

## Development of a Green ICT Model for Sustainable Enterprise Strategy

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### Abstract

Enterprise energy consumption is expected to increase enterprise costs and CO<sub>2</sub> emissions. Presently ICT is seen as an enabler to resolve high energy, cost issues and bring greater efficiency. This is referred as Green ICT which involves energy conservation and cost reduction of ICT usage. Various countries have already applied Green ICT initiatives to reduce CO<sub>2</sub> emissions. Greening ICT strategies in enterprise can decrease these negative impacts. Thus Green ICT aimed at influencing not only technology but also competitive strategy and even the legitimacy of some business strategic options in enterprise. Current findings suggest that although ICT Professionals are already concerns about climate change and power consumption of ICT, there is still a lack of a model that can reduce the time taken to implement Green strategies in enhancing business value in enterprise. Therefore this paper utilized secondary research by reviewing literature on Green ICT and developed a Green ICT model for sustainable enterprise strategy, aimed at reducing time taken to initiate and diffuse Green strategies for enhancing business value in enterprise. The research implication for future studies involves the evaluation of the Green ICT Model. The evaluation will be done using Structural Equation Modelling (SEM) to test the hypothesis derived from the literatures and to check the correlation among the independent, control and dependent variables in this research paper.

Keywords: Green ICT, Sustainability, Enterprise, IT strategy

### 1. Introduction

Green information and communications technology (Green ICT) is an emergent research related with the growing concern of enterprise environmental impact in the 21st century. Sustainability is becoming an imperative domain in ICT aimed at safeguarding our future. Green ICT offers the promise for ICT scholars and researcher to make a significant contribution to reduce CO<sub>2</sub> emissions and mitigating the effects of global climate change and other environmental problems (Mohammad et al., 2015; Jan et al., 2013). In enterprise, ICT mainly comprises all facilities buildings and rooms which contain communication networks enterprise servers, cooling power facilities and equipment for providing data services such as data handling and storage, website hosting, intranet, Internet, telecommunication and computer network (Stan et al., 2010).

Green ICT considers all the mechanical, electrical and computer systems in enterprises mainly geared towards energy efficiency and minimal environmental impact (Stan et al., 2010). The constant growth of information and communications technologies (ICT) has resulted to harmful effects on the environment; Green ICT can have the potential to reduce global CO<sub>2</sub> emissions by 15%. Going Green in enterprise directs results to reduce energy use and

pollution. ICT is faced with issues such as the consumption electricity for ICT operation and the problem of disposing of outdated & obsolete hardware, however sustainable ICT approaches can reduce these environmental problems (Jan et al., 2013; Mohammad et al., 2014). Presently ICT can be seen as one of the causes of environmental problems and ICT also can be seen as part of the solution to solving environmental problems (Alemayehu et al., 2009). On the problem side, each stage of the ICT lifecycle from development to operation and disposal has environmental implications. Approximations indicate that ICT account for 2% of global CO<sub>2</sub> emissions, which is comparable to the volume the aviation industry generates.

In Asia, the electricity consumption of enterprise servers, ICT cooling and power equipment utilize a substantial amount of electricity mostly in the commercial sector. Therefore, it is important to address enterprise energy efficiency in order to confirm that the related impacts, such as economic and environmental expenses are mitigated. Green ICT has emerged as a new domain that addresses environmental issues; it studies, develops and promotes techniques for improving energy proficiency and decreases waste in the full life cycle of IT infrastructure from initial production, through distribution, usage, maintenance, recycling and disposal in an economically responsible way. Green ICT also proposes medium to

decrease CO<sub>2</sub> emissions and reduce the effects of global climate change and other environmental issues. Green ICT involves information technology system initiatives and programs that address environmental sustainability. Due to increasing cost of energy, depletion of natural resources. Green ICT also addresses energy usage and waste related with the use of hardware and software, which tends to have a direct and positive effect. It has been claimed that ICT is an instrumental in tackling the negative environmental effects of the world's rapidly developing economies (Alok et al., 2013). Nathalia et al. (2011) mentioned that Green ICT seems to be the right component to connect both enterprise innovation and eco-friendly integration. Currently Green ICT practices have grown beyond being just a movement, to becoming a necessity, especially for enterprise that needs to attain considerable decreases of CO<sub>2</sub> emissions and cost savings.

ICT can act as a solution by facilitating CO<sub>2</sub> footprint analysis, monitoring and reporting capability via supplanting non-environmental business practices, to development of computerized models to increase energy efficiency and reduce CO<sub>2</sub> emissions. Enterprise can therefore adopt Green ICT either to minimize their ICT associated environmental footprint, thus using ICT as enablers of a broader sustainability strategy (Alemayehu et al., 2009). Sulaiman et al. (2015) suggested that enterprise can decrease energy consumption and can also lower capital expenditure costs significantly, e.g., by substituting laptops for desktops to reduce energy consumption and to avoid use of uninterrupted power supply systems, thus offering opportunities and allows for economic, social and environmental benefits. On the other hand, ICTs can be deployed to tackle the environmental footprint of enterprise strategy. This role of ICTs in enterprise also range from CO<sub>2</sub> investigation and reporting capability to deploying computerized models to reduce energy consumption. Telecommuting, which is a Green ICT approach that offers an important means by which traffic congestion and pollution can be addressed? Another example of Green ICT practice is converting manual paper billing to electronic billing. Telecommunication companies such as Digi, Maxis, Celcom, etc. in Malaysia also practice paper less top up and mobile prepaid subscription by changing e-prepaid subscription to which has a potential to reduce paper consumption.

