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The Common Guidelines and Procedures for Evaluating the Implementation of Greening ICT and ICT for Greening: A Case of Kenyan Universities.

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Abstract*: Green Information and Communication Technology (ICT) is the study and practice of using computing resources efficiently to achieve economic viability and improved system performance and use while abiding by ethical and social responsibilities. Green ICT frameworks are useful in measuring and evaluating different organizations' Green ICT efforts. Some frameworks make it easier to interpret and measure green ICT than others, while some do not offer guidance on which metrics to use. Features of Green ICT frameworks have not been studied and documented adequately. Furthermore, existing green ICT frameworks are all static, and have one major limitation, that is the inability to address the common guidelines and procedures for evaluating the implementation of greening ICT and ICT for greening. Attitude, technology, practice and policy represent the common guidelines and procedures. The purpose of this study is to device common guidelines and procedures for evaluating the implementation of greening ICT and ICT for greening.A cross sectional study involving 19 ICT directors and 145 ICT technical staff drawn from 19 universities with an established ICT directorate were contacted. Interview schedule and questionnaires were used to collect information on use of ICT equipment and technology. Print media and electronic media were used to collect literature on Green ICT and green ICT frameworks. Questionnaires were used to collect quantitative data while interviews were used to collect qualitative data. Standard statistical software was used to examine any cross-tabulation, associations or groupings which emerged from the quantitative data. Thematic technique was used to categorize and analyze qualitative data. The test re-test method was used to compute reliability coefficient by correlating the results. Validity of the tools used in the research was enforced by the use of multiple sources of data and auditing of the data. The benefits of this research is that it will enable institutions and organizations to implement Green ICT in relatively more adaptive and effective way and it should enable organizations to measure, evaluate and interpret their Green ICT efforts objectively.*

Keywords: *ICT, Green ICT, Attitude, Technology, Practice and Policy.*

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I. Introduction

Information and Communication Technology (ICT) can be used in several ways to help address environmental problems we face and to improve environmental sustainability. But ICT can also be a contributor to environmental problems confronting us(Murugesan, 2011). A downside of widespread adoption and use of ICT are the potentially harmful effects it can have on the environment if not managed well (Murugesan, 2011).

Improving environmental performance, tackling global warming and improving resource management are high on the list of global challenges that need addressing urgently. ICT industry needs to further improve its environmental performance for it is responsible for around 2-3% of the global carbon footprint(Organization for Economic Co-operation and Development, 2009).

The enablers and barriers to ICT transformation need to be understood at both micro and macro levels. However, green ICT implementations in various institutions have not been sufficiently analyzed at the micro level of an institution which represents a gap in the current academic literature(Jain, 2011). Green ICT implementations in institutions appear simple in concept but when we approach the details, they can be quite complicated. Hence it is important to focus on studying these implementations at the institutional level (Jain, 2011).

Most research shows that there is no official legislation to enforce green ICT practices within institutions, and therefore there is no such practice that has been implemented. We can summarize this section by deducing that some factors why green ICT practices are not implemented are; No official legislation enforcing green ICT practices, no pressure from management/customers and employees lack the appropriate knowledge or training. (Council of European Professional Informatics Societies (CEPIS), 2012). No university in their ICT policy has addressed green ICT framework. Even the Kenyan ICT policy does not address green ICT framework.

Green ICT and ICT for Greening

Greening ICT and ICT for greening are different but related concept. It is therefore necessary to draw the distinction between them and also clarify their relationship.

Green ICT is the practice of environmentally sustainable ICT and it also deals with designing, manufacturing, using, and disposing of ICT equipment such as monitors, printers, storage devices, routers efficiently and effectively with minimal or no negative impact on the environment. Green ICT strives to achieve economic viability and improved system performance and use, while abiding by our social and ethical responsibilities. Thus, green ICT includes the dimensions of environmental sustainability, the economics of energy efficiency, and the total cost of ownership, which includes the cost of disposal and recycling. It is the study and practice of using computing resources efficiently (Curtis & Lingarchani, 2011). So the main objectives of green ICT are to reduce the use of hazardous materials, maximize energy efficiency during the ICT equipment's' lifetime, and promote the recyclability or biodegradability of defunct ICT equipment. The initiative to implement green ICT should be embedded in the overall transformation process for an institution.

ICT for greening also called greening by IT, ICT for Green or greening by ICT is based around ICTs' ability to make other parts of everyday life more environmentally friendly. It is also claimed that ICT is to the knowledge economy what electricity was to the industrial revolution, and that ICT is the key to the decoupling between economic growth and climate change. Suggestions for how this can be done include dematerialization, smart buildings and smart logistics (Jarbur, 2014). Teleworking, teleconferencing and e-learning are other ways in which ICT can green other parts of life by reducing commuting.

