

Greening Information Communication Technologies in Small-Medium Sized Companies

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Abstract— Information Communication Technologies (ICT) imply the convergence of the audiovisual, telephone networks and computer networks through a cabling link system for the purpose of sharing information. This research analyzes the possible ways that small and medium sized business and educational institutions could implement and benefit from the environmentally and economically benign ICT. This research aims at increasing awareness regarding the advantages and limitations on green ICT in addition to providing guidelines for ICT utilization. Green ICT in general implies the study and analysis of creating, improving and sustaining environmental benign ICT practices to become permanent parts of the organizational efforts. Green ICT mainly proposes a unified network for communication and the integration of telecommunication, computers, audiovisual systems and storage devices. Various areas where ICT can be applied are computer architecture, data networks and communication; internet usage and multimedia applications. The paper also looks into common concerns regarding ICT implementation from social, health and safety aspects. It is commonly believed that the use of ICT create digital polarization, society segregation on rich and poor, while increasing disadvantage of populations that reside in remote areas. Health issues include eyestrain and exposure to harmful substances caused by the computer systems. Safety issues deal with the potential hazard to human health such as power surges and electric shocks. Educational leg focuses on utilizing ICT including video recordings, broadcasts, images, texts, and worksheets for idea generation and teaching purposes. To investigate these issues further this study reports the results of an ICT adoption survey conducted for small- and medium-sized US-based companies. Statistical analysis and diagrams were generated as the result of the research. Overall, of the survey is resulted in the following findings. The green ICT requires companies to be able to present the needs of the present generations compromising to meet their needs through pollution prevention. The goal of the green computing is to reduce the use of hazardous materials found in computer systems; to maximize the product lifetime and to promote recyclability and biodegradability of the defunct and factory waste products. The different approaches include server virtualization, multi-functional printing devices, active power management, virtual desktop and upgrading the organization's ICT equipment.

I. INTRODUCTION

Information Communication Technologies (ICT) means the convergence of the audiovisual, telephone networks and computer networks through a cabling link system for the purpose of sharing information. Green ICT is the study or analysis of obtaining the environmental sustainable ICT practices [1]. . Green ICT in general implies the study and analysis of creating, improving and sustaining environmental benign ICT practices to become permanent parts of the organizational efforts. Different organizations and educational institutes have been cumbered by the task of analyzing the different ICT equipment usage [2]. The main equipment are data center equipment; mail servers, databases, firewalls and file servers; wireless and connected hubs, routers and networking equipment, smart phones; printers, scanners, projectors and copiers [3]. Green ICT requires management to look at the definite methods that can be used for analysis of how the ICT materials are mined, conditions that they are used to manufacture; how they are transported to the consumer; the equipment energy consumption and how the equipment are disposed off at the end of their lifetime. Green ICT benefits companies, environment and society.

The purpose of the research is to outline the possible ways that institutions or schools could use in the implementation of the Green ICT. This research will help in the increased understanding of the concept of Green ICT and options of ICT usage.

Literature review

1. Information Communication Technologies (ICT)

ICT is built by three words. Information means the learning of facts about something or someone through statistics and data. Communication is described as the exchange of information through a certain medium. Technology is defined as the usage of scientific knowledge for the practical purpose in the industries [3]. Therefore, imply the convergence of the audiovisual, telephone networks and computer networks through a cabling link system for the purpose of sharing information. ICT can be explained as the communication medium that deals with the use of the new technologies in the teaching- learning and processing education. In fact, ICT plays an important role in speeding up technological progress and in the organizations growth [4].

The study done by Molla, Pittayachawan, Corbitt & Deng (2009) reveals the following: “For economics, ICTs are increasingly playing critical roles in transforming and generation economic opportunities. On the other hand, global warming and climate change coalescing with limited availability and rising cost of energy are posing serious challenges for sustainability of the global digital or otherwise economy” [5].

