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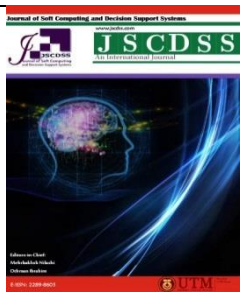

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# Green Information Systems Integration in Information Technology Based Organizations: An Academic Literature Review

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**Abstract**

In the last decades, environmental sustainability has become a significant organizational consideration. Yet, regardless of the ability of Information Systems (IS) to lower Information Technology (IT) based organizations' adverse environmental effects has not been fully achieved. Research has shown that the integration of Green practices in IT based organization is still relatively low. In order to better understand how Green practices affect the formation and outcomes of IT based organizational projects. The integration of Green IS strategies and initiatives within organizations business activities has become a vital enterprise need. However existing scientific contributions and discussions in Green IS are mainly based on empirical surveys and case studies. Furthermore, little research has been undertaken to highlight the contribution of IT based organizations in integrating Green IS practices in their business process and only few review papers relating to Green IS has been published. Although, there has been other review papers published in this domain, no paper has reviewed how IT based organizations integrated Green practices into their day-to-day business process. Therefore this paper carried out a literature review to synthesize and extract data from existing academic publications to review and report the current Green IS practices integration in IT based organizations. Findings from this review presents the sustainability goals to be attained and also shows that currently IT based organizations are beginning to integrate Green IS strategies and initiatives in their business process but are encouraged and at times limited by determinants (enablers and inhibitors).

Keywords: Green information system, Sustainability, Green integration, Academic literature review, Information technology based organizations

## 1. Introduction

Eco-friendly and sustainable strategies in Information Technology (IT) based organizations have emerged as crucial topics in research over the last few years. Sustainability has progressively become imperative to organizational practice and research since the 1990's, as a result of rapid utilization of natural resources and distresses over corporate social responsibility (Elkington, 1997; Elkington, 2004). Sustainability was defined by the Brundtland Commission as development that meets the wants and need of the present day, without conceding the ability of future generations to achieve their own wants and needs (WCED, 1987). According to WCED (1987) for organizational development to be sustainable, the decision of practitioners, management and stakeholders about institutional orientation, technological innovation with natural resource utilization have to be stable with present as well as needs future (Leyland et al., 2011). For IT based organizations, this entails complementing the alignment of economic target with corporate responsibility toward the natural environment and the wider society. Thus, an acceptable way of describing sustainability in IT based organization is through its orthodox paradigm that encompasses economic, environmental and social needs (Alemayehu et al., 2011).

In another study Hart and Milstein (2003) suggested that eco-sustainability practice in organizations is mostly concerned with reducing emissions, lessen water usage, diminish waste generation, improving effectiveness and lessening the total environmental footprint of enterprise business strategies. Hart's (1997) also recommended that organizational sustainability strategies of product stewardship, pollution prevention and sustainable development can offer a better and more organized ideal foundation to enlighten IT based organizational Green practices. Green Information Systems (IS) integration in IT based organizations includes the use of technologies to transform enterprise initiatives by integrating practices that preserve materials; that are non-polluting, energy proficient and produce lesser waste (Mohamad et al., 2011).

The state of creating a balance of social responsibility, environmental obligations with economic profitability is usually referred to as the Triple Bottom Line (Alemayehu et al., 2011). IT usage in organizations and the society at large has resulted to IT causing damage to the environment.

With more than 1.5 billion people online across the globe, the energy utilization of the Internet is aggregating by more than 10 percent each year. The power usage of the IT based organizations has gone from being moderately little to surpassing other sectors like the aviation industry. Discarded outdated and obsolete IT equipment contains several harmful substances which constitute several quantities of lead that are likely to percolate into groundwater or can also result to air pollution through burning. In IT based organizations each stage of the IT lifecycle from design, distribution to usage and disposal pose environmental issues. In the year 2007, it was estimated that IT based organizations had produced 1.3 percent of global CO2 emissions and used 3.9 percent of electricity (Alemayehu and Ahmad, 2011).

Present research by Leyland et al. (2012); Fabian (2013); Vanessa and Alemayehu (2013) suggests that just as IT has contributed to humanity environmental dilemma, IT through Green IS integration can also be a tool to help us get out of this dilemma. However, IT based organizations are required to diminish IT related energy usage, CO2 emissions, inefficiency servers utilization, and electronic waste reduction. These tasks to be implemented by IT based organizations can be accomplished by practitioners integrating Green IS strategies and initiatives to provide IS infused solutions that support enterprise to monitor, measure, report and enhance their environmental footprint within their business processes. Green IS can shape beliefs of practitioners in IT based organizations and also improve economic and environmental performance (Richard et al., 2010).

Referring back to the aim of this review paper Green IS practice in IT based organizations aims at reduce pollution at the end of production and business processes; diminishing the environmental footprint during design processes; using clean technologies to lessen polluting materials and increasing environmentally friendly capabilities (Alemayehu and Ahmad, 2011). Green IS assists the reuse of energy flows across organization resulting to a more supply efficient creation system and less adverse environmental effects. Hence, an increasing number of IT based organizations are moving to digitization of their enterprise processes to make them more energy efficient and less carbon intensive. Therefore, Green IS can help support enterprise wide application of product stewardship, pollution prevention and sustainable development initiatives and strategies (Hart, 1997; Alemayehu and Ahmad, 2011).

Green IS produces several research opportunities at the organizational, individual, environmental and social level. The focus of Green IS which usually refers to making IT more environmentally friendly and resource saving is extending as the years go by. According to Kranz and Picot (2011) Green IS incorporates improved solutions that help organizations increase environmental sustainability. Research in Green IS is one of the newest manifestations in the area of sustainable enterprise practices. The decisions surrounding Green IS integration initiatives and strategies provide persuasive challenges for IT based organizations. As practitioners and management have been highly concerned in this topic for a while (known as Green IS), there has also been emergent interest in Green IS within the IS research community. IT based organizations varies in their routine in practicing sustainable activities of their own operations and in their capability to deliver products and solutions that transform and enable the environmental sustainability. Green IS focuses on utilizing Information Systems to support energy effectiveness of IT facilities deployment and reduction of generated electronic waste to facilitate a sustainable organizational process.

Presently a few IT based organizations are beginning to see the benefits to be derived from integrating Green strategies and initiates in their business process. Although, few IT based organizations are currently integrating Green practices into their daily activities. However, according to Jan (2016) there is a gap in understanding how Green IS initiatives and strategies can be effectively integrated in IT based organizations. To resolve these gaps, this research-in-progress review paper conducts a comprehensive extraction and synthesis of “105” papers to provide answers to the research questions in this review paper.

This paper carries out an academic review to highlight and present existing IT based organizations that practice Green strategies and initiatives. This paper also presents the determinants that influence IT based organizations to go Green. To accomplish the aim of this review paper the author adopts the review method proposed by Webster and Watson (2002) in carrying out an academic literature review, thus existing literature related to Green sustainable practice in organizations are only included in this review paper. The scope of the academic literatures review search papers is from the period of 2007 because from this year academicians started to investigate deeper into Green IS.

According to Stoney et al. (2012) Green IS was mentioned for the first time in 2007 in a Chief Information Officers (CIOs) magazine. Therefore the author considers 2007 as the start point of this review. As mentioned previously a total number of “105” papers comprising of “99” journal articles and conference proceeding papers, “5” papers from the fathers of ecological sustainability and environmental sustainability research WCED (1987); Elkington (1997); Hart (1997); Hart and Milstein (2003); Elkington (2004); and another “1” paper on how to write an academic literature review by Webster and Watson (2002) was included to this review paper. However each selected paper is passed through a rigorous inclusion and exclusion criteria check, duplicate check and other related papers are added based on cross reference check.

The structure of this paper is organized as follows: Section 2 presents the materials and methods. Section 3 describes the results and findings of the review. Section 4 is the discussion and lesson learnt. Section 5 is the research motivation and implications of study. Finally, the conclusion and future work is presented in Section 6.


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## 2. Materials and method

In order to perform the academic literature review, a broad understanding of Green IS practice in IT based organization was necessary. Consequently, this Section aims to highlights how the literature review was carried out in order to present the existing organizations identified from academic literatures that integrates Green IS practices, adopting the academic literature review method. An academic review aims to syntheses, extract, appraise and critique academic literature related to the research area that is being investigated. An academic literature review identifies past research activities in a specific research area of interest and presents research contributions and limitations in the research domain (Webster and Watson, 2002). Fig. 1 illustrates the review protocol that was implemented in this review paper.

Fig. 1 shows the review protocol that is carried out in this review study; it serves as a guide or map mind to direct this review paper. Each of the three phases and activities were carried out in this review paper. The phases and activities adopted in this review paper are similar to the phases implemented by Mohammad et al. (2014); Noraini et al. (2015a) in their systematic literature review paper and Benjamin and Munster (2016); Bokolo and Noraini (2015) in their review paper.

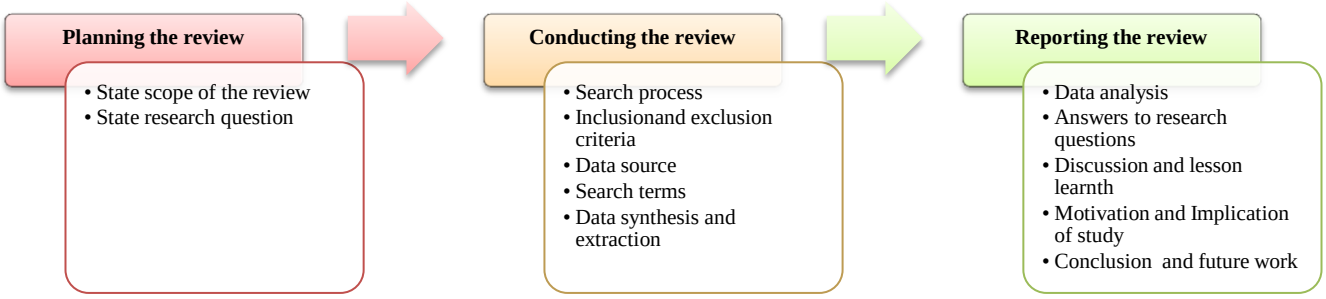


**Fig. 1.** Review protocol for this research study

### *2.1 Planning the review*

This study implements an academic literature review which is based on a predefined process as shown in Fig. 1. Where Fig. 1 serves as a guide in reviewing and presenting the findings of the research area (Green IS integration in IT based organization) that is being investigated. According to Webster and Watson (2002); Noraini et al. (2015b) an academic literature review must be thoroughly conducted and documented.

