Green computing implementation factors: UAE case study

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Abstract— **Green computing has been receiving lot of attention because of the growing environmental concerns and swelling energy consumption costs. Developments of computing performance and reduction in the consumption of energy and carbon footprints are among the most important objectives of green computing. Aim of this study is to explore and advance the green computing implementation practices among United Arab Emirates (UAE) organizations. Exploration of the green computing implementations in organizations within UAE revealed the awareness level of mere 41.23%, thus prompting the researchers to propose a model for the successful implementation of green computing. Proposed model derived from literature and validated among employees in various organizations in UAE aims to help organizations to go green.**

Keywords— Green computing; Green computing implementation

I. INTRODUCTION

Green computing has become one of the major and important topics because of its great impact on the environment as well as on the economy. Green computing is important and timely as computing is becoming increasingly pervasive and the energy consumption to computing is climbing, despite the clarion call to action to reduce consumption and reverse greenhouse effects [1]. One of research shows that the amount of global emissions of the greenhouse gas that comes from communication systems is almost equal to the amount that is produced by aviation industry [2]. Moreover, energy costs and electrical requirements of IT industry around the world show a continuously growing trend [3]. According to Kochhar and Garg [4] impact of using computers on the environment is as strong as dumping 1,500 pounds of CO2 into the atmosphere. The yearly cost of the electricity, if one computer is left on for 24 hours, charges between $115 and $160. Harmon and Auseklis [5] found that the Information Technology (IT) department can contributes 50% of organization's overall energy cost and producing 119100 pages is equal to cutting one tree [6]. By adopting green computing initiatives, organizations can produce products and services that address the environmental issues, lower energy cost and save more on government taxes, conserve energy by using energy star products and minimize energy consumption by using 'local cooling' [7] power management system.

Green computing refers to the practice and procedures of using computing resources in a friendly environment while maintaining computing performance [7]. Another researcher perceived Green computing/green technology as the use of computer and its resources in sustainable environmental way [8] that minimizes power usage of technical equipment like projectors, desktop and datacenters [5] . The main goal of green computing is to design computer system with a better processing with reduced energy consumption [9]. The idea of the green computing started in 1992 with the launch of the energy star program [4], a type of voluntary label awarded to computing products that reduce the use of energy and increase efficiency.

Green computing is now under the attention of not only environmental organizations, but also businesses from other industries [3], thus provoking researchers to seek answer to the question: What are the factors that are required for the successful implementation of green computing?

II. GREEN IT INITATIVE IN UAE

In UAE, Telecommunications Regulatory Authority (TRA) plays a vital role in implementing green practices and policies in the Information Communication Technology (ICT) sectors, thereby reducing the greenhouse gas emission's percentage from the ICT industry [10]. Dubai transport authority launched green IT initiative in 2008 that will better control over IT systems power consumption [11]. Another green IT strategy project initiative launched in February 2009 by Environment

Agency Abu Dhabi (EAD), aims to reduce the environmental effects and to capture the ICT driven innovation benefits for

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sustainable development [12]. Three key components included in the agency's strategy include: going paperless, advancing video conferencing, and making EAD data center more energy efficient. By implementing this strategy, the emissions of CO2 will be reduced by 596 tones yearly. Part of the strategy is to set up a green data center based on "Hot Aisle Containment" technology. Another example of green computing practices applied in UAE organizations include that of United Arab Emirates University (UAEU) that is committed to reduce the environmental impact by adapting sustainable aspects of Green IT UAEU [13]. The information technology services at the university are continuously developing to decrease the environmental impact on their IT use. The university will apply many green initiatives such as green data center, virtualization, cloud computing, unified infrastructure and green fax.

III. RELATED WORK

The G-readiness framework [14] was studied to understand the drivers, values and antecedents of Green IT principles and practices. The five pillars of success in greening IT which includes attitude (it is an intangible thing that describes how we think, not how we act), policy (policy readiness measures the sustainability and green policies that developed within an organization), practice (it's related to techniques and behavior (things, we do), technology (virtualizes servers, duplex printers and thin clients are not only green ICT technology) and governance (refers to green IT management infrastructure). This model became the starting point for performing empirical research.

IV. RESEARCH METHODOLOGY

In order to measure the awareness of green computing in UAE, this research uses qualitative research using interviews. Interviews were conducted among government and private sector employees of IT departments in different organizations, to identify the strategic plan for implementation of green computing and the best practices. The information collected from the interviews and the literature reviews helped to develop a model which provides guidance to the companies on going green, in clear and easy ways. Since green computing initiatives are decisions made by the top management and implemented at the operational level, interviews were conducted with five IT executives at both management as well as operational levels. Table 1 provides a summary profile of the respondents interviewed in this study.

Apart from the qualitative research, quantitative research was conducted using surveys, mainly to get the statistics on the implementation of green computing in the country and to measure the employees' awareness about green computing. An online survey was conducted involving 233 participants from private and government sectors (around 164 participants from government sector (70.48%) and 68 participants from private sector (29.52%)), to measure the awareness of the green computing among the employees in UAE.