ICT offers unified network for communication and integration of telecommunication, computers, audiovisual systems and storage devices. The name ICT started in 1997 by Denis Stevenson who introduced the term in the revision of the national curriculum for England. The term was supposed to replace the term computing. The ICT offers users the ability to manipulate information, transmit, store and access relevant data [1]. The purpose of ICT in education has led to the increased familiarization of students with the use of computers. The ICT has been a source of information for the million of citizens and companies all around the world. It has enhanced the creation of the global village where people who are miles or continent apart can share their day-to-day ordeals. Computer systems comprise of the storage capacity, input or output devices, software or hardware. The computer systems are seen to be the main core of the ICT. The computer systems allow one to launch or exit programs; manage files or folders by creating, moving and saving; and ensure data security through backup and virus protection [2]. The computer systems are seen to allow the running of the software and application through the use of the email and the Internet. The computer applications allow the processes of ICT to be conducted through word processing, spreadsheet analysis, power point presentations, desktop publishing, and computer graphics.

1.1. Options for ICT Application

The different options that ICT uses in computer systems are the following.

1. Computer Architecture

The computer systems allow the different users to have a choice on the computer architecture that they could decide to use as different individuals within the organization. The computer memory allows the presentation of the ROM and RAM that facilitate the usage of the computer memory [6]. The computer buses or ports are used for specific functions, capacity holding and speed. The computer systems will require the user to be aware of the compatibility of all the software and hardware that one will want to place in the computer [2]. The compatibility will be the determining factor on the usage of the computer in the organization.

2. Data Networks and Communication

The computer systems help in the use of data communication through networks. This is how the ICT is incorporated into the systems [3]. The use of the standards codes for information interchange will necessitate analysis of how the different issues within the analysis of operation for the organization will

be used. The networks for the communication are either Local area network, WAN, log on and off networks or access control avenue networks [1].

3. The Internet

The ICT uses the computer stems for the purpose of analyzing the different avenues for communication. This requires one can navigate his way using the computer browser and the World Wide Web to search for the different information that he requires [6]. The Internet provides powerful search engines that allow the increased analysis of the million of information that are provided in the Internet. The deciding of the websites is based on analysis of the Boolean operators and the Internet security issues.

The Internet has facilitated communication through the use of the emails that have allowed organizations to increase communication over to the million of branches that are around them. This requires millions of people or employees have been able to attach documents and share to different people in the world through the use of the computer systems [7]. The ease of setting up of the email address has allowed the presentation of the best analysis of the email account presentation. The issues that have arisen from the use of the ICT have been data protection. The email account holders in websites like Yahoo have been able to videoconference through different software. This increases the avenues of ICT.

4. Multimedia

The ICT can use the computer systems for the purpose of image editing or sound manipulation. In the computer systems users are able to import images and edit them. This helps in the presentation of the best cartoon animations or chart analysis. The individuals conversion of the file formats between the different individuals change the lack of compatibility of images to certain software. The sound function enables individuals to create sound files through different software and export them to different people [2]. The editing of the sound files is enabled by the computer systems. The user can convert the sound into the specific file format that he or she will require as an individual.

1.2. Issues of using ICT

1. Social issues

The social effects of the use of ICT have been seen to be the digital divide presentation between the millions of individuals in society. The difference between access to ICT and experience among the society has led to increased digital divide. The amount of children who choose to chat on the phone or on the laptop instead of speaking with the parents has been alarming. The Digital divide has led to the alienation of socialization skills for million of the individuals in the socioeconomic lines, geographic and racial lines [7]. The million of the parents have been seen to take different children to classrooms depending on how the school has used the ICT expertise. This has made the schools that do not have the facility to offer few fees for schools while the ones that have

the usage of the ICT technology hiking the school fees. The long-term results is seen that the poor in the society will be in the schools that do not use ICT while the rich are will have kids that are conversant with ICT [2]. The geographical social effect is based on the urban and rural ICT resources. The increased advancement in the urban areas makes the different individuals in the society to be conversant with the different ICT software, hardware and capabilities. The people that are in the remote areas will not be able to be conversant with the different issues that occur outside of society. The ICT has led to the increased replacement of the manual work to technical work [7]. The computer systems have led to the increased unemployment of the staffs that have limitation in understanding ICT systems and has brought in the individual that is capable to handle the computer systems.

2. Health related issues

Health practitioners have indicated that the use of the ICT has led to the increased eyestrain for the different individuals, who use computers for many hours. The use of computers and increased look at monitors that is in a constant distance away faces the eye muscles to strain in focusing at one specific spot. The other health issue is back and neck pains that occur after an individual has been working on the computer for a long time [8]. The lack of taking the regular breaks has led to the increased health hazard for the millions of individuals in the organization [2]. The repetitive strain and injury of the hand and wrist muscles while in typing or use of the mouse will affect the manner in which one obtains carpal tunnel syndrome. This affects the definite ways in which individuals conduct activities.