Green ICT holds greater promise for addressing environmental issues in enterprise. Nevertheless, very little research has examined this potential of Green ICT. This is due to lack of awareness on the impacts of ICT on enterprise' environmental footprints as well as the recent urgency regarding environmental issues. Existing research work in this domain are basically aimed at reducing energy efficient and cost reduction as seen in works by (Watson et al., 2010; Adele et al., 2011; Watson, 2008; Nuttapon and Gabriel, 2012; Alemayehu et al., 2009; Chris et al., 2014) etc. Other researcher aims to identify the factors and drivers that influence the adoption and implementation of Green practices in organisation as seen in works of (Schmidt and Kolbe, 2011; Stan et al., 2010; Stefan et al., 2010;

Sulaiman et al., 2015; Taha and Alemayehu, 2012; Tom, 2011; Zheng, 2011; Alemayehu, 2008; Mohammad et al., 2014; Mohammad et al., 2015) etc. The researcher address issues such as pressure from government and institutional institutions that influences the diffusion of Green practices in organisation. Other works also suggest the need for a model or framework that can assist practitioners in making decision and providing support on how to implement Green practices as seen in works by (Bokolo and Noraini, 2015; Jens et al., 2011; Michael and Aparna, 2010; Watson, 2008; Watson et al., 2010; Alok et al., 2013; Jenkin et al., 2011; Bokolo and Noraini, 2016; Joseph et al., 2013). The advancement of existing work also involves research work that suggested Green process implemented in organisation as stated by (Alemayehu and Vanessa, 2009; Alemayehu et al., 2009; Alemayehu et al., 2008; Xiuna and Lin, 2009; Markus et al., 2013; Biswajit, 2014; Stefan et al., 2011; Murugesan, 2008; Chandani and Anamika, 2015; Nuttapon and Gabriel, 2012; Ijab and Molla, 2012; Alemayehu et al., 2009b; Khalid et al., 2013; Ninlawan et al., 2010; Joseph et al., 2013). However, there is no research that focuses on how to reduce time taken to initiate and diffuse Green strategies for enhancing business value in enterprise. Therefore this paper contributes to the theory and practice utilized secondary research by reviewing literatures on Green ICT and developed a Green ICT model for sustainable enterprise strategy. The model aims to reduce the time taken to initiate and adopt Green strategies in enhancing business value in enterprise expected to minimization of energy consumption of IT equipment, and reduce CO<sub>2</sub> emissions.

The outline of this paper is as follows. Section 2 is the problem statement; section 3 introduces the theoretical background for this paper. The research method is presented in section 4, the Green ICT model is provided in section 5. The discussion of the paper is pointed out in section 6. Section 7 finally states the conclusion of the paper.

## 2. Problem Statement

Sustainable enterprise strategic implementation is a widely debated issue around the world and there has been increasing pressure on enterprise to diffuse eco-friendly practices (Sulaiman et al., 2015; Krishnadas and Radhakrishna, 2014). Although ICT Professionals are already concerns about climate change and energy consumption of ICT. However, the successful implementation of sustainable enterprise strategy is relatively difficult due to the increased time taken to implement Green strategies in enhancing business value in enterprise. Thus there is need for an approach for sustainable enterprise strategy, aimed at reducing time taken to initiate and diffuse Green strategies for enhancing business value in enterprise. Since the role of Green ICT towards sustainable enterprise is important in reducing the time taken in making decisions on how to adopt Green practices as well as minimizing carbon footprint, reducing

e-waste disposal and diminishing energy consumption (Savita et al., 2014).

### 3. Theoretical Background

Green ICT seems to be one area where practice is leading industries, academicians and researchers need to study the innovations put in place by IT Practitioners. Therefore, a review of academic literature, recent practitioner publications relating to Green ICT and environmental sustainability in enterprise domain was carried out. Followed by a summary of scopes of sustainability, information drivers for Green ICT operation, existing research and conceptual model/framework. Thus from the review of the literature, a preliminary theoretical research model is proposed as seen in section 5 of this research paper.

#### 3.1 Scopes of Sustainability

In general sustainability practice in enterprise ranges across 5 dimensions which are environmental, individual social, economic and technical. The dimensions of sustainability are important contributor to the reduction of Green House Gas (CO<sub>2</sub>) in the earth.

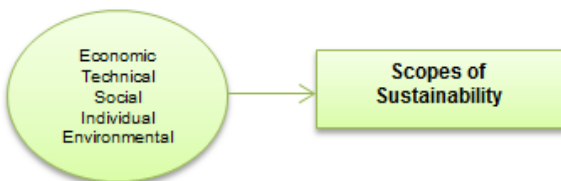


Fig. 1. Scopes of sustainability; based on work from (Birgit, 2015).

Fig. 1 illustrates the scopes involved for enterprise achieving sustainability in their business process. The 5 dimension of the sustainability scope are explained briefly below;

- a. **Environmental:** mainly concerned with the resource flow and waste management, which can be evaluated using Life Cycle Analysis. Moreover, the environmental effects of enterprise can be examined by environmental impact assessment (EIA) (Birgit, 2015). The environmental sustainability considers the impacts of ICT system on the environment.
- b. **Individual:** individual sustainability involves ICT Professionals privacy, safety, security, HCI and usability as well as personal health and well-being, which still needs to be made clear (Birgit, 2015). Individual sustainability is concerned with the welfare of the Professionals in the organisation.
- c. **Social:** social sustainability involves computer supported collaboration in enterprise, which involves the interaction among end users, decision makers and

team members, through ICT for political, development, constitutional, organizational usage etc. (Birgit, 2015).