II. Research Methodology

Research Design

Singh (2006) describes research design as to include the following components; research methodology or research strategy, sampling design, choice of research tools, and choice of statistical techniques.

Scientific studies tend to focus on one or the other of two major activities. The first activity consists of exploratory data collection and analysis, which is aimed at classifying behaviors within a given area of research, identifying potentially important variables, and identifying relationships between those variables and the behaviors. The second activity, called hypothesis testing, consists of evaluating potential explanations for the observed relationships (Bordens & Abbott, 2011). This research focused on the first activity which consists of exploratory data collection and analysis of the implementation of Green ICT in universities in Kenya.

Population and Sample Size

Given the nature of this research purposive sampling was specifically chosen when selecting the ICT directors of universities for a methodology judged by how well it informs research purpose.Simple random sampling means that every element in the population of interest has an equal and independent chance of being chosen. Here the word 'independent' means that the selection of any one element in no way influences the selection of any other. 'Simple' does not mean that random sampling is easier to carry out than other methods, but that steps are taken to ensure that nothing influences selection each time a choice is made, other than chance (Sapsford & Jupp, 2006). This methodology was applied when selecting the ICT technical staff in each university to participate in this study.

The target population comprised of ICT directors and technical staff members of ICT directorate. There are total of 19 ICT directors and 426 ICT technical staff members from the 19 universities. The total population is 445.Kothari (2004) recommends the use of 30% of the target population. That 30% of the population is enough for a study sample, the study used at least 30% of the target population as this was adequate and representative. This translated to 19 ICT directors and 145 ICT technical staff as the sample size as per the sampling procedure. The total sample sizewas 164.

Sampling Procedure

The researcher used simple random sampling procedure to sample 30% of the ICT technical staff members of each university. This gave the researcher 164 respondents from the population. All the ICT directors from the nineteen universities were required to participate in this study hence using purposive samplingprocedure.

Data Collection Instruments

Dawson (2009) asserts that research instruments are the tools you use to gather data, such as questionnaires or interviews. Three main research instruments will be utilised for primary and secondary data collection. These three are as follows:

Questionnaires

This tool was used to collect general information of the respondents, that is for both ICT director and the ICT technical staff. This tool was also used to collect information on Green ICT implementation.

Interview Schedule

Interviews are a major category of techniques for collecting data through questioning and are acknowledged as being some of the most effective ways of collecting data (Lancaster, 2005). Interviews were conducted specifically with the ICT directors of various universities.

Documents Analysis

Documents can be treated as a source of data in their own right though, alternative types of documents for research, take different forms of visual sources (pictures, artefacts) and even sounds (music) and that these constitute some form of 'document' which has a value for research (Denscombe, 2007). This tool was used to collect information on Green ICT and Green ICT frameworks. This was secondary data that was constituted from ICT policy reports from various universities, International journals and publications and Internet data.

Data Analysis

A number of ways have been used in this section to present the analyzed dataincluding tables, pie and bar charts among others. Before data analysis,data processing was done so as to correct possible errors such as; eliminating unusable data, interpretation of ambiguous answers and verifying contradictory data from relatedquestions.

Demographic Analysis

ICT directors and ICT technical staff formed the respondents who participated in the study to generate required data.

ICT directors and ICT technical staff Respondents

A total of 155 respondents were involved in this study. Further details of the distribution of the staff involved in this study are shown in Table 1.1. These respondents includes directors and other staff holding positions in the unit within the university charged with the responsibility of providing ICT related services to other units of the university.

These respondentswere drawn from across selected universities in Kenya.

Table 1.1:ICT directors and ICT technical staff Respondents

	Frequency	Percent	Valid Percent	Cumulative Percent
Database administrator	6	3.9	3.9	3.9
ICT Director	19	12.3	12.3	16.1
Network Administrator	18	11.6	11.6	27.7
Programmer	25	16.1	16.1	43.9
System Administrator	15	9.7	9.7	53.5
System Analyst	21	13.5	13.5	67.1
Technician	36	23.2	23.2	90.3
Web Master	15	9.7	9.7	100.0
Total	155	100.0	100.0	

The data presented in Table 1.1 for the ICT directors and ICT technical staff distribution was presented in the bar graph shown in Figure 1.1

