	ITG2	Executive involvement as an important role.	
	ITG3	Executive moral support.	
	ITG4	Executive exploration on approaches to decrease energy utilization.	
	ITG5	Executive supports the use of IT hardware from Green IT suppliers.	
	ITG6	Executive policy for the use of software to lessen e-wastes.	
	ITG7	Executive policy on employee's usage of IT in an energy resourceful way.	
	ITG8	Provides budgets and other monetary resources by executive.	
Technologies and Systems	TS1	Changing its business operation to be paperless.	(Hart, 1997; Info~Tech, 2008)
	TS2	Deploy server consolidation and virtualization to lessen energy usage.	
	TS3	Utilize teleconferencing for meetings.	
	TS4	Deploy video conferencing within the organization.	
	TS5	Encourages telecommuting for conveying staffs around the firm.	
	TS6	Deploy online group chatting systems for enterprise daily operations.	
	TS7	Use of software to decrease enterprise wastes and emissions.	
	TS8	Use of software to diminish total use of harmful materials.	
Motivating Forces	MF1	Influenced by government and NGOs rules and regulations in the firm.	(Butler, 2011a; Chen et al., 2011)
	MF2	Executive involvement motivates Green IT/IS initiatives.	
	MF3	Incentives provided by government influence Green IT/IS adoption.	
	MF4	Influence from other competitors influences Green IT/IS adoption.	
	MF5	Social pressure from consumer, stakeholder and dealers.	
	MF6	Motivation from external bodies.	
	MF7	Future outcome of firm actions	
IT Strategy	ITS1	Address the carbon foot print of IT facilitated systems.	(Chen et al., 2011; Molla et al., 2011)
	ITS2	Possess personal business strategy.	
	ITS3	Provide economic returns from enterprise IT assets.	
	ITS4	Employ strategies on how to attain ecological goals.	
	ITS5	Deploy operational routines to simplify the presentation of acquired knowledge.	
	ITS6	Refine measures to expedite newly assimilated knowledge.	
	ITS7	Improve business prospects based on ecological perspective.	
Information Availability	IA1	Provides the up-to-date data relating to the environment within the organization.	(Butler, 2011b; Chen et al., 2011)
	IA2	Provide un-restricted access to information in the firm.	
	IA3	Offers unique and detailed data within the firm.	
	IA4	Providing similar and reliable data within the firm.	

Table A2 Operationalization of environmental-friendly practices and associated items

Environmental-friendly Practices	Code	Items	References
Green Creation	GC1	Resolve electricity consumption of lighting and cooling in our organization.	(Murugesan, 2008; Molla et al., 2011)
	GC2	Interested about the effectiveness of running our firm IT systems.	
	GC3	Considers ecological elements in the design of our enterprise infrastructure.	
	GC4	Reposition our firms' data center to be close to renewable energy source.	
	GC5	Utilize energy from Green power providers in our firm.	
	GC6	Imposes electricity management in our organization.	
Green Distribution	GD1	Install applications to make logistics more eco-friendly.	(Hart, 1997; York et al., 2009)
	GD2	Replaces all systems to energy efficient systems in our firm.	
	GD3	Use software to analyze electricity usage.	
	GD4	Hire the services of expert to maintain our IT facilities.	
	GD5	Install more electricity proficient lightings in our firm.	
	GD6	Advance to effectual transformers and UPS in our firm.	
	GD7	Monitor electricity usage across the firm.	
	GD8	Eliminates and replace unused IT based systems.	
Green Sourcing	GS1	Deploy applications to make raw material purchasing more eco-friendly.	(Murugesan, 2008; Molla, 2009)
	GS2	Buys recycled hardware equipment for enterprise use.	
	GS3	Buy IT hardware from vendors with Green licenses and certifications.	
	GS4	Consider ecological factors when we procure IT hardware in our firm.	
	GS5	Install eco-friendly procurement policy.	
	GS6	Buy IT equipment from merchants that provides take back preference.	
Green Usage	GU1	Employ ecological concern in planning IT operations.	(Murugesan, 2008; York et al., 2009)
	GU2	We applied energy control features for IT equipment in our firm.	
	GU3	Switch off equipment when not in use to reduce energy usage.	
	GU4	Encourage our staffs to adopt double side printing.	
	GU5	Utilizes IT facilities to monitor capabilities and put in sleep mode when idle.	
	GU6	Uses natural cooling within our organization to decrease electricity cost.	
End of Life	EOL1	Recycle expendable apparatus such as paper, ink cartridges and batteries.	(Murugesan, 2008; Molla, 2009)
	EOL2	Ethically dispose outdated IT hardware in an eco-friendly approach.	
	EOL3	Implement policy on dealing with e-waste.	
	EOL4	Reuse IT facilities in our firm.	
	EOL5	Refurbish and repair obsolete IT hardware.	

Table A3 Characteristic of the questionnaire participants

Demographic Profile	Options	Response
Gender	Male	76
	Female	57
Age	< 25	1
	25-34	55
	35-44	59
	45-55	17
	>55	1
Educational Status	High School	4
	Diploma	30
	BSc	43
	MSc	37
	Doctorate	19
Industry	IT based firms	49
	Academic Institutions	66
	Health and Public Relation	2
	Engineering and Construction	2
	Government based Institutions	11
	Personal, Professional	1
	Other Services	2
Years of Experience	0-5	42
	6-10	31
	11-15	35
	16-20	15
	>20	10
Business Size	Below 50 employees	14
	51-250 employees	23
	251- 1000 employees	25
	Above 1000 employees	71
Date Established	Before 1967	10
	Between 1967-1980	26
	Between 1991-2000	52
	Between 2001- 2010	37
	From 2011- Till date	8
Business Income	RM 90,000 < below	19
	RM 90,000-RM 900, 000	14
	RM 900,000-RM 2, 700,000	32
	RM 2,700,000-RM 4,500,000	15
	RM 4, 500,000-RM 9, 000,000	12
	RM 9,000,000 and above	41

Table A4 Correlation analysis

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