3. Safety related issues

The use of the computer systems for ICT can be seen to be harmless issue but this could not be the case. The computer systems are often connected to many cables. Moore, Griffiths, Richardson, and Adam (2008) mentioned that the trailing of the cable networks or power cables could lead to serious accidents. The tripping over the cable to individuals could lead to the overall falling and lack of access [7]. The presence that certain liquids are poured on the electrical equipment could culminate to an electric shock. This poses a safety concern for the users of the equipment [6]. Many of the computer systems are seen to use high voltages. These voltages could exceed the power provided or lead to a power surge. The plugging of the many cables will ease the rate at which the fire will spread. The other aspect is where heavy objects of the computer could fall on users and cause damages. The example is the laser printers, CRT monitors or any heavy computer equipment [3].

4. Educational issues

The tool has been useful in the teaching of students in many ways. The use of ICT has increased the level of details that the teachers have been able to present to the different students. The ICT has enabled the teachers to use avenues like video recordings, broadcasts, images, texts and worksheets to express the main ideas to the students. The ICT has enabled the use of the best language proficiency for the students with

the help of recordings for the occurrences [7]. The ICT has been seen to be the most attractive form of teaching that millions of students uphold as compared to other forms of teaching. This makes the children to be attentive to understand the different issues that they are being taught as students. The exercise has been seen to encourage creative learning for the million of students [2]. The use of icons has helped the small children and adult students to be able to increase their comprehension through the cognitive skills. This has allowed the presentation of the authentic material and language presentation to the students. The tool has been helpful in providing the million of student's with as a source of information for their personal research. The ICT has created avenues where students are provided presentations in PowerPoint application in their respective classes [6]. Many critics of ICT usage in education have presented arguments that the use of the ICT has led to counterproductive measures for students in classrooms. The teachers who are change resistant and do not want to apply the ICT in their classroom. The increased challenge of using the ICT leads to the overall frustration of students and the teacher [6]. This makes the whole education integration to schools being a hectic ordeal. The pupils that are not conversant with the application of ICT are seen to fold the information in accordance to their needs. The student's cognitive skills can be hampered since they focus on the form of information presentation and not the content. This making the normal class lessons without ICT to be really boring and making the students to lack-interest in the class teachings that do not use ICT.

5. Internet related issues

The Internet use issues range from software to information reliability. The Internet and the web are not regulated by anybody. This requires there is no organizational control on the different things that one can perform within the computer [9]. The creation of the web pages is free. This has made the formation of fake web servers that are used for the spreading of hatred or lies between the different individuals in society. The other issue is the provision of the undesirable information over the Internet. These are like the high offensive or illegal materials. China had blocked Google Company from operating in their servers since they were allowing pornographic sites to be easily assessed. The other issue has been the security of the information that is transferred over the Internet. The sensitive and personal information that has been placed in social media websites have been easily accessed by the different individuals in the world [3]. ICT in the home has led to millions of children cutting and pasting of information from the Internet. This has reduced their cognitive skills of thinking [2].

2. Green ICT

Green ICT is the study or analysis of obtaining the environmental sustainable ICT practices. The green ICT requires companies or producers will be able to present the desires of the near generations compromising to meet their needs through pollution prevention [10]. According to

research done by Chen A., Boudreau M., & Watson R. (2008), the green ICT focuses on how the ICT systems are produced, used, products stewardship for minimizing the environmental footprint during use and reduction of the use of the polluting materials through the development of the environmentally friendly competencies [11]. Confronting to Hedman & Henningsson (2011), they mention in their research the following “Redesigning an entire company to leverage green IT might be too risky for many large organizations, because it challenges some of the ongoing operations and day-to-day routines” [12]. Green ICT’s main tool is to increase the energy efficiency and to conserve energy for the coming future. Green ICT is becoming a mandatory act since organizations are concerned with the costs they are incurring and with the level of energy they save for their future business [13]. Green ICT can be also defined in terms of reusing, recycling and disposing hardware. It should include all the business solutions that require very low carbon emission. Telecommuting and video conferencing are some of the examples [14]. Green ICT can be understood by outlining the following facts. The use of the ICT in different avenues of our lives has led to the overall environmental impact. According to research, the global ICT industries have been seen to account for approximately 2% of the global carbon dioxide emission. This is equivalent to the aviation industry emission [15]. These emanate from the production of the ICT equipment. These equipment are data center equipment; mail servers, databases, firewalls and file servers; wireless and connected hubs, routers and networking equipment, smart phones; printers, scanners, projectors and copiers. The goal of the green computing is to reduce the use of hazardous materials that build computer systems; maximization of the products lifetime and promotion of the recyclability or biodegradability of the defunct and factory waste products.

