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Themaincomponents For Evaluating The Implementation OfGreen ICT: 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 specify realistic components for evaluating the implementation of green ICT. Equipment life cycle, end user computing and enterprise and data center are the maincomponents. The purpose of this study istospecify realistic components for evaluating the implementation of green ICT.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, Equipment Life Cycle, End User Computing and Enterprise and Data Center*.

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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).

Challenges Facing the Implementation of Green ICT

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).

Green ICT initiatives are going beyond simply operational or tactical activities; these green initiatives are becoming part and parcel of business strategies and planning. So, if the green ICT initiative is not integrated

within an institution's strategies and planning, it will be difficult to implement it (Curtis & Lingarchani, 2011).Agreeing on what the green ICT principals and objectives will be and adhering to the plan of implementing them is another challenge. Also there are challenges especially where this involves changes in behaviors associated with new business processes and associated applications.

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.

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.

More specifically, the research was administered by the use of questionnaires sent via email as attachments to both ICT directors and ICT technical staff and interview schedulewith ICT directors. Denscombe (2007) describes cross sectional study as to relate to the present state of affairs and involves an attempt to provide a snapshot of how things are at a specific time at which the data are collected.

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

According to Lancaster (2005) questionnaires are among one of the most widely used and valuable means of data collection. Because the data collected was analysed stastistically, the questionnares was tightly structured with both closed and open ended questions.

Interview Schedule

Interviews were conducted specifically with the ICT directors of various universities. This tool was also used to collect information on technological, environmental, economic, corporate social responsibility and government influence factors on the implementation of Green ICT.

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.

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	

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.

The data presented in Table 1.2 for the universities distribution was presented in the bar graph shown in Figure 1.1

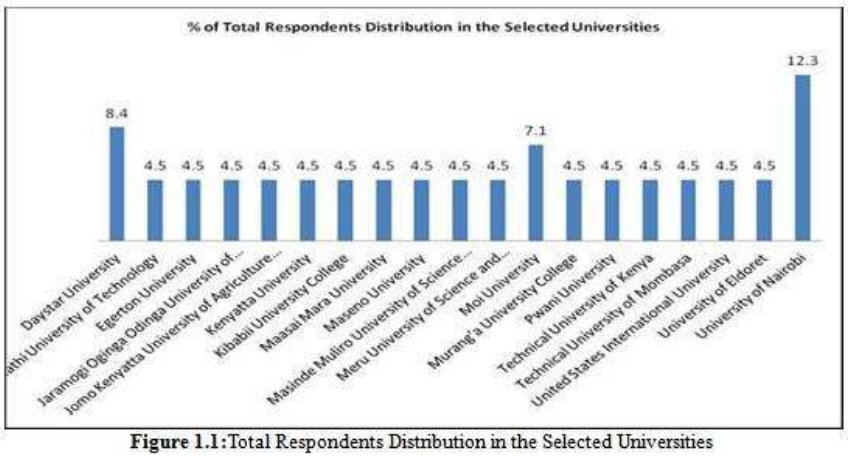

Figure 1.1: Total Respondents Distribution in the Selected Universities

Overall Gender Composition of the Respondents in the Study

Gender 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;

