Green IT principles in Cypriot organizations

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ABSTRACT

It is not only due to Information and Communication Technologies (ICT) that our planet faces such problems as unstable climate change and other environmental depredations. Nevertheless, ICT does have some impact - through the pollution caused by hardware manufacture and disposal and through life-time energy consumption. ICT also has a positive role to play via such green technologies as cloud computing and digital distribution.

In developed countries, with mature ICT infrastructures, there have been some substantial moves to apply green conservation principles, but in developing countries there is potentially a conflict between 'catching up' fast at any environmental cost or trying to implement more environmental methodologies and technologies from the start. Cyprus is a small developing nation with a steady economy, promising development prospects and a largely well-educated population. As such Cyprus seems like a good place to find out which way this conflict is likely to go.

To explore this proposition, a pilot questionnaire, designed to discover the organizational awareness and application of a number of appropriate issues (for example, virtualization, e-waste management), was administered to IT personnel in a selection of Cypriot organizations of differing sizes and sectors. As a result a picture has been developed of how green a typical Cypriot organization might be. Subsequently, some guidelines were constructed to assist Cypriot or similar organizations to adopt environmentally-friendlier ICT practices.

1. INTRODUCTION

The emergence of both Information and Communication Technologies (collectively ICT) have had a huge influence on shaping modern society. In particular, ICT has radically changed the way business is conducted. Nowadays it is unthinkable for a company not to have an IT department and many companies have gone online, taking advantage of e-commerce opportunities. Massive quantities of data are stored in databases and most business transactions are now digital instead of having humans doing all the work manually.

On the communications side, business partners can send electronic letters to anyone in the world and they will receive it in seconds in contrast to physical mail services that require several days to deliver messages. Moreover, they have the ability to e-mail, call, text, send any kind of data or even video-conference with anyone almost anywhere just using a mobile phone.

Beyond business, ICT plays a role in research and development, the manufacturing industry, the provision of public services and entertainment and the arts. Not only are computers used to create special effects in movies or sometimes entire films but video games have also developed into a new branch of the entertainment industry. Furthermore, the internet has provided a new medium for distributing music and literature as well as video and thus transformed those industries.

Our daily lives are not exempt from the IT revolution. Every home has at least one computer and everybody has a mobile phone. We use the internet to read the news, check out the weather and traffic, look something up in Wikipedia, order food or groceries online, book flights or hotels and socialize with our friends. Our home environment (lighting and temperature) may be controlled by a microprocessor as are our cars, washing machines and other appliances.

Undoubtedly, ICT has made our lives easier and safer, saved us time, helped us to save and even make money and in general led to a better quality of life. But there is another side to this coin. While trying to make our lives easier, it seems that we neglected to consider the consequences of the rapid and colossal development of ICT. Sadly, damage has been done and is still being done. The polar ice caps are melting and tonnes of greenhouse gases are being produced. Of course ICT is not responsible for all this damage but it has contributed through the many chemicals, hazardous materials and materials that are hard to recycle that are used in the manufacture of computers and peripherals, and through the growing electrical power that is consumed.

Green IT is all about developing technologies, methods and techniques that can make ICT safer and friendlier towards the environment. Green IT aims to help the environment but at the same time is focused on 'traditional' IT targets like efficiency and cost-savings [15]. The ICT industry has always been about innovation and pioneering so businesses should make the change now on their own instead of waiting for governments to force us to go green by legislation.

In the large developed countries, many companies have taken Green IT into consideration and applied at least some environmental measures [18] but what about other, smaller countries? Do they recognize the problem and try to be part of the solution? The aim of this research is to perform a survey among Cypriot organizations from various fields to determine how *green* they are. Cyprus currently has with a good record in green technology with an extremely high percentage of households using solar panels to exploit solar energy [20].

GREENIT Conference 2010, May 17–18, 2010, Singapore.

Cyprus has developed rapidly during the last decade with an economy based on land development, services and tourism. It is expected to grow even more in the near future [21]. Large organizations like banks and government ministries do exploit the latest technology and small businesses may work in unconventional ways in their struggle to survive the competition. This survey should give a picture of where Cypriot organizations stand as far as Green IT is concerned.

2. A GREEN IT QUESTIONNAIRE

Green IT can be a component of the struggle to reduce the harm that is being done to our environment. Before proceeding to construct the questionnaire, it would be useful to review the topics that go to make up Green IT technologies and techniques.

2.1 Data Centres

It is common practice, especially for larger organizations, to maintain a data centre to cover their needs in terms of computing resources. They use low end computers for data input and output and let the data centre computers do all the heavy processing. In general data centres are more secure and their servers have a longer lifespan than normal desktop computers [24]. A data centre consumes a lot of energy because it contains large numbers of high-end computers and the centre requires special interior design for cooling and ventilating the servers. Thus, power management, cooling and data centre design (or redesign) are areas where organizations can make steps towards becoming greener.

