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External Factors In Evaluating The Implementation of Green ICT In Universities In Kenya.

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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 and integrate external factors in evaluating the implementation of Green ICT. Innovations, market trends, and regulatory bodies represent external factors. The purpose of this study is to interrogate how to integrate these external factors in 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, Innovation, Market Trends and Regulatory Bodies.*

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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). The rapid innovations, replacement of ICT equipment and migration from analogue to digital technologies and to flat screen televisions (TVs) and liquid crystal display (LCDs) monitors are fueling the increase of electronic waste (e-waste). E-waste contains valuable and precious materials as well as hazardous materials.

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).

Consumers are a powerful ally in the fight against climate change. They can contribute to the reduction of carbon emissions by using energy more efficiently or moving to climate friendly ICT technologies that is green ICTs. For this to happen, however, they need to be sensitized to the impact of their consumption patterns on the environment and have access to affordable clean technologies (Organization for Economic Co-operation and Development, 2009).

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.

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.

Cost is also a potential issue especially where institutions have significant investment tied up in existing environments or where systems and infrastructure have been depreciated in value to the point where it has a limited investment impact on the institution. Institutions need approaches that will help plan these changes in better alignment with specific lifecycle policies for infrastructure. Where an institution has not attempted a project of this nature, a suitable migration strategy should be developed to provide a roadmap that will take the institution from the current state to the desired state. The migration roadmap should include a review and agreement of what the institution wants to achieve environmentally so that this can be evaluated in the context of green ICT (Curtis & Lingarchani, 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.

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 schedule with 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 size was 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 sampling procedure.

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 will be tightly structured with both closed and open ended questions. Some respondents completed on-line questionnares at their convenience. 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. This was be primary data.

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. 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. This was be primary data.

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

This section begins by presenting a demographic analysis of key aspects of the research. A number of ways have been used in this section to present the analyzed data including 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 related questions. Data

acceptability was verified and organized appropriately before analysis.

Quantitative and Qualitative Data Analysis

Data analysis was done in two different ways to take care of the qualitative data and quantitative data that were gathered during the study. Qualitative data was analyzed using thematic analysis technique. This method involved going through the collected data and identifying the information relevant to the research objectives and questions. The data was analyzed by matching themes, keywords, categories and patterns to domains. The quantitative data collected was analyzed using descriptive and inferential statistics. Correlation analysis and regression analysis were the main statistical inferential mechanisms used.

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 respondents were 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 cross tabulation 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
	Jaramogi Oginga Odinga 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
	Masinde Muliro 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 nineteen universities as shown in Table 1.2 even though with different numbers.

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 male than 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 larger number of male participants in the study across all the universities compared to female participants. Whereas gender disparity of respondents may not have a consequence on 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 1.1;

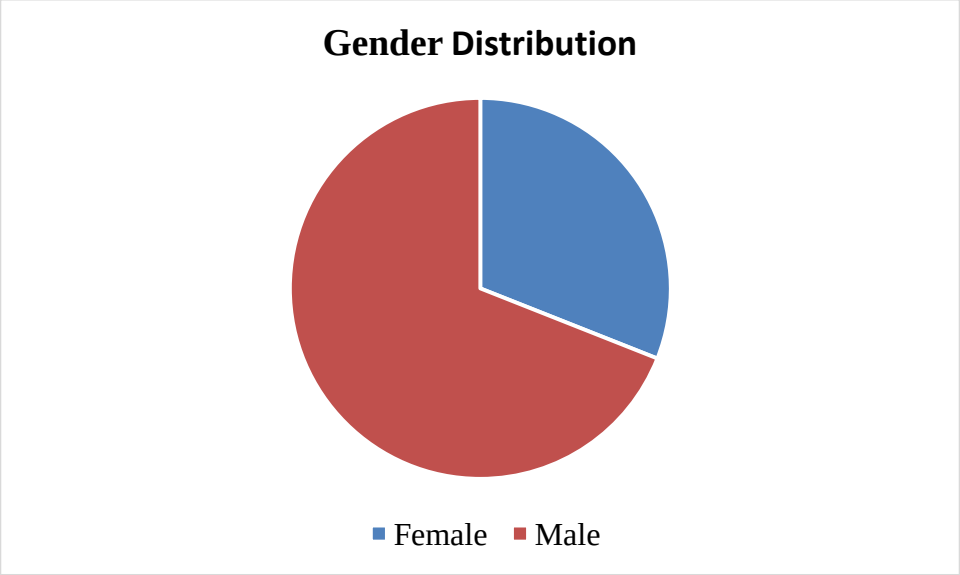

Figure 1.1: Overall Gender Distribution of Respondents in the Study

The External Factors in Evaluating the Implementation of Green ICT

The ability of a Green ICT framework to address the external factors is a characteristic of a dynamic framework, for it addresses on how to integrate emerging technologies when evaluating green ICT. Innovation, market trends, and regulatory bodies represent external factors.