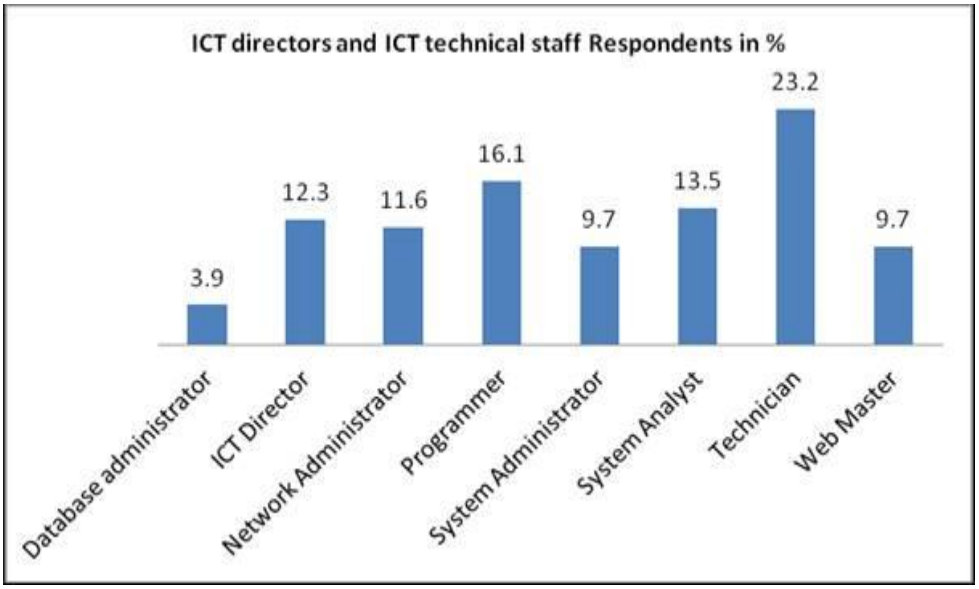

Figure 1.1:ICT directors and ICT technical staffrespondents

Respondent Distribution in Selected Universities

Different universities had different numbers of respondents participating in the study. Table 1.2 shows the particular universities with their corresponding total number of respondents. Different levels of participation were realized. The table provides frequency and crosstabulation of respondents and their distribution across the universities under study.

Table 1.2: Total Respondents Distribution in the Selected Universities

		Frequency	Percent	Valid Percent	Cumulative Percent
	Daystar University	13	8.4	8.4	8.4
	Dedan Kimathi University of Technology	7	4.5	4.5	12.9
	Egerton University	7	4.5	4.5	17.4
	JaramogiOgingaOdinga University of Science and Technology	7	4.5	4.5	21.9
	Jomo Kenyatta University of Agriculture Technology	7	4.5	4.5	26.5
	Kenyatta University	7	4.5	4.5	31.0
	Kibabii University College	7	4.5	4.5	35.5
	Maasai Mara University	7	4.5	4.5	40.0
	Maseno University	7	4.5	4.5	44.5
	MasindeMuliro University of Science and Technology	7	4.5	4.5	49.0
	Meru University of Science and Technology	7	4.5	4.5	53.5
	Moi University	11	7.1	7.1	60.6
	Murang'a University College	7	4.5	4.5	65.2
	Pwani University	7	4.5	4.5	69.7
	Technical University of Kenya	7	4.5	4.5	74.2
	Technical University of Mombasa	7	4.5	4.5	78.7
	United States International University	7	4.5	4.5	83.2
	University of Eldoret	7	4.5	4.5	87.7
	University of Nairobi	19	12.3	12.3	100.0
	Total	155	100.0	100.0	

Respondents were drawn from the nineteenuniversities as shown in Table 1.2 even though with different numbers.

Overall Gender Composition of the Respondents in the Study

composition of respondents varied across all the universities under study. Further details are reflected in Table 1.3; more male participated in the study at 69% compared to female at 31% indicating a higher number of malethan female in ICT, the area under study.

Table 1.3: Overall Gender Distribution of Respondents in the Study

		Frequency	Percent	Valid Percent	Cumulative Percent
	Female	48	31.0	31.0	31.0
	Male	107	69.0	69.0	100.0
	Total	155	100.0	100.0	

Table 1.3 indicated that the field of ICT is currently male dominated given the largernumber of male participants in the study across all the universities compared to femaleparticipants. Whereas gender disparity of respondents may not have a consequenceon the implementation of Green ICT technical aspects sought in the study, recognition of gender distribution across the universities under study is significant.
The data presented in Table 1.3 for the gender distribution was presented in the pie-chart shown in Figure 1.2