- d. **Economic:** is concerned with economic constraints and financial expenditure incurred by the organisation in diffusing sustainable practices.
- e. **Technical:** technical sustainability includes ICT quality system requirements such as supportability, reliability, maintainability and portability, which all lead to the durability of ICT systems and infrastructures in organisations (Birgit, 2015). Also energy efficiency and hardware sufficiency can be considered as component of technical sustainability in organisation.

#### 3.2 Information Drivers for Green ICT Operations

According to Watson (2008) the need for information by ICT Professionals leads them to seek information systems that provide *ubiquity* such as the usage of cell phones to communicate with end users, *uniqueness* such as navigation systems to transport developed software products/services to end users. *Unison*, which is involved when team members uses synchronized calendars, and lastly *universality* which involves services that has high functionality such as smart phones that provide ICT professionals with the latest information relating to the environment and weather. Sustaining these four information drives is a key component in creating a successful enterprise, which is also critical to implement sustainable practices in organisation. Thus to design and develop systems to serve end users, ICT systems and application should accomplished the four drives from both physical and theoretical perspective, for a sustainable business process. Helen et al. (2012) contributed by saying that information usage via ICT can assist to reduce energy consumption, which is one of the aims of IT Managers as there is a clear cost saving that comes with the use of less energy as energy prices increases.

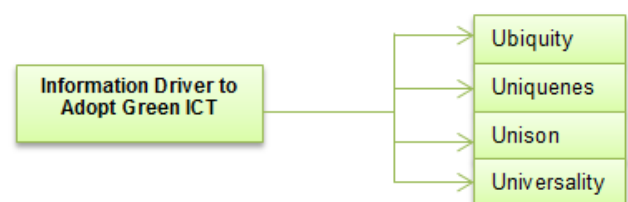


Fig. 2. Information driver of Green ICT adoption Adopted from (Watson, 2008; Grant and Sam, 2012)

Fig. 2 shows the information drivers for Green ICT adoption in enterprise. Fig. 2 also illustrates that information is an important driver in the form of ubiquity, uniqueness, unison and universality.

- a. **Ubiquity:** refers to ICT Professionals and end users having access to information unrestricted by time and

space (Watson, 2008; Grant and Sam, 2012). In a practical sense ubiquity is the ready availability of desired resource for practitioners' usage. For example in a sustainable environment, there is need for certain density of critical physical resources to be generally valuable. An appropriate ICT system can improve physical ubiquity by providing users with information about the ICT system or application. Ubiquitous information access could be used to enhance utilization of ICT infrastructures, thus contributing to environmental sustainability.

- b. *Uniqueness*: is concerned with the knowing of the characteristics and precisely location of a person or object (Watson, 2008; Grant and Sam, 2012). Thus uniqueness deals with the capability to design and provide precisely ICT infrastructure and resource to end user's unique needs.
- c. *Unison*: means to have consistency information (Watson, 2008; Grant and Sam, 2012). This refers to process involved in accessing or utilizing physical resource that has little variation across access points. ICT enhances procedures by providing a simple and useable system to end users. This is carried out by providing easy to use interfaces that hide procedural complexity and assimilates; integrate information across physical application and systems (Watson, 2008).
- d. *Universality*: means overcoming the friction of ICT incompatibilities (Watson, 2008; Grant and Sam, 2012). Universality is sought to overcome the friction of physical differences among various ICT applications and system. ICT can help in information transition between different physical systems when implementing Green practices in enterprise.

### 3.3 Existing Green ICT Research and Conceptual Model/Framework

An enterprise sustainability pursuit is basically based on its organisational strategic employed in its business process. Thus Katrina et al. (2014) focused on infusing Green in supply management adoption due to the fact that the ecological impact of the purchased products, like pollution, inadequate waste management and recycling, CO<sub>2</sub> emissions (especially in transportation), water and energy consumption in the production phase, are a serious concern. The researcher developed a conceptual model based to mitigate risk that occurs in Green supply management. The conceptual model comprises of property right, brand & image, quality, price control and outsourcing as independent variables and firm's size, volume of the purchases and industry type as control variable.

Jens et al. (2011) contributed to Green and environmental sustainability by researching on impact of pressure for environmental sustainability on grid assimilation trying to address high cost and increase energy usage. The researcher designed a research model based on the theory of pressure being the determinant variables for

Green practice adoption in enterprise. Their research model comprises of pressure for environmental sustainability, memetic pressure, coercive pressure and normative pressure as independent variables and Grid assimilation as Green IT strategy as dependent variable. Their model also comprises of country, firm size and earliness of grid adoption as the control variables. The designed research model helped the researchers to validate the impact of ecological pressure and institutional pressure on the assimilation of grid technology in enterprise.

Alemayehu and Ahmad (2012) researched on the factors influencing the adoption of Green technologies in enterprise. They empirically investigated the influence of enterprise sustainability motivations on the adoption of Green IT, showing that eco-efficiency and eco-effectiveness motives influence the adoption of technologies that improve the energy efficiency of IT infrastructure and subsequent pollution reduction. They also explain differences in the acceptance of strategy and practices that aim to enhance product ethics of the IT lifecycle from sourcing to disposal phase. They proposed a researched framework that comprises of eco-efficiency motive, eco-effectiveness motive, eco-responsiveness motive and eco legitimacy motive as independent variables and adoption of Green IT as dependent variable. The control variables are size of the enterprise and type of industry.