The review should comprise the implemented search strings, names of the queried databases, date of query, inclusion and exclusion criteria and results of the literature selection process (list of journals articles and conference proceeding papers). In addition, duplicate check and cross reference check should be carried out to strengthen the selected studies for the review. Therefore this phase stated the review scope and also presented the research questions that need to be answered in this review paper.

**Scope of the Review.** The scope of this review as mentioned previously involves Green IS practices in IT based organizations, inclusive of organizations that integrate Green IS. Thus Green IS research started in 2007, so this review paper will consider Green IS research in organizations from January 2007 till September 2016. This review paper only includes studies that relate to Green IS sustainability practice (initiatives and strategies) integration in organizations (mainly in IT based organization).

**Research Questions.** To achieve the aims of the review, which is to investigate the practice of Green IS initiatives and strategies in IT based organizations. There is need for research questions that are specifically addressed by this review paper. Thus the research questions to be answered in this study are as follows:

RQ1: What are the sustainability goals IT based organizations need to consider in order to integrate Green IS strategies and initiatives in their enterprise process?

RQ2: What are the determinants that motivate and also discourage IT based organizations to integrate Green IS practices?

RQ3: Which organizations currently promote and integrate Green IS practices in their enterprise process?

### *2.2 Conducting the review*

This phase describes how the author carried out the review by identifying relevant journals papers and conference proceeding papers to provide answer to the mentioned research questions in Section 2.1 of this review paper. This phase involved the search process that was carried out, the inclusion and exclusion criteria, the data source where the journals articles and conference proceeding papers were queried from, the search terms and lastly the data synthesis/extraction activity being carried out by the author.

**Search process:** The search process was carried out from 1st September 2016-till 3rd September 2016; during this time that author queried several leading Information Systems journals and Information Systems Conference databases as seen in Table 5 and Table 6, manually to search for relevant papers relating to Green IS integration, Green IS adoption, Green IS assimilation, Green IS implementation, Green IS diffusion, Green IS practice in


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organizations. This was carried out by the author in other to get an in-depth understanding of the present state of Green IS studies. After which additional journal and conference papers were included if they ascertained to be useful and relevant to the aims of this study. The reviewed journal articles and conference proceeding papers retrieved were later examined by the author.

**Inclusion and exclusion criteria.** The inclusion and exclusion criteria are used to confirm that the appropriate and relevant journals articles and conference proceeding papers are included in the review process. The inclusion and exclusion criteria are shown in Table 1.

**Table 1**
Inclusion criteria.

| Inclusion criteria |
|---|
| Indirectly or directly provides answer to the research questions. |
| The abstract and content is written in English Language. |
| Was published within the year January 2007 till date (September 2016). |
| Focus on eco-sustainability, Green IS practice in organizations. |
| The study is published or accepted in press in a journal or conference proceeding. |
| Reported review papers on Green IS practice in organizations. |

**Table 2**
Exclusion criteria.

| Exclusion criteria |
|---|
| In form of book chapter, book and presentation slides. |
| The abstract and content is written in languages other than English. |
| Journals articles and conference proceeding papers that did not match the inclusion criteria |
| Did not fully focus on eco-sustainability, Green IS practice in organizations. |
| Is not related organizational practice domain |
| The patterns are not described in detail, or a structured template is lacking |

Table 1 and Table 2 present the inclusion and exclusion criteria that were used by the author to screen selected papers. If any research paper meets all the inclusion criteria, it is added in the review to help answer the research question mentioned in Section 2.1. However if the paper meets any one of the exclusion criteria it was removed and excluded for this review paper.

**Data source.** In order to locate and retrieve suitable and relevant material, additional searches were performed directly on key electronic databases to get important papers to provide solution to the research questions in the paper. The utilized data sources used to retrieve the selected journal articles and conference proceeding papers are shown in Table 3.

**Search terms.** This Section describes the data sources search keywords based on the review guidelines by Webster and Watson (2002) and previously adopted by Noraini and Bokolo (2015). A search keyword string was constructed by the author using relevant keywords related to the research questions in the research question Section of this paper. The resulting Boolean search strings were used: In retrieving the relevant journals articles and conference proceeding papers from the data sources shown in Table 3, the author came up with different search terms or keywords that were used to query the different data sources individually. The resulting Boolean search strings included; "Green IS" or "IS for Green" or "Green ITIS" or "Green in IS" or "Sustainability" or "Eco-sustainability" or "Green practice" or "Sustainability practice" or "Green initiatives" or "Sustainability initiatives" or "Ecological practice" or "Ecological initiatives" or "Ecological Strategies" or Green in Organization " or "Organizational Sustainability" or "Green IS integration" or "Green IS implementation" or "Green IS diffusion" or "Green IS infusion" or "Green IS assimilation" or "Green IS in Organization" or "Green IS factors" or "Green IS determinants" or "Green IS motivators" or "Green Information Systems " or "Green IS readiness" or "Green IS techniques" or "Green IS tools" .

**Table 3**
Data source.

| Data sources | Data source URL |
|---|---|
| Google Scholar | https://www.scholar.google.com |
| Scopus | https://www.scopus.com |
| ISI Web of Science | https://www.webofknowledge.com |
| Wiley InterScience | http://onlinelibrary.wiley.com/ |
| Research Gate | https://www.researchgate.net/ |
| Springer Link | http://link.springer.com/ |
| Science Direct | http://www.sciencedirect.com/ |
| ACM Digital library | http://dl.acm.org/ |
| IEEE Xplore | http://ieeexplore.ieee.org/Xplore/home.jsp |
| Emerald | http://www.emeraldinsight.com/ |

Table 3 outlines the ten different data sources utilized to query to retrieve relevant papers related to this research study domain. Each of this data sources was search by the author over the period of 2016.

**Data synthesis and extraction.** This Section describes how important and relevant data are retrieved from the selected journal articles and conference proceeding papers. However before the author synthesized and extracted the journal articles and conference proceeding papers to be used for the review. The author checked for similar studies to ensure there is no study duplication. Thus if the same study is retrieved from more than two different data sources with same authors and same title, only one study would be selected for inclusion in the review. Commonly the most recent and comprehensive study will be selected. This was carried out to reduce data redundancy in the reporting the review Section of this paper. The relevant data were synthesized and extracted from the literatures of the selected studies based on Table 4.

Table 4 shows the data synthesis and extraction terms, used by the author to retrieved relevant data related to our research question. The retrieved data is later used to provide answers to all the three research questions stated in Section 2.1 in this paper.

### *2.3 Reporting the review*

This phase is the final phase involved in this review as seen in Fig. 1 in this paper. In this phase the authors presents the data analysis of the selected journal articles and conference proceeding papers. After which answers are provided to each of the inquired research question stated in Section 2.1. Thus the author can simply say that this phase is the most important Section of this review paper. The


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answers to the research questions are provided based on data synthesized and extracted from the selected journal articles and conference proceeding papers.

**Paper selection.** This Section discusses on how the journal articles and conference proceeding papers were selected. This is shown in Fig. 2.

**Table 4**
Data synthesis and extraction terms and description.

| Data synthesis and extraction terms | Description |
|---|---|
| Main Information | This includes the paper title and the author(s) of the selected paper. |
| Paper Year | Basically outlines the year the paper was published (within 2007 till 2016) |
| Paper Type | This refers to either the study is a journal article or conference proceeding paper. |
| Research Objective | Retrieves the research aim and objective (s) of the selected paper. |
| Research Field | Documents the field of the paper, either Green IS or Sustainability practice integration in organizations |
| Research Contribution | Retrieves the contribution of the study selected. This synthesized and extracted term is important, because this is the term were answers to the research questions are provided from the selected studies. |
| Research Implication | Retrieves mainly the limitation, implication and future works the researchers' intents to resolve in future. |

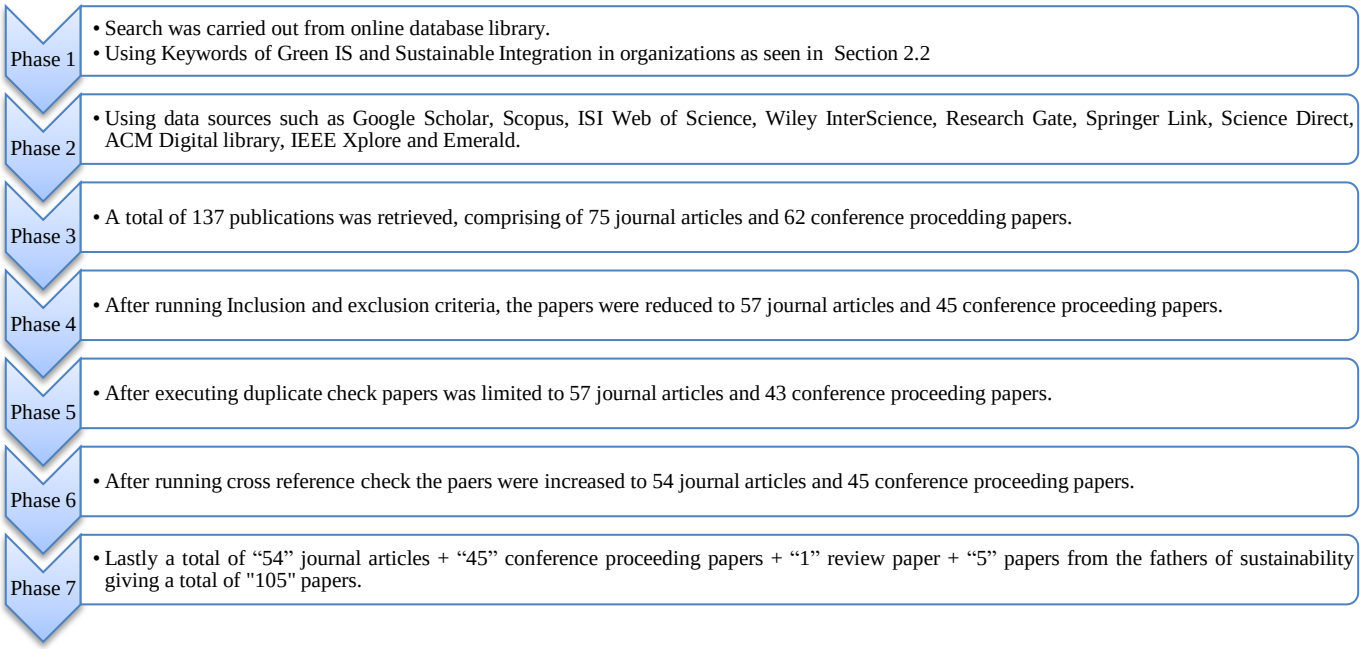


**Fig. 2.** Paper selection process

Fig. 2 shows how the "105" papers was selected by the author for the review paper starting from the first phase till the seventh phase.

