

# **AN ASSESSMENT OF GREEN ICT IMPLEMENTATION BENEFITS TO KENYAN ORGANISATIONS: A POSSIBLE MOTIVATOR FOR ADOPTION OF GREEN ICT**

Mark Milingo Onimbo

MSc. Information Technology Management Student

University of Nairobi

Nairobi, Kenya

Email: [onimbomark@gmail.com](mailto:onimbomark@gmail.com)

## **Abstract**

There has been an increase in the use of computers and computing devices in Kenya and generally in the world due to the reduced cost of ICT equipment and improved technological advancements. This increased use of ICT, despite bringing positive effect to an organization do also pose some environmental and monetary negative effects on an organization and the planet. Studies have shown that ICT contributes to 2% of the world's greenhouse gases and in addition ICT resources have increased the overall consumption of electricity within organizations. Most computer hardware also has components like mercury, cobalt, lead, etc that are considered hazardous to both environments, people, and animals.

This study's objective was to establish if the expectation of green ICT benefits could be a motivator for adopting green ICT practices within and organization. The research also sought to establish some explicit benefits of green ICT enjoyed by organizations that practice green ICT within the study population.

The methodology employed for this study was a purposive stratified research design. A study of organizations within the Nairobi metropolitan was conducted and results were analyzed from a population that constituted organizations from different sectors, mainly government, private, and not for profit organizations, with a majority of respondents being from the government. Due to challenges arising from the COVID 19 pandemic data collection was restricted to online questioners and secondary data from literature review.

Study results pointed to the availability of possible benefits of practicing green ICT within organizations and at the same time also shed some light on factors that do not persuade organizations to practice green ICT. The overall study finding greatly highlighted a strong

correlation between organizations practicing green ICT and anticipated monetary benefits that result from the practice. Most organizations do not have a green ICT policy and therefore the practice of green ICT is still not as pervasive as expected. **Key Words:** End of ICT use, Sustainable ICT, Energy efficient, environmentally friendly, ICT equipment lifecycle, ICT, WEEE, Disposal, ICT equipment end of life, ICT procurement, Kenya, University of Nairobi.

## **Introduction**

In the past few years, Kenya has made strides in the adoption and accelerated use of information communication technology in various sectors to improve productivity and to drive economic growth. The government has taken measures like switch from analog to digital television transmission signal systems, Improved internet speed and access by deploying undersea internet fiber cables dubbed the National Optic Fibre Backbone Infrastructure (NOFBI) project. Government services have been digitized through the famous e-citizen among many more to say the least. Usage of smartphones has increased and mobile phone subscribers had reached 29 million by 2012, between March 2011 and March 2012, total mobile money deposits grew by 42.4% and there were about 19million mobile money transfer subscriptions (Waema, 2012).

Kenya has adopted large scale use of technology in virtually all sectors of the economy, we have very high internet penetration, use of e-learning, apps for banking, farming, etc. According to the world bank, as of 2019, there were 35 technology business incubators and accelerators in the country. ("How tech changed lives of Kenyans", 2020).

This research paper will be focusing on highlighting the possible economic benefits of green ICT to organizations in Kenya and scenarios where ICT can be used to green other sectors of the community. With the primary focus being on a case study of organizations in Kenya, practicing green ICT to some extent and or organizations that deal with e-waste management on the other. It is worth noting that e-waste management is a direct and more widely recognizable green ICT initiative. Green ICT is a term that needs to be clearly explained and made clear to users of ICT services and hardware thus making them capable of playing an integral role in the promotion and practice of green ICT. According to (Suryawanshi & Narkhede, 2014), green ICT is an approach entailing the use of information technology techniques in the protection of the environment and for sustaining ICT practices for the

achievement of corporate social responsibilities through the minimization of ICT waste, carbon footprint and energy consumption.

There exist government institutions that could be better equipped to fast track green ICT implementation. Bodies like Kenya Bureau of Statistics, the ministry of environment, and mineral resources, with proper guidance and research, these bodies can formulate policies customized to support the implementation of green ICT in the Kenyan workplaces.

Green Technological innovations are promoted and should be guided by environmental legislation for there to be a success in green technology implementation (Zhiyong, 2017). It is commendable that the Kenyan government has put in place efforts of establishing bodies and legislations towards environmental protection.