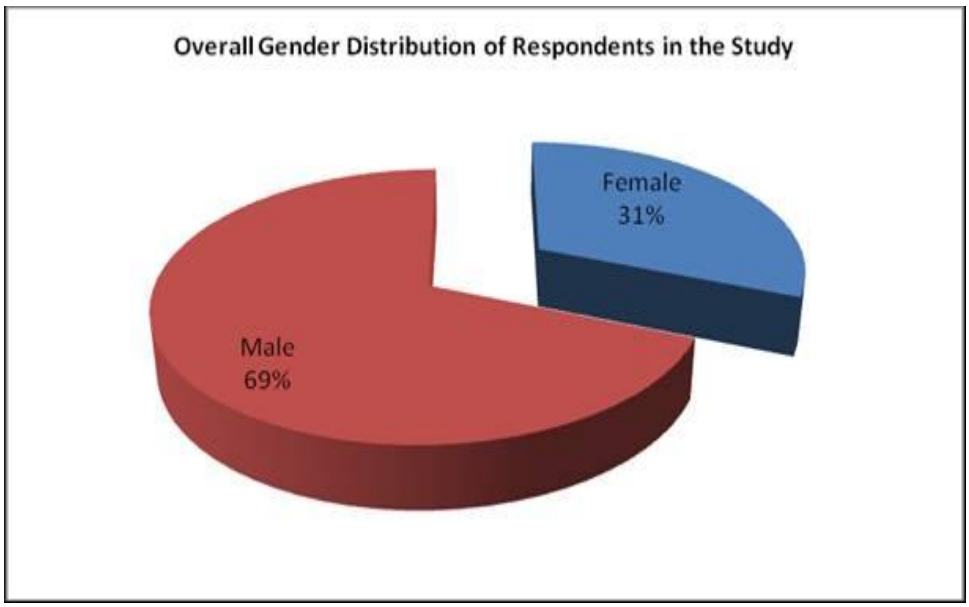

Figure 1.2: Overall Gender Distribution of Respondents

Common Guidelines and Procedures for Evaluating the Implementation of Greening ICT and ICT for Greening.

Greening ICT and ICT for greening that is the two aspects environmentally sustainable ICT practices should use the same framework and procedures for the evaluation of their implementation. The dynamic green ICT addressed this, but the static green ICT frameworks take a different approach that is it uses a part of the framework to evaluate the two aspects of greening. The common guidelines and procedures are; Attitude, technology, practice and policy.

Thisstudy sought to device common guidelines and procedures for evaluating the implementation of greening ICTand ICT for greening. To achieve this, relevant data was analyzed accordingly to cover the following aspects among others from the stakeholders; Attitude, technology, practice and policy.

Universitiesthat have a Green ICT Policy

Responses were obtained from respondents and summarized in a tabular form. Generally, it was noted that a significant number of respondents with 80.6% recognized Universitiesdo not have a Green ICT, followed by 15.5% who noted that they are not sure whether their Universities have a green ICT and lastly 3.9% noted that their Universities have a green ICT and presented as shown in Table 4.7.

Table 1.4: Responses on the Universities that have a Green ICT Policy

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	125	80.6	80.6	80.6

	Not Sure	24	15.5	15.5	96.1
	Yes	6	3.9	3.9	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that what would be the main driver for creating a university green ICT policy are; Carbon reduction, improve efficiency, cost saving, improve green credentials, political pressure, and legislation.

The data presented in Table 1.4on responses on the universities that have a green ICT was presented in the pie-chart shown in Figure 1.3

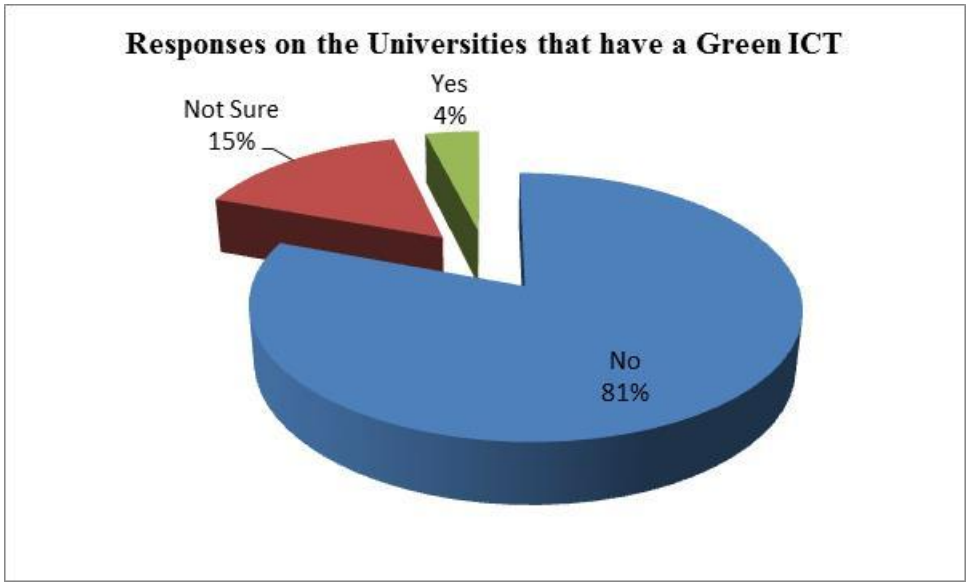

Figure 1.3: Responses on the Universities that have a Green ICT Policy

Lack of Monitor and Measure Culture in the Universitieswith Regard to Green ICT

Data was collected in the study on the lack of monitor and measure culture in Universities with regard to Green ICT and presented as shown in Table 1.5