**Data analysis.** This Section proceeds to present all the selected studies, journal articles and conference proceeding papers included for this review paper. It is to be noted that each of the selected papers was rigorously checked against the inclusion and exclusion criteria, duplicate check was carried out as stated in the data synthesis and extraction Section to exclude similar or same studies and lastly other related papers are added based on "cross reference check".

In cross reference check the author checked the references of the first selected papers and used the references to retrieve other relevant studies related to Green IS and Sustainability integration in organizations. However the scope of this review paper is based on only IT based organizations, the author included organizations general since presently all organizations utilizes IT and IS infrastructures in their enterprise process.

Table 5 and Table 6 outline the selected journal articles and conference proceeding papers names where the paper selected were derived or sourced from. A total of "105" studies were selected for this review paper. A total of "54" journal articles + "45" conference proceeding papers + "1" paper on how to write a review paper by Webster and Watson (2002) + "5" papers from the fathers of ecological sustainability and environmental sustainability research WCED (1987); Elkington (1997); Hart (1997); Hart and Milstein (2003); Elkington (2004).

Each of the papers is included in the reference Section of the paper. Although several papers was retrieved but the author only included papers related to Green IS and sustainability strategies and initiatives practice integration in organizations only which is in line with the scope of this review paper as stated previously in this paper (in scope of the review Section). Table 5 and Table 6 shows the total number of "54" journal articles and "45" conference proceeding papers included in this review. Each of the included journal articles and conference proceeding papers are added because each study provides a direct or indirect


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contribution in answering the research questions in the paper. The other papers include "5" papers from the fathers of ecological sustainability and environmental sustainability research WCED (1987); Elkington (1997); Hart (1997); Hart and Milstein (2003); Elkington (2004); and another "1" paper on literature review process was included to this review paper but not included to Table 5, Table 6, Fig. 3, Fig. 4 and Fig. 5. Since the review paper only discuss review process. Whereas the other "5" papers sustainability provides foundation for environmental sustainability research in organizations.

**Table 5**
List of journal articles included in this review

| Journals | Frequency |
|---|---|
| Computers in Human Behavior | 2 |
| Computer Standards and Interfaces | 1 |
| Journal of Soft Computing and Decision Support System | 4 |
| Journal of Strategic Information Systems | 4 |
| Information and Organization | 1 |
| Information and Management | 1 |
| Communication of the Association for Information Systems | 4 |
| Journal for the Association for Information Systems | 1 |
| MIS Quarterly | 2 |
| Inf Syst Front | 3 |
| Australasian Journal of Information Systems | 2 |
| Journal of Cleaner Production | 1 |
| International Journal of Logistics: Research and Applications | 1 |
| Information Systems A Global Text | 1 |
| Journal of Systems and Information Technology | 2 |
| Current Opinion in Environmental Sustainability | 1 |
| Green Business Process Management | 1 |
| Sustainability | 1 |
| Management Research Review | 1 |
| Procedia –Social And Behavioral Sciences | 1 |
| Sprouts: Working Papers on Information Systems | 2 |
| Asia Pacific Management Review | 1 |
| Journal of Theoretical and Applied Information Technology | 3 |
| Journal of Computer Information Systems | 3 |
| Green IT Working Paper | 2 |
| International Journal of Digital Information and Wireless Communications (IJDIWC) | 1 |
| International Journal of e-business Management | 1 |
| International Journal of Strategic Decision Sciences | 1 |
| International Journal of Computer Trends and Technology (IJCTT) | 1 |
| Organizacija | 1 |
| Information Technology Journal | 1 |
| ARPN Journal of Engineering and Applied Science | 1 |
| Technics Technologies Education Management | 1 |
| Total Numbers of Journal Articles | 54 |

**Table 6**
List of conference proceeding papers included in this review

| Conference proceeding | Frequency |
|---|---|
| Proceeding of the Americas Conference on Information Systems | 9 |
| Pacific Asia Conference on Information Systems (PACIS) | 6 |
| European Conference on Information System (ECIS) Proceedings | 5 |
| Australasian Conference on Information Systems | 7 |
| International Conference on Information Systems | 1 |
| Proceeding of the Hawaii International Conference on System Sciences | 4 |
| International Conference on Green Computing, Technology and Innovation | 1 |
| Confluence the Next Generation Information Technology Summit (Confluence) | 1 |
| IDT Mini-Conference on interesting Results in Computer Science and Engineering | 1 |
| Portland International Conference on Management and engineering technology (PICMET) Proceedings | 1 |
| Mediterranean Conference on Information System (MCIS) Proceedings | 1 |
| GREENS, Zurich, Switzerland | 1 |
| European Conference on Information Management and Evaluation | 1 |
| Proceedings of American Society of Business and Behavioral Sciences ASBBS Annual Conference | 1 |
| SAICSIT Proceedings of the South African Institute for Computer Scientists and Information Technologists Conference | 2 |
| International Conference on Computer and Information Sciences (ICCOINS) | 1 |
| Semana de Engenharia | 1 |
| Proceeding of the International MultiConference of Engineers and Computer Scientists (IMECS) | 1 |
| Total Number of Conference Proceeding Papers | 45 |


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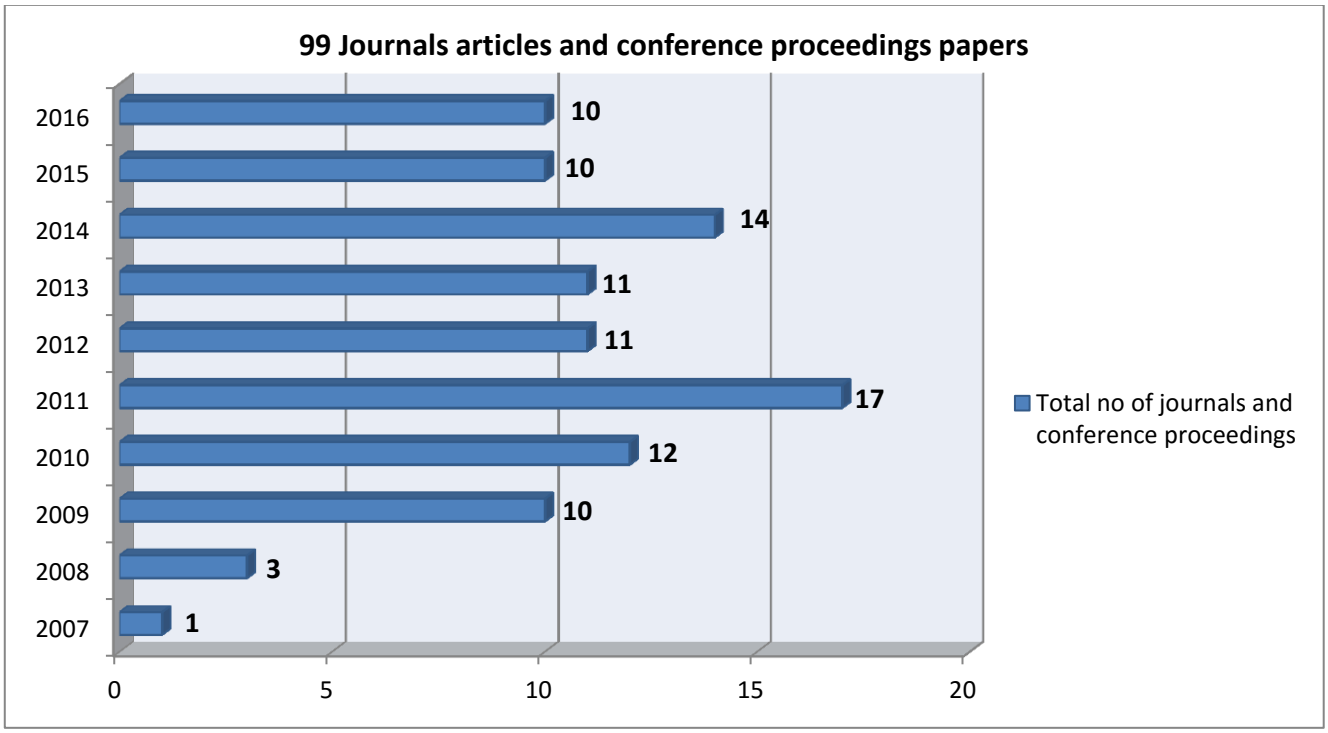


**Fig. 3.** Total no of journals articles and conference proceedings papers

Fig. 3 shows the chart of distribution of "99" journals articles and conference proceedings papers from the year 2007 to 2016. From Fig. 3 it can be seen that only "1" papers related to this review scope and aim of the paper was published in 2007. Thus 2007 have the lowest number of publication since it was the starting year of Green IS research. Only "3" papers was published in 2008, "10" papers were published in 2009. "12" papers were published in 2010, 2011 has the highest publication with "17" publications. 2012 and 2013 both has "11" publications. 2014 has a total of "14" publication. 2015 and 2016 both has "10" publications.

Fig. 4 shows the "54" number of journal articles included for this review paper. As seen in Fig. 4, 2007 has only "1" article, 2008 has "2" papers. 2009 has "4" papers. 2010 produced "5" papers. 2011 has the highest journal paper included for this review paper with "9" papers. 2012 has a total number of "4" papers. 2013, 2015, 2016 has a total number of "8" papers. Lastly 2014 has total number of "5" papers.

Fig. 5 shows the "45" number of conference proceeding paper included for this review paper. As seen in 2007 no paper was included. In 2008 only "1" paper was added, in 2009 only "6" paper was included. In 2010 and 2012 "7" papers was selected for both year. In 2011 "8" papers was selected for the review. 2013 included only "3" papers, 2014 had the highest number of papers with a total of "9" papers and lastly 2015 and 2016 both had a total number of "2" papers.

## 3. Result of the review

This Section aims to provide answers to the three research questions mentioned in research question Section of this paper.

Thus the author proceeds to provide answers to the research questions.

### *3.1 Sustainability goals in IT based organizations*

In order to provide answer to research question 1; what are the sustainability goals IT based organizations need to consider in order to integrate Green IS strategies and initiatives in their enterprise process? The literature on sustainability practice in IT based organizations is emerging but still in its infancy. Sustainability was defined by WCED (1987) as development that meets the needs of the present without affecting the ability of future generations to meet their needs. More lately, a triple bottom line (TBL) viewpoint of sustainability has been embraced which considers organizations sustainability to include three modules: society, natural environment, and economical state of the organization.