Through these government agencies, the effects of ICT on the environment in Kenya can be monitored, assessed, and regulated. Having studied the Environmental Management and Coordination Act (EMCA), 1999. There is no provision that explicitly mentions ICT and Information technology, or how they are regulated in regard to environmental sustainability and protection.

Kenya like other countries in the world has been implementing sustainable development and embracing eco-friendly technologies to enhance efficiency in the use of natural resources and energy. These initiatives have not made it a priority to explicitly focus on ICT products, services, and their impact on the environment.

Through these government agencies, the effects of ICT on the environment in Kenya can be monitored, assessed, and regulated.

## **Statement of Problem**

Information and technology resources also referred to as ICT resources, have a negative effect on the environment and to people's health. A good number of academic researchers have pointed out that the ICT sector and use of ICT resources are responsible for 2% of global carbon emission (Masud and Malik, 2012) (Molla et al, 2008) and (Murugesan, 2008).

ICT hardware equipment contains toxic materials including but not limited to lead and mercury that produces harmful chemical substances that have been found to pollute water, land, and air, with far-reaching effects like global climate change and respiratory diseases (Masud and Malik 2012).

As Kenya experiences more modernization and technological development, its use of technology to stay ahead increases and so does the effects of ICT resources used (i.e. hardware and software) increase in our environment. Over ninety-seven percent of scientist specialized on climate strongly believe and that global warming and the adverse weather patterns in the last century are mainly due to human activities ("Climate Change Evidence: How Do We Know?", 2020)

Information and Communication technology can be used to reduce global warming and prevent world temperature from going beyond 1.5 °C warming, which is considered a red line beyond which catastrophic impacts would follow ("Global Warming of 1.5 °C ", 2020).

Global warming is real as the earth's temperature has risen steadily in the past decades. Natural resources are over-utilized and becoming more and more scares. The world meteorological organization some of the effect of climate change as follows, over a five-year period of 2014 - 2019 sea levels have risen at a higher rate than ever before, i.e, 4mm per year. The amount of ice lost annually from the Antarctic ice sheet increased at least six-fold. More than 90 % of the natural disasters are related to weather. The dominant disasters are storms and flooding, which have also led to the highest economic losses. Heatwaves and drought have led to human losses, intensification of forest fires and loss of harvest (World Meteorological Organization, 2019).

It is evident that some of the EEE produce highly toxic materials that when not disposed of in an environmentally sound manner may cause harmful effects to human life and the environment. (Otieno and Omwenga, cited in Schluep et al 2009). Lack of ICT personnel capacity readiness for green ICT challenges the reaping of green ICT benefits (Wabwoba et al., 2014).

The researcher's hypothesis is that the low adoption of green ICT practices is partly contributed by lack of knowledge on green ICT, the negative effects of ICT on the environment and most

importantly the failure of organizations to exploit explicit benefits that comes with green ICT (Which is likely influenced by unawareness of the existence of such benefits)

## **Literature review**

Some of the ways to mitigate global warming and ensure sustainable resource usage are to go green. Green ICT adoption is very low in Kenya based on a study conducted by Wabwoba et al. According to Dr. Wabwoba, the implementation of sustainable ICT practices in Kenya was recorded as lower compared to other countries in the world such as Australia, New Zealand, and the USA as of 2009 and Indonesia as in early 2012 (Wabwoba 2012). The study purposed to determine the personnel capacities readiness towards green ICT in Kenya. Four data centers and one hundred and sixteen ICT managerial, technical and user personnel were purposively sampled, the study established the ICT personnel's Green ICT adoption readiness was very low on both training and professional development perspectives in Kenya. A study by (Wabwoba 2012) confirms the availability of green technologies in Kenya.

To achieve sustainability within ICT, there has to be human intervention and support, therefore human capital is critical to implementations of Green Information and Communication Technology. Organizational staff needs to have experience, competency, commitment, values, and norms of ICT consumers (Byrd and Turner, 2000).

Taxation laws and financial subsidies are enablers to green technology innovations, awareness, and adoption. These measures have the potential to stimulate a population to strongly develop pollution control technology, waste utilization technology, clean production technology, and other environmentally sound technology (Zhiyong, 2017). In this research we will explore the available enablers put in place by the government of Kenya in promoting Green ICT initiatives.