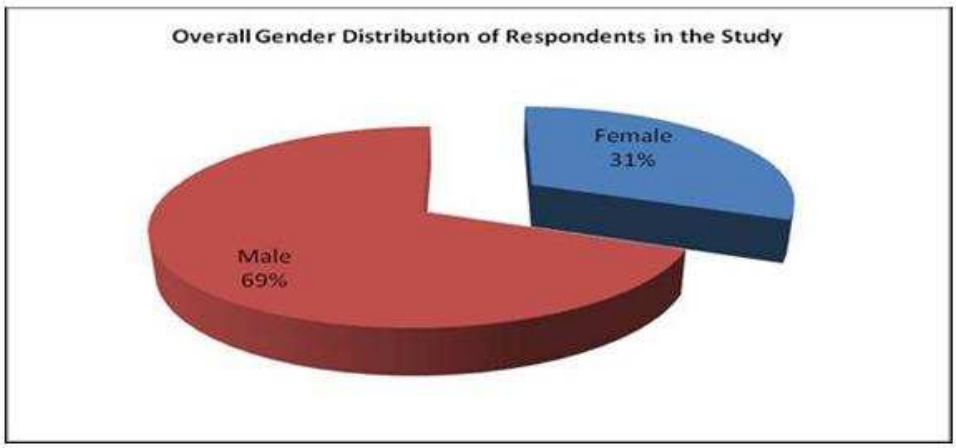

Figure 1.2: Overall Gender Distribution of Respondents in the Study

Components for Evaluating the Implementation of Green ICT

There is an oversimplification of components being used in green ICT frameworks making them more subjective rather than objective,as a result the frameworks become rigid in evaluating the implementation of green ICT. This rigidity is addressed by the dynamic framework by illustrating on the following components; equipment life cycle, end user computing and enterprise and dacta center.

This study sought to specify realistic components for evaluating the implementation of green ICT. To achieve this, relevant data was analyzed accordingly to cover the following aspects among others from the stakeholders; equipment life cycle, end user computing and enterprise and data center.

The ICT equipment suppliers reclaiming and recycling the old ICT equipment

Data was collected in the study on ICT equipment suppliers reclaiming and recycling the old ICT equipmentand presented as shown in Table 1.4.

Table 1.4: Responses on ICT equipment suppliers reclaiming and recycling the old ICT equipment

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	112	72.3	72.3	72.3
	Not Sure	42	27.1	27.1	99.4
	Yes	1	.6	.6	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that majority (72.3%)ofICT equipment suppliers do not reclaim and recycle the old ICT equipment.

The data presented in Table 1.4on ICT equipment suppliers reclaiming and recycling the old ICT equipmentwas presented in the bar graph shown in Figure 1.3;

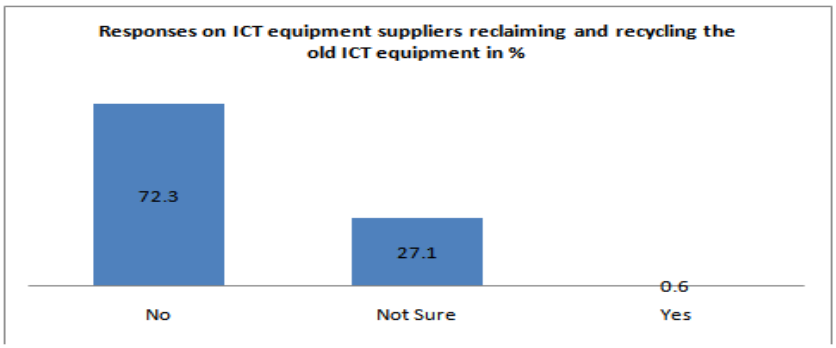

Figure 1.3: Responses on ICT equipment suppliers reclaiming and recycling the old ICT equipment

ICT Suppliers Delivering the ICT Equipment, Unpacking and Taking the Packaging Away With Them

Data was collected in the study on ICT suppliers delivering the ICT equipment, unpacking and taking the packaging away with themand presented as shown in Table 1.5.

Table 1.5: Summary of responses on ICT suppliers delivering the ICT equipment, unpacking and taking the packaging away with them.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	95	61.3	61.3	61.3
	Not Sure	57	36.8	36.8	98.1
	Yes	3	1.9	1.9	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that majority (61.3%) of ICT suppliers do not deliver the ICT equipment, unpack and take the packaging away with them.