Table 1.5: Responses on the lack of monitor and measure culture in Universities with regard to Green ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	64	41.3	41.3	41.3
	Disagree	1	.6	.6	41.9
	Neutral	7	4.5	4.5	46.5
	Strongly agree	83	53.5	53.5	100.0
	Total	155	100.0	100.0	

culture in universities with regard to green ICT.The data presented in Table 1.5responses on the lack of monitor and measure culture in Universities with regard to Green ICT was presented in the pie-chart shown in Figure 1.4

From the respondents, it was noted that there is lack of monitor and measure

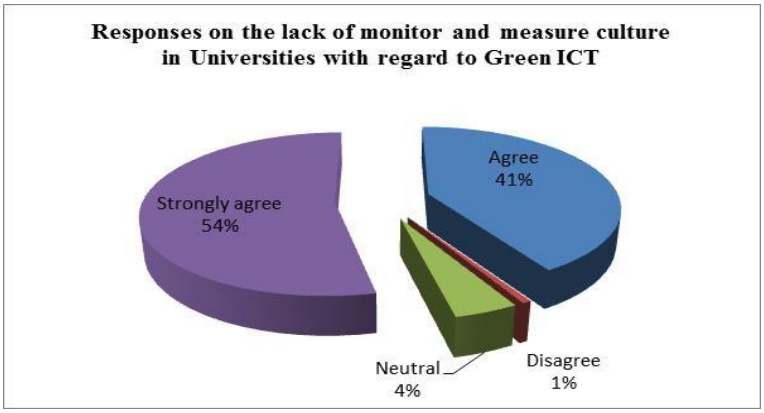

Figure 1.4: Responses on the lack of monitor and measure culture in Universities with regard to Green ICT

Lack of awareness amongst the staff in Universities regarding the importance of Green ICT

Data was collected in the study around thelack of awareness amongst the staff in Universities regarding the importance of Green ICT and presented as shown in Table 1.6

Table 1.6: Responses on lack of awareness amongst the staff in Universities regarding the importance of Green ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	79	51.0	51.0	51.0
	Disagree	1	.6	.6	51.6
	Neutral	5	3.2	3.2	54.8
	Strongly agree	70	45.2	45.2	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that there is lack of awareness amongst the staff in Universities regarding the importance of Green ICT.\The data presented in Table 1.6responses on lack of awareness amongst the staff in Universities regarding the importance of Green ICT was presented in the bar graph shown in Figure 1.5

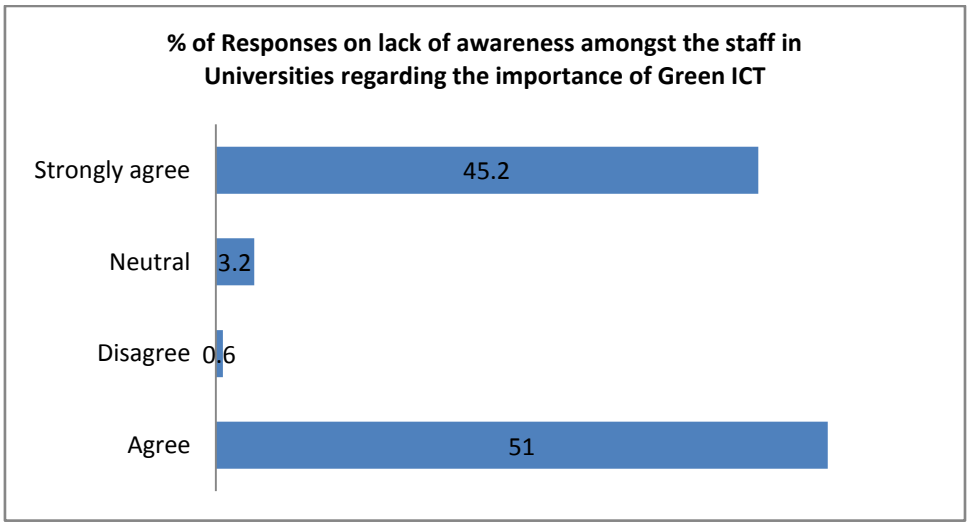

Figure 1.5: Responses on lack of awareness amongst the staff in Universities regarding the importance of Green ICT

Switching Computers to "Low-Power Consumption" Mode Every Time Whenever Necessary

Data was collected in the study on switching computers to "low-power consumption" mode every time whenever necessary and presented as shown in Table 1.7

Table 1.7: Responses on switching computers to "low-power consumption" mode every time whenever necessary

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	77	49.7	49.7	49.7
	unaware of such mode	1	.6	.6	50.3
	Yes	77	49.7	49.7	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that half of the respondents switch their computers to "low-power consumption" mode every time whenever necessaryand half do not.
The data presented in Table 1.7responses on switching computers to "low-power consumption" mode every time whenever necessary was presented in the pie-chart shown in Figure 1.6