2.1.1 Redesign

The way that a data centre is designed can affect the overall energy consumption, the cost and the efficiency of the centre. Some have been designed with built-in ventilation systems and special devices to block the sun and control the temperature [8]. In other cases, organizations have sited their data centres close to renewable energy sources such as hydroelectric and tidal power [24]. In this way the energy transport losses and costs are reduced and the organization reduces its carbon footprint. Data centres do not need to be anywhere close to the organization or its users.

Another redesign measure for a data centre can be the 'hot aisle and cold aisle' arrangement of server racks [9]. Even small design decisions can affect the performance and consumption of a data centre. For example, to keep air-flow obstructions to a minimum, cables should be sealed under the floor and floor openings and air conditioning units should be carefully sited.

2.1.2 Heating and Cooling

Cooling the data centre is important both in terms of cost and energy consumption. The energy load required for cooling a data centre can take up to 63% of an IT department's power consumption [27]. The equipment in the data centre consists not of desktop computers (PCs) but high-end servers that consume much more power than a PC and consequently produce more heat [22]. On top of that, having multiple racks of servers in small spaces amplifies the concentration of heat.

However, much modern equipment can run hotter than older equipment and some data centres may be overcooled. ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) [3] has modified their recommendations for temperature and moisture limits for data centres to reduce the amount of energy required for cooling (Figure 2.1).

Cooling a data centre does not necessarily mean using machinery such as air conditioning units and fans. Where possible, a data centre could be cooled down by free, natural cooling sources such as wind and water [9]. Finally, electricity is generally supplied with an alternating current (AC) and this must be rectified to direct current (DC) before it can power a server. Because energy is lost as heat during this process, if DC power can be generated instead, both energy and cooling costs can be cut down [27].

Figure 2.1 - ASHRAE Recommended Operating Table [3]

	2004 Version	2008 Version
Low End Temp	20°C (68°F)	18°C (64.4°F
High End Temp	25°C (77°F)	27°C (80.6°F)
Low End Moisture	40% RH	5.5°C DP (41.9 °F)
High End Moisture	55% RH	60% RH 15°C DP (59°F DP)

2.1.3 Power Management

Another crucial method for energy saving, cost reduction and pollution reduction is to take advantage of power management techniques. Knowing the energy needs of a data centre, it is possible to calculate the total cost of the data centre's operation. A study by Ziff Davis Media [30] suggested that 18% of the subjects reviewed said that they did not have sufficient electrical power in their data centres and half of the IT managers that took part in the study believe that they will need more power in their data centres in under two years.

Power management has to do with methods to cut down the energy consumption of machinery to the minimum. The Green Grid [5] has devised power efficiency metrics for data centres. PUE (Power Usage Effectiveness) is defined as the total facility power divided by the IT equipment power. The DCIE (Data Centre Infrastructure Efficiency) is the reciprocal of PUE expressed as a percentage. Total facility power includes all equipment - for example Uninterruptible Power Supplies (UPS), Computer Room Air Conditioning Units (CRACs) and even data centre lighting. A PUE close to 1 means that the data centre is running very efficiently. (A PUE of 1 would mean that the power is used by IT equipment only.) Ohara [19] has defined some power management levels for data centres (Figure 2.2).

Figure 2.2 - Green Level Calculation Chart (after [19])

Level	Steps
Basic	Review monthly electricity bill
	Check equipment regularly for capacity planning
Intermediate	Install automated metering and reporting of electrical load and consumption
	Check energy efficiency when purchasing equipment.
Advanced	Monitor energy efficiency per rack/device/circuit
	Analyze historical data reporting
	Use real-time reporting at departmental level
	Use data to negotiate rates with utility company.

2.1.4 Rightsizing and Virtualisation

The methods to monitor, measure and save the energy consumed in a data centre all seem to be reactive solutions to reduce the effects of an existing problem but not how to avoid the problem itself. Rightsizing looks to strike at the root of the problem by reducing the amount of working hardware in a data centre. Rightsizing can improve the efficiency of a data centre effectively [26] and was being implemented by 70% of the IT managers surveyed by Molla et al [18].

Rightsizing is about using exactly the hardware you need and eliminating redundant equipment. It needs careful monitoring of systems, measuring their performance and reviewing the results. For example, there might be a different server for each business

function with each one running at only 50% of its capability. Why not use half the servers to 100% of their potential [27]?

Where business functions are represented by a single or a suite of applications, these can simply be migrated onto a different, underused server. Frequently, however, the business function is configured to run exclusively on a server of its own and in these cases, rightsizing can be achieved through virtualisation. Here a single physical server is configured to run as a number of virtual servers. Even though virtualization can improve server efficiency, the server's computational power is decreased because the server has to run some emulation tasks to implement the necessary interfaces and systems [23].

Virtualization provides several advantages. It can be applied by medium size businesses as well large organisations to solve storage capacity, electricity supply and budget problems [14]. It can speed up new infrastructure provision using deployment software. It can be used to rehost old legacy applications from 'decaying' servers to newer ones [27]. In addition, virtualization offers remote desktop services - the installation of software and data in centralised servers that perform all the processing tasks. End users can just use low-end desktop machines for input and output. This service cuts down the costs of providing and updating expensive hardware and software licences for end users, cuts down the costs of energy and maintenance and improves security [16].