The data presented in Table 1.5of responses on ICT suppliers delivering the ICT equipment, unpacking and taking the packaging away with themwas presented in the bar graph shown in Figure 1.4;

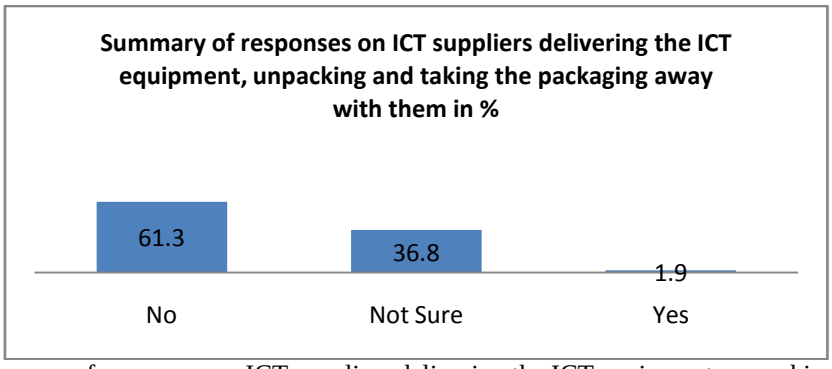

Figure 1.4: Summary of responses on ICT suppliers delivering the ICT equipment, unpacking and taking the packaging away with them

How printing of documents like memos, assignments, and notes, among others are done.

Data was collected in the study on how printing of documents like memos, assignments, and notes, among others are doneand presented as shown in Table 1.6.

Table 1.6: Summary of responses on how printing of documents like memos, assignments, and notes, among others are done.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Depends on the document	79	51.0	51.0	51.0
	Do not print	2	1.3	1.3	52.3
	Double sided paper	64	41.3	41.3	93.5
	Single Sided paper	10	6.5	6.5	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that (51%) print documents like memos, assignments, and notes, among others depends on the documents and (41.3%) do double sided printingwhile (6.5%) do single sided paper.

The data presented in Table 1.6onsummary of responses on how printing of documents like memos, assignments, and notes, among others are done was presented in the bar graph shown in Figure 1.5;

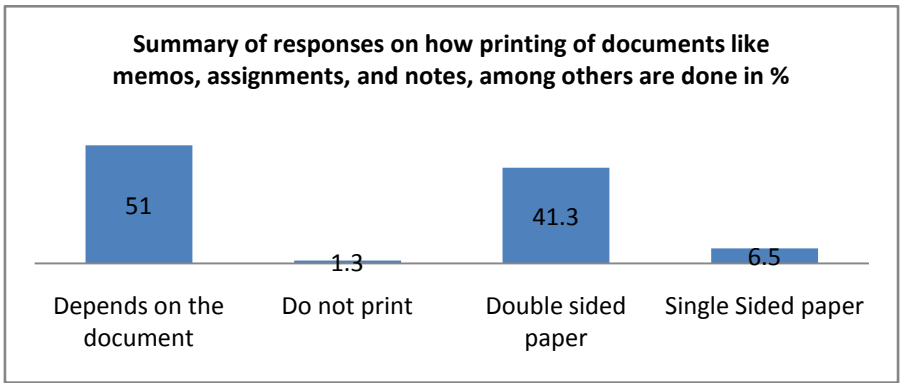

Figure 1.5: Summary of responses on how printing of documents like memos, assignments, and notes, among others are done

The understanding of is green disposal of ICT equipment.

Data was collected in the study on theunderstanding of green disposal of ICT equipmentand presented as shown in Table 1.6.

Table 1.6: Summary of responses on theunderstanding of green disposal of ICT equipment.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	33	21.3	21.3	21.3
	Not Sure	25	16.1	16.1	37.4
	Yes	97	62.6	62.6	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that majority (62.6%) of the respondents understand what green disposal of ICT equipment is.

The data presented in Table 1.7onsummary of responses on theunderstanding of green disposal of ICT equipment was presented in the bar graph shown in Figure 1.6;

