

Ecological Monitoring and Feedback Approach for Green and Sustainable IT

Mohd Norhisham Razali, Helmer Ron Loindin, Leau
Yu Beng
School of Engineering and Information Technology
Universiti Malaysia Sabah
Kota Kinabalu, Sabah, Malaysia
hishamrz@ums.edu.my, helmer_ron@yahoo.com,
leauyubeng@gmail.com

Rozita Hanapi
Faculty of Office Management and Technology
Universiti Teknologi Mara
Kota Samarahan, Sarawak, Malaysia
rozitahanapi@gmail.com

ABSTRACT

The innovation and development of the Information Technology and Communication (ICT) industry has significantly contributed to almost all aspect in human life. However, ICT is also responsible for the global carbon footprint due to several studies have suggested that ICT is already responsible global carbon emissions from the consumptions of IT products and applications. Realizing that, the implementations of Green IT framework by MAMPU are important as an initiative towards sustainable environment by reducing the energy consumptions and carbon emission of ICT equipment in all public sectors. The aim of this paper is to demonstrate the development of prototype system to monitor the ecological and sustainable behavior in Malaysia public sector community. The prototype system is designed as augmentations tool to the implementation of Green IT framework that used by MAMPU. Prior to the prototype system development, this paper will review the current practices of Green IT in Malaysian Public Sector and the related examples of monitoring application in order to get some understanding about Green IT Monitoring applications. The prototype system is then will be developed and has gone through the common software development process. The screenshots of working prototype system will be showed in the last section of this paper.

KEYWORDS

green IT; green ICT; sustainable IT; sustainable design

1. INTRODUCTION

ICTs and their applications can have both positive and negative impacts on the environment. Like all electronic devices, computers have an impact on the environment since there are many studies have demonstrated the significant increase of energy consumption and carbon emissions due to the use of ICT [9]. The consumption of ICT applications have contributed about 2% to 3% of global carbon emissions and global warming [10]. Many recent publication shows that the ICT industry carbon footprint is about exceed than the aviation industry and the rate of growth of energy consumption is doubling about every 5 years [16]. It is quite alarming and thus, the implementation of Green ICT framework and policy are the key factor that can sustain the usage of ICT applications.

The Malaysian Government under the Ministry of Energy, Green Technology and Water promotes the green technology as a driver to accelerate the national economy and promote sustainable development. Besides, creating a sustainable ICT environment is now becoming one of strategy enabler under the 2010-2015 Malaysian Public Sector ICT Strategic Plan [13].

The ICT user awareness, behavior and understanding on the green ICT policy is one of the success factor in sustainable consumption as according to Ahola[3], the user segment have significant impact potential on reducing energy

consumption and carbon emissions. ‘Empowering people’ is the first sub roadmap of ICT sustainability [2]. The ICT users are willing to change their behavior according to the Green IT requirements but they are confused with the overflow and complexity of green information. Furthermore, in order to conserve the sustainable existence on earth, the future information and communication technologies must be also inherently sustainable both by nature and in usage [16]. Thus, this paper is intended to demonstrate the development of prototype system in order to monitor the ecological behavior among employees for Green and Sustainable IT in Malaysian public sector as it can support the monitoring process as mentioned in Green IT framework. This monitoring tool is important as one of the green IT strategy by Ahola[2] suggested ‘Empowering People’ that can raise people’s awareness of the environmental impact of their actions and to channel their behavior in a more environmentally-friendly direction. Furthermore, the successfulness of Green IT Framework is depending on the well executions of all components in green IT framework. One of the components is Green IT measurement and monitoring is one process that should be conducted during the measurements [4].

2. GREEN IT

Green IT or sustainable IT is a hot topic and they are many initiatives taken to address the environmental sustainability problems consequences from the ICT appliances usage. The idea of Green IT or Green Computing started in 1992 after the launching of Energy Star and a voluntary labeling approach to recognize electronic equipment’s energy-efficiency characteristics by US Environmental Protection Agency(EPA) [17]. Energy Star became an important certification as many IT equipment starts offering Energy Star compliance in their product. Green IT aims to make the overall impact of ICT clearly environmentally sustainable and positive. It is about the use of ICT to consider

environmental problems and find solutions for them as ICT is a cause of carbon dioxide emission, high energy consumption and hazardous waste production due to the increases of ICT equipment used.

3. THE PRACTICES OF ‘GREENING’ GOVERNMENT ICT

The increasing awareness about the benefits that IT can bring into their operations, various ministries and departments of government across Malaysia are focused and geared-up for a greater role for IT in their daily working. The development of e-government in Malaysia is a good initiative to improve the information flow and processes within government. The Government used computer systems to increase their services productivity where hundreds of thousands of public servant use desktop computers to work more efficiently.