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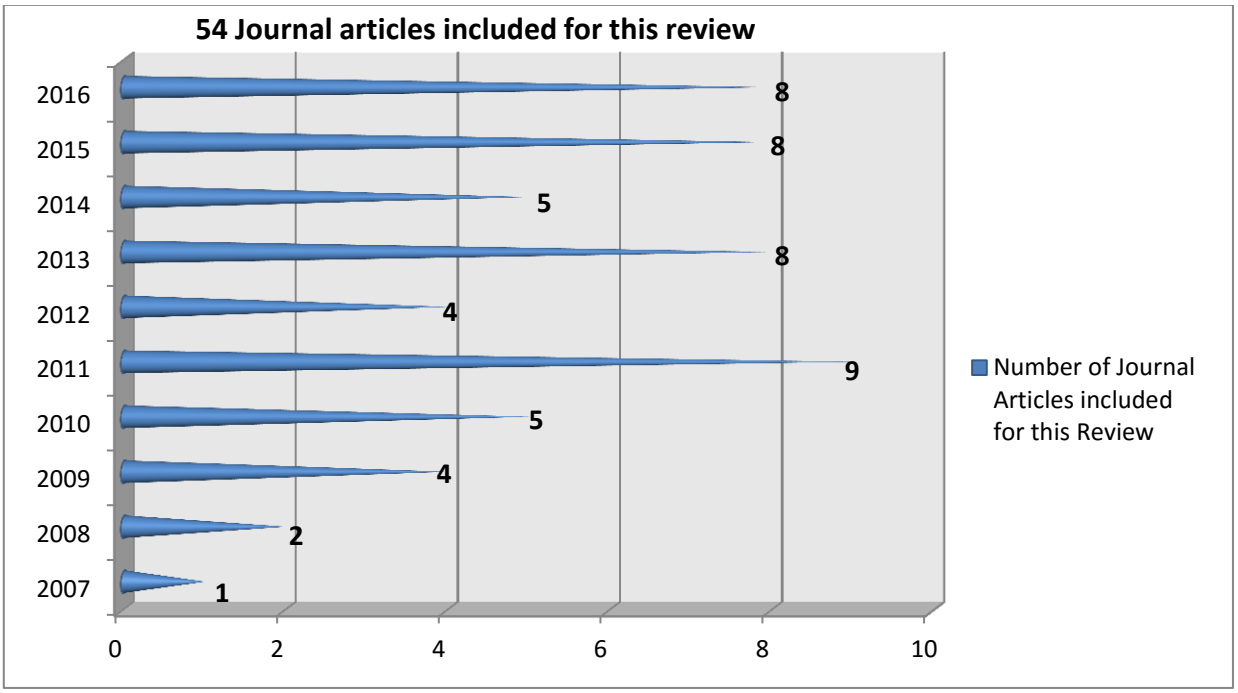


**Fig. 4.** Total no of journals articles

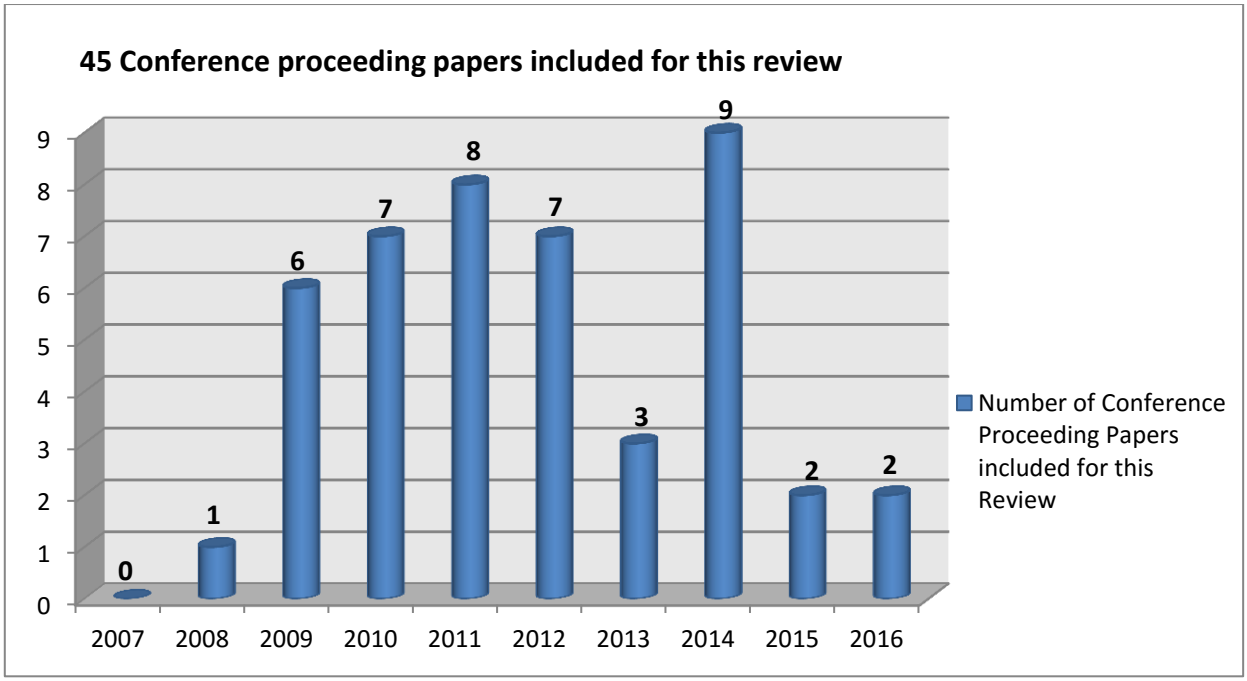


**Fig. 5.** Total no of conference proceeding paper


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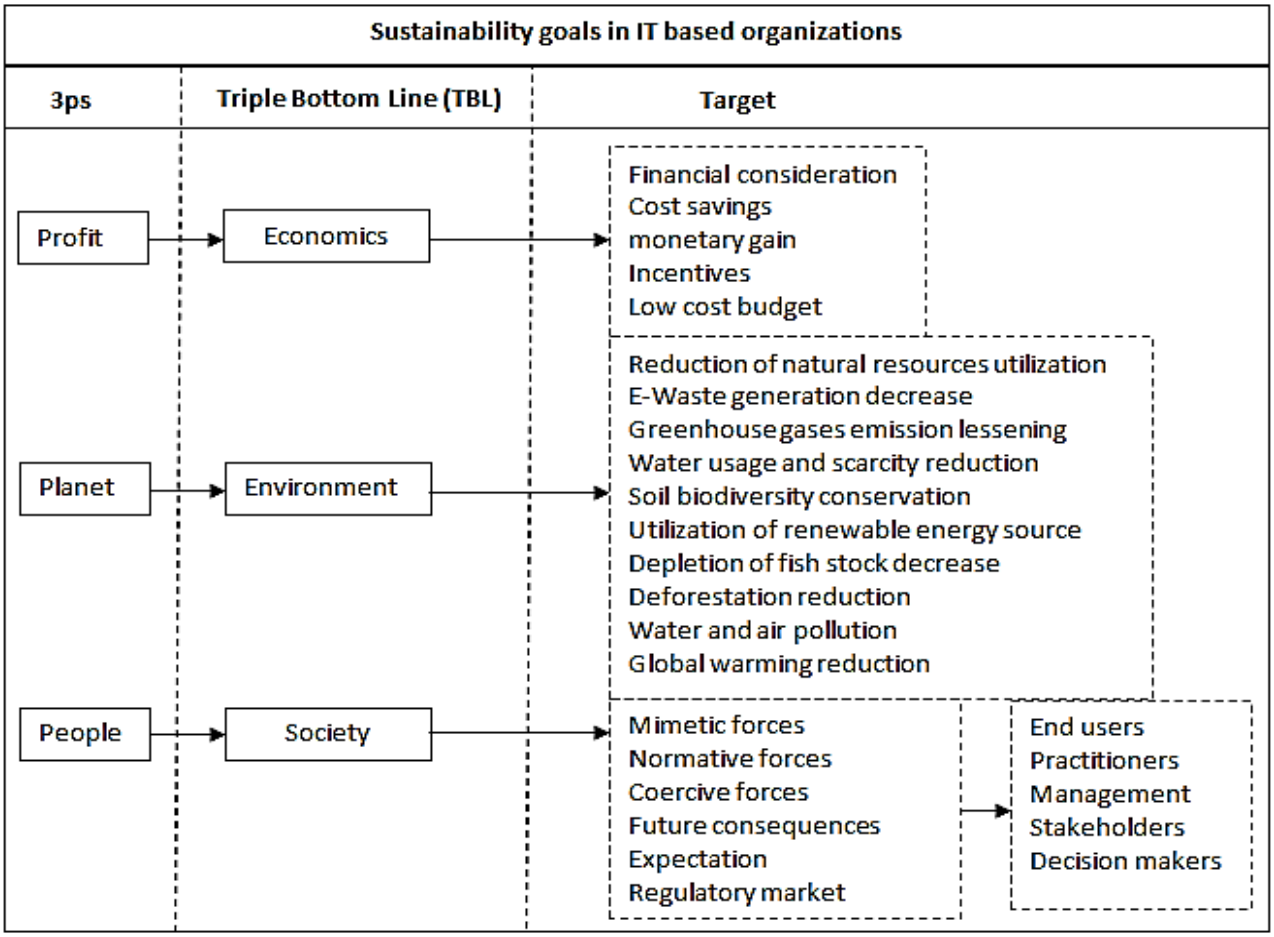


**Fig. 6.** Sustainability Goals in IT Based Organizations

**Table 7**
Sustainability Goal in IT based organizations

| 3Ps | Triple Bottom Line (TBL) | Target | Citations |
|---|---|---|---|
| Profit | Economics | Financial consideration- This is the amount of money the management is willing to invest into Green processes. This will directly influence IT based organizations decision in integrating sustainable practices. | (Adela et al., 2008; Alemayehu, 2008; Stefan et al., 2010; Stan et al., 2010; Tracy et al., 2011; Adela et al., 2011; Alemayehu et al., 2011; Daqing, 2014; Chris et al., 2011; Dietmar et al., 2011; Mohamad et al., 2012; Hong-Mei and Rick, 2012; Robert et al., 2012; Ming et al., 2012; Ijab and Molla, 2012; Sung and Chulmo, 2013; Katrina et al., 2014; Daphne and Anol, 2014; Molla and Cooper, 2014; Chin-Jung et al., 2015; Mohammad et al., 2015; Sanna, 2015; Badrunnesa and Darshana, 2015; Laura-Diana, 2016; Roya et al., 2016; Jan, 2016). |
| | | Cost savings- IT based organizations are mainly concerned with actions that will result in accomplishing of the objectives of sourcing at a cost lesser than the original cost. In essence IT based organizations considers the cost of sustainable IT infrastructures in relation to cost of normal IT facilities without Green labels. | |
| | | Monetary gain- If there exists a financial gain, particularly in the difference between the amount earned from integrating Green initiatives and the amount spent in operating, buying, or deploying these Green initiates and strategies, then IT based organizations will be encouraged to integrate sustainable practices. | |
| | | Incentives- this are additional reward that serves as inspiration to practitioners in IT based organizations, if the management decides to give our rewards or incentives to practitioners that practice sustainable strategies and initiatives, then this might influence practitioners action. | |
| | | Low cost budget- this is usually a type of pricing scheme where sustainability vendors sets a moderately low price of Green IS infrastructures in order to improve the demand for Green IS facilities among IT based organizations. Thus a low cost pricing approach is an economic target that can influence IT based organizations to integrate sustainable initiatives strategies. | |