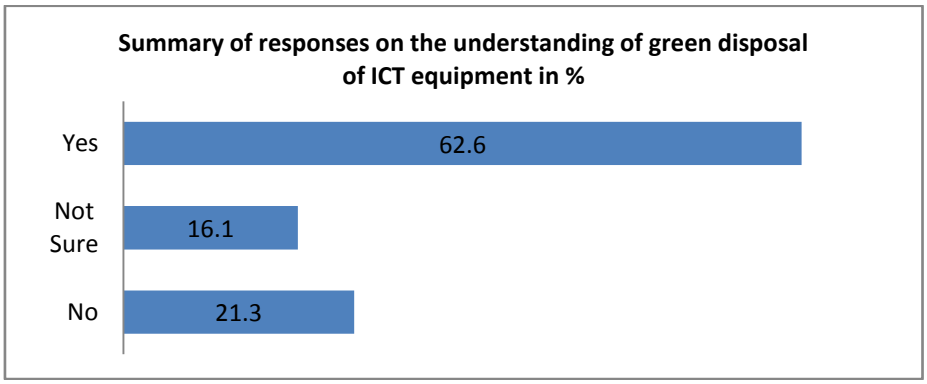

Figure 1.6: Summary of responses on theunderstanding of green disposal of ICT equipment

Staff dedicated to combating negative environmental impacts of ICT.

Data was collected in the study on staff dedicated to combating negative environmental impacts of ICTandpresented as shown in Table 1.8.

Table 1.8: Summary of responses on staff dedicated to combating negative environmental impacts of ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	148	95.5	95.5	95.5
	Not Sure	5	3.2	3.2	98.7
	Yes	2	1.3	1.3	100.0

Table 1.8: Summary of responses on staff dedicated to combating negative environmental impacts of ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	148	95.5	95.5	95.5
	Not Sure	5	3.2	3.2	98.7
	Yes	2	1.3	1.3	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that there is no staff dedicated to combating negative environmental impacts of ICT by (95.5%) of the respondents.

The data presented in Table 1.8onsummary of responses on staff dedicated to combating negative environmental impacts of ICT was presented in the bar graph shown in Figure 1.7;

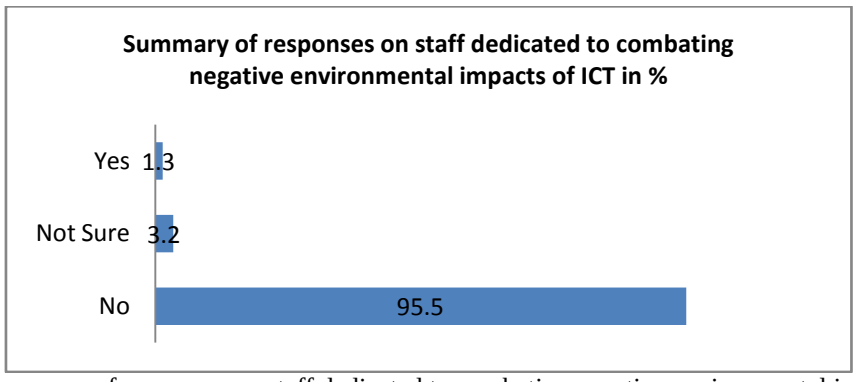

Figure 1.7: Summary of responses on staff dedicated to combating negative environmental impacts of ICT

Mitigation of the negative environmental impact of ICTs by reusing and recycling of ICT equipment.

Data was collected in the study on mitigation of negative environmental impact of ICTs by reusing and recycling of ICT equipmentandpresented as shown in Table 1.9.

Table 1.9: Summary of responses on mitigation of negative environmental impact of ICTs by reusing and recycling of ICT equipment.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	63	40.6	40.6	40.6
	Neutral	8	5.2	5.2	45.8
	Strongly agree	84	54.2	54.2	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that majority (94.8%) of the respondents agree that there can be mitigation of negative environmental impact of ICTs by reusing and recycling of ICTequipment.