Sustainability is the planning plus investing in technological infrastructure meant to serve the needs and wants of the present day plus the future while conserving resources (Pollack, 2008). ICT is a driver of sustainable solutions through proactive initiatives like sustainable economic growth through ICT driven solutions. Green ICT affects sustainability in a positive way by using renewable sources of energy, improving recycling, and the disposal of ICT gadgets and reducing the use of toxic materials (IISD, 2010).

## **Financial benefits.**

According to the International Telecommunication Union (ITU), digital transformation is a crucial player in the achievement of the United Nation's set sustainable development goals (SDGs). Goals such as e-health, financial inclusion through mobile money, smart sustainable cities among many others all trickle down to financial savings in the form of efficiency or averted spending due to monitoring and warning systems (Sharma, n.d.).

## **Societal benefits**

It has been found that at least 2% of global greenhouse gas (GHG) emissions come from the Information and Communication Technology (ICT) sector (Mingay & Pamlin, 2008). Knowing that greenhouse gasses affect human wellbeing, it is only imperative that ICT is used to reduce such effects with an overall effect of minimizing the negative long-term impacts on human health. Academic scholars like Hilty embrace the idea that ICT can be a driving force of enabling the transition of a society to a less material-intensive economy, overall leading to sustainable ICT use and lower ICT carbon footprint (Hilty et al, 2011)

## **Energy consumption**

Energy demands for the ICT equipment in the various sectors will increase as more efficient systems are made available and their use subsequently increases too. This increase in computer use has been attributed to the increase in service sector work which demands the use of main computers and computing equipment to deliver (Aebischer and Hilty, 2014).

A logical assumption would be to focus on using more energy-efficient computing hardware and software in order to reduce the cost of electricity associated with using ICT equipment. In other words, adopt green ICT.

Hilty (2008) explains that more energy-efficient technological hardware, which would lower the cost of running ICT systems or faster and cheaper equipment due to Moore's law, will make people buy more ICT equipment, thus cancelling out the effects of choosing more energy-efficient (Green ICT compliant). This however does not cancel out the benefits of using energy-efficient ICT hardware and software.

Some studies have shown there is a lot of energy waste within ICT use, and some point out to as much as half of the energy consumed by ICT is wasted, due to inefficient technologies or the behaviours of employees (Jenkin et al, 2011).

### **Contributors to low Green ICT practices.**

One of the major reasons why most organizations fail to adopt green ICT is largely due to a lack of knowledge of Green ICT and the impact of ICT on the environment and the population. Coupled with this lack of knowledge for some organizations there is a lack of support for green ICT initiatives from top management (Suryawanshi and Narkhede, 2013). It can be fairly assumed that this lack of knowledge goes beyond awareness of the potential benefits of adopting green ICT.

### **General literature review**

As everyone now is more conscious of global warming and the importance and sustainable development and production, there is more reason for the IT industry to also be conscious of its environmental footprint. The environmental dimension of the digital economy deserves great attention more than other dimensions because it is one of the important aspects of sustainable development (Munasinghe, 1996).

As the world shifts from one technology age to the other, our industrial needs only grow larger and larger and does the impact on the environment over the years. Understanding the possible environmental impact of technology use is important because it offers valuable understandings to identify and coordinate environmental protection and conservation strategies.

Murugesan expresses that "Sustainable technology additionally endeavors to accomplish financial reasonability and improved framework execution and use, while maintaining our social and moral obligations." (Murugesan, 2008). Most associations practice green ICT somewhat yet not intentionally and with a promise to accomplish some ideal result.

Molla in his publication (Molla et al., 2009) highlights that most organizations are aware of and have expectations of there to be benefits of green ICT, and therefore ready to adopt Green IT/IS initiatives. Most are held back by the uncertainty over Green IT/IS costs, and the unclear business value (Molla et al., 2009).

Bachour and Chasteen accept that the reception of green ICT in associations means utilizing innovation productively while considering the triple main concern (TBL): "financial suitability, social duty, and ecological effect. The triple primary concern (TBL) is a structure or hypothesis

that prescribes that organizations resolve to concentrate on social and ecological concerns similarly as they do on benefits (Bachour et. al, 2010).