Virtualization has some drawbacks. The number of servers is reduced running mutiple applications and systems simultaneously. If one physical server dies more data and functionality will be lost so more significant damage can occur.

2.2 Cloud Computing

The rationale for cloud computing is based on the concept of virtualization. Cloud computing refers to using software and hardware as a service or alternatively as using the internet as a computing platform. Cloud computing is similar to the remote desktop services provided by virtualization. The user, equipped with a low-end device like a netbook, accesses the internet and uses online applications like word processing applications through a web browser. Although the netbook is running the browser, it acts simply as an input and output device and all data and commands are transferred through an internet connection to the application's host servers for processing. Remote desktop services have been described as 'private clouds' within an organization [2].

The services that cloud computing offers either virtualize software applications or hardware resources, and thus divide into two service categories - Software as a Service (SaaS) and Hardware as a Service (HaaS) [12][28].

SaaS enables users to use applications over the internet without having to install the application on their machine's hard drive. Some examples of SaaS are Google Docs [25] and Blist [6] which allow users to create documents online, store them, access and edit them through the internet; Clarizen - an online project management tool and Salesforce which offers an online CRM (Customer Relationship Management) [7].

HaaS allows users to utilize computing resources without owning them physically. Even though the philosophy is quite different from SaaS, the way that HaaS works is similar to SaaS. Users can use computing resources like storage space to store data through the internet. Amazon's EC2 [1] (also known as Amazon elastic compute cloud) is a good example. It provides the opportunity to purchase computer resources in the form of storage, data transfer and CPU (Central Processing Unit) demand.

Cloud computing can help save money and energy. Instead of physically buying software like office applications or hardware resources like external hard disk drives, users choose the services offered by cloud computing. Using SaaS services, users only need cheap low-powered computers and an internet connection. SaaS software is not distributed on physical media so production costs are reduced. HaaS eliminates the need to own, run and regularly update hardware. Such services allow for cost reductions and increase efficiency and flexibility. More widely shared and efficiently utilised hardware implies reduced hardware manufacture and distribution activity.

Cloud computing sounds promising but there are some other points to consider. Trust and security are important issues. Many companies are reluctant to store critical data such as trade secrets or customer records in a remote location not controlled by them with the danger of unauthorized access or accidental loss. Cloud computing centralises resources in one place in the hands of one provider. If the provider fails the company will be very vulnerable.. Cloud computing requires a broadband connection - if a company's internet goes down there will be no way to use the computing services. In countries or remote areas that do not have high speed internet connections there could be difficulties using cloud computing services [2].

2.3 E-waste Management

The topics discussed so far have focused on the impact caused by IT in terms of energy consumption. There is another very important topic - the IT industry produces a lot of waste which is also known as e-waste.

E-waste is waste electronic equipment - discarded computers, monitors, printers, disks, mobile phones and batteries. Every year some 20-50 million tonnes of e-waste is generated [4]. E-waste is an issue because it is not just garbage but contains a lot of hazardous materials - noxious gases, deionised water, lead, mercury, cadmium, PVC, ferrous materials and various oxides [17]. It is dangerous to discard electronic equipment as if it were normal garbage because of the by-products and wasteful because a lot of the materials could be reused or recycled. There are various ways to tackle the e-waste problem like recycling, refurbishing and reducing.

2.3.1 Recycling

Recycling is the most effective measure. Many domestic households now use special bins to throw away recyclable material. This recycling culture must be extended electronic equipment. Services for the collection of electronic equipment for recycling are provided to the public by local government [13]. It is important to persuade businesses to embrace the cause of reducing e-waste since businesses usually produce more e-waste as they change their equipment more often.

Companies should recycle their equipment instead of stockpiling it. Companies may stockpile because they don't know how to dispose of the equipment properly, or they believe that they might to use the equipment in the future or they hope to sell it [27].

The best solution for any organization would be to sign a contract with a professional recycler. Professional recyclers dispose of hazardous materials so that they won't harm the environment and all remaining recyclable parts are shipped out manufacturers so they can be used again [10].

2.3.2 Refurbishing

Much electronic equipment can be refurbished instead of thrown away. Refurbishing, in contrast to recycling, is about bringing the hardware to an acceptable working condition. Refurbishing could be a good solution in reducing e-waste as it is relatively cheap and easy - usually requiring just a few new parts and somebody to do the work. Some refurbishers work to help those who cannot afford to buy a computer - poor families, schools with low budgets, third world countries [27]

2.3.3 Reducing e-waste

Apart from recycling and refurbishing there are other simple practices that can be applied to reduce e-waste. Older computers can be used as the low-end machines for remote desktop input and output. Software designers can design efficient software and reduce the need for frequent upgrades. Hardware manufacturers can design their hardware to last longer and enable machines to be upgraded more easily [11]. Everyone can try to get the most out of their hardware before replacing it.

