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Green ICT in Institutions of Higher Learning in Kenya

Irine Samoei[a] , Christopher Moturi[b] , Daniel Orwa[c]

[a] SCI University of Nairobi, Kenya
[b] SCI University of Nairobi, Kenya
[c] SCI University of Nairobi, Kenya

Abstract:- There is increasing pressure on institutions of higher learning to adopt more sustainable approaches to ICT use. For Kenya to realize its Vision 2030 development blueprint there is need to apply green ICT to improve chances of realizing both organizational and environmental sustainability. The study sought to determine the effect of green ICT on sustainable environment and how effective green ICT management is in institutions of higher learning in Kenya (IHL) in Kenya. Explanatory research design, quantitative and qualitative approaches were used. Survey of sixty seven (67) IHL in Kenya was done using random sampling while specific elements under study were identified using purposive sampling. Findings showed that to large extent green ICT is negatively affecting the environment where IHL do not manage power despite installing energy efficient equipment. There is incomplete substitution and lack of realization of optimization of green ICT solution; induction of other product and re-materialization. Further consolidation and reduced printing, disposal of equipment based on government disposal laws is a positive indicator. Challenges included low awareness, uncertainty in return on investment, constrained collaboration and scarcity of financial resources in institutions of higher learning. The study recommends that IHL should focus on a framework for implementing green ICT policies.

Keywords:- *Green ICT, Green ICT Effects, Green ICT Management, Sustainable Environment, Institution of Higher Learning.*

I. INTRODUCTION

The rising use of ICT has made significant impact in institution of higher learning and whether the effects on sustainability are largely positive or negative it is not evident. In UK it is evident that ICT in institutions of higher education has a large environmental footprint but it is however accompanied by an environmental and social cost (James & Hopkins, 2009). Institutions of higher education needs more sustainable ICT by taking action in integrating different perspectives, minimizing ICT impacts, maximizing beneficial ICT applications, organizational commitments and effective implementation processes, and support form sector institutions (James & Hopkins, 2009). Currently institutions of higher learning in developing countries are implementing green ICTs in order to minimize energy consumption, carbon footprint, and waste. Although Wabwoba (2012) established that green technologies are available in Kenya that can mitigate the concerns, they are not bearing fruit and therefore this calls for an understanding of barriers to their implementation.

An analysis of the role of the Kenyan government in establishing green ICT within organizations by (Kevin et al., 2015) identifies some of the areas through which the low carbon value added by new technologies could be increased as developing a green ICT policy to guide in implementation of green ICT, public-private partnerships in developing and implementing green ICT solutions, raising awareness of green ICT, and allocating resources. Where policies are in place in Kenya, only a few government programmes and industry association initiatives have measurable targets and indicators to measure achievement of targets. The ICT master plan for 2014-2017 for Kenyan government requires all institutions involved in its implementation adhere to the green ICT concept by environmentally friendly equipments and ensuring there is no e-waste dumping. However, very little exist in terms of policy to provide guidelines on green ICT within the Kenyan government.

Institutions of higher learning in Kenya (IHL) have introduced e-learning, institutional mail, use of online library systems and repositories and adopted information system such as finance system, human resource system and student management system. These initiatives have focused more on enabling effect of green ICT but with minimal focus on direct and systematic effect of green ICT. This is an indicator that is lack of holistic approach in implementation of sustainable green ICT in IHL. Therefore there is need to assess green ICT effect on sustainable environment and determine the role of green ICT management on the relationship between green ICT effect and sustainable environment in Institutions of Higher Learning.

An extensive literature review pertaining Green ICT and its effects on sustainable environment was carried out and its effects were summarized. This paper attempts to

assess the Green ICT effects and role of green ICT management for sustainable environment which would help decision makers in learning institutions to focus on framework for implementing Green ICT policies.

Nomenclature

CO2	Carbon dioxide
ICT	Information and Communication Technology
IHL	Institutions of Higher Learning
KGUN	Kenya Green University Network
KEBS	Kenya bureau of statistics
NEMA	National Environment Management Authority
PPOA	Public procurement oversight authority
UNEP	United nations environment programme

1.1. Green ICT

Green ICT is a pioneering approach of using ICT related to the environment protection and sustainability of ICT in future (Suryawanshi & Narkhede, 2014). Green is generally understood to mean friendly to the environment and energy efficient whereas sustainable implies planning and investing in a technology infrastructure that serves the needs of today as well as the future while conserving resources and saving money (Pollack, 2008).