Adele et al. (2011) studies how institutional pressures affect the implementation of Green IS/IT in enterprise. They studied Green IS/IT practices with strategic emphases on pollution prevention, product stewardship, and sustainable development. Each of incorporates the different roles played by ICT (as a problem) and IS (as a solution). They presented a research model that comprises of mimetic pressures, mimetic coercive and coercive pressure as independent variables and adoption of Green IS & IT as dependent variable. For control variable two ordinal variables was used; industry type and revenue range was of the organisation.

Sulaiman et al. (2015) worked on the impact of Green IT practices on organisational performance and examines the factors that affect the adoption intensity of Green IT practices and their subsequent influence on the firm's performance in the context of a developing country. The researcher recommended a research model. The model 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. The research model dependent variables are economic performance, environment performance and customer satisfaction.

Chin-Jung et al. (2015) researched on an empirical study on the impact of Green activities on firm performance. The researcher compared an array of Green activities among ISO 14000, Green processes, pollution prevention, green certifications and analyse their associations with enterprise performance.



The researcher classified Green activities to identify the connection between enterprise features, the types of Green activities and they discovered what Green activity can cause better enterprise performance. Their research approach was to find out if an enterprise's characteristics affect its Green strategy decisions? And do the Practitioners Green activities affect enterprise performance? To answer these question. They introduced Green activities and performance as dependent variables, degree of research and development (R&D) as independent variables. Lastly firm size, timing and industry sector as the control variables.

Stefan et al. (2010) explored on the enablers and barriers to the organizational adoption of sustainable business practices. They exactly believed that there is a need to investigate how sustainable practices can be adopted within an enterprise to enable, support, or achieve long-term sustainability. Their conceptualized idea comprises of strategic definition, organizational support, motivation and traceability through information systems as independent variables and successful adoption of sustainable practice as dependent variable.

Stan et al. (2010) develop a conceptual framework abased on an exploratory case study in Greening data centres. The researchers contributed by identifying the antecedents to the adoption of technologies and techniques including those that are commonly accepted to produce successful outcomes, such as best practices in Greening data centres. The developed conceptual framework aims to show the variables that influences the adoption of the best practices in Greening data centres in enterprise. The framework comprises of institutional forces, motivation, ability and expectancy as independent variables and adoption of Green data centre best practice as dependent variable.

#### 4. Research Method

The paper is theoretical and exploratory in nature, and conducts a research synthesis on relevant literature on Green ICT and sustainability in enterprise. Research synthesis and extraction of the literatures was carried to identify the Green variables and Green process needed for developing the model. Research syntheses make a valuable contribution to the academic body of knowledge, and further academic discourse by uncovering meaningful, abstract features, patterns in providing new perspectives. This research paper synthesis begins by analysing the existing model purposes and variables. The model variables are then aligned compared to each other based on the aim of the proposed model to be developed. Also in order to develop the conceptual foundation of the model developed in this paper, we undertook review of IT Professionals oriented Green IT publications and literature on the adoption of Green process in enterprise.

##### 4.1 Green Meta-Concept of ICT in Enterprise

Alemayehu (2009) cited Orlikowski and Iacono (2001) and mentioned 5 meta-concepts of ICT namely tool view,

proxy view, ensemble view, computational view and nominal view.

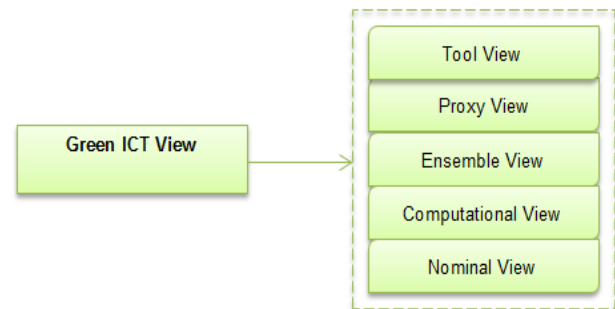


Fig. 3. Green ICT view; based on work from (Alemayehu, 2009).

Fig. 3 shows the Green ICT view or the Green meta-concept of ICT in enterprise. It can be seen that Green ICT has and can contribute in any of the 5 view shown in Fig. 3. Below is a brief explanation of each of the view of Green ICT contribution;

- Tool view*: refers to the ICT technical infrastructure and signifies the engineered system. The tool view has established in ICT related study in 4 different ways. Which are ICT as a tool for labour replacement, ICT as a tool for improving production, ICT as a tool for information handling, and ICT as a tool for exchanging collective associations among team members.
- Proxy view*: mainly involves the critical aspects of ICT through substitute measures such as organisations perceptions, information dissemination rates, or money spent.
- Ensemble view*: denotes the network of computing which includes the commitments, supplementary resources such as training, skilled staff & support services and the improvement of managerial arrangements, policies and incentives to support the operational management and use of new ICT technologies. It also focuses on the approach in which ICT came to be developed and on how ICT come to be utilized and deployed in organisations.
- Computational view*: emphasizes on the competences of the ICT to manipulate, represent, store, transmit and retrieve information, in so doing processing, supporting, simulating or modelling aspects of the real world. It usually comprises the advancement of computational models and algorithms that aims to reduce energy usage in enterprise. This research is under computational view.
- Nominal view*: indicates where the IT artefact is neither conceptualized nor theorized. In the nominal view, despite the use of the words IT or IS, IT does not constitute either a dependent or independent variable.