2.4 The Questionnaire

On the basis of the Green IT issues discussed above, a simple questionnaire was constructed to gather the views and practices amongst Cypriot companies. The questionnaire consists of 25 questions arranged as follows:

Questions 1–6:	Demographic questions concerning the respondent and his/her organization.
Questions 7&8:	General green questions to establish environmental awareness of respondents.
Questions 9&10:	Green infrastructure questions for localized or centralized installations.
Questions 11–13:	E-waste questions.
Question 14:	Organisational/management awareness question (not discussed in this paper).
Questions 15–19:	Data centre questions.
Questions 20–22:	Cloud computing questions.
Questions 24&25:	General Green IT commitment questions.

The full questionnaire appears at **Section 8**

3. Analysis

3.1 Demographics

Questionnaires were handed out to IT managers or IT professionals in various organizations of different sizes and sectors.

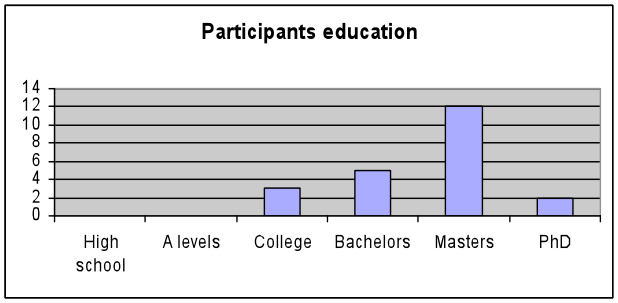

Figure 4.1: Participants' Educational Status

Twenty two of the twenty-five people who were asked to participate responded. The respondents came from different age groups and work positions but with a generally high educational status (Figure 4.1). This sample is small, but it covers the most common business sectors in Cyprus. The participating organizations came from eight different sectors, mostly manufacturing and retail, with five small, ten medium and seven large organizations. Almost all are well-established and have operated successfully for many years.

3.2 Organizational Green IT awareness

The most important Green IT topics are reducing the energy costs of IT infrastructure and e-waste management (15 and 14 votes respectively). Environmentally friendly ways to purchase and dispose of IT equipment are also prominent (12 votes each) while IT's contribution to the organisation's green house gas emissions and environmental footprint are not so popular (6 and 5 votes).

Larger organizations are concerned with a wider range of Green IT aspects whilst small and medium sized organizations are more focused on topics related to cost saving solutions. A topic might be considered as relevant to an organization because it is aware of the topic and plans to take action in the future.

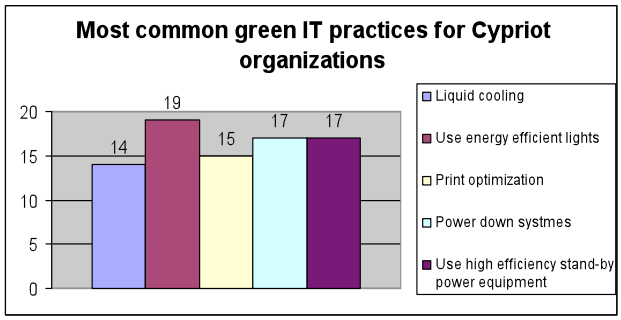

Figure 4.2: Common practices

Part of the questionnaire was concerned with which Green IT solutions are currently used by Cypriot organizations. Figure 4.2 shows the top five practices that are currently used by the organizations that took part in the research.

These are popular because they are simple and inexpensive to apply so they can be adopted even by small organizations such as family owned businesses. More effective solutions such as server and desktop virtualization are less popular since they cost more

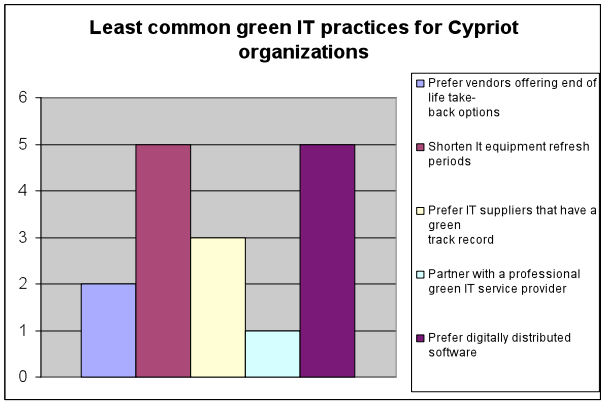

Figure 4.3: Uncommon practices

and may be less applicable. There is little enthusiasm for initiatives like preferring suppliers with a green track record or vendors that offer hardware take-back (Figure 4.3). Without

pressure from the government or European Union perhaps organizations choose to ignore solutions that do not cut costs.

Only one organization was partnered with a professional Green IT service company and although twelve organizations claimed that environment friendly IT disposal was one of their Green IT topics, only two favoured vendors that offer take-back options.

3.3 E-waste

When it comes to managing aging IT equipment, it seems that Cypriot organizations do not do well. Among the twenty-two participants only five refurbish old hardware, six recycle the usable parts and no more than two discard them in an environmentally friendly way. In addition, only four have a contract with a recycling or a refurbishing company, none of which know whether their recycling/refurbishing partner utilizes legal and ethical solutions. This indicates that organizations in Cyprus have problems with recycling and discarding unwanted hardware. This might be due to the absence of strict laws and regulations for recycling and a lack of awareness of the issues.