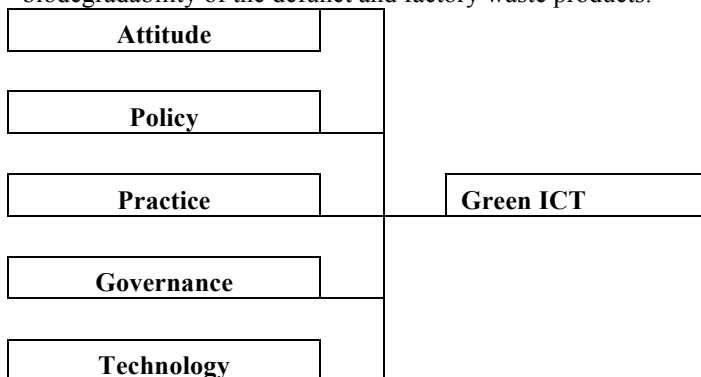


Figure 1: Green ICT Model (Adopted from Molla A., Cooper V. A., & Pittayachawan S. (2009)) [16].

2.1. Why is it important?

The reason why green computing is vital is due to the benefit that it provides to the environment and the general society. By referring to Murugesan & Laplante (2011), they mentioned that the struggles occur because many people do not really understand what is Green ICT is all about in the first place [17]. Thus, people are somehow neglecting the facts that it is destroying our environment. People should know that the main benefit of implementing Green ICT is the reduction of energy usage and implementation of techniques that reduce carbon

dioxide emissions. Furthermore, it will reduce operating costs of data centers and lower hardware needed as firms beneficial [18]. The Human activities have been kept in the spotlight as the issues that lead to the rise of GHG. The ICT use has been part of the blame for the increased affecting of the ICT problem for the millions of individuals. Research shows that half the power used in computers is based on cooling [15]. The green ICT makes sure that this issues are removed during manufacture and reducing the wastage of energy. The increased changes in the climate due to ICT impact to the environment could be reduced through the use of the climate change [10]. The green peace movement in 2006 released a study that analyzed an x-ray that analyzed the hazardous materials in the five leading brands of computers and laptop producers. The research revealed that the components of the computer were very hazardous and harmful to the environment. The computers had chemicals that could cause cancer, immune reactions and nerve damages in humans. The implementation of the green ICT helps in the reduction of the health hazards that could occur to the different users of the ICT [9].

The other importance for the implementation of the green ICT is due to the overall issue of increasing the energy and carbon cost [8]. The million of the corporate institutions in the world use technology for communication and presentation to the investors. The opportunity for reducing the operation cost through going green has been seen to be definite moves that the different individuals in the organization are seen to uphold as an institution. This requires different individuals in the research firms that use ICT avenues are the highest users of electricity. The rising cost of operation could be reduced by the implementation of the green economies by the organization. The implementation is thus important in reducing management carbon and electricity costs.

The other importance is that it has led to the impacting of the brand images. The implementation of green ICT has led to different firms to tap to new profits and reduce their overall financial risk. The rise in the digital world has enabled and equipped different consumers and companies stakeholders on the overall disadvantage that certain industries in the organization have been seen to produce due to the carbon emission [15]. The impact of the change was over the environmental issues on the brand values and customers behaviors. The lack of compliance to the environmental issues has led to the degradation of the customer’s loyalty and brand values. This has increased the overall presentation of losses for the millions of individuals in the ICT products production. The implementation of the green ICT has led to the reduction of the regulatory and governmental pressure and voluntary initiatives. Many institutions have started to research on the different ways that they could use in order to go green [3]. The looming penalties from different institutions have required the firms to search for the appropriate going green avenues. The examples of the bodies that have heightened pressure on the production of those products are EU directives and Eco-labeling Initiatives. This has been fostered by institutions such as ROHS, EPEAT, WEEE, Green Grid, CSGI, EUP or ENERGY STAR, Page and Hill, (2008). The bodies require that different organizations to procure green procurements for changes in the regulatory environment which will put pressure

on the different vendors of the ICT equipment and infrastructure for proving their green credentials.