## 5. Green ICT Model

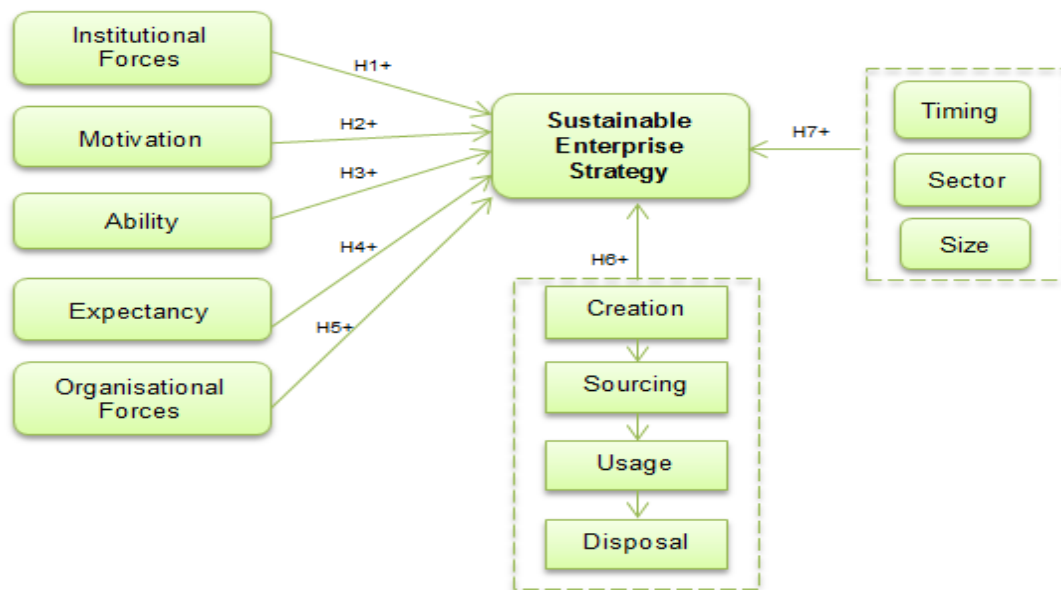


Fig.4. Green ICT model.

Fig. 4 shows the developed Green ICT model for sustainable enterprise strategy. The model is aimed at reducing the time taken to initiate and adopt Green strategies in enhancing business value in enterprise. The model variables are shown in Fig. 4. The independent variables in the model are mostly based on previous research by Stan et al. (2010). It can be seen that the institutional forces, motivation, ability, expectancy and organisational forces are the **independent variables** that influence the **dependent variable** sustainable enterprise strategy. Whereas timing, sector and size are **control variables** which are constant in the enterprise. Lastly creation, sourcing, usage and disposal can be seen as the **Green process** being carried out by IT Professionals in the enterprise. It is observed from the literature that the Green process and the control variables also influence the dependent variable.

H1+ to H7+ are hypotheses that are to be tested to check if there is really a correlation between the independent variables and the **dependent variable, between the control variables and the dependent variable and between the Green process and the dependent variable.**

### 5.1 Variables, Green Process Description and Hypothesis Development

The model in Fig. 4 was developed based on previous work. Existing models address various issues of sustainability in enterprise such as energy consumption reduction and decreased cost of organisation in achieving business process. But there is still a lack of a model that can reduce the time taken to implement Green strategies in enhancing business value in enterprise. Thus the developed model aimed to reduce the time taken to initiate and adopt Green strategies in enhancing business value in enterprise.

This is achieved based on the variables and hypothesis below;

- Institutional forces: this variable was mentioned by (Bokolo and Noraini, 2016; Jenkin et al., 2011; Stan et al., 2010; Sulaiman et al., 2015; Bokolo and Noraini, 2015; Alemayehu et al., 2008; Decio et al., 2015; Roya et al., 2013; Mohammad et al., 2014; Qi and Shaobo, 2015; Carolyn and Jean-Paul, 2014; Krishnadas and Radhakrishna, 2014; Savita et al., 2014; Sachin et al., 2015; Sachin et al., 2015; Birgit, 2015; Carolyn and Jean-Paul, 2014; Mueen et al., 2015; Ibrahim and Alok, 2014; Oriana and Elena, 2014). Institutional forces are concerned with the inspirations that affect social and enterprise structures, norms, rules, routines and behaviour of IT Professionals and organisational management. It also affects the sustainable enterprise strategy, since it's an independent variable. It refers to understanding of sustainability and environmental issues in enterprise. Institutional forces motivate social behaviour via normative, coercive and mimetic pressures (Stan et al., 2010). Thus institutional forces control how an enterprise conducts its business relation to adoption Green ICT based on standard set mostly by government or industries. These standards and regulation are dedicated to sustain external groups and would include responding to pressure from government, regulatory bodies, and staffs of organizations (Bokolo and Noraini, 2015). However, government policies and regulation are put in place to ensure IT professionals and organisations respond to environmental issues and incorporate it into their business strategy, which is usually required, but also in the form of guidelines

(Bokolo and Noraini, 2016). Based on the institutional forces variable, the hypothesis is formulated;

**H1:** Institutional forces will be positively related to the adoption of a sustainable enterprise strategy.

- b. Motivation: this variables was mention by (Grant and Sam, 2012; Mohammad et al., 2015; Bokolo and Noraini, 2016; Jenkin et al., 2011; Stan et al., 2010; Sulaiman et al., 2015; Bokolo and Noraini, 2015; Krishnadas and Radhakrishna, 2014; Savita et al., 2014; Sachin et al., 2015; Mohammad et al., 2014; Qi and Shaobo, 2015; Deepti et al., 2014; Ibrahim and Alok, 2014). The motivation of enterprise to implement Green and sustainable practice are based out of concern for improving effectiveness, and out of care for the natural surroundings. It can also affect the sustainable enterprise strategy, since it's an independent variable.