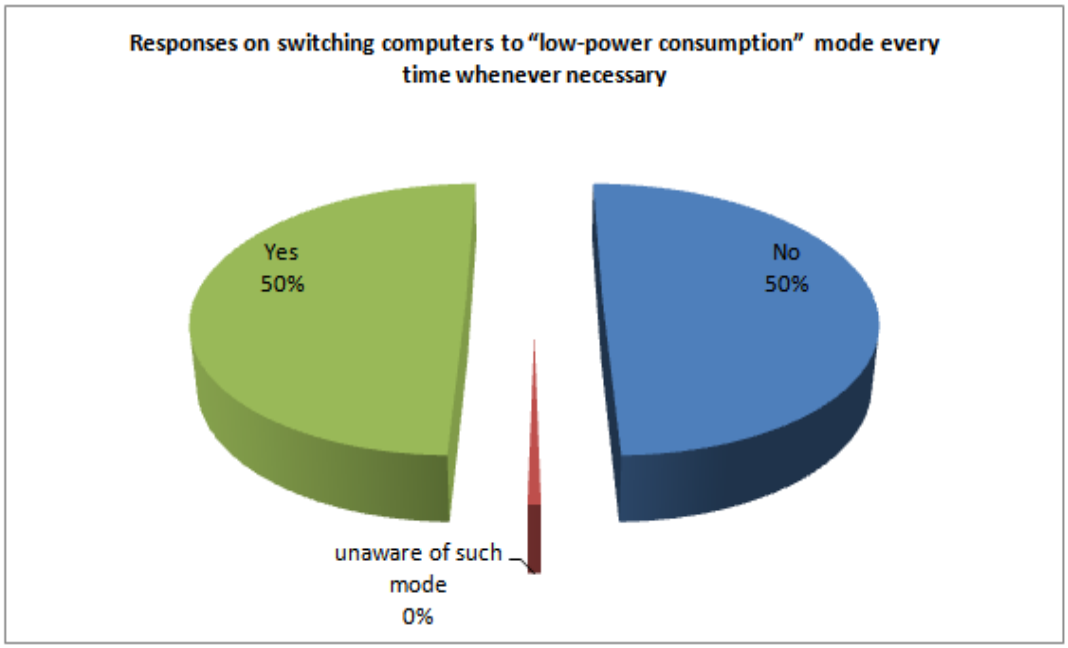

Figure 1.6: Responses on switching computers to "low-power consumption" mode every time whenever necessary

Computers Running Screensaverswhentheyare Idle

Data was collected in the study around computers running screensavers when they are idle and presented as shown in Table 1.8

Table 1.8: Responses on computers running screensavers when they are idle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	4	2.6	2.6	2.6
	Yes	151	97.4	97.4	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that most computers run screensavers when they are idle.
The data presented in Table 1.8responses on computers running screensavers when they are idle was presented in the pie-chart shown in Figure 1.7

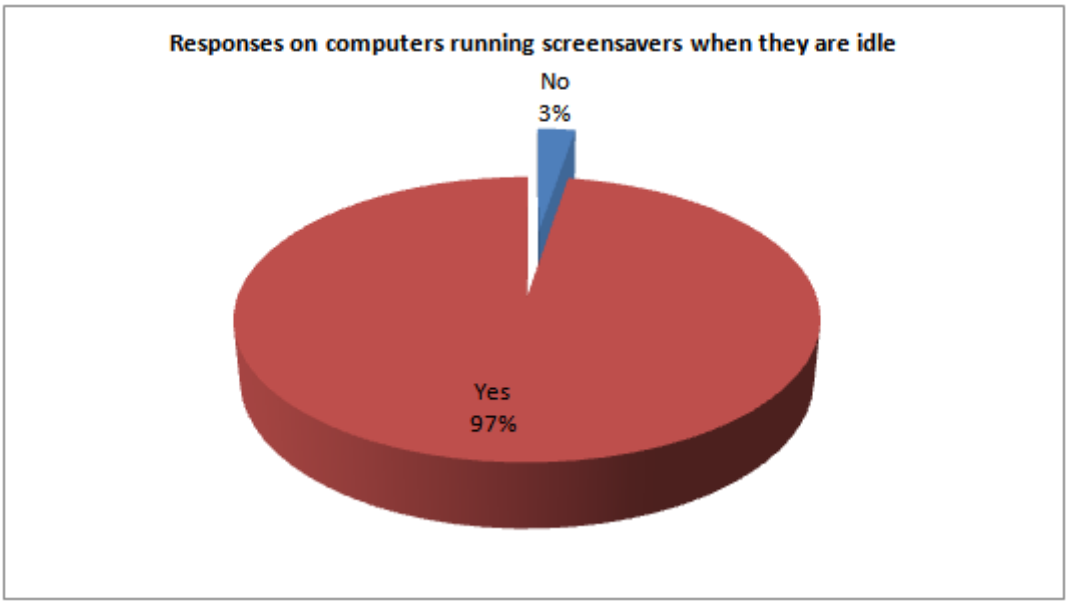

Figure 1.7: Responses on computers running screensavers when they are idle

The Necessity of Green ICT Policy in Institutions

Data was collected in the study on the opinion about the necessity of green ICTpolicy in institutions and presented as shown in Table 1.9