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**Table 7**
Sustainability Goal in IT based organizations (Cont.)

| | | | |
|---|---|---|---|
| Planet | Environment | Reduction of natural resources utilization- the earth's natural resources are limited, which means that as we consume them continuously, they will eventually by deplete by humans. This simple observational fact is undeniable. However another way of observing this issue is far more pertinent to considering human's well-being as these natural resources are being utilized. Thus here is need for IT based organizations to contribute to humanity by reducing the consumption of the exhaustible and irreproducible natural resources. | (Adela et al., 2008; Alemayehu, 2008; Stefan et al., 2010; Stan et al., 2010; Nils-Holger et al., 2010; Tracy et al., 2011; Tom, 2011b; Jung et al., 2011; Grant and Sam, 2012; Mohamad et al., 2012; Chun and Ngai, 2014; Ijab and Molla, 2012; Alemayehu, 2013; Yulia and Chulmo, 2012; Ahmad and Alemayehu, 2013; Jan et al., 2013; Fabian et al., 2013; Roya et al., 2013; Jeramy et al., 2013; Damianos and Konstadinos, 2014; Carolyn and Jean-Paul, 2014; Biswajit, 2014; Navneet and David, 2014; Chris et al., 2014; Molla and Cooper, 2014; David, 2014; Bokolo and Noraini, 2015; Carolyn and Jean-Paul, 2015; Aijaz and Heikki, 2015; Sanna, 2015; Badrunnesa and Darshana, 2015; Bokolo and Mazlina, 2016a; Laura-Diana, 2016; Roya et al., 2016; Jan, 2016; Bokolo and Noraini, 2016; Nima and Yeganeh, 2016; Shannon et al., 2016; Bokolo and Mazlina, 2016b). |
| | | E-Waste generation decrease- e-waste is a general name for electronic waste generated from old, out of date IT infrastructures. These e-wastes are considered hazardous, as certain components of IT infrastructures contain materials that are toxic. The dangerous content of e-waste pose a threat to environment and human health. Thus discarded monitors, central processing unit (CPU) mother board, fax machines, video cassette recorders (VCRs), stereos speakers, batteries, photocopiers, audio facilities, cell phones and electric lamps if wrongly disposed can percolate lead and other substances into groundwater and soil. Redundant, out of date and damaged IT infrastructures can be refurbished, reused or recycled in an eco-friendly manner so that they are less dangerous to the environment or ecosystem. | |
| | | Greenhouse gases emission lessening- these includes several gases that trap heat in the air or atmosphere. When these gases have been trapped for too long it results to climatic changes and theses gases includes CO2, Methane (CH4), Nitrous oxide (N2O) and Fluorinated. These gases are emitted from IT based development and manufacturing process. Although the amount of greenhouse gases released by IT based organization are little compared to other industries, there is still need to lessen the amount release by IT based organizations. However how to reduce Greenhouse gas generated by IT based organization is out of the scope of this review paper. | |
| | | Water usage reduction - water consumption lessening in IT based organization can be achieved through a combination of changing attitude of practitioners in the organization, amending and/or changing facilities with water saving facilities to lessen general water utilization and increase organizational reuse. To reduce water consumption in IT based organization, it is essential to measure the current water use and set targets and goals. Reducing IT based organizations water consumption is a means of resolving and also reducing the world water crisis. As of 2015, organizational water use accounted for 5 percent of world freshwater usage. | |
| | | Soil biodiversity conservation- A healthy soil provides nutrients to thousands of micro-organisms and plant and animal species in a region. Species will disappear as a result of soil pollution or a lack of nutrients caused by the fertile upper layer of the soil being removed. Reversing land degradation also improves food security. Many countries are now trying to reverse loss of biodiversity. These services are not only essential to the functioning of natural ecosystems but constitute an important resource for the sustainable management of agricultural systems. | |
| | | Utilization of renewable energy source- it is advisable for IT based organizations to use renewable energy source and rely less on coal generated electricity that emits CO2 to the atmosphere. Renewable energy can be derived from wind, sunlight, rain, waves, geothermal heat and tides. Renewable energy source are not gotten from fossil or nuclear fuel. Renewable energy source are naturally replaced or replenished over a period of time. IT based organizations can use renewable energy source to provide energy for air, water cooling/heating, transportation across the organization, electricity generation and off-grid energy services. | |


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**Table 7**
Sustainability Goal in IT based organizations (Cont.)

| | | | |
|---|---|---|---|
| People | Society | Mimetic forces- are the pressure to imitate operationally similar successful enterprise in the same business area without necessarily considering the enterprise context. Mimetic pressure is supposed to certainly impact the intention of enterprises to assimilate Green practices. | (Adela et al., 2008; Alemayehu, 2009; Robert and Nora, 2009; Nils-Holger et al. 2009; Alemayehu, 2008; Tom and Mary, 2009; Alemayehu et al., 2010; Richard et al., 2010; Stan et al., 2010; Tracy et al., 2011; Adela et al., 2011; Tom, 2011b; Mohamad et al., 2012; Chun and Ngai, 2014; Ijab and Molla, 2012; Alemayehu, 2013; Carolyn and Jean-Paul, 2014; Navneet and David, 2014; Molla and Cooper, 2014; Bokolo and Noraini, 2016; Carolyn and Jean-Paul, 2015; Badrunnesa and Darshana, 2015; Bokolo and Mazlina, 2016a Alenka et al., 2016; Benjamin and Munster, 2016; Laura-Diana, 2016; Roya et al., 2016; Jan, 2016). |
| | | Normative forces- are pressure that is embedded in the current process of professionalization. This pressure arises from the interchange of best practices among practitioners across different enterprise. Normative pressure is pressure within the enterprise. | |
| | | Coercive forces- refers to pressure chastised in societal dependencies and expectations towards other enterprises Also, various industry regulations and government exert coercive pressure on enterprises and determinedly drive the diffusion of Green IS. | |
| | | Future consequences- If the consequence of future action is observed as harmful, and the practitioner declares the responsibilities, a sense of guilt will surface because the attribution of harmful consequence that will occur in future. | |
| | | Expectation- If practitioners and management are mostly influenced by the strong belief that going Green will lead to enterprise cost saving and reduction of resources they will support the Green movement. | |
| | | Regulatory market- This is the market where the government controls the determinants of demand and supply, such as who is allowed to purchase from the market, and/or what amounts may be charged. Thus these market forces can affect enterprise going Green. | |
| | | • End users- this are the domestic consumers that utilized the developed IT based projects or services. How they use and dispose the developed product can have an effect on the environment<br>• Practitioners- these are the staffs, experts and professionals in IT based organizations that develops, implements and distributes the products to end users. The practitioners in IT based organizations are the people that will integrate sustainable strategies and initiatives in their day to day process in order for their organization to achieve a sustainable enterprise business process.<br>• Management - these are the stakeholders and decision makers in IT based organizations, they introduce and enforce sustainable governance policies and strategies for the practitioners in the organization to adhere to. This governance polices aimed to ensuring that the practitioner integrate the sustainable initiatives and strategies laid down by the management. | (Craig and Paul, 2007; Albert, 2009; Ninlawan et al., 2010; Alemayehu, et al., 2010; Ana and Joao, 2010; Stefan et al., 2011; Schmidt and Kolbe, 2011; Richard et al., 2011; Helen et al., 2012; Yulia and Chulmo, 2012; Ahmad and Alemayehu, 2013; Jan et al., 2013; Fabian et al., 2013; Roya et al., 2013; Jeramy et al., 2013; Damianos and Konstadinos, 2014; Savita et al., 2014; Deepti et al., 2014; Badrunnesa and Darshana, 2015; Ibrahim and Alok, 2015; Mohammad and Azizah, 2015; Benjamin and Munster, 2016; Laura-Diana, 2016; Roya et al., 2016; Jan, 2016). |

Fig. 6 shows the sustainability goals to be attained in IT based organizations and it was first presented by Elkington, (1997); Elkington (2004) as the 3ps; people, planet and profit. Other researchers such as (Adela et al., 2008; Alemayehu et al., 2009a; Alemayehu et al., 2009b; Sergio and Alemayehu, 2009; Robert and Nora, 2009; Nils-Holger et al., 2009; Tom, 2011a; Alemayehu et al., 2011; Alemayehu and Ahmad, 2011; Viet et al., 2011; Mohamed et al., 2011; Dietmar et al., 2011; Stoney et al., 2012; Vanessa and Alemayehu, 2013; Alok et al., 2012; Hong-Mei and Rick, 2012; Alemayehu and Ahmad, 2011; Alemayehu, 2013; David, 2013; Fabian, 2013; Nicky et al., 2014; Daphne and Anol, 2014; Mohammad et al., 2014; Mohammad et al., 2015; Birgit, 2015; Badrunnesa and Darshana, 2015; Laura-Diana, 2016; Roya et al., 2016; Jan, 2016) also mention the 3ps termed as the Triple Bottom Line (Economic, Social and Environmental).

By considering the planet (effects on the environment), people (society) in relation to enterprise profit (economic) sustainability can be achieved in organization (Elkington, 1997; Hart, 1997; Hart and Milstein, 2003; Elkington, 2004). Thus IT based organization need to consider the 3Ps in integrating Green IS strategies and initiatives in their organizational process. This is shown in Fig. 6 and Table 7. The citations in Table 7 is based on the researchers mentioning the triple bottom line targets direct or indirectly in their research and is not based on the description of the targets. Based on the report presented in Table 7, IT based organizations are encouraged to attain the 3Ps also known as the Triple Bottom Line (economic, social and environmental) in order for them to attain a sustainable enterprise. It is to be known that each of the sustainability goal is important as such no one is more important that the other. Although it is practical difficult to adhere to all the goals in real world scenarios, IT based organizations must


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set up their sustainability effort because the little sustainable initiative or strategy that is practiced will go a long way to sustain our environment.

### *3.2 Green IS practice (initiatives and strategies) determinants in IT based organizations*

In order to provide answer to research question 2; what are the determinants that motivate and also discourage IT based organizations to integrate Green IS practices? IT based organizations fail to integrate Green practices due to a lack of innovativeness in their initiatives and strategies and for failing to get support from the management. Such initiatives and strategies have been largely unsuccessful due to IT based organizations lacking understanding of the determinants that influences IT based organizations action to integrate Green IS practices. The determinants include the motivators/enablers that influence IT based organizations to integrate Green practice and the inhibitors/barriers that discourages IT based organizations from integrating Green practices in their organization. The motivators/enablers that encourage practitioners to integrate Green practices in IT based organization are shown in Fig. 7.