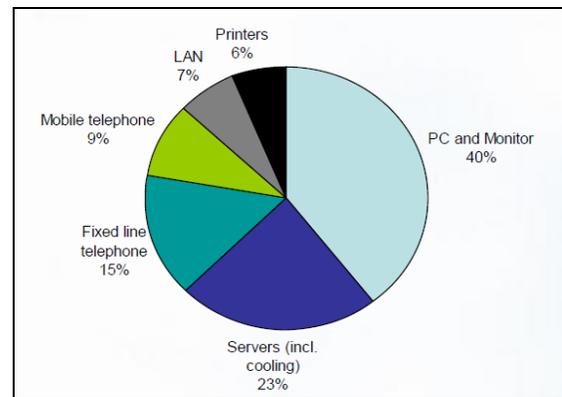


Figure 1 ICT CO2 emissions [11]

The figure 1 showed the percentage of ICT equipment usages in Malaysian Public Sectors by MAMPU[11]. Personal Computer and monitor is the most equipment used (40%) followed by server(23%), fixed line telephone(15%), mobile telephone (9%), LAN (7%) and printer(6%). This statistic showed that it is important for the organization to monitor the ICT equipment usages especially the personal computer.

The environment sustainability issues have caused government and industry bodies to take a proactive stance for Green IT. Malaysia is very serious about the green growth and low carbon economy. The Malaysian Green Technology Corporation is a non-profit company administered by Ministry of Energy, Green Technology and Water was established to fulfill the need for a national energy research centre that will coordinate all the activities related to energy planning and efficiency. The four pillars of National Green Technology Policy are to seek to attain energy independence and promote efficient utilization, to improve the quality of life for all, to enhance the national economic development through the use of technology and to conserve and minimize the impact on the environment [14]. This ministry was also providing the Green Practices and some of the practices relate to green IT are to configure personal computers into sleep mode when not in use, to ensure all the equipment are turned off before leaving the office and print or make copies only when needed. Others than that, the Information Management Division under this Ministry is currently upgrading their data centre to become a green data center through the modification of server room layout, air conditioning system, lighting system and power supply system.

Malaysian Administrative Modernization and Management Planning Unit (MAMPU) is another government body that taking many initiatives to promote Green IT in Malaysia. Mampu was specifically introduced the Green IT program in Public Sectors as an effort to conserve the environment as stated by Ministry of Energy, Green and Water by outlining the guidelines on the usage of ICT towards Green IT. Every year, Mampu organized several programs and activities to spread-out the information about Green IT to the public sector community as well as to the citizens. In 2010, three programs were organized by Mampu and there are Seminar on Initiative of Green IT in Public Services, Seminar on Green ICT Usages Guidelines and Sabah Green IT

Seminar. The efforts in promoting the Green IT continued in the year of 2011 which two program was held and there are briefing on Green IT Guidelines in Public Sectors and Green IT Initiatives in Public Services.

In 2010, MAMPU[12] has introduced a Guideline for Green IT for Malaysia Public Sector and in the document, there are three main levels that should took into consideration: i) ICT equipments acquisition, ii) ICT equipments use and iii) ICT equipments disposal. During the ICT equipment acquisition, buying the greener equipment is the starting point for green IT practices where the products are chosen based on the energy efficiency and low carbon emission as well as supported by the green star rating and eco-friendly product or any green awards. This ensures the people think in their mind how the equipment will impact the environment at the end of its life-cycle. The second level of the green IT practices are during using the ICT equipments. When using the personal computers or laptops, the screensaver should be deactivated, the monitor should be set into standby or hibernate mode after five minutes not active and switch-off them if they will going not be used for a long period of time. By 2011, MAMPU was targeting to start evaluate and audit the implementation of Green IT guidelines.

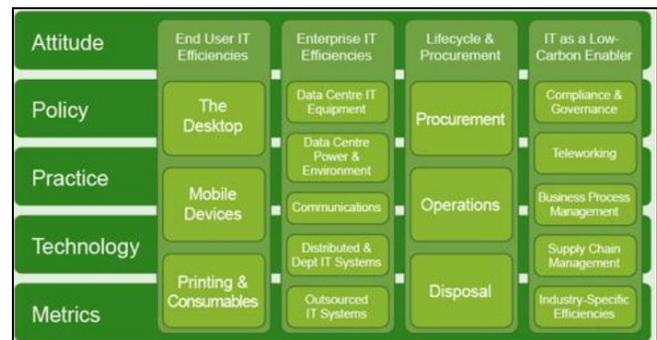


Figure 2 Green IT Framework[13]

4. ISSUES

Although the Government has started many initiatives on promoting green ICT among society, it is still quite challenging for the Government to implement the policy due to the lack of people awareness and motivation [2]. An interview session was conducted with five government servants to identify their awareness level on green IT. The results from the interview have found their understanding level on green IT is still low. Furthermore, Green IT in Malaysia is a new thing and they were still not exposed enough on the Green IT information due to no action taken by the higher management to practice green IT in the workplace. Although MAMPU has release the green IT guidelines, but some organizations are still not aware on this matter. The Higher Management may spread-out the information about green IT to the workers but it seems difficult to measure the the implementation of green IT. In this context, a monitoring mechanism is needed that can make ICT users aware about the sustainability of their behavior while using the ICT equipment. This can promotes the ecological behavior and will be designed to simplify the complex information on green IT as well as presented in more personal and motivating manner.