IISD (2010) found that green ICT positively affect sustainability by lessening direct effects on the environment of the manufacturing, distribution, operation and discarding of ICTs equipment through enhanced energy and resources efficiency, increased use of renewable energy sources, reduced use of toxic materials and improved recycling and end-of life disposal of ICTs.

It also increase the enabling effects of ICTs on sustainability by reducing energy consumption and demand of materials through the whole or partial substitution of virtual goods and services for their physical equivalents and through the dematerialization of human activities and interactions; by supporting systemic effects it result in the change of behavior, attitudes and values of individuals as citizens and consumers; economic and social structures; and governance processes. ICT is not only an enabler but the contributor of carbon print, (Trewin, 2009) states that ICT is responsible for 2 % of global emission of carbon dioxide (CO2) which is on par with the aviation industry and both are growing rapidly .However its quantification of benefits and cost of ICT in relation to sustainability can be maximized hence reducing its effect to the society by reducing the remaining 98% of carbon emission.

1.2. Green ICT in institutions of Higher learning Global Overview

One of the most widespread concerns globally Green ICT and sustainability this calls for transformational changes in regards to ICT use in relation to environment protection and sustainability of ICT in future. The learning institutions are alerting as well as instructing and preparing the society to tackle environmental issues and to adopt environmental sound practices in their approach of using ICT. United Kingdom is one of the first countries to focus on Green ICTs in form of governmental policies and put pressure on UK Higher Education Institutions to implement Green ICTs (Suryawanshi et al., 2013). Chai-Arayalert& Nakata (2011) stated that the overall evolution of Green ICT practices in UK HEIs displayed a significant increase in concerns on ICT and environmental issues. UK HEIs paid attention to develop Green ICT practice for printing in term of reduction consumables usage, minimizing ICT waste and the Green ICT practice of personal computing. The Dutch Higher education institutions are following Green ICTs practices by building a Green ICT community of more than 300 members which stimulate and help their universities to work on green (ICT) issues, They are also following various Green ICT practices like mobile workplace, flexible office/classroom spaces, distance learning/teaching, minimize student commuting (Hankel et. al., 2013).Study done by (Thomson et al., 2015) showed that actual level of Green ICT adoption and readiness within higher education institutions in South Africa appears to be fairly low. Asabere et al., (2016) argues that some green ICT practices are being done on a very low scale in institutions of higher learning in Ghana. This literature shows that green ICT adoption and implementation level in institutions of higher learning in developing nation is relatively low as compared to institutions of higher learning institutions in developed nations. 2016 global ranking of universities evaluated Carbon footprint and found that only five out of 400 universities ranked from Africa practice environmentally friendly policies to help combat climate change, 67 institutions of higher learning from Kenya were among 400 universities ranked internationally).

1.3 ICT for Green and Sustainability

Suryawanshi& Narkhede (2015) argues that sustainable growth demands transformational changes concerning both technology and behavioral changes. Green ICT and sustainability are linked to each other hence green growth is not a replacement for sustainability, Rather, use of green ICT helps to ensure sustainability by providing a practical and flexible approach for achieving concrete, measurable progress across its economic and environmental pillars, while taking full account of the social consequences of greening the growth dynamic of economies (OECD, 2012).Ernst & Young (2012) established that green ICTs is a specific process that focuses on greening of ICT this involves making the ICT sector green by managing power, optimizing software, reusing and recycling materials greening of ICT in narrower sense refers to ICTs with low environmental burdens; while greening by ICT involves using of ICTs applications such as smart motors, smart logistics, smart buildings, smart grids, dematerialization, optimized and adaptive networks and lifecycle efficient production to transform socioeconomic sectors. Thus using ICT as an enabler reduces environmental impact across the economy outside of the ICT sector.

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1.5 Green ICT Effect

There are diverse set of effects of ICT on environment according to ICT impact analysis framework by (Hilty, 2008). The effects can be categorized into three levels namely; first order or direct effects, second order or indirect effects or enabling effects and third order or systemic effects. Bomhof et al. (2009), Souter et al. (2010), Vickery (2012) and Hankel (2014) have defined these effects as:

Direct Effects: - These are effects as a result of physical existence of ICT equipment in an environmental which involves the production, use, recycling and disposal of ICT hardware.

Enabling effects: These are indirect environmental effects of green ICT as a result its influence to change processes which includes production or transport processes, leading to decrease or increase of their ecological effect.