Based on the findings from Alemayehu et al. (2009a); Alemayehu et al. (2009b); Jason (2010); Alemayehu et al. (2010); the drivers that encourages and enables IT based organizations to integrate Green practices include is shown in Fig. 7 and Fig. 8.

Fig. 8 also shows other motivators that influence IT based organizations action to integrate Green IS practices. Each of these factors will affects IT based organizations action in integrating Green IS.

Based on the findings from Alemayehu et al. (2009a); Alemayehu et al. (2009b); Jason (2010); Alemayehu et al. (2010) the inhibitors that encourage IT based organizations to integrate Green practices is shown in Fig. 9.

With reference to findings from Alemayehu et al. (2009a); Alemayehu et al. (2009b); Jason (2010); Alemayehu et al. (2010) Fig. 9 shows the inhibitors that prevents IT based organizations in integrating Green IS practices in their enterprise process.


**Fig. 7**. The motivators that influences Green IS practices integration (Alemayehu et al., 2009b; Jason, 2010)


**Fig. 8**. More motivators that influences Green IS practices integration (Alemayehu et al., 2010)


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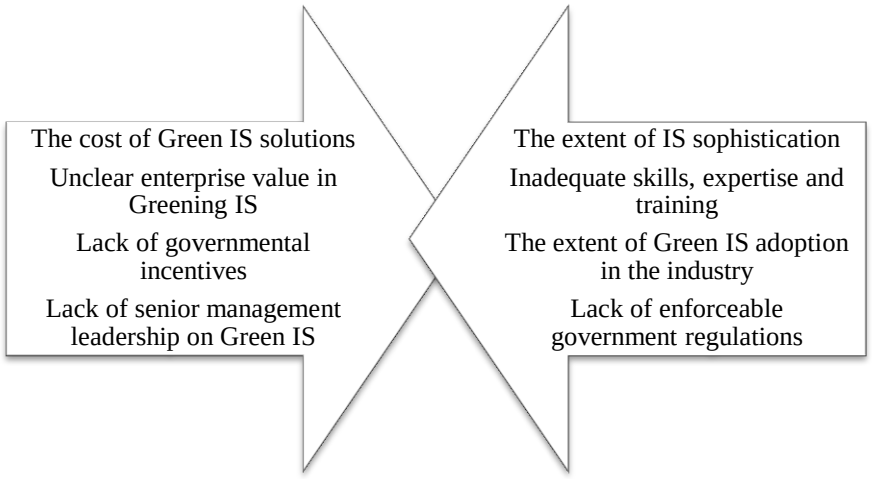


**Fig. 9**. Inhibitors that discourages Green IS practices integration (Alemayehu et al., 2009a; Alemayehu et al., 2009b; Jason, 2010; Alemayehu et al., 2010)

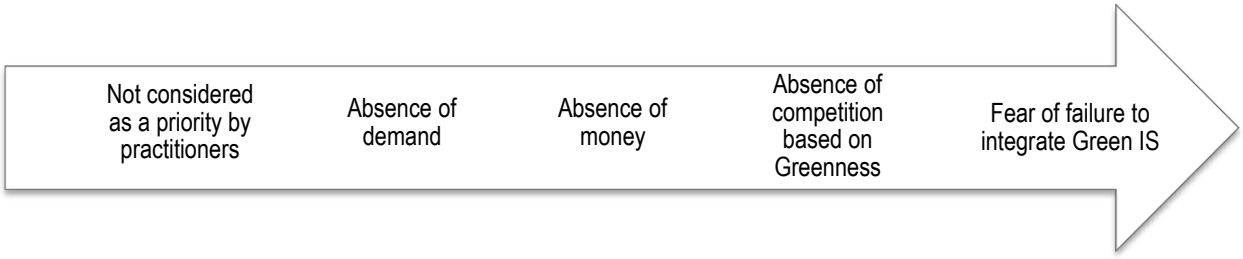


**Fig. 10**. Other inhibitors that discourages Green IS practices integration (Alemayehu et al. 2010)

Fig. 10 shows other inhibitors the limits the integration of Green IS practice in IT based organizations mentioned by Alemayehu et al. (2010). The inhibitors that discourages IT based organization to integrate Green IS practices in their enterprise as stated as seen in Fig. 9 is based on findings from Alemayehu et al. (2009a); Alemayehu et al. (2009b); Alemayehu et al. (2010); Jason (2010). IT based organizations motivations for Greening IS can include an economic prospect of enhancing efficiency, a normative objective of attaining legitimacy and a regulatory response of ensuring compliance. The forces between the regulatory and ethical pressure on the one hand and the business case for top-line income and bottom-line budgets on the other hand can impact the integration of Green IS.

Based on the survey conducted by Alemayehu et al. (2009a); Alemayehu et al. (2009b) and also cited by Jason (2010) in their research majority of IT based organizations mentioned that the main enablers and motivators for Greening IS are business strategies that emphasize not only environmental consideration but also cost savings. This implies that as IT based organization finances continue to reduce, the management may turn to Greening their enterprise only if Green solutions are affordable and yield tangible benefits (Alemayehu et al., 2010). 71 percent of organizations are pursuing legitimacy within the wider societal context as concerned bodies of local and global communities for Greening IS. The maturity of the IT based organization in providing Green IS products and services appeared as one of the top five drivers or motivators (Alemayehu et al., 2009a).

Despite most IT based organizations featuring Green IS as one of the top considerations for enterprise as in 2009, market pressure such as IS vendors', competitors' and client's pressure have not so far emerged as motivating Green IS integration. Most of the existing Green legislations and regulations are non-binding (Alemayehu et al., 2009b). As a result, a substantial number of organizations do not yet see government regulations or incentives as motivating their Green IS strategy (Alemayehu, 2009). For IT based organizations with large number of servers, government incentives, government law/regulations, own strategy and environmental considerations plays an important role in shaping their actions to integrate Green IS initiates and strategies.

The enablers as seen in Fig. 7 and Fig. 8 motivates IT based organization to integrate Green IS practices can result to the reduction of energy usage and lessening of Greenhouse gases emissions thereby caring for the environment, reducing cost and lastly enabling creating a healthy environment for practitioners to work. In accomplishing these criteria the 3Ps has been achieved. However IT based organizations are inhibited, prevented and bared from integrating Green IS practices in their enterprise process based on the determinants shown in Fig. 9 and Fig. 10.


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*3.3 Green practices (initiatives and strategies) integration in selected organizations*

This Section presents organizations that utilize IT in managing their business process such as Toyota, Volvo, Wal-Mart etc. In order to provide answer to research question 3; which organizations currently promote and integrate Green IS practices in their enterprise process? It is a known fact that few IT based organizations are currently integrating Green practices in their enterprise process. Indeed, IT based organizations have been at the forefront of integrating Green IS initiatives and strategies, but while IT based firms such as Sun Oracle, HP, Dell and Intel have already built advanced data centre design for energy optimization services, other IT based organization such as IBM and Deloitte are offering services on how to position Green IS can enabler sustainable business initiatives.

Currently non-governmental organizations such as Greenpeace are increasingly creating awareness and disseminating the negative effect of IT usage on the environment and climate. In a report in 2012 Greenpeace was very concern of Google, Apple, Microsoft and others for their over dependence on non-eco-friendly cradle of energy, such as coal, and their failure to highlight energy efficient data centres design over the acquirement of non-clean sources of energy (Barbara et al., 2012).

Such pressure from non-governmental bodies has forced leading IT based organization across the globe to integrate Green initiatives and strategies in order to have a good branding. In view of this the author was motivated to review and describes IT based organizations that currently integrates Green practices in their day to day enterprise process.

Many organizations have already taken steps towards integrating Green IS practices in the development of their processes, products, services and facilities. They include;

**IBM.** IBM is an IT based organization that deals computer related hardware, software and network communication facilities. In 2005, IBM deployed a Tele-work system application that involved over 20,000 staffs, saving up to 5 million gallons of fuel there by reducing up to 50,000 tons of $CO_2$ emissions. IBM's Tele-work system program facilitated by Information Systems resulted to the concept of telecommuting which offers a significant means by which pollution and congestion traffic can be reduced (Alemayehu and Molla, 2009; Alemayehu et al., 2009c; Navneet and David, 2014). In 2007, the organization invested $1 billion service strategy to develop and re-implement data centres that consumes less energy. Later, IBM inaugurated a project called Big Green that allows end users to monitor their energy depletion in real time (Stoney et al., 2012).

IBM went further to utilize cloud computing technology in achieving energy savings by displacing mass barrels of oil, claiming that pooling of technology and software in the cloud supports enterprise resource operation maximization leading to a more effective IT infrastructure. In cloud computing 73 percent less power is utilized which is more efficient than traditional laptops and desktops. It is imperative that cloud computing can support enterprise develop their Green IS integration by providing a common and on-demand IS facility with virtualization proficiencies (Joseph et al., 2013).

A Green IS technique called virtualization was first developed by IBM to increase the deployment competence of mainframes computers. Virtualization uses few servers to control several services in an enterprise. In virtualization few servers are used which means improved manageability, less headcount, lower cooling costs and less $CO_2$ emission (Robert and Nora, 2009).

According to David (2013) IBM also developed a Green business model that comprises of Information Technology, strategy, information, property, business operations, people and product. The model integrated Green strategies and initiatives into IBM enterprise processes to support eco-sustainability attainment. It is therefore visible that IBM is interested in Green practice integrated and the organization had succeeded in the implementation of energy efficient IT services and $CO_2$ emission reduction practices which in turn resulted to business gain for IBM (Jose et al., 2010).

Lastly IBM industrialized a Green Mobile Monitoring Technology to improve data center energy effectiveness, by evaluating the thermal profiles of functioning data centers. The technology aided in finding opportunities for decreasing energy consumption at various data centers resulting in energy usage decrease (Daphne and Anol, 2014).

**Dell.** Dell a Computer Software and Hardware based organization known across the world also integrated Green strategies and initiative in their enterprise. At present, Dell promotes a Zero Carbon strategy aimed at reducing the energy consumption of Dell products, and over time Dell plans to reduce its $CO_2$ emission (Biswajit, 2014). Dell also allows its customers to recycle their previous printers if they purchase a new printer by simply providing the old printer's package tag and booking a pick-up date and time. Customers can use Dell website to implement all these process. Dell contributed to recycling by providing a convenient and simple process, supported by an information system to track and monitor the movement of the products to be recycled (Richard et al., 2008). Dell attitude is related to Dell's product life cycle which is composed of designing, building, shipping, operating and recycling procedures (Nuttapon and Gabriel, 2011).

