Green Information Technology (Green IT) Perspectives, Motives, Barriers, and Solutions within Manufacturing Companies

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Abstract. There is still little common understanding of what green IT actually means, the measure to determine the capability of organizations to Green their IT remains elusive. In Malaysia Green IT development is still at the early stage, greater efforts and promotion is required to ensure understanding and success of development and implementation of Green Technology Policy in Malaysia. To overcome some of misunderstanding in Green IT field, this paper clarifies deferent perspectives and some important related issues like motives, readiness, barriers, and solutions within green IT paradigm. The researchers have reviewed previous literatures to ensure wide understanding for issues regarding green IT.

Keywords: Green IT, Perspectives, Motives, Barriers, and Solutions.

1. Introduction

Some studies have shown the necessity of Green IT in companies' sustainability, it is becoming more common in discussion nowadays [1, 2]. And It refers to the effective and efficient use of ICT in organizations through developing and adopting specific strategies and policies for developing sustainable businesses [3].

In 2010, according to Symantec [5] there are three good reasons to go after Green IT; cost, demand from customers or potential customers, and attracting talent-many people want to work for a company that's ecologically responsible. In addition, Sarkar and Young [6] have stated that Green IT has become a significant issue for current organizations around the world because it affects their current environment and profit margins through an increase in energy costs. That consist with what [12] have stated about the intense power requirements that are needed to run and maintain data centres that create almost quarter of global carbon dioxide emissions from IT industry.

Furthermore, in 2009 Deng, et al. [4] have stated that there is still little common understanding of what green IT actually means, and the measure to determine the capability of organizations to Green their IT remains elusive [8]. Addition to that, there is currently no academic or practitioner investigation known to be applying theories from Organizational Learning to the specific domain of Green IT [9]. In Malaysia, Green IT development, still at the early stage, and greater efforts and promotion is required to ensure the success of development and implementation of Green Technology Policy in Malaysia [10].

Based on that, the researchers have founded this global issue is a significant matter and need more clarification. For that, the aim of this paper is to present backbone for Green IT within companies, and to ensure wide understanding for this critical issue by highlighting beneficial related literature from previous literature of Green IT [25, 34, 41, 42, 51, 53, 54]. That became more necessary nowadays all business homes in obtaining sustainability. This paper is going to clarify some important concepts in Green IT fields like perspectives, motives, barriers, and Solutions within green IT paradigm.

2. Literature Review

The green movement is a significant social movement representing a general reaction to the malfunctioning of the western social formation [11]. Previous relevant literature shows that "Green

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IT" can be viewed from different angles like; an economic concern [12, 3], an environmental concern [13, 14, 15, 16], a social concern [17,18, 19,20], a strategic differentiator [21], and an enabler of other green initiatives [22].

Furthermore, it encompasses different aspects of everyday life such as technology, politics, product purchases and consumption, marketing, and manufacturing and resources [23], these aspects contribute critically in sustainability. To effectively pursue the green movement for developing sustainable businesses, a holistic approach is needed [11, 24]. From Green context, sustainability refers to meeting the needs of present generations without compromising the ability of future generations to meet their needs. It consists of environmental sustainability, community sustainability and economic sustainability [13].

Green IT is emerging as an increasingly important issue as organizations come under pressure to address environmental sustainability concerns. Despite increased attention from business, government and more recently, information systems (IS) researchers, a measure to determine the capability of organizations to Green their IT remains elusive [8]. Some researchers defined Green IT as a systematic application of ecological-sustainability criteria (such as pollution prevention, product stewardship, use of clean technologies) to the design, production, sourcing, use and disposal of the IT technical infrastructure as well as within the human and managerial components of the IT infrastructure in order to reduce IT, business process and supply chain related emissions, waste and water use; improve energy efficiency and generate Green economic rent [25, 8]. Therefore, Green IT can include hard technologies as well as soft systems and business policies and practices spanning the IT lifecycle from production, through sourcing, building and use to disposal [25]. Green IT also strives to achieve economic viability and improved system performance and use, while abiding by our social and ethical responsibilities [26].

Addition to that, firms can obtain some benefits from pursuing green initiatives like building positive brand image, mitigating environmental liabilities associated with a firm's products and services and influencing the mindset of customers and investors [27, 24, 28]. Furthermore, it affects how the public and private sector award competitive tenders [19]. In other hand, firms go green for three good reasons makes economic sense in lowering cost, customers or potential customers are demanding it, and important for attracting talent many people want to work for a company that's ecologically responsible[5]. Many nations considering being both a producer and a consumer of green IT for three major benefits are: creating "green-collar" jobs, generating energy savings, and boosting economic productivity [29].