The study sought to integrate the external factors in evaluating the implementation of green ICT. To achieve this objective, relevant data to the objective were analyzed accordingly to cover the following aspects among others from the stakeholders; their opinion on the market trends' influence on the implementation of Green ICT, their opinion on Green ICT policies' influence on the implementation of Green ICT, their opinion on various innovations' influence on the implementation of Green ICT, their opinion on various regulatory bodies such as National Environment Management Authority (NEMA), Energy Star, and Electronic Product Environmental Assessment Tool (EPEAT) influence on the implementation of Green ICT, their opinion on experience in ICT usage influence the implementation of Green ICT and their opinion on education level of an individual influence the implementation of Green ICT.

The Market Trends' Influence on the Implementation of Green ICT

Responses were obtained from respondents and summarized in a tabular form. Generally, it was noted that a significant number of respondents recognized the influence of the market trends' influence on the implementation of Green ICT and presented as shown in Table 1.4.

Table 1.4: Responses on the Market Trends' Influence on the Implementation of Green ICT.

		Frequency	Percent	Valid Percent	Cumulative Percent
	Influential	138	89.0	89.0	89.6
	Not sure	17	11.0	11.0	100.0
	Total	155	100.0	100.0	

Market trends have a positive contribution towards Green ICT, for instance, learning institutions strive to be competitive and affordable in delivering its services by adopting electronic learning platforms. Also, as long as the market trends address the issue of environmental friendliness, it will influence the implementation of Green ICT.The data presented in Table 1.4 on the market trends' influence on the implementation of Green ICT was presented in the bar graph shown in Figure 1.2;

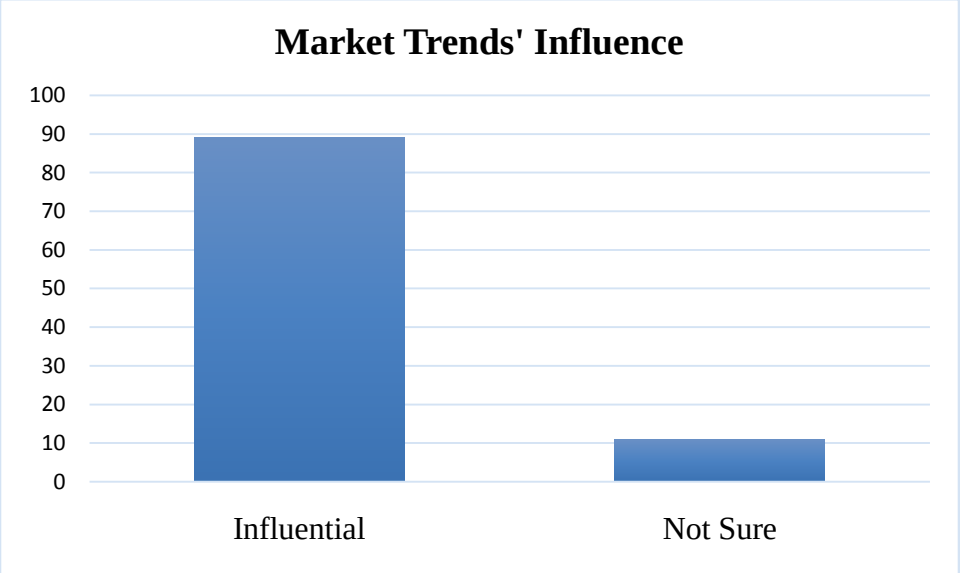

Figure 1.2: Responses on the Market Trends' Influence on the Implementation of Green ICT.

The Various Innovations' Influence on the Implementation of Green ICT

Data was collected in the study around the various innovations' influence on the implementation of Green ICT and presented as shown in Table 1.5.

Table 1.5: Responses on the Various Innovations' Influence on the Implementation of Green ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
	Influential	141	91.0	91.0	91.0
	Not sure	14	9.0	9.0	100.0
	Total	155	100.0	100.0	

It was noted that a significant number of respondents recognized the various innovations' influence on the implementation of green ICT. Most institutions would like to use the latest technologies which could be more economical and environmental friendly.

The data presented in Table 1.4 on the various innovations' influence on the implementation of Green ICT was presented in the bar graph shown in Figure 1.3;