2.2. How Can We Implement Green ICT?

According to Ogunyemi & Johnston (2012), the green ICT can be implemented when the adoption has been completed and accepted [19]. Green ICT can be implemented in five different ways, which are server virtualization, multifunctional printing devices, active power management, virtual desktop and changing the organization's ICT equipment.

1. Server virtualization

This is the act of creating a virtual version of the server while not limited to the virtual hardware platform, storage devices, operating systems or network resources. The server virtualization is a method that has been implemented by different technological firms [20]. The server virtualization allows the provision of the efficiencies and capabilities that are just constrained to the physical world. The virtual machines are consolidated onto few physical servers through the lowering of the monthly power or cooling cost of server equipment [9]. The second issue is that it reduces the data center footprint and lab environments. This is through the use of the powerful and useful lab environments. The analysis allows fast server provisioning and reduces the hardware vendor lock-in. The virtualization will help in improving disaster recovery of data that was in the server and help in the isolation of the different applications for accessing the server data.

2. Multifunctional printing devices

These are office and home ICT devices that incorporate the purposes of multiple devices into one device. This allows it to leave a small carbon footprint in the environment [3]. These devices have different features [21]. In the print features, the input requires the network print types to be available while having the printer drivers being compatible with different operating systems. The output feature ensures that the output or the ability to use the MFP internal storage function or duplex printing capabilities is provided by the documents provision. These devices will allow little energy usage, efficient use of space within the organization [9]. The placement of the different equipment having one function could consume a lot of space in the organization. The multifunction devices offer the upgradability option since they have the RAM. This allows one to customize the device with regard to his or her requirements. The devices allow different users to use the equipment once it is inserted in a network for communication.

3. Active power management

The active power management allows the reduction of the power cost for the different individuals in the organization [10]. Management reduces the amount of money that is spent on funding the PC's energy cost. This allows the reduction of the corporate energy consumption by around 15 percent. The

reduction of the use of energy will lower the environmental impact and allow the contribution of the sustainability initiatives [8]. The power management reduces the usage of the different equipment within the ICT framework. This ensures that the application of the equipment will be based on serving a long period of time. The implementation allows the PC to shutdown, hibernate, standby or wake up.

4. Virtual desktop

This is an alternative desktop deployment for windows 7. The strategy helps in the saving of money and time for the organization through to the display capabilities that it provides. The virtual desktop ensures that management has a great defense in the occurrence of a catastrophic failure for the ICT devices. This helps in increasing the useful life of different computer systems and increasing the organizations running [9]. The desktop virtual helps in the reduction of the disposal and manufacture of display VDU since it provides immediate cost saving for management in requiring them not to purchase any type of desktop. The increased capability of customization allows the equipment to offer the best response to the millions of the different clients.

5. Changing the organization's ICT equipment

The research done by Lee (2010) states that management of the firm should look at avenues that they can use to create green sustainable organizations through the conducting of an annual energy audit [22]. This requires management of the organization will analyze the different avenues that they could use for the purpose of going green [23]. The use of the policy implementations for recycling and reducing commuting by increasing ICT video conferencing will help in the reduction of the overall impact on the lives of the different individuals in the organization [9]. Management should get the employees involved through the changing of the mission and vision for the organization in order to provide the overall analysis of the activities in the organization.

3. Green ICT Adoption Survey

3.1. Research methodology

The research conducted a qualitative conceptual survey. The electronic survey was the one that was utilized in the research [24]. The statistical sample elimination was based on analysis of the companies that had obtained support from different ICT innovation with the enterprise and Innovation program of 2010 in USA. These were both medium and small companies. The research was random stratified. The basic contact information was founded for the identification of the subject in the sample. Management looked at the possible ways by emailing the employees the questionnaire electronically. The data collection was carried out in the period of 10 days. As shown in Table 1, the study sample that was analyzed was only 37 individuals after asking 227 individual employees to

reply to the electronic questionnaire. The response to reply was accepted and when the questions were asked for the first time less than 25% of the employees answered the questions. The second enquiry increased the individuals who answered to a total of 37 individuals. The applications that were made to management of the firms to interview their employees often resulted with strict warning that their names not to be disclosed. This was followed and the research was centered on the definite research questions.