**Apple.** Apple which is known to everyone around the world is a firm that mostly develops mobile phones, laptops and desktops for commercial purposes. The company is also devoted to Greening the environment and has mentioned that it will lessen or remove poisonous chemicals existing in its old products and also recycle its old mobile phone, laptop and desktops (Biswajit, 2014). Presently in Apple when an end user buys an Apple monitor or computer, the licensed dealer normally offer unrestricted recycling services to handle customer's old monitor or computer, irrespective of the manufacturer (Alemayehu and Molla, 2009). Alemayehu and Molla (2009) mentioned that many companies such as Apple have welcomed contribution of unwanted IT facilities to


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charitable organizations and academic institution across the world. Apple also inspires their customers to sell their old IT facilities through the CellForCash.com for recycling purposes, where IT facilities will be refurbished and resold in the market.

**Google, Yahoo, and Microsoft.** Data centres energy utilization is one of the most imperative Green target concerns because data center's cooling and power consumption account for up to 40 % of a data center's expenses. Thus Google, Yahoo, and Microsoft have re-located some of their data centers in the Pacific Northwest in the United State situated close to inexpensive hydroelectric energy source (Richard et al., 2008; Robert and Nora, 2009). Google went further to install solar power facilities in their United States headquarters (Nigel, 2010). Google currently purchase electricity from renewable energy sources such as solar, wind or hydro. Google has been utilizing renewable energy at a low-cost (Robert and Nora, 2009).

**Sun Microsystems.** Sun Microsystems International is a leading global supplier of network computing infrastructure solutions. Sun decided to reduce the transport cost and $CO_2$ emission generated when their employees comes to work daily, therefore the organization implemented and deployed a "Open Work" system, which entails solution suite of policies products and support tools that enable Sun staffs to work efficiently in the office at a remote location. Currently Sun has about 43 % of its utilizing the Open Work system, Sun aims to encourage the utilization of cleaner technology through the Open Work" system (Richard et al., 2008).

**Hewlett Packard (HP).** Hewlett Packard popularly called HP, is a popular company that manufactures computer infrastructure such as desktop, laptops, printers e t c. HP has been involved in eco-sustainable strategies and initiatives for the past 30 years and has integrated environmental concerns into their enterprise strategy. HP's practices a service stewardship function that focuses on the improvement of global processes to reduce the negative effect of their products and services on the environment. HP implements a Design for Environment (DfE) application to identify environmental development for service throughout the manufacturing stage, aiming on materials innovation, recyclability and energy efficiency (Navneet and David, 2014). Green practices in HP includes energy effective data centers, visual collaboration, energy effective services and environmental control systems through design for environment program (DfE), ecological system, recycling suites and eco-sustainable buildings.

**Intel.** Intel is a multi-national company that develops chips, processor, motherboard chipsets, network interface controllers and integrated circuits. Intel is currently spending time and resources towards integrating Green Information System. The presently Green IS strategies and initiatives implemented by Intel involves energy competent data centers, server operation analyser, virtualization, energy effective services through Green manufacturing, Green procuring, and solar panel installations (Navneet and David, 2014).

**Toshiba.** Toshiba is a leading electronics company. The organization aims to be one of the world's leading environmental friendly companies and decrease the environmental impacts of their enterprise activities. To accomplish its goal, Toshiba developed 3 Green initiatives under the new Toshiba eco brand which includes Greening technology, Greening of process and Greening products (Nuttapon and Gabriel, 2011).

**Nokia.** Nokia once a leading mobile phone manufacturer are not left out in supporting the sustainability of the environment. Nokia's developed a computer managed maintenance system (CMMS) for mobile manufacturing process to help conserve water and natural resources energy used in production process (Daphne and Anol, 2014). Another sustainable strategy practiced by the mobile firm is Nokia's mobile phone which is can be operated using a solar panel fused in the back cover. The solar panel back cover is able to harvest energy to run the phone on standby mode and even aloe the end user to use the phone to make calls and perform other functions when carefully placed directly to sunlight.

**SAP.** SAP is a German based software enterprise that develops organizational software to manage firm business process. SAP integrated Green practices by developing an agenda called sGreen, which aims to promote Green eco-practice to change the roles and responsibilities of organizations across the globe in integrating Green initiatives (Alemayehu et al., 2011). The organization also developed a SAP's Recycling Administration System Application that can support enterprise meet governing documentation requirements and reporting to manage the recycling activities of organization thereby reducing environmental cost and risk. The developed application also helps enterprise in adhering to environmental policies and laws in reducing associated risks and costs incurred. It simplifies all environmental processes through continuous integration mainly for environment safety and health (Alemayehu et al., 2011; Navneet and David, 2014).

**United Parcel Service (UPS).** UPS operates across the whole in delivering parcels and packages to individuals, and companies. UPS possess a fleet of about 88,000 vehicles, comprising airplanes; it is currently difficult for UPS to become free of fossil fuels. Thus, UPS has made significant Information Systems investments in discovering medium to reduce their consumption of fossil fuels. These strategies save expenditures and develop UPS' Green business initiatives. The organization implemented a project called "telematics"; The telematics uses a black box that records and gathers data such as, harsh braking, seatbelt usage during travel, time spent reversing, delivery while idling, speed rate, as well as routes and direction taken by drivers using the in-built Global Positioning System (GPS). The data from telematics system is loaded into the UPS data repository (Richard et al., 2008; Alemayehu and Ahmad, 2011; Ijab and Molla, 2012; Daphne and Anol, 2014).

The telematics system developed by UPS also mine data to show trends in vehicle maintenance, logistics and fuel consumption. The company mentioned that it was able to


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reduce idle time by 24 minutes per driver daily, an expected fuel savings of $188 per driver per year. With more than 90,000 drivers, this significantly contributes to the reduction of the organizations $CO_2$ emission. The telematics system demonstrates how UPS was able to create a Greener, cost investments, lowering greenhouse gas emissions, conserving energy, as well as a cleaner, more sustainable environment for the society (Richard et al., 2008).

**Sony.** Sony one of the leading electronic and house hold appliance manufacturer developed an e-book called Sony's eBook reader which can lessen paper consumption. While the earlier e-readers licenses are quite costly, Sony's eBook provides premium functionalities for free. According to a report published by UNESCO, it was stated that the minimum 1,510 sheets of paper is produced for one person in the world annually, at least half of these paper sheets go through copiers and printers to create office documents. Electronic media is more environmentally friendly than manual printed paper (Richard et al., 2008).

**Wal-Mart.** Wal-Mart is an enterprise that deals with mostly household and domestic goods, presently the organizations utilizes Information Systems to manage their supply chain processes. Wal-Mart presently uses environmentally friendly pack among their merchants. In the context of integrating Green IS, the organization is usually subjected to pressures from its supply chain associates that have previously or currently integrating Green initiatives (Adele et al., 2011). Wal-Mart uses Green IS to monitor and measure their expenses, $CO_2$ emissions and waste generated in each phase of a product packaging (Richard et al., 2008).

**Deloitte.** Deloitte is an organization that provides tax and audit services to leading firms across the world utilizes a Green model based on a 3 step progression of planning sustainability methods, implementing/tracking the procedures and lastly resolving Green organizational change (Alemayehu et al., 2011). The organization also recycles their IT related wastes at the end of use and disposes the hardware generated waste using an environmentally friendly approach. Other Green strategies implemented by the firm includes introducing application centralization, replacing old computers with thin laptops, platform standardization and adopting Leadership in Energy and Environmental Design (LEED) for new data centers (Alemayehu et al., 2011; Alemayehu et al., 2009).

**Freeitathens.** Freeitathens is an Athens based organization that is committed to recycling of old unused IT hardware. The organization collects old computers, refurbishes and repairs the computer, installs Linux operating systems and Open Office word processing application, and donates the renewed computers to charitable institutions. Freeitathens encourages the cradle-to-cradle re-manufacturing process. The organization also notifies computer users to always check its company's web site for recycling opportunities and processes when they decide to dispose of any electronic computer related products (Richard et al., 2008).

**Freecycle**. Freecycle is an organization that promotes Green strategies and initiatives. The organization was founded in 2003, termed as the Freecycle Network. Freecycle encourages waste decrease by providing an electronic forum to recycle unwanted and unused computer related items. The organization believes in the popular saying that one individual's trash can be another person's treasure. Ever since 2003 the Freecycle perception has since extended to 75 countries and includes millions of participants. The organization recently published that they have keep over 275 metric tons of electronic generated waste per day out of landfills (Richard et al., 2008).

**Herman Miller.** Herman Miller is an organization to uses Information Systems to facilitate its enterprise process, which is mainly to the design, manufacture and distribute of finished interior products. The organization believes in sustainability and has also integrated several Green strategies to differentiate itself from its contenders. The organization implements a cradle-to-cradle development design approach into its products, in which the organization reuses old products in developing new products. This strategy resulted to the creation of an Information System Design for Environment system (DfE). Currently the organization is shifting its supply chain to embrace only merchants that can subsidize to the attainment of its sustainability goal (Richard et al., 2008).

**Chevron.** Chevron an oil exploration company also responded to the need to advance environmental risk assessment and mitigation by integrating a decision support system to organize cost-benefit risk mitigation analysis (Nigel, 2010; Alemayehu and Ahmad, 2011).

**Ford.** Ford a multi-national motor vehicle manufacturer utilizes Information Systems to manage their supply chain vehicle sales and services to all their suppliers presently adopts and integrates ISO 14001 Environmental Management System (EMS). Adopting ISO 1401 support Ford sustainability target of caring for the environment when the organization dispose by-products generated from motor vehicle manufacturing (Alemayehu and Ahmad, 2011).

**Toyota.** Toyota corporation a leading manufacturers and dealers of motor vehicle also integrates Green strategies. The company new Toyota's Prius is built-in with information system managed hybrid engines and features to facilitate ecological friendly driving, which observers the level of eco-driving in diverse driving positions and eco wallet, which shows the cost-expenditure attained through greater fuel effectiveness (Daphne and Anol, 2014). Toyota also develops a battery-to-battery recycling strategies and initiatives that improves nickel from the nickel-hydrogen batteries used in hybrid vehicles and reuses it in new batteries.

**Volvo.** Volvo a Swedish multinational vehicle and motor manufacturing company integrates a viable information system that aims at reduce energy consumption in their logistics division called Dynafleet, the Volvo vehicle management information system collects real-time data in order to improve and optimize truck logistics and decrease $CO_2$ emission from the vehicle exhaust (Barbara et al., 2012).