3.4 Data Centres

Only seven organizations reported that they had a data centre, five being large organizations and two of medium size. This figure is lower than expected and it is possible that some respondents consider that their IT departments run server rooms rather than data centres and therefore replied negatively.

Out of the seven organizations that use a data centre, four use some metrics to calculate their data centre's energy consumption. Using metrics is a sign of maturity in organizations as it is a first step towards taking measures to target a greener data centre. In addition to metrics, three of the respondents use rightsizing techniques, four have hot/cold aisle configurations and six of the seven switch off lights and idle equipment. Once again the simpler and least expensive techniques are the most popular.

3.5 Cloud Computing

None of the small or the medium sized organizations use remote desktop techniques and only four of the larger organizations - from the education, quasi-government and banking sectors - employ more advanced and expensive solutions. Five large organizations (including the four above) and one medium-sized one use server virtualization to rehost older systems.

As was expected larger organizations use cloud computing technologies but so do others including one of the small organizations. (Figure 4.4) Cloud computing might be a relatively new technology but it isn't necessarily expensive. However, only four (large) organisations use a private cloud. That is understandable, as private clouds can be expensive and complicated to develop and smaller organizations can easily satisfy their needs by using commercial cloud computing services.

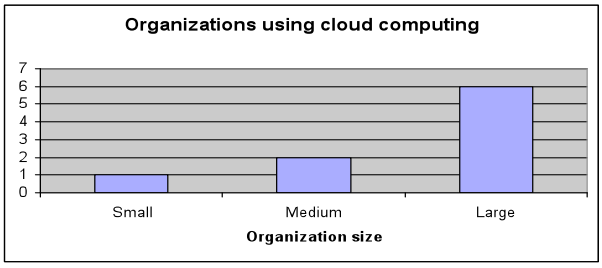

Figure 4.4: Cloud Computing

HaaS is used slightly more than SaaS and also by a small organization. HaaS is easy to deploy and is scalable since most providers offer an option to rapidly alter resources according to need. SaaS could be less popular due to the organizational culture in Cyprus. Fewer than 25% of participating organizations buy digitally distributed software indicating that Cypriot organizations tend to prefer tangible rather than digital products.

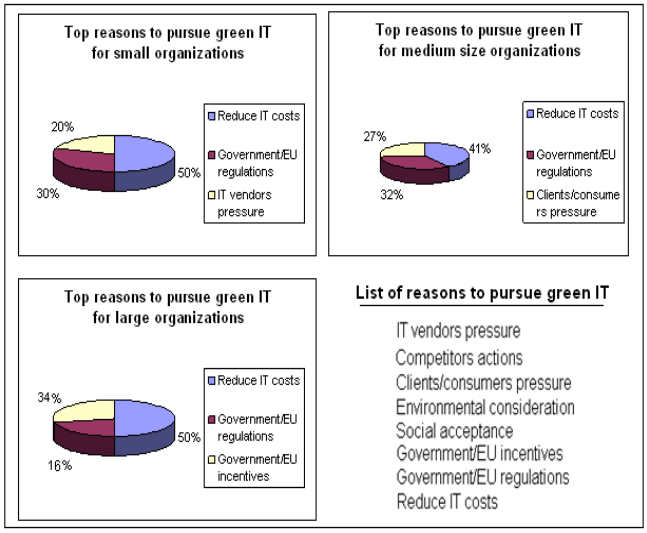

Figure 4.5: Green IT Motivation

3.6 Motivation

Finally, the questionnaire sought organizations' opinions on reasons which would persuade them to turn to Green IT. This is broken down by organisation size in Figure 4.5. Overwhelmingly, it is cost-driven in all cases although there is some differentiation amongst the secondary factors. Only the larger organisations view government incentives as a major factor, whilst the smallest organisations seem to be more influenced by the vendors.

4. Discussion

In designing the questionnaire, some care was taken to pose questions that covered the range of Green IT issues pertinent to all organisations and enterprises. In administering the questionnaire however, it was not possible to ensure that the sample truly represented the target population either in terms of size or composition. Consequently, it would not be statistically safe to represent our conclusions as definitive statements of the situation in relation to Cypriot organisations. Nevertheless, the results do give a sound basis for generating hypotheses for future studies and it is possible to develop some guidelines for consideration by businesses aiming to green their IT operations.

4.1 Small Organizations

Only five small organizations, from manufacturing, imports & exports and retail, participated in the study. Environmentally friendly disposal of equipment and reduction of the energy costs of IT were the most significant Green IT issues for them. Thus simple and cost-effective solutions would be ideal for small organizations having little money to invest.

4.1.1 Energy saving

Reducing the energy consumption within an organization not only cuts costs but the organization's environmental footprint is also reduced. Small organizations can achieve energy saving in a

number of ways - PC power management steps like shutting down all systems when the office is closed and putting monitors on stand-by instead a screensaver; replacing energy inefficient devices like old CRT monitors that consume more energy than flat-screen LCD monitors. Data storage and printing optimization can lower energy consumption. Many hard drives with low storage capacities use more energy than fewer drives with larger capacities. Printer servers per office or per floor use less energy than individual printers for each PC.