TABLEI PROFILE OF THE INTERVIEWED ORGANIZATIONS

S/N	Type of organization	Position of the Interviewee	Organization field
1	Private	Manager, Information Technology	Education - University
2	Private	Network Administrator	Education - School
3	Government sector	E-Learning Specialist	Education – School & institute
4	Government sector	Senior Systems Engineer – IT Department	Ministry
5	Government sector	IT - Support	a chamber of commerce

V. ANALYSIS AND DISCUSSION

Based on the interviews and surveys conducted, main issues related to green IT initiatives in UAE are as follows:

A. Green Computing Policy

Some of the participant companies did not have a green computing policy, which is one of the main factors that any organization needs to implement to go green. Green computing policy may include policies on recycling policy, IT procurement policy, printing policy, etc.

- Recycling Policy: Recycling policy is one of the most important factors that help the organization to go green. Most of the organizations interviewed have a recycling policy. One of the organizations dealing with recycling company in Sharjah to collect the used cartridge and papers for recycling which save energy and minimize green gas emissions. Other organizations offering the old IT equipment to other schools to reuse them instead of disposing, however, some of them send the old PCs, printer, and other IT equipment to Dubai municipality. The above ways help the organizations to go green.

- Printing Policy: Most of the organizations interviewed do have a printing policy. This policy is important to go green because it prevents wasting the ink, toner, paper, and so on by restricting the staff to print only a specific number of pages (give them a specific quota). Some organizations adjust the printer setting to produce only black and white copies with double sided (education sector – school & institutes). Other (education sector – university, school & institutes) organizations put the printer in a specific room called printer room instead of adding a printer in each department. Furthermore, some of the organizations move already to green by minimizing the number of printing to zero (ministry). One of them has an e-learning center and they deal with an electronic document only (education sector - school & institutes). Printing policy helps the organizations to reduce the energy consumption and consumable waste.

- IT Procurement Policy: The purpose of the IT Procurement policy is to provide a framework for the IT equipment such as hardware and software. Most of the interviewees have another priority when purchase the IT equipment rather than environmentally friendly products such as specification, cost and meet the requirements. However, they have some products with star logo such as printer. Developing a team to check the IT product before purchasing them is a very important, because they are responsible to check if the product is environmentally friendly or not such as purchasing the products with energy start log which

helps the organization to buy energy efficient products that protect the environment as well as save money at the same time.

B. *Automatic Switch off Computers When They Are Not in Use*

The automatic switching off of the computers when they are not in use helps the organization to reduce the power consumption and save the performance of the devices. Some of the interviewees have an automatic system to turn off the computers at a certain time, other interviewee mentioned that the PCs are plugged into the network directly so after 20 minutes the computers go into standby, and after 6 hours the computers automatically shut down if not in use. One of the interviewee mentioned that computers go to sleep mode after 10 minutes.

C. *Budget for Green Computing:*

Most of the organizations do not have a budget for green computing that affects the organization to go green. Allocating a budget for green computing will help the organization to change the IT products by purchase green IT products that save energy and electricity as well as protect the environment.

D. *Best practice in the organization:*

Some of the organizations don't have enough budgets to buy the green IT equipment, but they can go into green by educating the staff or students. For example, they should not leave their PCs running while they are not in use because most of the organizations have automatically shutting down or sleeping mode, etc. Some of the organizations have printing policy, which helps to restrict the number of printing papers and the user can print both sides and black-and-white color only.

E. *Electronic business process:*

Most of the organizations use an electronic business process, which helps the organization to reduce the number of printing papers. As an example of electronic business process that use by organizations is the Enterprise Resource Planning (ERP) system which enables the staff to enter their sick leave, vacations, education certificate, and personal documents. Also some of the interviewees have online system to take the customer order, feedback, inquiry, applying for certificate of origin. Furthermore, some organizations use Google applications over the cloud, Google forms for online survey, and other organization send SMS to customers to inform them about such thing, and other have the e-learning center and all the books, weekly scheme, grades, exams and assignments online.

VI. RESULTS AND DISCUSSION

Results of the interviews conducted revealed that not all of the interviewed organizations have a green computing policy, or a budget for green computing. Furthermore, the awareness of the green computing is low with 58.77% of the participants not knowing about green computing. Some (24.67%) of the employees in surveyed, do not know where to change the printing options to single/double sided. This percentage is quite high, especially these days when everything has changed to electronic. 10.13% of the employees in both sectors are not even aware of an option like this. 30.53% of participants have misconceptions that recycling printer cartridges is greener than refilling them. 81.86% of participants think that using a screen server conserves energy when the computer is ideal. Still 1.30% of employees always keep their computers on while they are not in use. 2. 20% misuse the printer,11.01% do not print on both sides,3.93% never try to reduce the number of pages when printing, 57% never recycle unwanted computer equipment's, 6.17% buy computers whenever a new model is available and 29.69% never buy recyclable computer equipment.