Such motivation is in accordance with the notion that enterprises are bound to assure decision makers that the organisation makes an adequate profit. Therefore, any decision concerning Green practices is likely to be based on a cost benefit analysis that is in line of the organisation gaining profit. Presently it can be seen in enterprise that rising energy costs, cost savings and a desire to get more out of existing savings are the main motivators for adopting best practices to Green and sustainable enterprise (Stan et al., 2010). Based on the motivation of the enterprise we put further the following hypothesis;

**H2:** IT Professionals and Management with higher motivation will be more likely to adopt a sustainable enterprise strategy.

- c. Ability: proposed by (Stan et al., 2010; Sachin et al., 2015; Mohammad et al., 2014; Qi and Shaobo, 2015; Deepti et al., 2014; Ibrahim and Alok, 2014). The ability of an enterprise includes its willingness, capability and learning in respect to adopting a sustainable and Green practice. In the context of improving enterprise strategy, this is reflected through the attitude of an IT Professional in the enterprise towards the natural environment. It can also affect the sustainable enterprise strategy, since it's an independent variable. However the commitment of enterprise management to environmental performance, and the capability of the enterprise for implementing sustainable practices for improving the enterprise environmental performance (Stan et al., 2010).

Enterprise climate and IT professionals attitude towards the natural environment is an important factor for the diffusion of Green practices in an enterprise. But this is dependent on the commitment of management to shared environmental strategy, along with active encouragement of environmental procedures that emerge from lower levels of the

enterprise. Enterprise ability can also include governance, which offers an outline for describing a composite set of associations and activities in enterprise relationships. It is the operating agenda that defines the governance of IT decisions and Green IT initiatives. Based on the work by Stan et al. (2010), we put forward the hypothesis;

**H3:** The IT Professional ability is positively associated with the adoption of a sustainable enterprise strategy.

- d. Expectancy: suggested by (Stan et al., 2010; Carolyn and Jean-Paul, 2014; Qi and Shaobo, 2015; Deepti et al., 2014; Ibrahim and Alok, 2014). The expectancy of the management and decision makers in the organisation is a variable that can influence the sustainable enterprise strategy, since it's an independent variable. Nevertheless, the expectancy of the management in the enterprise is likely to influence organisations' adoption of sustainable practices. The expectancy refers to the concepts of supposed usefulness and anticipated benefits, that is, the return on investment derived from Green ICT usage and effort from IT Professionals.

The expectancy of the management and decision makers in the organisation has emerged as an important variable in adoption of Green ICT for sustainable enterprise strategy. Similarly, in enterprise, there is a clear lack of confidence that Green practices strategies will lead to savings, suggesting that sustainable practices are not perceived as useful (Stan et al., 2010). Thus we hypothesized the following;

**H4:** The adoption expectancy of Green ICT practices by the management is positively associated with sustainable enterprise strategy.

- e. Organisational forces: suggested by (Alemayehu et al., 2008; Grant and Sam, 2012; Alemayehu, 2008; Bokolo and Noraini, 2016; Jenkin et al., 2011; Stan et al., 2010; Sulaiman et al., 2015; Bokolo and Noraini, 2015; Alemayehu, 2009; Stefan et al., 2010; Adela et al., 2011; Stefan et al., 2011; Alemayehu and Ahmad, 2012; Watson, 2008; Katrina et al., 2014; Jens et al. 2011; Chin-Jung et al., 2015; Sulaiman et al., 2015; Daqing, 2011; Tom, 2012; Savita et al., 2014; Sachin et al., 2015; Mohammad et al., 2015; Mohammad et al., 2014; Birgit, 2015; Carolyn and Jean-Paul, 2014; Qi and Shaobo, 2015; Mueen et al., 2015; Deepti et al., 2014; Ibrahim and Alok, 2014; Oriana and Elena, 2014). This variable comprises the involvement of the IT Practitioners and the management working together to achieve sustainability in their organisation. Thus the organisational force is a variable that can influence the sustainable enterprise strategy, since it's an independent variable.

The management works together to realize the social, economic as well as environmental benefits of

accomplishing the aims and objectives of the firm. The management must provide training successions and campaigns to inform their staffs on how techniques such as telematics can improve enterprise sustainable strategy (Bokolo and Noraini, 2015).

The organisational forces influence ICT Managers and professionals, environmental stewards and top management. Although, IT Professional' commitment is Important in achieving a sustainable enterprise strategy in planning, deploying, implementing, validating and maintaining the enterprise ICT system with eco sustainability considerations in mind.

Thus IT Professional collaboration is based on their shared interest and stakes in achieving the objectives and aims of the enterprise (Bokolo and Noraini, 2016). Thus we propose to find out the relationship between the organisational forces and the sustainable enterprise strategy, thus we formulate the following hypothesis;

**H5:** Organisational forces will be positively related to the adoption of a sustainable enterprise strategy.

f. Green process in enterprise: mention by (Alemayehu and Vanessa, 2009; Alemayehu et al., 2009; Bokolo and Noraini, 2016; Mohamad et al., 2010; Alemayehu, 2009; Robert et al., 2012; Bokolo and Noraini, 2015; Nathalia et al., 2011; Alemayehu et al., 2008; Xiuna and Lin, 2009; Markus et al., 2013; Biswajit, 2014; Stefan et al., 2011; Murugesan, 2008; Chandani and Anamika, 2015; Nuttapon and Gabriel, 2012; Ijab and Molla, 2012; Alemayehu et al., 2009b; Khalid et al., 2013; Ninlawan et al., 2010; Joseph et al., 2013; Krishnadas and Radhakrishna, 2014; Savita et al., 2014; Deepti et al., 2014). This are the current sustainable activities implemented in the enterprise by the management and IT Professional. The processes are shown below;