4.1.2 E-waste management

Older systems should not be automatically presumed to be garbage, but should be examined to see whether they can be of further use or refurbished. However, not everything can be refurbished or reused and when the machine is beyond further use, all the recyclable parts should be removed and whatever is left should be discarded properly.

The organization should raise the awareness of employees. Incentives can be offered to promote a recycling culture, not only for hardware but for printer paper and other office consumables.

4.1.3 Cloud computing services

Cloud computing services are not necessarily expensive. Their flexibility, scalability, reliability and price make them suitable for organizations of any size. An organization can use SaaS to provide software for its employees. The organisation saves money on the software licences and by avoiding the expensive hardware needed to run the software in-house. HaaS services can provide easy,inexpensive data storage to small organisations.

4.1.4 Green IT management

Any organization should develop its own Green IT strategy. Having an organized plan is more effective than the random efforts by individual members of the organization. The plan can include policies and rules about power management, device purchasing, printer-sharing and recycling. Once the plan is decided the members of the organization need to be informed. Various metrics can be used to measure the Green IT level of the organization and to measure progress towards its Green IT targets.

4.1.5 Other Measures

When it is necessary to buy new software the organization could choose digital distribution [29]. Digitally distributed software eliminates the manufacturing process as there is no need for any discs or packaging. Finally organizations should choose vendors and suppliers based on their Green IT credentials – a supplier with a green track record or a vendor offering hardware take-back options should be preferred over other suppliers .

4.2 Medium and Large Organizations

Seven large and ten medium size organizations participated in the research, mostly from manufacturing, government and quasi-government sectors. The respondents were better qualified overall than those from smaller organizations with most at postgraduate level. The targets that larger organizations sought to reach through Green IT were cutting the costs of the IT infrastructure; gaining the rewards offered by government and the European Union (and avoiding being penalized by legal and regulatory bodies); and pleasing their customers and clients with their green credentials.

4.2.1 Green IT Management and Practices

In contrast to the smaller ones, larger organizations need to have a well-organized Green IT strategy that goes deeper than preferring energy efficient systems and vendors. Such a strategy could include additional goals such as establishing metrics and utilizing them; reducing the carbon footprint; appointing a person or group to work exclusively on Green IT matters and establishing an environmentally-friendly culture within the organization. Ideally, the plan should aim to reach a point where the environmental impact of important decisions taken by the organization will affect the outcome of the decisions.

4.2.2 Data centres

Only seven out of seventeen larger organizations reported using a data centre. Those that do not could investigate the benefits of developing one. An organization deciding to develop (or rebuild) a data centre should consider the following factors. If feasible, construct the data centre near renewable energy sources. If the climate is suitable, provide free natural cooling. For example, the Cypriot climate is ideal for using solar panels to gather energy but is not good for providing cooling. The hot/cold aisle server configuration technique should be applied to improve the data centre's cooling efficiency. Finally, there are simple things like extra insulation, blinds for any windows and limiting the number of people inside that can affect the cooling efficiency

Keeping metrics for the data centre is important as the measurements can help to make the data centre more efficient. Metrics can be used optimise the configurations and settings or for comparison with competitors' data centres. Lastly, rightsizing, server virtualization and remote desktop services are all techniques which larger organisations can apply to exploit their data centre infrastructure for the maximum benefit to the organisation and the environment.

4.2.3 Cloud computing

Larger organizations might find HaaS and SaaS solutions even more useful than smaller organizations although more vulnerable to the security risks. However, larger organizations can afford to go one step further by developing a private cloud, enabling employees to login and work from home.

4.2.4 E-waste management

Larger organizations produce more e-waste so they should take additional. Contracts can be signed with professional recycling and refurbishing partners to ensure the safe and environmentally friendly disposition of unwanted equipment.

5. Conclusion

The aim of this project was to study the extent to which Green IT methodologies and technologies are used by Cypriot organisations. A questionnaire was created and distributed among IT professionals working for various organizations. To design the questionnaire, it was essential to review which methodologies and technologies are applied elsewhere. The participants' responses would establish an idea of the environmental awareness and practices of the Cypriot IT community. In the event, the sample was not very large but was reasonably balanced - the organizations that participated coming from various representative sectors and being of different sizes. Although the data was gathered during a holiday period, nearly 90% of participants were able to complete the questionnaires given to them.

Small organizations preferred inexpensive and easy-to-apply solutions while medium and larger organizations appear to share other, more expensive and complicated approaches to Green IT. For most organizations, the primary motivation for becoming *greener* would be to reduce IT costs and/or to comply with government or European Union regulations.

Above all Green IT seeks to develop an environmental consciousness within the IT culture of organisations which have previously only been concerned with growth and profit. If the environmental impact of each policy decision relating to IT can become a critical determining factor, organizations can achieve the goals of Green IT.