VII. RESEARCH MODEL

Based on the literature review and the empirical research, a green computing model is proposed (fig.1) that shows the main factor that can help the organizations to go green. The factors are: green computing policy (such as printing policy, IT procurement policy and recycling policy), budget, attitude, awareness by attending seminars, conference, in house training, electronic business process, up to date with the new technology, and using a single device for each staff in an organization.

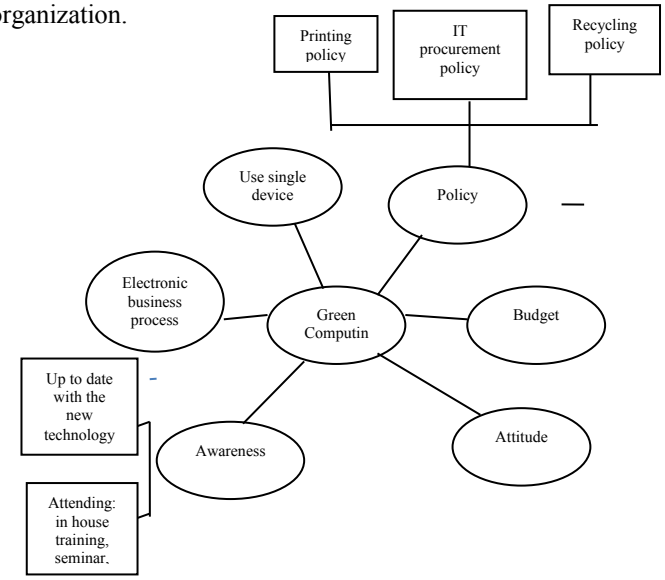

Fig. 1. Proposed model for successful implementation of green computing

A. *Policies:*

It is important for each organization to make a policy for recycling ink, papers, and any other equipment. Policies need to be in place for printing, recycling and for IT procurement.

Printing Policy: Each organization should put a policy for printing such as restrict the users to print a specific amount of prints/papers, reduce the number of the papers by changing the margins of the page, change the printer setting to print black-and-white copy and double sided as a default, to reduce the paper and ink usage.

Recycling policy: It is important for each organization to make a policy for recycling ink, papers, and any other equipment can be recycled. A new studies show that the percentage of recycled empty ink cartridges are 20 up to 40% so 60-80% will finish up in land filled [15].

IT Procurement Policy: Any organization should have a policy for IT procurements so as to buy up-to-date products using new technologies consuming less power , satisfying the needs of the organization, ones with a star logo, are efficient as well as cost less.

B. Budget:

Each organization needs to put a budget in order to move to a green, as there will be some changes in the IT products. Organizations may use virtual server, online application to take the customers feedback, as an example instead of printing out the forms, or to measure staff satisfaction of the company, to fill an application. Now most of the organizations in UAE deal with a customer complain, request, order, registration, etc. through their applications.

C. Attitude:

Top management should care about the environment and encourage the staff to be green not only in the work area but also in their daily life. The companies can encourage their staff to follow the green computing best practices by using penalties or reward system.

D. Awareness:

The awareness of the green computing in the organization should be increased. More than 50% of employees in surveyed organizations do not know about the meaning of the green computing, which show the lack of awareness among the staff in both private and public sectors. Thus the organizations should increase their efforts by making house training or sending the staff to attend workshops, seminars, training, conference, getting periodically magazine or newspaper, distributing the green computing logo everywhere in the organizations, especially in the printer devices. Electronic business process is one of the important factors that help the organization to go green. If all employees move to electronic business process it means they having zero printings. As instance, they use email to communicate and send documents or contact with clients. Furthermore, they can move the transactions in the organization to be electronic. Nowadays, in the UAE most of the organizations do that by letting the customer to install their application in the smart phone, and they can complete the form and send it where an employee has to complete the process and check the required.

VIII. CONCLUSION

The goal of green computing is to increase the energy efficiency during the product lifetime. It seeks to conserve the energy and reduce the e-waste. This study used qualitative and quantitative research methods to explore the green computing initiatives within organizations in the UAE and to propose a model for organizations to go green. While the qualitative method helped in collecting information from the interviewees to propose a model, the quantitative method helped to measure the awareness of green computing among the staff of UAE organizations. Results show that some of the organizations in UAE have moved already to green computing by changing the IT equipment such as servers, printers, desktops in the organizations and by reducing the number of printing paper to zero. At the same time, some of the organizations are reluctant to adopt green computing for various reasons including lack of budget, lack of policies or lack of top management's will.

The proposed model provides six factors that can guide the top management in the successful implementation of green computing within their organizations. Organizations are suggested to start implementing the change, in phases. Since, the scope of this study has been limited to five organizations within one country (UAE), a broader study encompassing other different sectors can aid the validation of this model at a higher level.

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