In contrast, there is still little common understanding of what green IT actually means [7]. For instance; In Malaysia, there is a lack of empirical studies that investigate the existence of green supply chain initiatives [30], and a lot of companies in Malaysia still behind and yet to adopt the green supply chain concept in their business strategy [31]. Furthermore, Green Technology development in Malaysia is still at the early stage, greater efforts and promotion is required to ensure the success of development and implementation of Green Technology Policy in Malaysia [10]. Moreover, Lacked of skilled, qualified, competent and productive human resource with lack of research concerned this global movement, represent the challenges to support green IT growth in Malaysia, and how to foster research, development and demonstration in green IT Promotion and public awareness [10].

The current issue is Malaysia's CO2 emissions have increased sharply over four decades, based in report of "Chart by the Carbon Dioxide Information Analysis Center, U.S. Department of Energy's Oak Ridge National Laboratory". In instance; figure (1) shows how it is exceedingly difficult for Malaysia to achieve the goal and significant commitments that have already made in Copenhagen to deliver a 40% reduction in CO2 emissions by 2020 (compared to 2005) [32]. This is a major challenge for the economy and will need careful consideration; planning and implementation/ enforcement, as Malaysia's CO2 emissions are notably higher than their neighbours [33].

Figure 1
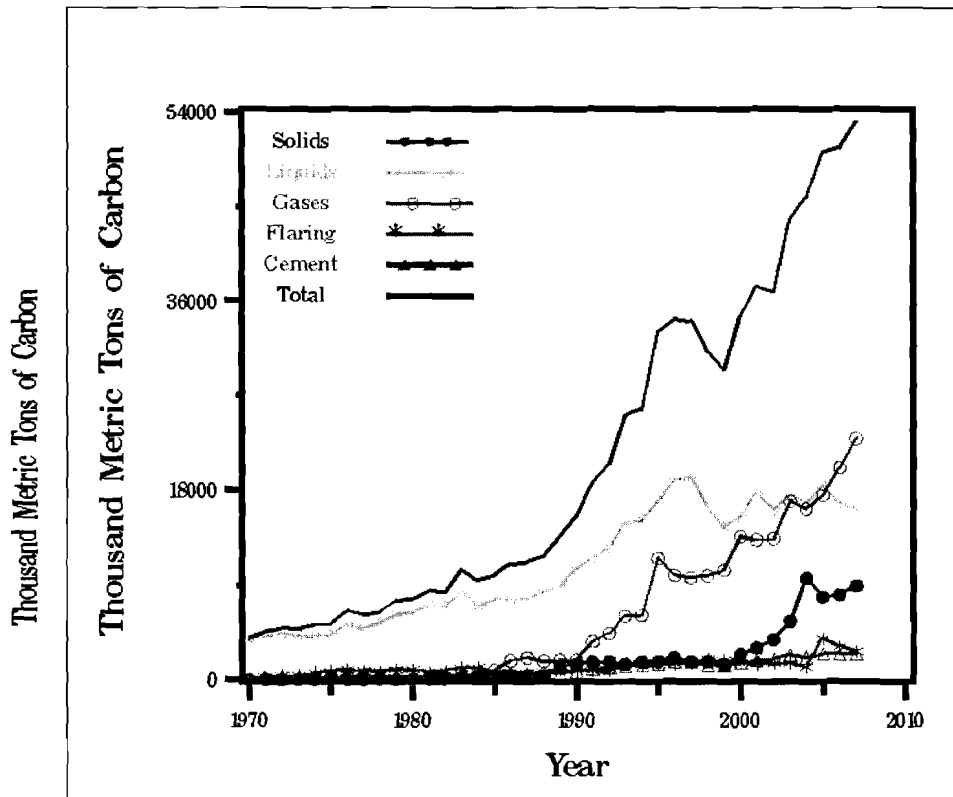
Therefore, the aim of this paper is trying to present beneficial related literature from previous researches of Green IT to ensure wide understanding for this critical movement. Currently it becomes more necessary for all business homes in obtaining sustainability. Furthermore, to contribute to existing researches regarding to this matter, with highlighting current issues that need more investigation in future. In the following, this paper will include four parts to clarify important issues regarding Green IT perspectives, motives, barriers, and solutions.

3. Broad Perspectives for Green IT

Green IT can be defined from four different but interrelated perspectives (sourcing, operations, services and end of IT life management) [34].

3.1. Sourcing perspective

It refers to purchase ecological IT product through adopting green sourcing practice such analyzing environmental foot print of an IT hardware supply chain, evaluating green track record of software and IT services providers, incorporating green issues (e.g. recyclable design and packaging) in vendor evaluation, and inclusion of social concerns (such as use of child labour and presence of harmful materials in IT supply chain) in IT procurement decisions [34, 35]. For that, developing a clear policy statement on environmental IT purchasing and Green IT request for proposals can be used as indications of Green IT adoption [34].