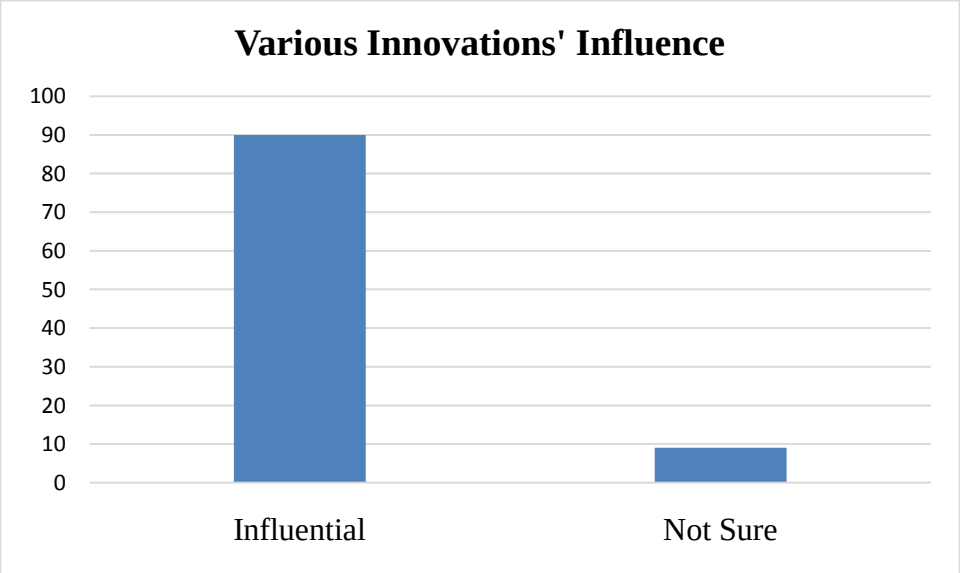

Figure 1.3: Responses on the Various Innovations' Influence on the Implementation of Green ICT

The Regulatory Bodies' Influence on the Implementation of Green ICT

Responses were obtained from respondents and summarized in tabular form. It was noted that a significant number of respondents recognized the influence of the regulatory bodies such as National Environment Management Authority (NEMA), Energy Star, and Electronic Product Environmental Assessment Tool (EPEAT) influence on the implementation of green ICT and presented as shown in Table 1.6.

Table 1.6: Responses on the Regulatory Bodies' Influence on the Implementation of Green ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
	No	16	10.3	10.3	10.3
	Yes	139	89.7	89.7	100.0
	Total	155	100.0	100.0	

From the respondents, it was noted that these regulatory bodies can influence the implementation of Green ICT by documenting benchmarks that guide ICT users on how to go Green and by encouraging people to conserve trees/forests. The bodies can also achieve this by giving incentives to those willing to make the effort towards Green ICT. These bodies can also regulate the levels of carbon emission and set minimum standards that need to be observed. They can set up legislation for ICT users to abide by as they go Green and come up with innovation grants to promote Green ICT implementation. They can influence the implementation by designing best practice frameworks in Green ICT.

The data presented in Table 1.6 on the regulatory bodies' influence on the implementation of Green ICT was presented in the bar graph shown in Figure 1.4;

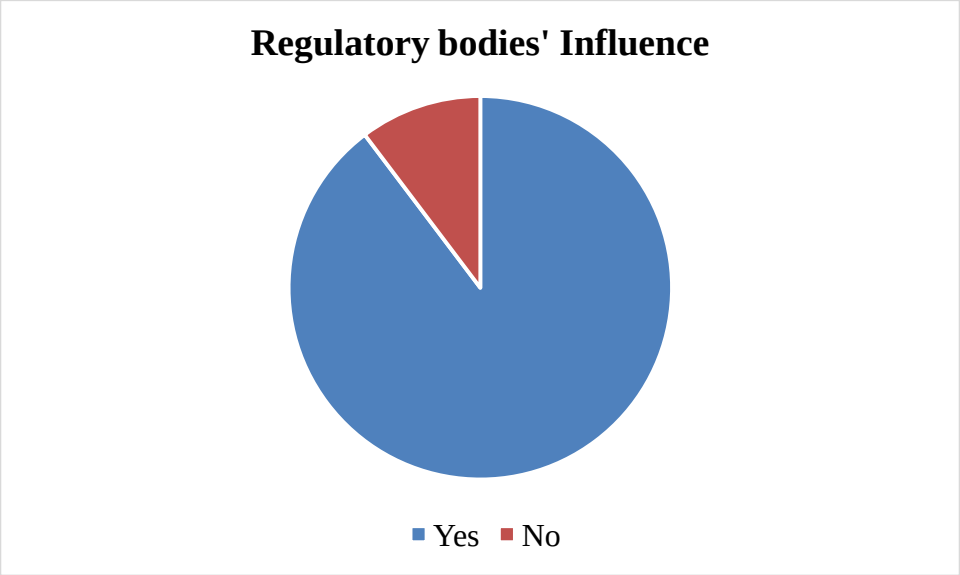

Figure 1.4: Responses on the Regulatory Bodies' Influence on the Implementation of Green ICT

III. Conclusion

To enable institutions and organizations to implement Green ICT in relatively more adaptive and effective way and to measure, evaluate and interpret their Green ICT efforts objectively, then, there is a need to integrate emerging technologies with the framework for evaluating the implementation green ICT. This has been made clear from this study. Innovation, market trends and regulatory bodies stands out as major factors that influence the Implementation of Green ICT as external factors to the static frameworks.

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