6. ACKNOWLEDGMENTS

Our thanks to Elli Georgiadou for suggesting we could work together on this topic.

7. REFERENCES

[1] Amazon. Amazon Elastic Compute Cloud (EC2). DOI=http://aws.amazon.com/ec2/ (accessed 04/08/10)

[2] Armbrust, M., Fox, A., Griffith, R., Joseph, A. D., Katz, R. H., Konwinski, A., Lee, G., Patterson, D. A., Rabkin, A., Stoica, I., Zaharia, M. 2009. Above the Clouds: A Berkeley View of Cloud Computing DOI= http://www.eecs.berkeley.edu/Pubs/TechRpts/2009/EECS-2009-28 (accessed 04/08/10)

[3] ASHRAE. 2008. Environmental Guidelines for Datacom Equipment. American Society of Heating, Refrigerating, and Air-Conditioning Engineers. Atlanta, USA

[4] Basel 2006. Basel Conference Addresses Electronic Wastes Challenge, Press Release 2006, United Nations Environment Programme (UNEP). DOI= http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=485&ArticleID=5431&l=en (accessed 04/08/10)

[5] Belady, C., A. Rawson, J. Pfleuger, and T. Cader. 2008. Green Grid Data Center Power Efficiency. DOI= http://www.thegreengrid.org/en/Global/Content/white-papers/The-Green-Grid-Data-Center-Power-Efficiency-Metrics-PUE-and-DCiE (accessed August 5 2010)

[6] Blist 2008. Blist web-based database. DOI= http://download.cnet.com/Blist/3000-2124_4-10817866.html (accessed 04/08/10)

[7] Clarke R. 2010. Computing Clouds on the Horizon? 23rd Bled eConference eTrust:Implications for the Individual, Enterprises and Society June 20 - 23, 2010; Bled, Slovenia

[8] Garretson, C. 2007. Inside a green data centre. DOI= http://www.networkworld.com/research/2007/110207-green-data-center (accessed July 2, 2009).

[9] Greenberg, S., E. Mills, and B. Tschudi. 2006. Best Practices for Data Centers. ACEEE Summer Study on Energy Efficiency in Building, Asilomar, California.

[10] Greiner, L. 2008. The truth about tech recycling: it's green or it's mean. netWorker. 12, (2), 9-11.

[11] Hanselman, S., and P. Mahmoud. 2007. The wild wild waste: e-waste. SIGUCCS '07: Proceedings of the 35th annual ACM SIGUCCS conference on User services.157-162.

[12] Hayes, B. 2008. Cloud Computing. CommACM. 51,(7), 9-11.

[13] Household waste - disposal sites. 2009. Barnet London Borough. DOI= http://www.barnet.gov.uk/index/environment-planning/rubbish-waste-and-recycling/household-waste-disposal-sites (accessed July 15, 2009).

[14] Info-Tech Research Group. 2009. Green IT: Why Mid-size Companies Are Investing Now. Toronto, Canada.

[15] Kurp, P. 2008. Green Computing. CommACM, 51,(10),11-13.

[16] Miller, K., and M. Pegah. 2007. Virtualization: virtually at the desktop. SIGUCCS '07: Proceedings of the 35th annual ACM SIGUCCS conference on User services. 255-260.

[17] Mohamad, R. 2003. The environmental effect and waste management of computer manufacturing. Journal of Computing Sciences in Colleges 19, (2), 95-100.

[18] Molla, A., S. Pittaya, and B. Corbitt. 2009. Green IT diffusion: An international comparison. School of Business Information Technology RMIT University.

[19] Ohara, D. 2009. Build a Green Datacenter. DOI= http://technet.microsoft.com/enus/magazine/2007.10.green.aspx?pr=blog (accessed July 5, 2009).

[20] Papastavros, C. 2007. Energy Efficiency and Renewable Energy Cyprus. Mediterranean and National Strategies for Sustainable Development DOI= http://www.planbleu.org/publications/atelier_energie/CY_Summary (accessed 05/08/10)

[21] Portrait of the regions – Cyprus – Economy. 2005. DOI= http://circa.europa.eu/irc/dsis/regportraits/info/data/en/cy_eco (accessed June 18, 2009).

[22] Server Power and Cooling Requirements. 2006. DOI= http://docs.sun.com/source/819-5730-10/powcool

(accessed July 5, 2009).

[23] Steinder, M., I. Whalley, D. Carrera, I. Gaweda, and D.Chess. 2007. Server virtualization in autonomic management of heterogeneous workloads. IM '07. 10th IFIP/IEEE International Symposium. 139-148.

[24] Tebbutt, D., M. Atherton, and T. Lock. 2009. Green IT for Dummies. England: John Wiley & Sons, Ltd.

[25] Thompson J. 2008. Don't be afraid to explore web2.0. Phi Delta Kappan, DOI= http://web2denmark.pbworks.com (accessed 04/08/10)

[26] Trujillo, A. 2007. Right-sizing is the key to energy efficient data centers. DOI= http://searchdatacenter.techtarget.com/news/interview/0,289202,sid80_gci1242407,00 (accessed July 10, 2009).