Green ICT can take the form of many domains, that include green in hardware, green in software that trickles down to how both ICT software and hardware use and production effects on the environment and how ICT can be used to monitor and conserve environmental effects of ICT. (Calero and Piattini, 2015)

Some supposition that is made and checked by writing in a paper by Laura-diane radu in her paper Determinants of Green ICT Adoption in Organizations: A Theoretical Perspective (Radu, 2016). Feasible ICT inclinations are portrayed by the endeavors of IT the board, fundamentally to utilize IT assets all the more productively and successfully and to decrease the ecological effect. Additionally, the immediate and aberrant advantages assume a noteworthy job in impacting the two associations and people to receive economical ICT benefits.

Over the ongoing years, scientists' enthusiasm for the connection among ICT and the environment seems, by all accounts, to be expanding consistently. Stakeholders are progressively worried about grasping green ICT and in expansion manageable strategic approaches (Radu, 2016)

According to Radu (Radu, 2016, green ICT and eco-friendly technology use is motivated by three main factors,

1. General determinants; include things like pro-environment grants, organization culture, etc.
2. Specific determinants that include things like cost reduction, technology dynamics, unlocking the company's potentials in the virtual pace without negative effect on the environment
3. Government regulations. These are laws passed to ensure that the environment is protected and sustained.

Of all the reasons government regulations seem to be some of the strongest catalysts to the adoption of eco-friendly practices. This is since government regulations are enforceable by law and may carry strict fines including jail and or revocation of business licenses. With a clear outline of some economic benefits of adopting Green ICT, this trend can be changed, and the

adoption of green ICT can be incorporated into an organization's strategic document and planning.

Certain initiatives, particularly ones pertaining to Green ICT or sustainable ICT in an organization are influenced by different factors depending on the organization's environments, culture, strategies, and leadership. According to Molla et al. a number of factors have been suggested to affect the embracing of sustainable Tech. Cost reduction considered as being a major deciding factor or influencer of whether an organization will adopt green ICT. This research also aims at linking economic benefits whether in cost reduction or income generation through the adoption of green ICT. A clear and well-documented paper on factual economic benefits of green ICT would most likely influence the organization to consider green ICT adoption and incorporation in their business strategies.

Laura Diana (Radu, 2016) in her publication, infers some organizations can also play an important role in green ICT by influencing its employees and other stakeholders in adopting the practice of Green ICT. With the right setup of green ICT training and disposal mechanisms, employees could bring to work all their spoiled and or used electronic waste to a single central repository for waste management and recycling. It is worth noting that one of the reasons why people don't go green is the lack of proper and committed structures and systems that support individual e-waste disposal and green ICT with the least minimal effort.

Laura Diana Radu also summarized some key motivations for green ICT adoption and classified them into three categories: financial, moral, and administrative. This order is intended to guide organizations' initiative towards an ecological technique as per their needs, assets, industry, and vision. From her publication, we also get an aspect of the importance of cost or monetary factor in Green ICT. Laura further highlights the limitations of her paper as being only theoretical. This serves a pointer to doing a case study of organizations that does green ICT to get factual and empirical data to support availability of economic benefits hypothesis.

According to (Murugesan, 2008), some of the ICT service management task that can or should be focused on to promote green ICT or sustainable ICT use in an organization include,

- i. Eco-friendly computing waste disposal and reuse.
- ii. Employ stateless computers with centralized processing
- iii. Consolidation and utilization of virtualization

- iv. Use of low power consumption computing units.

A closer look at the above recommendations of sustainable ICT usage clearly points to some aspect of cost savings, an example of virtualization, which saves on the number of physical servers purchased and the number of servers consuming electricity in the organization. Just from the two initiatives, savings are clearly seen, and a theoretical economic benefit of green ICT demonstrated.

(Cater-Steel and Tan, 2011) In their paper "Its Role Service Management In Green IT" Carter-steel and Tan recommend that an investigation done by Sarkar and Young (2009) endeavored to investigate the primary financial, social, and organizational impacts that persuade top administration frames of mind towards the execution of a Green IT approach. Their discoveries recommend that eventually mentalities may be changed without hesitation when a clear financial framework exists that features the connection between potential cost reserve funds and Green IT activities, enhanced by plainly structured long-haul mindfulness projects encompassing the issue. This study by Sarkar and Young further proves that cost or economic factors play a huge role in motivating green ICT adoption.