5. MONITORING APPLICATIONS

This section will review three existing applications related to Green IT named as Energy Calculator for PC Equipment, Dell Client Saving Calculator and Green Computing Energy Usage Calculator.

5.1 Energy Calculator for PC Equipment

Energy Calculator for PC Equipment is a system developed and used by currently used and created by European commission to monitor the energy usage of ICT equipment [8]. This system will

acquire the information regarding PC power, monitor power and the usage duration. The dropdown list for PC and Monitor will need the user to choose one of the 4 presets for the equipment. The values of on-, sleep- and off-mode as well as the purchase prices will automatically adjust. User can change these values based on the specific values of the equipment that the user use or intend to buy. The same goes for the dropdown list of the 'use' column, which gives presets for the typical daily usage. After all data are fill by the user, the calculate button must be hit to get it result. This system is meant only for monitoring the green purpose and being such there are no any other activities involved in this system. This system is developed using ASP language and Microsoft SQL.

5.2 Dell "Client Energy Saving Calculator"

Dell Client Energy Saving Calculator is a system that can compare three types of personal computer or laptop [7]. To use this system calculator, user must first fill the first configure baseline system completely then the second and third which called as configure a comparison system. The different about this system is, user have to fill a detailed information such as the brand of PC or Laptop, the model, power supply, types of processor, type of disk drive, graphic adapter, optical drive, memory types and also the display types which is the size of flat screen of monitor used. After all information entered, the annual energy used and the CO2 annual avoided total calculation are being shown. This is a good system because it requires a detail information from user to get the entire calculation total before calculate it. The more details the system it is, the calculation to get the energy used and CO2 emission will be more correct or right.

5.3 Green Computing Energy Usage Calculator

CoSN's web based Energy Usage Calculator provides a quick approach for estimating annual kilowatt hours and related cost for computer use by K-12 users (by group) and the related datacenter infrastructure [6]. This system allowed user to enter many types of ICT equipment for example Desktop type, Projectors, Monitor type, Laptop, printer, Photocopy, Server, Networking switch port, router, power supply and many more. The counting of energy usage is based on the quantity of the equipment, average usage, hours or day activate and hours or day power on. After all the requirement are enter at the green box, the power consumption and cost for all the ICT equipment usage can be calculate. This system not only calculates the energy usage but also the carbon dioxide emission either in pound or metric tons. To use the system, users have to enter the quantity of the equipment used and also the active used equipment per hours or day and days or years. Users also have to enter how many hours and day their powered on the equipment. After all the information needed is entered, the system then can calculate the annual energy use and the total of the energy cost.

6. PROTOTYPE SYSTEM DEMONSTRATIONS

The prototype system development has gone through common software process which is Waterfall Model has chosen as a model development [18]. This system is developed using PHP language and MYSQL as a database platform. In this section, few screenshots of system interfaces will be showed. There are two types of user which is administrator and normal user. The administrator of this system can be the staff who in-charged Green IT in organization and the normal user will be all the office workers who using ICT equipment in their works.



Figure 4

Figure 4 shows the homepage of this system. Users can browse all the information and guidelines about Green IT. The login page is also can be reached in this page where the user can logon this system to assess the other functionalities.



Figure 5

The organization's staff will use this system to update the ICT equipment usage by filling all the information needed as shown in Figure 5. The information about the equipment types, brands, model, quantity, monitor size, monitor type and usage duration is compulsory in order to calculate the energy consumption and CO² produced. The

calculation performed by the system will use the following formula:

Energy consumption= ((equipment model KWH * quantity) * usage hour)

Carbon Dioxide emission = ((equipment model CO² * quantity) * usage hour)



Figure 5

After the computation performed by the system, it will generate the result which is shown in Figure 5. Energy consumption (KWH) and CO² produced (pounds) is calculated for day and weekly basis. The results are used to measure the ‘green’ level in using ICT equipment. This feedback mechanism is important to ensure the staff more alert and aware while using technologies. The result will be also submitted to the administrator.



Figure 6

Figure 6 showed how the administrator or any person who in-charged green IT in their organization, can monitor the ICT equipment usages for all staff within the organization. From this page, the administrator may access and measure the green IT implementation in the organization.