The data presented in Table 1.9onSummary of responses on mitigation of negative environmental impact of ICTs by reusing and recycling of ICT equipment was presented in the pie-chart shown in Figure 1.8;

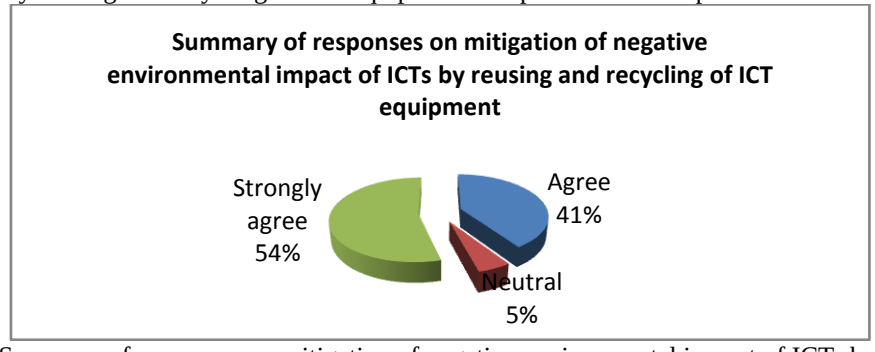

Figure 1.8: Summary of responses on mitigation of negative environmental impact of ICTs by reusing and recycling of ICT equipment

Changing printer settings for single sided or double sided printing options.

Data was collected in the study on how to change printer settings for single sided or double sided printing optionsandpresented as shown in Table 1.10.

Table 1.10: Summary of responses on how to change printer settings for single sided or double sided printing options.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	2	1.3	1.3	1.3
	Not aware of the printing options	2	1.3	1.3	2.6
	Yes	151	97.4	97.4	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that majority (97.4%) of the respondents know how to change printer settings for single sided or double sided printing options.

The data presented in Table 1.10onsummary of responses on how to change printer settings for single sided or double sided printing options was presented in the pie-chart shown in Figure 1.9;

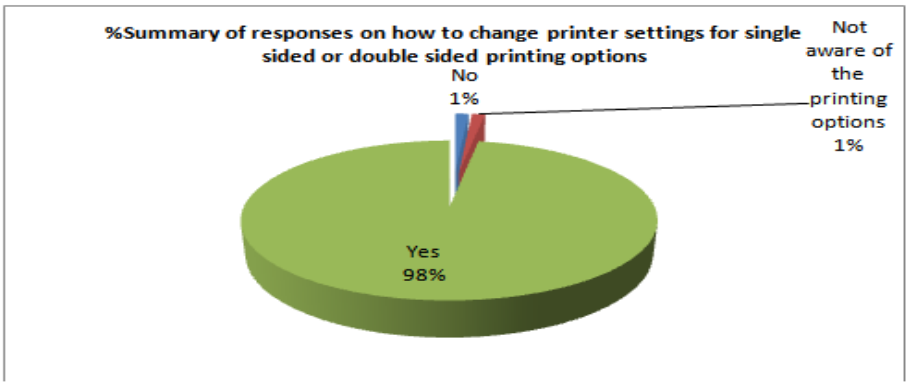

Figure 1.9: Summary of responses on how to change printer settings for single sided or double sided printing options

The operating system(s) used.

Data was collected in the study on the operating system(s) usedandpresented as shown in Table 1.11.

Table 1.11: Summary of responses on the operating system(s) used.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Linux	6	3.9	3.9	3.9
	Linux, Windows	53	34.2	34.2	38.1
	Windows	96	61.9	61.9	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that majority (61.9%) of the respondents use windows operating system.

The data presented in Table 1.11onSummary of responses on the operating system(s) used was presented in the pie-chart shown in Figure 1.10;

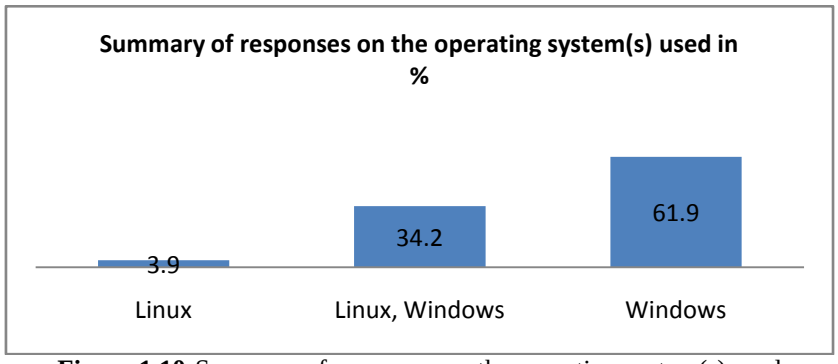

Figure 1.10: Summary of responses on the operating system(s) used

Switching computer to "low-power consumption" mode every time whenever necessary.