### **Research Methodology**

This study research was informed by the literature review and to a great extent by (quantitative data) primary data and secondary data collected from the sample population to explain and justify the benefits of green ICT with an aim of eliciting more interest in its adoption.

An exploratory research design was used to investigate of the effects of green ICT on the implementing organization and other indirect causal effects.

### **Target Population**

The target population for this research will be registered organizations and companies that have operations within the Nairobi metropolitan area. The population of the study comprised;

- a. Financial institutions
- b. Educational institution
- c. Government institutions
- d. Not-for-profit organizations
- e. Telecommunications company

The above sample population was selected purposively as they are among the main sectors where most organisations fall in. Research and data collection will focus establishing the existence of benefits associated with green ICT practices.

### **Profile of the Organisation of study**

For the purpose of gaining an insight into the dynamics of green ICT in the Kenyan organization, the researcher saw it best to explore the empirical and qualitative variables with certain organizations that practice green ICT. Practicing in Green ICT can involve reusing ICT hardware and services by extending their life, Donating ICT products and services for other viable and productive use, employing the use of low power consuming ICT products, and or participating in direct reproduction and recycling of the e-waste.

Organizations that are easily identifiable as practicing green ICT are electronic waste recyclers WEEE Center and Electronic Waste Initiative Kenya (EWIK) were unfortunately not able to provide feedback to our questioners.

### **Sample and Sampling techniques**

For this study, the researcher used Judgement (or Purposive) Sampling to select my study population (the organizations of study). Data collected within the organizations selected will be subjected to Stratified sampling where the respondents will be divided into different strata e.g. NGOs, Government and private companies.

### **Research Instruments**

The main instruments used in this research include online google forms questionnaires, face to face interviews, secondary data already available in previous literature and published works. Limitation in data collection methods used is mainly due to the current situation in the country involving lockdowns and curfews as measures to curb the CORONA virus pandemic.

### **Discussion of Results and Findings**

Data collected during the study was partly analysed by google forms for a high-level inferencing, and R program software used to test for significance in the relationship of research variables. A standard chi square test was used to calculate the relationship on the categorical variables.

## Response Rate

ITEM	Frequency/ Occurrences	Percentage
Total questioner forms sent	80	100%
Responded questioners	67	84%
Valid responses	64	80%

Gender	Male 64%
67 Respondents	Female 36%

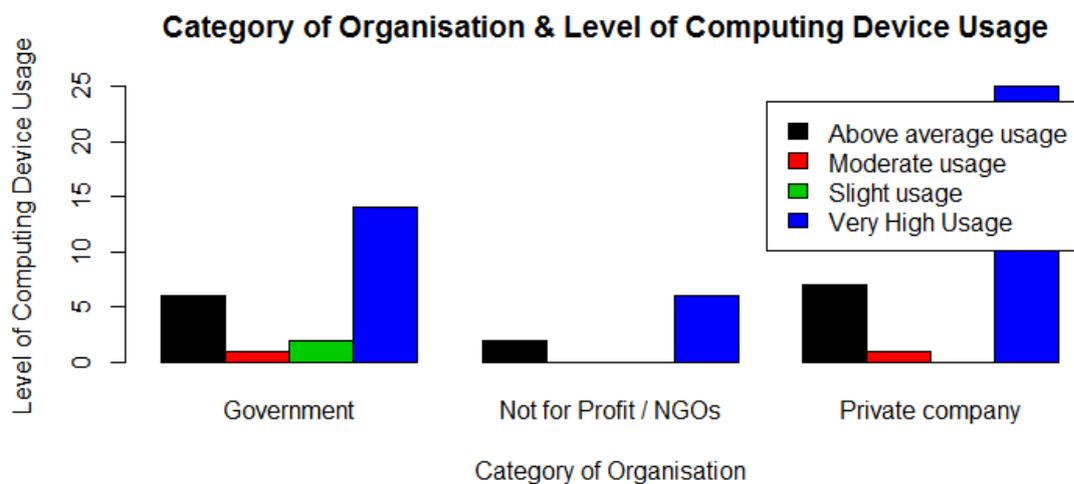
Highest level of Education	Masters 28%
67 Respondents	Undergraduate 61%
	Higher Diploma and below 11%

Chi square analysis of categorical variables

1. Relationship between the category of organization & level of computing device usage

### *Conclusion*

The calculated value of the test statistic is less than the critical value, we therefore accept the null hypothesis that the category of an organization and Level of computing device usage in an organization is independent. Therefore, we can confidently infer that most organizations use computer devices at a very high level.