VI. DISCUSSIONS AND CONCLUSIONS

The prototype system to monitor the ecological behavior while using technology is intended developed to support the Green IT implementation in government public sector. It is a proposal, since MAMPU have targeted 2011 as a starting point to evaluate and audit the Green IT practices after introducing the Green IT guidelines in 2009. Greening the ‘government ICT’ is only need a simple and easy practice like to switch off computers overnight, defaulting printer to duplex mode and an efficient cooler for data center. However, the simple practice will bring a significant implication to our earth as by turning off just one computer overnight is just like to save 235kg of CO² in a year and turning off 500,000 computers at night would have same effect as taking 40,000 cars off the road[5]. The prototype system is just a foundation that might generate other innovative and useful ideas for designing the

technology and tools that can help the government to ensure the Green IT can achieve its intended purposes. It also provided an intuitive feedback to users on real time energy consumption as according to one report [1], this technique has significant potential to change the behavior and different studies have shown the reduction from 5% to 15% of energy consumption could be achieved through the implementation of this measure. Another way to motivate people on this matter is to reward the business and consumers who adopting green IT practices as reward programs have been very successful in order industry sectors and hotel travel to encourage loyalty and promote greater usage of a given product or service [16]. The awareness of green ICT among ICT users in government sectors is still poor due they did not see the significant on it. Mansystems[15] suggested the government should separate the budgets or financial for ICT and energy consumption because ICT departments and users do not pay for energy, hence they see no reason to switch to energy-saving equipment. Defining the 'green' level or defining whether the organization is sustained in using technology is still questionable due to lack of guidelines for an accurate green measurement. For this reason, future works should study and explore on this issue. 'Green' indicator must be constructed as a concrete guideline for define the 'green' level while using the technologies. Many types of novel tool and application should be developed to motivate and educate the ICT users to be more aware about sustainable ICT and the dark sides of uncontrolled ICT equipment usages. There are lots of rooms for improvement for producing comprehensive software that can manage the value-chain of Green IT implementations from green software acquisition, use and disposal.

REFERENCES

1. Ad-Hoc Advisory Group Report, "ICT for Energy Efficiency", *DG Information Society and Media*, 2008.

2. Ahola.J, Ahlqvist.T, Ermes.M, Myllyoka.J and Savola.J, "ICT for Environmental Sustainability", *VTT Research Notes*, <http://www.vtt.fi/inf/pdf/tiedotteet/2010/T2532.pdf>.
3. Ahola.J, "Green ICT: Empowering People", Koranet Workshop on Green ICT Solution", 2009.
4. Arayalart.S.C and Nakata.K, "The Evolution of Green ICT Practice: UK Higher Education Institutions Case Study", *International Conference on Green Computing and Communications*, pp.220 – 225, 2011.
5. CabinetOffice, Greening Government ICT: Efficient, sustainable, Responsible, www.cabinetoffice.gov.uk/media/270265/one_year_on.pdf, 2007.
6. COSN, Energy Usage Calculator , 2010.
7. Dell, "Client Energy Savings Calculator", <http://www.dell.com>, 2011.
8. Energy Calculator for PC Equipment, http://www.euenergystar.org/en/en_008.shtml, 2011.
9. Fernandez.J.F.Gomez, Padilla.F.J.Alvarez, Fumagalli.L, Diaz.V.Gonzalez, Macchi.M and Marquez.A.Crespo, "Condition Monitoring for the Improvement of Data Center Management Oriented to the Green ICT", *Proceedings of the 4th World Congress on Engineering Asset Management*, 2009.
10. James.P, Hopkinson.S, "Sustainable ICT in Further and Higher Education", *A Report for the Joint Information Services Committee*, 2009.
11. MAMPU, "Inisiatif ICT Hijau dalam Perkhidmatan Awam", Seminar ICT Negeri Sabah yang bertemakan Green IT, 2010.
12. MAMPU, "Garis Panduan Penggunaan ICT ke arah ICT Hijau dalam Perkhidmatan Awam", www.mampu.gov.my, 2010.
13. Mampu, "Malaysia Government's Green ICT Initiative:Towards Sustainable Environment", <http://www.greenit-pc.jp/activity/asia/file/malaysia2.pdf> , 2010.
14. Md Farid Md Salleh, "Green IT in Malaysia", *Asian Green IT Forum*, 2010.
15. Mansystems, "Survey of sustainable ICT in higher education 2010", 2010.
16. Riaz.M.Tahir, Gutierrez.Jose M and Pedersen.M, "Strategies for the Next Generation Green ICT Infrastructure", *2nd International Symposium on Applied Sciences in Biomedical and Communication Technologies*, pp.1-3, 2009.
17. Ruth.S, "Green IT – More Than a Three Percent Solution?", *Internet Computing*, vol.13, pp.74-78, 2009.
18. Sommerville. I, Software Engineering. *Addison Wesley*, 2007.