[27] Velte, T., A. Velte, and R. Elsenpeter. 2008. Green IT Reduce Your Information System's Environmental Impact While Adding to the Bottom Line. USA: McGraw-Hill Professional.

[28] Weiss, A. 2007. Computing in the clouds. netWorker. 11,(4), 16-25.

[29] WSP. 2008. Calculating business value and environmental benefit of digital software distribution. DOI= http://www.wspgroup.com/upload/documents/PDF/newsattachments/USA/Microsoft_White_Paper (accessed 04/08/10)

[30] Ziff Davis Media. 2006. Data Center Power and Heat Management: Ready or Not? DOI= http://internet.ziffdavis.com/amd_assets/AMD_PowerConsumptionCooling (accessed 04/08/10)

8. Appendix: the Questionnaire

8.1 Demographics

Please tick (✓) at the correct answer.

1. Male ☐ | Female ☐

2. What is your age range?

20-29 ☐ | 30-39 ☐ | 40-49 ☐

50-59 ☐ | 60+ ☐

3. Education

High School ☐ | College ☐ | Bachelors ☐

Masters ☐ | PhD ☐

4. Position in the organization

Employee ☐ | Intern ☐

IT manager ☐ | Other ☐

5. Do you consider your business/organization as:

Small ☐ | Medium ☐ | Large ☐

6. In which category is your organization?

Government ☐ | Quasi-government ☐

Retail ☐ | Banking ☐ | Retail ☐

Education ☐ | Services ☐ | Manufacturing ☐

Imports/exports ☐

8.2 Organization's Green IT Awareness

7. Which of the following Green IT issues are relevant to your organization?

Environment friendly IT disposal ☐

Reducing cost of powering IT infrastructure ☐

Environment friendly IT purchasing ☐

E-waste management ☐

IT contribution to green house gas emissions ☐

Overall organizational environmental footprint ☐

8. Which of the following Green IT practices are applied?

Prefer vendors offering end of life take-back options ☐

Shorten IT equipment refresh periods to gain access to more energy efficient equipment ☐

Prefer IT suppliers that have a green track record ☐

Retire energy inefficient systems ☐

Partner with a professional Service provider regarding green IT ☐

Enforce pc power management ☐

Prefer to buy software which is digitally distributed ☐

9. Which of the following infrastructure solutions are applied?

Liquid cooling for IT equipment ☐

Install energy efficient lights ☐

Use High voltage AC power ☐

Use DC powered IT equipment ☐

High efficiency stand-by power equipment ☐

10. Which of the following Green IT infrastructure solutions are applied?

Server virtualisation ☐ | Storage virtualisation ☐

Print optimization ☐ | Desktop virtualisation ☐

Power down systems ☐

11. When IT equipment reaches the end of its lifecycle do you:

Recycle consumable parts? ☐

Dispose them in an environment-friendly way? ☐

Refurbish the equipment ☐

(if none of the above applies don't tick anything)

12. Do you have a contract with any recycler or refurbisher?

Yes ☐ | No ☐

(If the answer is no go to question 14)

13. Are you aware whether your partnering recycler/refurbisher uses legal and ethical methods?

Yes ☐ | No ☐

14. Has your organization taken any of the following steps regarding green IT management?

Establish metrics to assess green IT initiatives impact ☐

IT department responsible for its own energy costs ☐

Set targets to reduce corporate carbon footprint ☐

15. Does your organization use a data centre?

Yes ☐ | No ☐

(If the answer is no go to question 18)

16. Are any metrics used to measure the energy consumption of the data centre?

Yes ☐ | No ☐

17. Tick all that apply for your organization's data centre.

Located/relocated near clean energy sources ☐

Environmental factors were considered during the design of the centre ☐

Lights and equipment are switched off when not in use ☐

Use the hot/cold aisle layout configuration ☐

Use Rightsizing techniques ☐

Use air-side economizers for cooling ☐

Use water-side economizers for cooling ☐

Other (please specify)

18. Do you use remote desktop services?

Yes ☐ | No ☐

19. Do you use server virtualization to rehost old systems?

Yes ☐ | No ☐

20. Do you use any cloud computing services?

Yes ☐ | No ☐

(if the answer is no go to question 24)

21. Do you have any private cloud facilities?

Yes ☐ | No ☐

22. Are any HaaS (hardware as a service) services used?

Yes ☐ | No ☐

23. Are any SaaS (software as a service) services used?

Yes ☐ | No ☐

24. Rate the following reasons for pursuing Green IT on a scale 1 (Strongly Agree) to 5 (Strongly Disagree).

Reducing IT costs ___

Environmental considerations ___

Social acceptance ___

Government/EU regulations ___

Government/EU incentives ___

Clients/Consumers pressure ___

Competitors actions ___

IT vendors pressure ___

25. Rate the following reasons that might restrain you from pursuing Green IT on a scale 1 (Strongly Agree) to 5 (Strongly Disagree).

Cost of green IT solutions ___

Unclear business value in green IT ___

Lack of government incentives ___

Inadequate skills and/or training ___

No enforcement by government/EU ___