- **Creation:** From a design viewpoint, Green ICT refers to the role of ICT in supporting enterprise's sustainability initiatives. This is done when IT Professional utilizes analytical information systems for their organizational process, environmental management and carbon foot print analysis in their design and production activities. It also comprises ICT based low CO2 enterprise solutions such as telecommuting, IP telephony, thin client, web based business services, video-conferencing and virtual collaboration.
- **Sourcing:** In sourcing or procurement Green ICT implies the practice of environmentally preferable ICT infrastructure purchasing in enterprise. This involves adoption of sourcing practices such as analysis of the environmental foot print of an IT hardware, evaluation of the Green track record of software application and ICT services providers, integrating Green issues such as recyclable design and packaging in merchant evaluation, and

inclusion of social concerns such as the presence of harmful materials in ICT process in Green procurement decisions.

- **Usage:** From a usage or operation perspective, Green ICT involves enhancing energy efficiency in powering and cooling enterprise IT assets and reducing IT induced CO2 emissions. This phase aims to bring about energy consumption reduction by optimizing of energy utilization without reducing the installed power base, structural avoidance results in reduction installed power capacity.
- **Disposal:** From disposal or end of life perspective, Green ICT refers to practices in recycling reusing and disposing IT hardware.

Based on the Green process activities by IT Professional in their enterprise, we hypothesized that;

**H6:** Interaction between creation, sourcing, usage, disposal practice will have a positive effect on the adoption of a sustainable enterprise strategy.

g. Timing, sector and size: presented by (Chin-Jung et al., 2015). These are the control variables, which are constant and unchanged throughout the research.

- **Enterprise size:** mentioned by (Chin-Jung et al., 2015; Jens et al., 2011; Bokolo and Noraini, 2016; Katrina et al., 2014; Sulaiman et al., 2015; Alemayehu and Ahmad, 2012; Bokolo and Noraini, 2015; Schmidt and Kolbe, 2011; Savita et al., 2014; Sachin et al., 2015; Mohammad et al., 2014; Jack and Lucky, 2015; Oriana and Elena, 2014). Enterprise size may affect strategic main resources, which strongly correlate to enterprise performance. Thus, the present study includes enterprise size and measures based on enterprise's total assets. According to Sulaiman et al. (2015) Sustainable enterprise strategic adoption differs according to the size of the enterprise. Smaller firms have a less sophisticated understanding of technical ICT issues while larger firms are usually in possession of more technology, finance and human resources. However, larger enterprises are also disadvantaged as they tend to be less agile and flexible than smaller enterprise. In contrast, smaller enterprise are expected to be more innovative, as they require less communication, less coordination and less external influence to make decisions. Although Small and Medium Enterprises (SMEs) often suffer from a lack of financial resources, they are usually quicker to adapt to meet new market needs.
- **Industry sectors:** mentioned by (Chin-Jung et al., 2015; Katrina et al., 2014; Bokolo and Noraini, 2016; Adela et al., 2011; Sulaiman et al., 2015;



Bokolo and Noraini, 2015; Alemayehu and Ahmad, 2012, Chris et al., 2014; Krishnadas and Radhakrishna, 2014; Savita et al., 2014; Sachin et al., 2015; Mohammad et al., 2014; Carolyn and Jean-Paul, 2014; Deepti et al., 2014; Jack and Lucky, 2015; Oriana and Elena, 2014). Enterprise in different industry sectors may perform differently in terms of Green and sustainable practice adoption and implementation in their organisation. As enterprise in different industry sectors have dissimilar needs, it appears that those in more information intensive sectors are more likely to adopt Green ICT practices than those in less ICT intensive sectors.

Enterprise such as customer service industries such as banking, airlines, courier services, etc. which tend to have more information content in their products and services are more likely to utilize Green ICT for competitive advantage than those in manufacturing sector. Presently adopters of electronic-commerce from the manufacturing sector tend to face more setbacks than other sectors. Enterprise type could affect the intensity of adoption and implementation of sustainable enterprise strategy (Sulaiman et al., 2015).

- Timing: mentioned by (Chin-Jung et al., 2015; Jens et al., 2011; Sachin et al., 2015; Mohammad et al., 2014; Jack and Lucky, 2015; Oriana and Elena, 2014). The time an enterprise first employs Green activities may affect its performance due to first-mover advantage or disadvantage. The present study includes timing as a control variable to identify when an enterprise starts to adopt Green and sustainable practices. Based on the control variables, we hypothesized that;

**H7:** The adoption of a sustainable enterprise strategy varies due to how long the enterprise is existing, enterprise sector and enterprise size.

#### h. Sustainable enterprise strategy

This is the dependent variable as previously stated; this variable depends on other variables. A sustainable enterprise strategy is the target of this research paper, which aims to reduce the time taken to initiate and adopt Green strategies in enhancing business value in enterprise.

### 5.2 Sustainable Enterprise Strategy

Enterprise strategy mainly involves description of the firm in terms of its revenue, scope, size, management structure and geographical location of the firm (country). Enterprise strategy also describes how the enterprise implements their business strategies to accomplish the aims and objectives of the enterprise (Bokolo and Noraini, 2016). Thus strategies implemented by the enterprise to accomplish their objectives are very important in adopting

sustainable practices in enterprise. Enterprise strategy support enterprise in reducing their cost of operating in product development. Thus sustainable enterprise strategy is the most prominent drivers of Green ICT by reducing costs and CO2 emissions, thus achieving sustainable development in enterprise (Bokolo and Noraini, 2015). However, Green ICT practices is able to redesign how IT professional in enterprise advancing their future eco-sustainability procedures and practices, especially those facilitated by ICT implementation.