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Based on the findings from the presented 21 organizations it is obvious that most of the organizations practice recycling, refurbishing, reuse and environmental friendly disposal of old outdated IT hardware. According to Albert (2009) organizations integrating only recycling practices is not enough, there is need for organizations to consider all Green strategies and initiatives in enterprise process such as in Green design or creation, Green distribution or manufacturing, Green sourcing or procurement, Green operation or usage and lastly Green disposal or end of life. Although as mentioned previously disposal or end of life is the process that is mostly implemented by organizations as mentioned by Albert (2009).

This fact is support by the findings of Alemayehu et al. (2009a); Alemayehu et al. (2009b); Jason (2010); Badrunnesa and Darshana (2015); Laura-Diana, (2016) in their research on the diffusion and implementation of Green practice in organizations and also correlated in another research conducted by the authors in assessment of capabilities of IT based industries (Alemayehu et al., 2010).

## 4. Discussion and lesson learnt

IT based organizations currently utilize more energy than data centres and this propensity is estimated to intensify towards the year 2020. A report by Barbara et al. (2012) predicted almost 100 % increase in the IT based organization's footprint by 2020, but also appraised that the efficient integration of Green IS practices within IT based organizations might cut $CO_2$ productions by up to five times this amount. Thus the authors proposed that "increased efficiency = reduced energy utilization = lesser $CO_2$ emissions".

But recently, organizations have realized the long term effects of IT and therefore they have commenced taking initiatives to improve their environmental footprint. It is widely accepted throughout practice and literature that outdated and obsolete hardware results to harmful effect on the environment. The illegal discarding of e-wastes may lead to severe health problems. Also, energy usage in operating IS infrastructures such as data centres in IT based organization ultimately add to $CO_2$ emissions. Additionally the extreme use of IT in organizational day to day process has become the cause of numerous environmental problems including Greenhouse gas emissions and possibly global warming. Consequently, IT organizations using IT hardware and manufacturers need to integrate eco-friendly policies and strategies containing, sustainable development, pollution prevention and product recycling in running IT facilities.

With reference to WCED (1987) opinion, sustainability is a main corporate capability that safeguards and protects without harming or endangering the future generations. To reduce sustainability issues, the IT based organizations can play an essential role by integrating Green Information Systems to reduce the effect of IT usage on the environment, which is commonly known as Green IS. Green IS relate to usage of Information Systems the manage energy utilization and the waste associated with the use of computer hardware and software. Green IS is the methodical application of practices that enable the reduction of environmental impact that results from IT usage, maximize competence and allow for enterprise $CO_2$ emission reductions.

Furthermore, Bokolo and Mazlina (2016b) defined Green IS as the study and practice of creation, distribution procurement, operation and lastly disposal of life products such as computers, monitors, storage devices, servers, networking communication and printers effectively and efficiently with negligible or no effect on the environment. Green IS refers to an organized application of eco-sustainability standards, such as use of clean technologies, product stewardship and pollution prevention for the design, manufacturing, procurement, operation and end of life of IT facilities, as well as within the practitioners and decision maker's constituents. Thus in integrating Green IS in IT based organizations the role of practitioners and management should not be ignored since they influence practitioners' behaviour. The decision makers (management) in the enterprise can influence organizational strategies and initiatives.

IT based organizations can contribute to $CO_2$ reduction in their enterprise, the effective use of IS can help practitioners decrease their Greenhouse gas emissions. Decision makers in IT based organizations are expected to provide novel tools that have the capabilities to support enterprise $CO_2$ lessening and sustainability initiative attainment and as organizations are under aggregate regulatory inquiry to decrease their carbon intensity, Green IS initiatives and strategies can deliver some of these decrease and can provide the capabilities to support IT based organizations going Green. Thus, for achieving Green IS practice integration, organizations must have their own performance strategy. The decision makers must utilize Green IS strategies and initiatives to measure their sustainability performance (Badrunnesa and Darshana, 2015).

## 5. Research motivation and implication of study

This review is an answer to the call placed by Navneet and David (2014) starting that IT based organization are currently integrating Green IS practices, although these practices implementation suggests a growing interest in the implementation of Green IS initiatives in IT based organization. Navneet and David (2014) went further to say that even as IT based organizations are integrating Green strategies and initiatives; there are still inconsistency between Green IS interests and actual implementations in enterprise process. According to the author only 25 percent of IT based organizations are concerned about environmental sustainability; however, only 10 percent of them have integrated Green initiatives and strategies.

Further, the research is vague about long term environmental and social and economic benefits of Green IS integration. Therefore, it is necessary to investigate why IT based organizations are reluctant to integrate Green IS


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and what are the underlying inhibitors and motivators that determine Green IS integration in IT based organizations. Although such studies has been carried out by researchers such as Alemayehu et al. (2009a); Alemayehu et al. (2009b); Jason (2010); Alemayehu et al. (2010) in other organizations there is still need to investigate further in IT based organizations.

Presently IT based organizations across the world exchanges information electronically such as in using email rather than the traditional method of posting a letter. This is also a Green IS practice since it leads to a cleaner society because information exchange through paper postal system leads to deforestation and it affects the environment, since less tress results to more $CO_2$ in the atmosphere. It is imperative for IT based organizations to integrate Green IS to implement the use of online energy monitoring systems that provide regular feedback on individual energy use (Nigel, 2010). Green IS integration in IT based organizations can lead environmental sustainability into the digital age and thereby contribute to economic, social and a healthy planet earth for generations to come as seen in Section 3.1 of this paper.

Leading IT based organizations such as Dell, Apple, IBM etc. have already declared their environmental strategy designed to make their enterprise Green for the long term, according to Alemayehu and Molla (2009) an increasing number of utility corporations are moving to electronic billing, which has a potential to decrease paper consumption. Other practices involves organization paying their enterprise bills online and activating e-bank account statement thus reducing paper involved in printing bills by their financial institutions.

While organizations like Dell, HP, Intel and Sun have built innovative data centres design and optimization facilities, other firms such as IBM and Deloitte are proposing services on how to position IT as an enabler of Green business initiatives (Alemayehu, 2008; Alemayehu et al., 2009c). IBM argues that data centres account for 2 percent of $CO_2$ emissions, implying that the true figure is much higher than this. However, a recent study by IBM argues that a majority of IT based organizations do not possess a Green IS strategy, let alone the competences to develop one (Tom and Mary, 2009).

The implication of this study is that this review is only related to organizations like IBM, Hewlett Packard (HP) that integrates Green IS initiatives and strategies to Green their organizations. These organizations utilize liquid cooling, Nano-fluid cooling systems, and in-server, in-rack, and in-row cooling for efficiency cooling of enterprise. They apply novel methods of making their data centre more environmentally friendly by using new high-density servers, using hydrogen fuel cells as alternative green power sources, and applying virtualization technologies that reduce the total power consumption of servers and lower the heat generated (Biswajit, 2014). Another implication of this study is that the author presented a list of organizations that integrates Green strategies and initiatives in their enterprise process, however these organizations presented in this study are derived from the available studies included in this review, thus there may be other organizations that integrates Green IS practices in their enterprise process that may have not been included in this review.

Lastly this review only considers IT based organizations and organizations that utilize Information Systems to facilitate their business process. The organizations presented in Section 3 are all derived from existing studies that are based on Green IS integration, implementation, diffusion and assimilation. This study did not carry out a case study investigated on the IT based organizations, the author only derived organization that practice Green IS in their daily process from the literatures only.

The determinants/factors (inhibitors and motivators) presented in Section 3 of this review paper were only extracted and synthesized from the some selected studies included in the review. The determinants were not confirmed with any IT based organization.

The author mostly considered more sustainability, Green IS and Green ITIS literatures in this review, only few studies related to Green IT was included because the paper is mostly based on sustainable Green IS integration in IT based organizations.

## 6. Conclusion and future work

Due to the swift growth in natural resource utilization together with the increase of Greenhouse gas emissions; sustainability has become a crucial concept for IT based organizations. IT based organizations can play an important role in decreasing climate change and continuation environmental sustainability pursuit by using their ascendancy in the global economy. IT based organizations can attain eco-sustainability by informing practitioners and decision makers of the need to make changes to enterprise as usual. By encouraging them to integrate Green IS strategies and initiatives in attaining the 3ps, and by evaluating the effect of such activities on the people environmental and economic performance (Triple Bottom Line (TBL)).

Furthermore there is need for IT based organizations to understand the sustainability goal present in Section 3.1. IT based organization need to integrate the 3ps (profit, people and planet) into their enterprise process. They need to know how to make profit, care for the environment and at the same consider the people's health and wellbeing when they dispose of e-waste. In practice, IT based organizations are continually dedicating resources in an effort to be inventive in their enterprise practices of becoming more sustainable. But are currently limited by several determinants both positive and negative determinants as seen in Section 3.2.

By reviewing, synthesizing and extracting data from several literatures on Green IS, the author identified the determinants that encourage IT based organizations from going Green and the determinants that limit IT based organizations from not going Green. The positive determinants called motivators or enablers encourages IT based organizations to integrate Green IS practices whereas the negative determinants called inhibitors or barriers limits


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and often discourages IT based organizations to integrate Green IS practices.

From the findings of this paper IT based organizations will practice Green IS if the positive determinants are more than the negative determinants. Nevertheless, Green strategies and initiatives integration is commonly unsuccessful and require an in-depth understanding of the determinants (motivators/enablers and inhibitors or barriers). Green IS practice strategies and initiatives can lead to changes in enterprise processes. Presently Green IS integrations is already gaining eminence in some organization, and in some cases compulsory for organizations as seen in Section 3.

In summary management and practitioners in IT based organizations are looking for prospects which are more original. The successful integration of Green IS practice initiatives and strategies depends on several determinants. IT based organizations should be aware of the determinants presented in this paper, since they influences Green IS practice integration. The findings from this review can serve as an agenda for IT based organizations to infer to in integrating Green IS practices strategies and initiatives in their enterprise.

The determinants presented in this paper can be useful to IT practitioners and management, decision makers when they want to integrate Green practices in their business process. By reviewing and describing the existing literatures this research attempt to provide pathway and assistance to IT managers and IT professionals who are currently thinking of integrating Green IS within their organization and give them an idea about current state of Green IS practice.

In future there is need to carry out an in-depth case study in different selected IT based organization to validate the determinant presented in Section 3 of this review paper. The case study will also assist in verifying each of the inhibitors and motivators that encourages and discourages IT based organizations to integrate Green IS practices in their organization. In carrying out the case study data will be collected using semi-structured interview. The interview questions will be based on all the determinants presented in this review paper. Lastly the case study will be conducted in five IT organizations based in Malaysia. Each of the organization to be used for the case study will be an enterprise that practice and integrates Green IS strategies and initiatives in their organizational daily process.

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