3.2. Operation perspective

All Green IT improves efficiency of powering and cooling energy of corporate IT assets that contribute in the reduction of greenhouse gas emissions. There are two types of energy consumption reduction the *temporary and structural consumption avoidance* represents. The temporary avoidance refers to optimization of energy utilization without reducing the installed power base, structural

avoidance results in reduction in installed power capacity [34, 38, 36]. Others include carbon offset programs [37], right-sizing the network critical physical infrastructure (NCPI) system to IT load, upgrading to energy efficient servers, retiring old systems, using efficient NCPI devices, and designing energy efficient systems [36].

3.3. Service perspective

Green IT refers to the role of IT in supporting a business's overall sustainability initiatives. Adopting a Green IT from a services perspective includes adoption of analytical tools for green supply chain management, environmental management and carbon foot print analysis. It also includes ICT based low carbon business solutions such as video-conferencing, thin client and web based business services, virtual collaboration and IP telephony [38, 39]. In addition, it concerns the adoption that integrates information from Green IT sourcing and operation technologies for management decision making is also another dimension [1]. Further, desktop virtualization, and policies and practices for corporate wide PC power management, PC use and print optimization regimes can be included in this category [34].

3.4. End of IT life management perspective

Green IT refers to practices in reusing, recycling and disposing IT hardware. Due to the growth and rapid change of ICTs, electronic devices are making up the fastest growing proportion of waste materials [40, 34]. Paradoxically, green IT initiatives to replace IT equipment with more energy efficient equipment would generate a surge in electronic waste and consume additional resources if equipment is replaced before the end of its natural life., unless complemented with would generate Some of these include hazardous materials and can contribute to a firms total environmental foot print[34]. For example, Leading IT vendors such as Sun, IBM and EDS and services providers such as Accenture have adopted e-waste recycling programs [1].

By understanding the four green IT prospects, so companies can utilize one or two prospects that can serve them in their initiatives for being green..

4. Motivation for Green IT Practice

The economic expectation of enhancing efficiency, a regulatory response of ensuring compliance and a normative objective of attaining legitimacy regarded as one of organizational motivations to go Green [41, 42, 43]. Add to that, efficiency, regulatory compliance, legitimacy represent the most motives [41].

First; the Efficiency Motive refers to energy costs which make a significant proportion of the total cost of running IT assets and infrastructure [36]. Reducing costs and improving the energy efficiency of corporate IT assets and infrastructure are most IT managers' top priorities [41]. In 2008 Accenture estimates that US's data centres and servers consume 1.5% of US's total electricity consumption and cost over USD 4.5 billion annually. In Australia, the ANZ Bank's initiative to ban screensavers has provided an estimated savings of approximately 4% reduction in its annual electricity bill. In cost terms, this translates to AU$500,000 per year [34]

Second; Regulatory Compliance Motive refers to actions that enforce some businesses to accept a technology or practice even if they do not have a strong intention to do so [39].

Third; legitimacy motive within the wider social context is one of the motivating factors affecting organizational behaviour [44].

The Internal and External motivation setting and the focus area of the motivation like Economic and Regulatory/Normative represent most motivation factors. These factors are labelled as eco-effectiveness, eco-responsiveness, eco-legitimacy and eco-efficiency [45, 46]

5. Obstacles for Green Initiative Adoption

The government is playing an important role to boost the awareness and knowhow about environmental improvement. Therefore, government involvement and support through funding,

taxation policy, import duty, business training to promote SMEs to make their move to involve in green initiative [47]. That also consistence with finding of [48] that most of the SMEs in UK were unaware of the environmental legislation and the requirements. According to Min and Galle [49] adopting green supply chain initiative requires additional effort and higher cost and it is less visible economic benefits from these initiatives. Furthermore; Simpson [48] stated that, most of the SMEs think that adopting good environmental practice unable to gain competitive advantage and improvements in their business and it was a financial cost added to the business which not possible to pass on to customers. Previous research has also found that cost concern is the most serious obstacle for taking environmental factor into account in purchasing process [49]. Therefore, SMEs had poor perception that there is a need for environmental improvement. Another barrier which highlighted by Wycherley [50] in the case study of Body Shop International, existing investments, information system and habits are costly and difficult to change. According to Perron and Student [51] there are four barriers found to prevent green initiatives adoption in SMEs, which are: Attitudinal and perceptions, Information related, Technical, and Resources barriers.

5.1. Perceptions and attitude barriers

Resistance to change is one of the common attitudes observed in top management, particularly among SMEs. Fear of the unknown and fear of failure are the primary reasons for such an attitude [31].