Table 1.9: Responses on opinion about the necessity of green ICT policy in institutions

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Necessary	152	98.1	98.1	98.1
	Not Sure	3	1.9	1.9	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that it is necessaryto have green ICT policy in institutions. The data presented in Table 1.9responses on opinion about the necessity of green ICT policy in institutionswas presented in the pie-chart shown in Figure 1.8

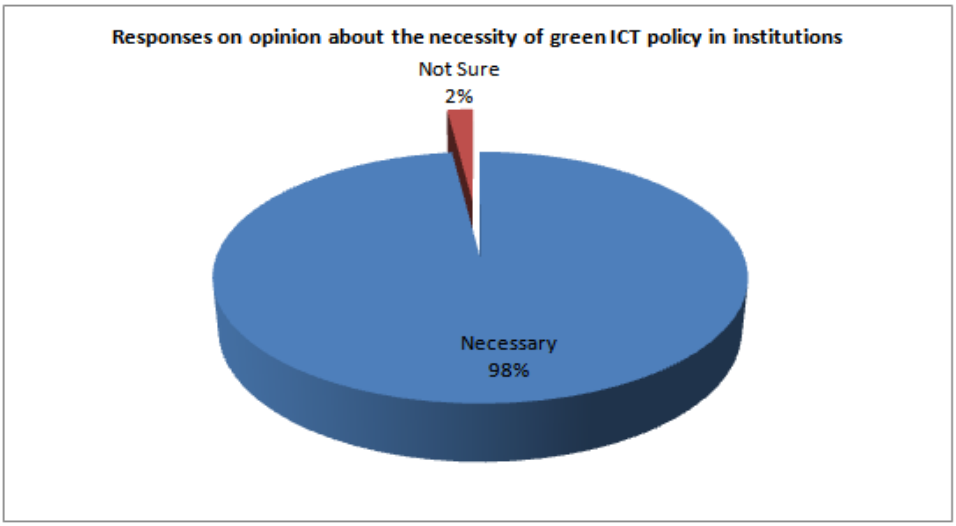

Figure 1.8: Responses on opinion about the necessity of green ICT policy in institutions

The Top Management of Institutions' Influence on the Implementation of Green ICT

Data was collected in the study on the opinion on the top management of institutions' influence on the implementation of green ICT and presented as shown in Table 1.10

Table 1.10: Responses on the top management of institutions' influence on the implementation of green ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Influential	147	94.8	94.8	94.8
	Not Sure	8	5.2	5.2	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that the top management of institutions influence the implementation of green ICT.The data presented in Table 1.10responses on the top management of institutions' influence on the implementation of green ICT was presented in the pie-chart shown in Figure 1.9

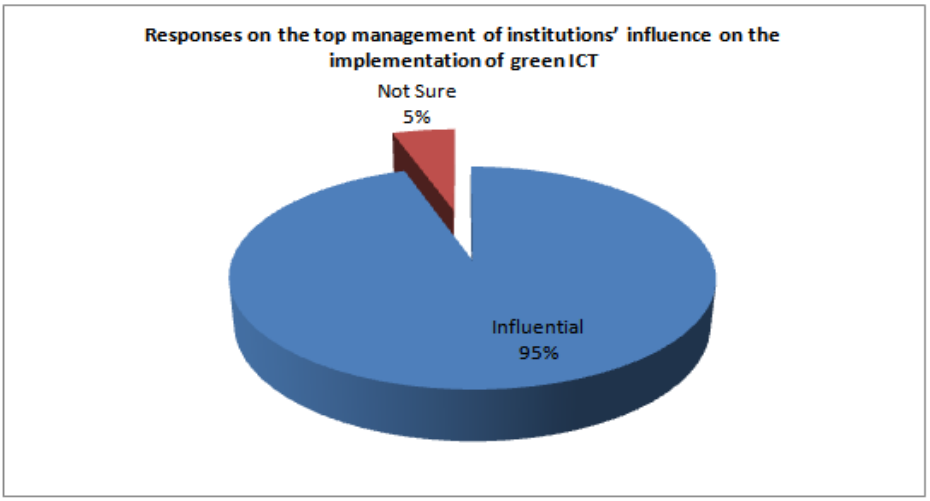

Figure 1.9: Responses on the top management of institutions' influence on the implementation of green ICT

Theattitude's influence on the implementation of Green ICT

Data was collected in the study on the attitude's influence on the implementation of Green ICT and presented as shown in Table 1.11

Table 1.11: Responses on the attitude's influence on the implementation of Green ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Influential	131	84.5	84.5	84.5
	Not Influential	9	5.8	5.8	90.3
	Not Sure	15	9.7	9.7	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that attitude influence the implementation of Green ICT. It was further noted that attitude influence, because positive attitude towards green ICT will influence the implementation and good attitude will influence the implementation and vice versa.