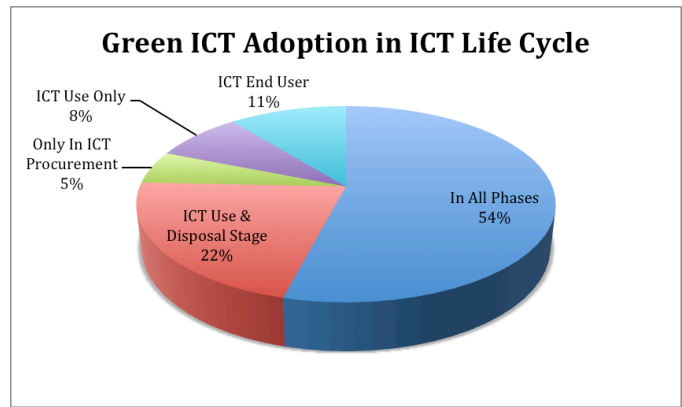


Figure 2: Green ICT Adoption in ICT Life Cycle

Table 1: Asking & Response Rate

Sample Size	Asking Sample		Response Rate	
	Frequency	%	Frequency	%
Small company	77	33.92%	25	67.57%
Medium company	150	66.08%	12	32.43%
Total	227	100%	37	100%

The analysis indicated the personal perception of individual’s application of the ICT practices for the small and medium companies that were across all phases of ICT lifecycle. As shown in Figure 2, the results indicated that about 54% of the businesses were seen to reflect green ICT in all phases of the ICT lifecycle phases. On the other hand, 22% were seen to adopt green ICT in ICT use and disposal stage; meanwhile, 11% said in ICT end user phase. The analysis indicated how the different institutions were able to implement their Green ICT policy.

3.2. Statistical analysis and Diagrams

The research found the following facts. The answers for questions on the manner in which, green ICT has affected management and the overall recognition of awards for the firm led to the identification of the following information. The different employees were seen to believe that their organization had implemented the green policy by analysis of the disposal of ICT equipments, ICT procurement and ICT usage practices. Both the small and medium companies were seen to be keen on ensuring Green ICT practices in the disposal of the ICT equipment.

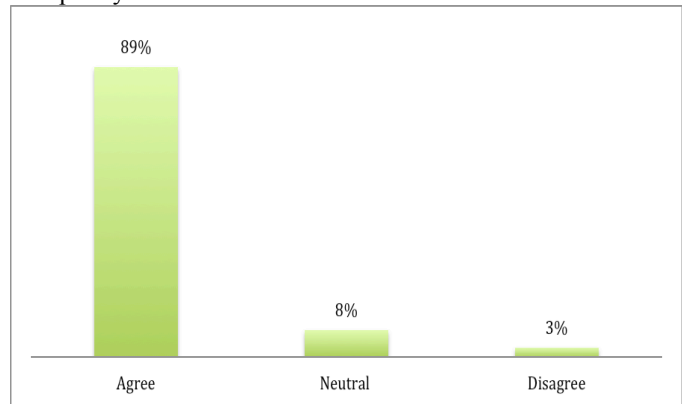


Figure 3: Green ICT Benefits The Society

Table 2: Green ICT Adoption in ICT Life Cycle

Company Size	In All Phases	ICT Use & Disposal Stage	In ICT Procurement	ICT Use	ICT End User	Total
Small	13	5	2	2	3	25
Medium	7	3	0	1	1	12
Total	31	24	5	4	8	37

After asking if the green ICT will benefit the society, as shown in Figure 3, 89% of the employees in both small and medium are agree that implementation of green ICT benefits the society. Meanwhile, 8% of the employees said natural and 3% disagree.