Joseph et al. (2013) mentioned that the adoption of Green practices in enterprise is necessary to help ICT practitioners address environmental issues in their organisations. Therefore Green ICT can support enterprise processes in using less energy, recycling, reusing materials, reducing waste, reduce pollution, preserve natural resources, and finally achieve environmental sustainability strategic in enterprise. Thus, Green ICT for environmental sustainability involves enterprise practices and processes that enhances environmental and economic performance of enterprise. ICT supports business processes and strategy nowadays, indeed, enterprise can only benefit from the potential of ICT, leading to improved enterprise performance, if ICT is strategically aligned with organization business process. Thus Green ICT strategies in enterprise supports eco-sustainable target.

## 6. Discussion

Green is associated with enterprise, systems, products and development processes which involved use less energy; recycle and reuse materials; reduce waste, water use, and pollution; and preserve natural resources (Mohankumar and Anand, 2015). Green ICT is the practice of modelling, developing, utilizing and disposing of computer, servers and associated subsystems effectively and efficiently with insignificant or no impact on the environment, and with a strong focus on using ICT to improve sustainability across the enterprise (Qi and Shaobo, 2015). In recent years, Green ICT has been implemented with incredible success among companies on both local and international scale. The environmental protection aspect has become the adequate core that many industries are trying to follow in order to be more environmentally responsible.

Computers and electronic machines from all companies are consuming significant amounts of electricity, releasing CO2 gas, which contributes to greenhouse gas emissions. The electrical usage is the main cause of climate change. Furthermore, the unwanted ICT hardware's also results to environmental problems during both of production and disposal process. These unwanted hardware equipment's are referred to as electronic waste (e-waste). Most companies are trying to minimize or eliminate the environmental impact of IT and to support the managing sustainable environment. In particular, Green ICT is about improving or maintaining computing performance, while reducing the energy consumption and the carbon footprint.

However, implementing Green ICT principles into practice involves the usage of many resources. Presently,

companies have to spent huge amounts of money in order to reconstruct their IT infrastructure (Nuttapon and Gabriel, 2012). ICT Infrastructure in enterprise is technologies that support sustainable related businesses, and IT Professionals refers to IT human processing the knowledge and skills to implement Green ICT systems and applications. However, due to the increasing impact of ICT on economy, society and environment, the administration of ICT hardware manufacturers and ICT service organizations are facing the issues to take the concept of sustainability into account for their organizational services. While ICT industry is under the responsibility of 2% of the world's total CO2 emissions. Since Green ICT is also useful to reduce CO2 emissions by other industries, therefore it is looked as the latest solution with a promise to solve the environmental problem. Green sustainable strategy can support economical enterprise strategies as well as it can shape them, depending on the role of ICT within the enterprise (Fabian et al., 2012).

Therefore the role of Green ICT is determined by the shared view and managerial perception of ICT infrastructure and capabilities in relation to the business requirements of the organisation. Thus Green enterprise strategy is the firms' perspective on the investment in, deployment, use and management of ICT in order to minimize the negative environmental impacts of ICT infrastructure usage. The strategies at administrative level influences the values and attitudes of IT Professional in the organisation and thus influence organizational culture and social perception of the enterprise to improve resource productivity and decrease costs..

## 7. Conclusion

Green ICT represents the support of environmental management efforts by assisting enterprise internal environmental management systems and by meeting the reporting needs for various IT professional and stakeholders. Green ICT can provide sustainable enterprise strategy needed for coordinating with IT Professional in terms of eco-activities. Green ICT also provides the information necessary to make decisions about sustainable, in terms of resource and energy consumption, reuse, recycling and recovery of ICT related materials (Jeremy et al., 2013). A model was developed in this research paper. The developed model assist IT Professionals to monitor enterprise strategies using the Green process to ensure environmental sustainability in enterprise.

The model can also track environmental information, which can be used to decrease energy consumption, and monitor emissions and e-waste reduction. The model also system provide information that encourages Green choices adoption and diffusion in enterprise aimed at improving decision making of decision makers and management on issues related to sustainability. The model also reduces the time taken to initiate and adopt Green strategies in enhancing business value in enterprise. IT Professionals can utilize the variables in the model to diffuse Green strategies in their organisation. The model can also be used

by other researchers that are studying on Green and sustainable practices in enterprise. Therefore researcher and academicians can use the model as a road map to attain sustainability in enterprise.

In addition, the proposed model is useful to Green ICT Professional, and ICT Managers who are considering to adopt Green ICT in their enterprise, the research model can be used as an analytical outline to support their Green decision making process. The model aims to assist practitioners in implementing and adopting Green ICT practices aimed at attaining a sustainable enterprise strategy. However the model cannot fully support practitioners in spending less when adopting Green practices in their organisation. The model also cannot assist practitioners in making decisions on how to implement Green practices in their organisation.

Future work involves the evaluation of the developed model. The evaluation will be done using Structural Equation Modelling (SEM) to test the seven hypothesis and to check the correlation among the independent variables (the institutional forces, motivation, ability, expectancy and organizational forces), control variables (timing, sector and size) and Green process (creation, sourcing, usage and disposal) with the dependent variable (sustainable enterprise strategy).

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