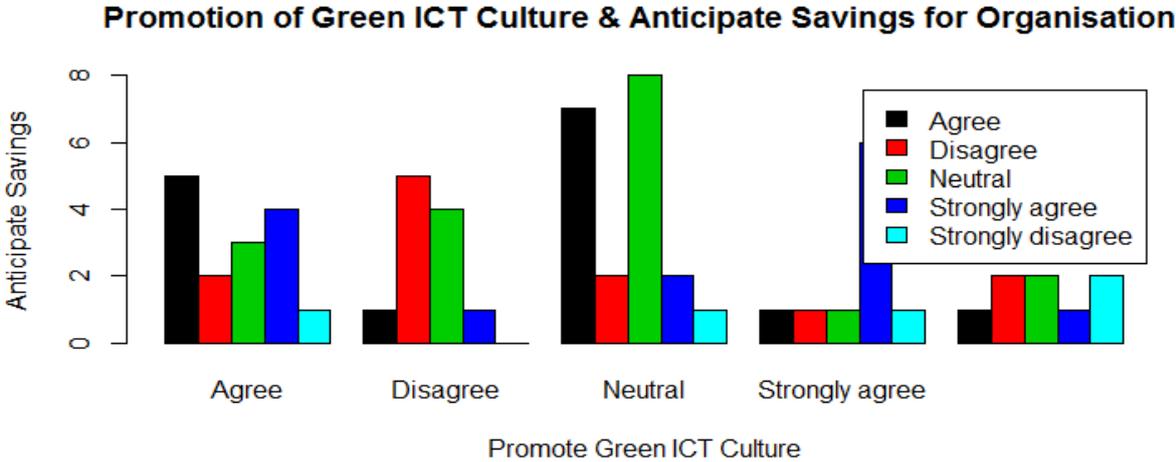
According to the analysis of this research data, it is apparent that computer usage is high across all sectors within the Nairobi metropolitan. This shows that ICT has been embraced as a

business tool within business across all devices. ICT resources can be a problem and a solution and with this high usage emphasis and great focus should be placed on their obsolescence management.

- 2. Relationship between anticipated savings & promotion green ICT culture in an organization.

**Conclusion**

The calculated value of the test statistic is greater than the critical value, we therefore reject the null hypothesis that Promotion of practice of Green ICT or any other form of environmental conservation & Anticipation of savings on the cost of doing business by an organization are independent.



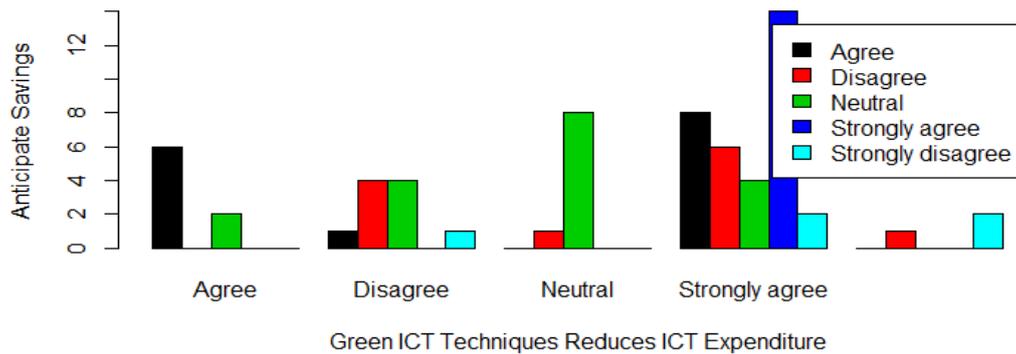
There Is also a significant relationship that points to the fact that most organizations that practice green ICT to some extent have an expectation of cost reduction in their business operations. This supports the theory that availability of monetary or other benefits can act as a key motivator for practicing green ICT. Such green ICT techniques involve low power consuming ICT equipment, printer sharing, cloud computing among others.