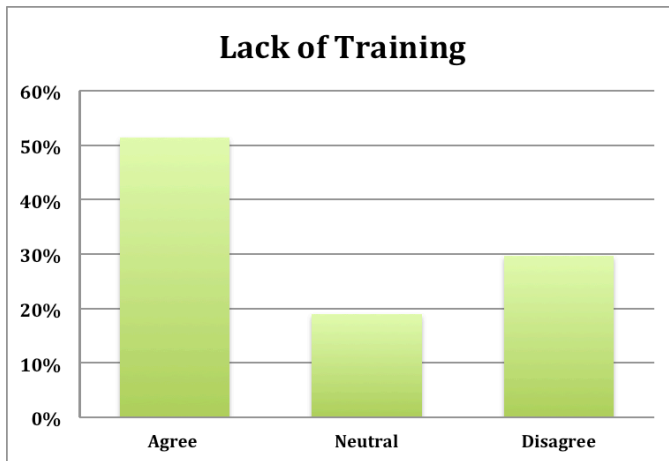


Figure 4: Lack of Training Issue for Green ICT Implementation

One of the most issues for green ICT implementation is Lack of training, since many organizations don't know when and how they start implementing this technology. After the survey has been done as shown in Figure 4, 51% of the respondents, who is the half of the responses are agree that lack of training is an issue for green ICT implementation. While only 19% indicated as neutral and 30% are disagree.

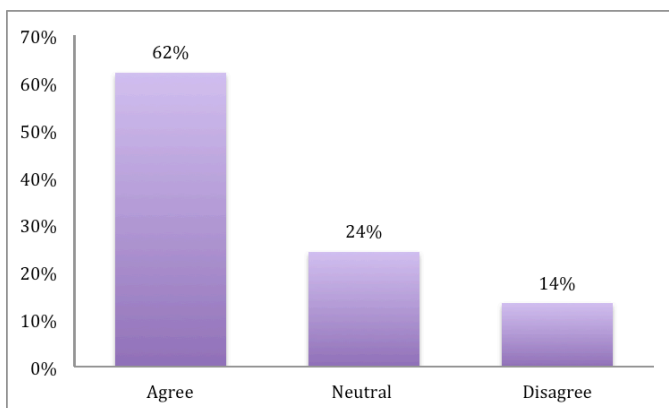


Figure 5: Green ICT Implementation is Costly

As shown in Figure 5, found 62% of the responses decided that green ICT implementation is costly; whereas, 24% of others were neutral in their answer. However, the rest of the employees, which is 14% disagree with this concern. Green ICT Implementation should start with regardless the cost, if the benefits of implementation green ICT in organization more important compare to the technology's cost.

4. Findings Results

The data was analyzed for 37 employees for small and medium enterprises through the definition of the business branches that were obtained by the use of the electronic questionnaire survey as part of a large research. The survey results indicated that there existed a potential or opportunity among businesses for the improvement of phases that are observed for only 54% of the respondents. The application of the principles of green ICT increased the stressing of the ICT

distributors, producers and friendliness [25]. The Challenge that the green ICT implementation was seen to face was that the application of the computing services was affecting the legislation and computing services for organizations. The research helped in understanding the leveraging Green ICT importance to the business operations. The green ICT initiatives were on ad-hoc analysis of the structural requirements for the presentation of the structural requirements. This leads to the sinking of resources into Green ICT initiatives without the seeing the results for the expected returns.

5. Conclusion

In conclusion, Green ICT benefits companies, environment and society. ICT means the convergence of the audiovisual, telephone networks and computer networks through a cabling link system for the purpose of sharing information. Green ICT is the study or analysis of obtaining the environmental sustainable ICT practices. Green ICT has offered unified network for communication and integration of telecommunication, computers, audiovisual systems and storage devices. The different options for ICT application are in computer architecture, data networks and communication; Internet usage and multimedia application [7]. The issues that were seen to be prone to the ICT sector have been seen to be the following. Social effects of the use of ICT are digital divide, society segregation on rich and poor, increases disadvantage on the people in remote areas [8]. The health issues are with regard to eyestrain and exposure to harmful substances from the computer systems. The safety issues deal with the overall injury people obtain from serious accidents like power surges or electric shocks. The educational issues for ICT deal with video recordings, broadcasts, images, texts, and worksheets usage for expressing the main ideas to the students. The Internet use issues have been seen to affect the reliability of the information and the removal of the environmental friendly competencies.

The green ICT requires companies or producers will be able to present the desires of the current generations compromising to meet their needs through pollution prevention. The goal of the green computing is to reduce the use of hazardous materials that build computer systems; maximization of the products lifetime and promotion of the recyclability or biodegradability of the defunct and factory waste products. The different approaches that it could be implemented are server virtualization, multi functioning printing devices, active power management, virtual desktop and changing the organization's ICT equipment.

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