5.2. Information related barriers

It reflects the lack of awareness and information within companies for the benefits of green supply chain initiative as well as the environmental legislation and the requirements [48] weak internal communication. Furthermore, lack of exposure is another common problems faced by SMEs. Management does not have information on what initiatives have been taken by other organizations and how successful they have been. Benefits of a system based and business-environment integrated approach are often not known to the top management [31].

5.3. Technical barriers

Refer to the lack of technical expertise for top management for new technologies, materials, operations and industrial processes and technical support is not updated within the industry [31]. For instance; When SMEs not able to find alternative solution in designing their products to fulfill the design for environment requirements [52].

5.4. Resources barriers

Financial and human resources barriers represent the main obstacle to adopt green initiatives. The issues for financial barriers include lack of funding for environmental projects or ROI period is too long. While lacking of quantity and quality of human resource can be the barrier to pursue environmental management [31].

6. Solutions of Green IT

A few of the most common green IT solutions that can be incorporated into an overall strategy for organizations to go green such as consolidation , decommissioning unused systems, virtualization, and thin clients [53, 54] utilization management, and, power management, and upgraded hardware technology [53].

6.1. Decommissioning Unused Systems

Retire systems that are rarely or never used but draw power should be retired. Any relevant data or services should be moved to an alternate server [53]. The larger the data centre, the more likely it is that there will be servers running without providing services. Decommissioning unused servers saves power, release software licensing for use elsewhere, reduces maintenance charges and lowers the required cooling level. BT has saved 5.3 GWh per year by adding server decommissioning to its virtualization plans and associated cooling reductions (Search Virtual Data Centre 2009).

It is not unusual with unapplied equipment that is plugged in but no longer in use, as mentioned before. Hence it is a good idea to create a program that check and remove unused equipment. A program to continually check on what equipment is used respectively not used saves CO2 emissions as well as money by reduction of energy consumption [54].

6.2. Consolidation

Consolidation of data from multiple sources into a centralized system makes better use of IT resources as well as of IT support. Many data centres have plenty of plugged in equipment not in use, wasting energy and generating CO2 emissions [54]. By consolidation these can be eliminated. It is the process of consolidation for some servers onto a fewer number, If they are not being utilized to their storage and performance capacity. With considering the ability for consolidated systems to handle peak loads for the combined services they will support, and when possible, the retired systems should be those that are the least power efficient [53].

6.3. Cooling system of servers

The cooling system in the computer halls is a substantial part of the energy consumption from IT solution provider companies. Therefore it is important to review what kind of system that is used. District cooling is the most environmental friendly way of cooling system today. It is the opposite of district heating and works on similar principles. District cooling delivers chilled water to buildings needing cooling. The source for the cooling is often lake-water; hence it is a less expensive and more eco-efficient resource than using electricity to run compressors for cooling [54].

6.4. Utilization Management

It is the processes that allow computing services to be distributed across available servers to maximize their utilization. Unused systems can then be retired and new systems will not need to be purchased unless absolutely necessary [53].

6.5. Virtualization

It is a process by which two or more logical computer systems can be run on one set of physical hardware [53, 54]. The purpose behind that is to decrease consumption of energy and power [53].

6.6. Power Management

Power management schemas can also be extended to desktops to ensure they are turned off when employees are not in the office and to enforce the use of power usage options, like hibernation and sleep modes. Many systems management solutions now allow the automation of shutdown and power-up processes to ensure servers are only running when they need to be available [53]

6.7. Upgraded Hardware Technology

As hardware manufacturers continue to improve power efficiencies and develop new features (like CPU throttling during low use periods), the incentive to upgrade aging IT components increases proportionally. Here again, evaluation of system power and performance data versus expected improvements can help determine if an upgrade is warranted.

6.8. Thin Clients

A network computer without a hard disk drives, whereas a fat client includes a disk drive. The idea of thin clients is simple: rather than having a network of standalone PCs, each containing its own hard disk, powerful CPU, copies of the software, and so on, there is one or a small number of servers on which everybody's applications run [54]. Extremely energy efficient workstations with little or no disk capacity can take advantage of virtualization and streaming technology to significantly reduce desktop power consumption [53].

7. Conclusion

Green IT still in the early stage of development and adoption, companies have to have broad overview on the nature of Green IT and how they can start their initiatives. It is seem that, the proper adoption and better utilization for current IT from green prospective companies should understand from what perspective and the motives they have to catch from such adoption for their benefit. In the same time, companies have to be well known about the obstacles they may face to prevent failure. Finally, going green presents real solutions that can help in somehow to the overall companies' strategy.

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