- 3. Relationship between reduced ICT expenditure and green ICT practice as a cost saving strategy

**Conclusion**

The calculated value of the test statistic is greater than the critical value, we therefore reject the null hypothesis that Belief in Green ICT techniques like printer sharing, cloud computing, etc. reduce organizational ICT expenditure and anticipation of savings by an organization on the cost of doing business by practicing green ICT are independent.

### Green ICT Reduces ICT Expenditure & Anticipate Saving from Green ICT



The study data also point to the fact that organizations have little regard to effects of ICT resources on the environment and thus it may not be a motivator for adopting green ICT, with this in mind stakeholder know where not to put more emphasis should they need results. The data collected also shows that the level of computer usage among organizations does not determine whether a green ICT policy is present or not.

Some of the Green ICT benefits highlighted by the respondents are as below.

- i. Proper disposal of ICT waste
- ii. Recycling
- iii. Cost
- iv. Safety
- v. Environmental improvements
- vi. Reduced energy
- vii. Efficiency

Respondents' level of education also showed no significant relationship with the awareness or knowledge of green ICT practices or techniques. This points out to a shortcoming in training or education with reference to environmental conservation in the workplace.

### Limitations of the Study

The research study experienced a number of limitations which may to some extent affect the outcome of the study. Some of the limitations experienced were as follows

- i. The Corona Virus pandemic has to a great extent affected the accessibility of organizations and data collection methods limited to online techniques only. The virus has also limited the number of respondents as most persons are either locked up in quarantine, out of work and network coverage area or sick.
- ii. The study population was limited to the Nairobi metropolitan, therefore the influence of organizations in other cities or rural settings was not considered and may make study findings not applicable or transferrable everywhere.
- iii. Generalization of the sampling technique and respondent selection. Some organizations may have only given a biased or a one-sided response since a fair representation of organizational staff was not experienced or could not be guaranteed. This would open up opinions from only one or two of respondents in an organization who may respond with personal accounts, knowledge or experience which may or may not be representative.

## **Recommendations**

This study has shown that most organizations have a high usage of ICT resources, which may include Laptops, desktops printers, CCTV cameras and so on. This high usage however will not translate to the adoption of sustainable ICT practices. Since we know that organisations are using ICT resources at a very high rate, stakeholders should consider tapping in to promoting green ICT among the organisations.

The data collected show a significant relationship between adoption of green ICT and expectation of some form of monetary benefits or in-kind benefits. The researcher recommends that precise study of the actual benefits of green ICT be conducted within organizations that are known to fully practice green ICT to a large extent so as to clearly inform organizations that anticipate practicing green ICT but lack the proper expected benefit motivation to do so.

The National Environmental Management Authority (NEMA) should make it a requirement for all organizations to have a green ICT policy. This will intern create more awareness on the importance of green ICT, effects of ICT resources on the environment and elicit more interest among researchers on the topics relating to green ICT.

## **Conclusion**

This research aims at adding to the knowledge that already exists in the field of sustainable ICT / green ICT practices in Kenya as well as provides an incentive for organizations to integrate green ICT into their business and operations strategies.

The main objective of the study was to ascertain a relationship between practicing green ICT and green ICT related benefits, especially those that are financial in nature. This relationship was established by the findings of the data collected, and therefore should also act as a motivator to other scholars and researcher to conduct further studies on to explicit and fact-based benefits of green ICT.

This study also plays a role in the fight against global warming which is a big concern to humanity and our future generations by promoting evidence-based benefits to promote sustainable information communication and technology (ICT) use.

## **References**

Aebischer, B., & Hilty, L. (2014). The Energy Demand of ICT: A Historical Perspective and Current Methodological Challenges. *Advances In Intelligent Systems And Computing*, 71-103. doi: 10.1007/978-3-319-09228-7\_4

Bachour, N.; Chasteen, L. Optimizing the Value of Green IT Projects within Organisations. In *Proceedings of the Green Technologies Conference, Grapevine, TX, USA, 15–16 April 2010*; Institute of Electrical and Electronics Engineers: New York, NY, USA, 2010; pp. 82–91.

Byrd, T., and Turner, D. (2000). Measuring the Flexibility of Information Technology Infrastructure: Exploratory Analysis of a Construct. *Journal of Management Information Systems*, 17(1)pp.167- 208.