Data was collected in the study on switching computer to "low-power consumption" mode every time whenever necessaryandpresented as shown in Table 1.12.

Table 1.12: Summary of responses on switching computer 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 (46.7%)of the respondents do not switch computers to "low-power consumption" mode every time whenever necessary and (46.7%) of the respondents do switch computers to "low-power consumption" mode every time whenever necessary.

The data presented in Table 1.12onsummary of responses on switching computer to "low-power consumption" mode every time whenever necessary was presented in the bar graph shown in Figure 1.11;

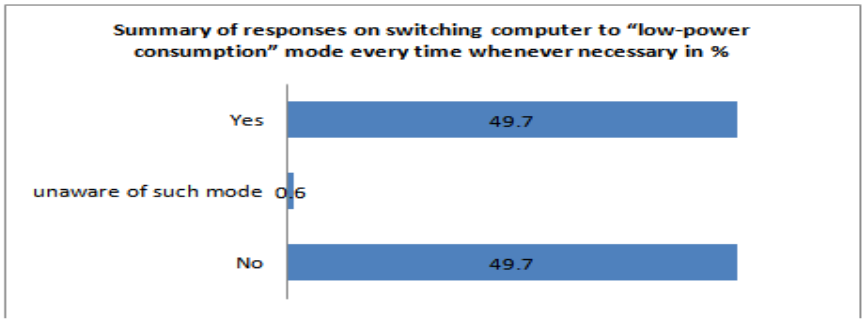

Figure 1.11: Summary of responses on switching computer to "low-power consumption" mode every time whenever necessary

Computer running a screensaver when idle.

Data was collected in the study on whether computer runs a screensaver when it is idleandpresented as shown in Table 1.13.

Table 1.13: Summary of responses on whether computer runs ascreensaver when it is 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 (97.4%)do run screensaver when idle.

The data presented in Table 1.13onsummary of responses on switching computer to "low-power consumption" mode every time whenever necessary was presented in the pie-chart shown in Figure 1.12;

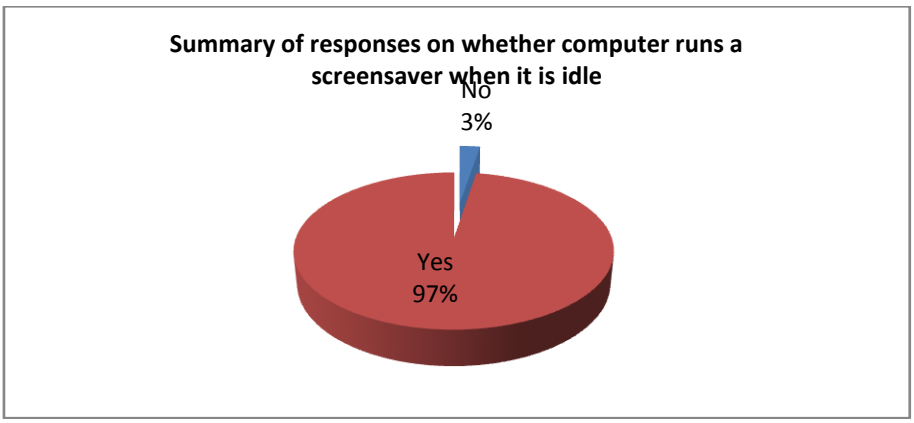

Figure 1.12: Summary of responses on whether computer runs ascreensaver when it is idle

III. Conclusion

Equipment life cycle, end user computing and enterprise and data center stands out as the main components to be considered in the implementation of green ICT. The various activities discussed above clearly indicate how crucial these activities are in the implementation of green ICT. Green ICT frameworks will be useful in measuring and evaluating different organizations' green ICT effort if they address these components.

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