The data presented in Table 1.11responses on the attitude's influence on the implementation of Green ICT was presented in the bar graph shown in Figure 1.10

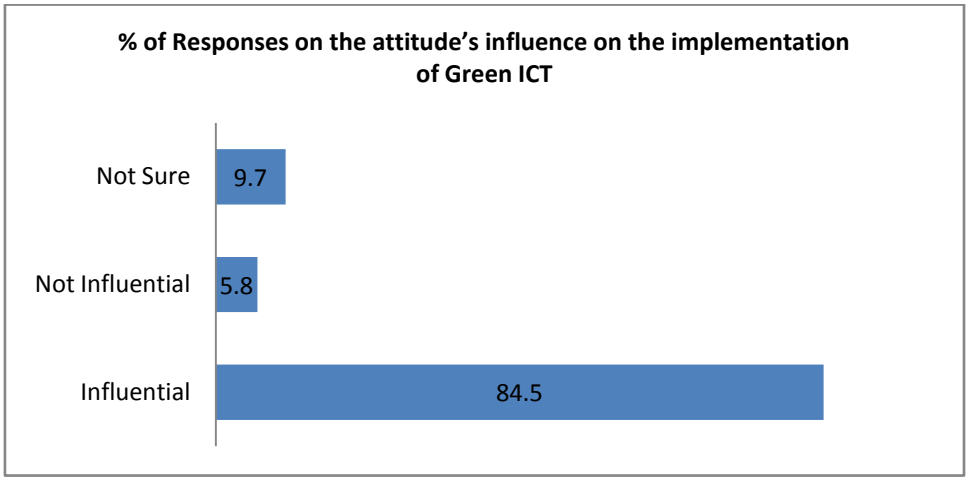

Figure 1.10: Responses on the attitude's influence on the implementation of Green ICT

The necessityofmeasuring, monitoring, managing and mitigation in the whole process of implementation of Green ICT

Data was collected in the study on the necessityofmeasuring, monitoring, managing and mitigation in the whole process of implementation of Green ICT and presented as shown in Table 1.12

Table 1.12: Responses on the necessity of measuring, monitoring, managing and mitigation in the whole process of implementation of green ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Necessary	143	92.3	92.3	92.3
	Not Sure	12	7.7	7.7	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted thatmeasuring, monitoring, managing and mitigation are necessary processes in the whole process of implementation of Green ICT.The data presented in Table 1.12responses on the necessity of measuring, monitoring, managing and mitigation in the whole process of implementation of green ICT was presented in the bar graph shown in Figure 1.11

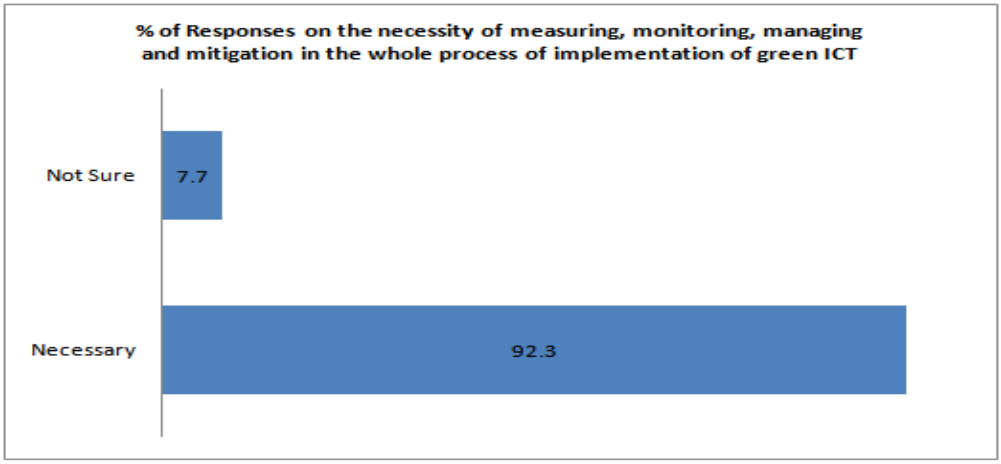

Figure 1.11: Responses on the necessity of measuring, monitoring, managing and mitigation in the whole process of implementation of green ICT

III. Conclusion

Greening ICT and ICT for greening are the two aspects of environmentally sustainable ICT practices. These two aspects should use the same framework and procedures for evaluating of their implementation. The study indicate that the common guidelines and procedures are; Attitude, technology, practice and policy. The study further indicates that in evaluating the implementation of green ICT, the above discussed activities are fundamental.

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