Calero, C., & Piattini, M. (2015). Introduction to Green in Software Engineering. *Green In Software Engineering*, 3-27. doi: 10.1007/978-3-319-08581-4\_1

Cater-Steel, A. and Tan, W. (2011). The Role of IT Service Management in Green IT. *Australasian Journal of Information Systems*, 17(1).

Climate Change Evidence: How Do We Know?. (2020). Retrieved 17 February 2020, from <https://climate.nasa.gov/evidence/>

Global Warming of 1.5 °C —. (2020). Retrieved 17 February 2020, from <https://www.ipcc.ch/sr15/>

Hilty, L. M. (2008, May). Environmental impact of ICT-A conceptual framework and some strategic recommendations. OECD workshop on ICT and environmental challenges Copenhagen.

Hilty, L., W. Lohmann, and E. Huang. 2011. Sustainability and ICT—an overview of the field. *Politeia* 27 (104):13-28

How tech changed lives of Kenyans. (2020). Retrieved 16 February 2020, from <https://www.businessdailyafrica.com/datahub/How-technology-changed-lives-of-Kenyans/3815418-5409714-mdu8v8/index.html>

Suryawanshi, K. and Narkhede, S., Green ICT Implementation at Educational Institution: A Step Towards Sustainable Future. 2013 IEEE International Conference in MOOC, Innovation and Technology in Education, pp. 251-255.

IISD (2010), The Digital Economy and the Green Economy: Opportunities for strategic synergies, International Institute for Sustainable Development, 2010. Retrieved October, 2010, from: [http://www.iisd.org/pdf/2010/com\\_digital\\_economy](http://www.iisd.org/pdf/2010/com_digital_economy)

Jenkin, T.A., Webster, J. and McShane, L., 2011. An Agenda for ‘Green’ Information Technology and Systems Research. *Information and Organization*, 21(1), pp. 17-40

Masud, M. and Malik, N. (2012), “A strategic model for evaluating energy efficient ICT infrastructures for sustainable environment”, *J. Appl. Sci. Res.*, 8(9), 4842-4853.

Molla, A. (2008). Organizational Motivations for Green IT: Exploring Green IT Matrix and Motivation Models. In *Proceedings of the 13th Pacific Asia Conference on Information Systems*, Hyderabad, India, 10–12 July 2009. Paper 13.

Molla, Alemayehu; Cooper, Vanessa A. (2009); and Pittayachawan, Siddhi, "IT and Eco-sustainability: Developing and Validating a Green IT Readiness Model". ICIS 2009 Proceedings. Paper 141.

Mingay, S. and Pamlin, D. (2008). Assessment of Global Low-Carbon and Environmental Leadership in the ICT Sector, WWF/Gartner: 66

Murugesan, S. (2008). Harnessing Green IT: Principles and Practices. IT Professional, 10(1), pp.24-33.

Otieno, I. and Omwenga, E. (2015). E-Waste Management in Kenya: Challenges and Opportunities. Journal of Emerging Trends in Computing and Information Sciences, 6(12).

Pollack, T. A. (2008). Green and sustainable information technology: A foundation for students. ASCUE 2008 Proceedings, 63-72.

Radu, L. (2016). Determinants of Green ICT Adoption in Organizations: A Theoretical Perspective. Sustainability, 8(8), p.731.

Sharma, S. ICT Development trends and approaches for Digital Transformation. Geneva. Retrieved from <https://bit.ly/2Bn6HIT>

Suryawanshi, K. and Narkhede, S., Green ICT Implementation at Educational Institution: A Step Towards Sustainable Future. 2013 IEEE International Conference in MOOC, Innovation and Technology in Education, pp. 251-255.

Wabwoba, F., Wanyembi, G. W., & Omuterema, S. (2012). Barriers to implementation of green ICT in Kenya. International Journal of Science and Technology, 2(12), 823-836. 76.

Waema, T. M. (2012). what is happening in ICT in Kenya. A supply- and demand side analysis of the ICT sector Policy report.

World Meteorological Organization. (2019). The Global Climate in 2015 - 2019. Centre for Research on the Epidemiology of Disasters National Institute for Space Rese

Zhiyong, X. (2017). Research on Green Technology Innovation Model and System Improvement based on Environmental Protection. IOP Conference Series: Earth and Environmental Science, 94, p.012115.