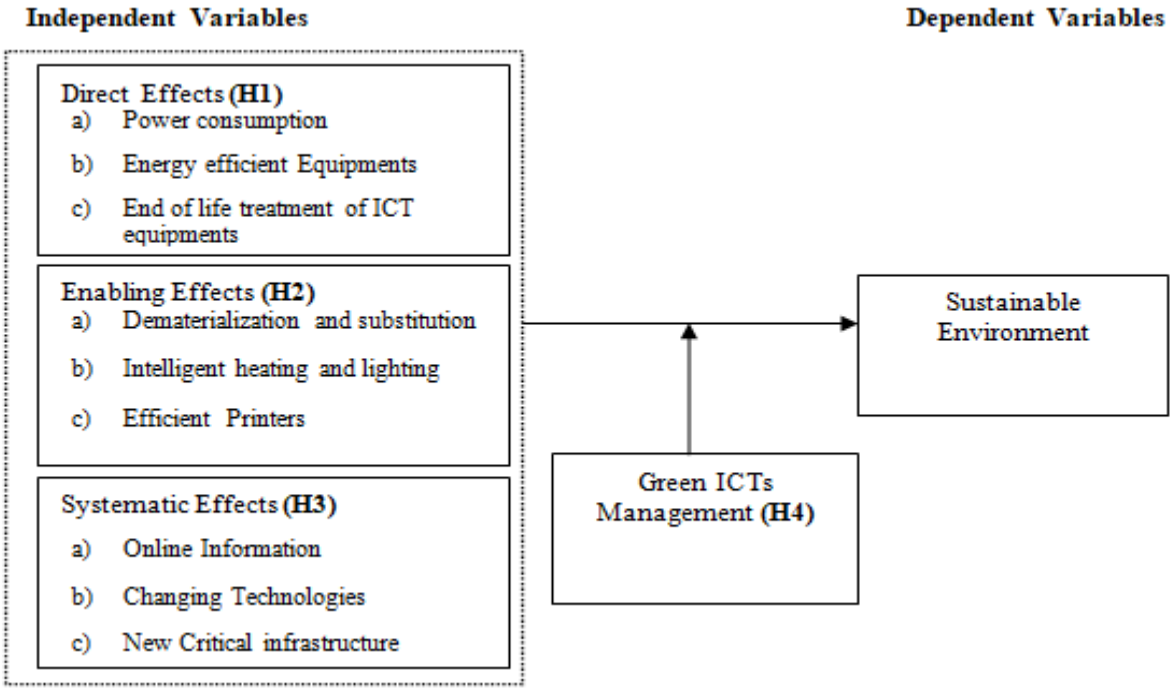
Systematic effects: Due to availability of ICT and services it provides it leads to environmental effects of the medium- or long-term adaptation of behavior (e.g. consumption patterns) or cost-effective structures, systemic impacts of ICT application.

1.6Green ICT Management

Green ICT involves management taking actions and making decisions, leading to a sustainable ICT environment (Ambtman, 2011). Green ICT management actions includes:-strategies which involves measuring and progress reporting, greening the ICT infrastructure, exploiting ICT to green government operation and exploiting ICT to green public service(Stewart et. al.,2016). An effective Green ICT strategy should clearly identify reduction measures in such areas as achieving energy savings, reducing carbon emissions, improving recycling efforts and conserving water; Green ICT policy which outlines aims, objectives, goals, plans of action, and schedules based on green ICT strategy thus ensure green ICT becomes a business-endorsed program of work rather than a discrete ICT project while best practices are techniques and behavior when using ICT equipments (Philipson,2010); Standards this amount to internationally agreed technical means of improving energy efficiency, reducing waste and curbing greenhouse gas emissions (Raju etal.,2013).

1.7Conceptual Framework

The research adopted ICT impacts framework by (Hilty, 2008). Three other framework were found to have limitation included:-Green IT Value Framework (Scott &Watson, 2012) was developed to identify and measure the value derived from Green ICT impact levels (Sourcing, Operation, Services and End of life) and value dimension (Economic, Environmental and Ethical). This framework assesses the net benefits, leaving out Green ICT risk. Bomhof et al. (2009) proposed an approach analyze the rebound effects of Green ICT i.e. effects that negative influence on the intended positive effect. By applying it on teleworking and smart working centre's, they demonstrated that rebound effects can by structured. Zhang & Xiong-jian (2012) proposed analytical framework to identify the critical system failures of a green ICT innovation systems but this framework is limited to structural components of a system. Hilty(2008) framework was conceptualized as follows;



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II. METHODOLOGY

The research methodology was guided by research objectives and hypothesis of the study. The study used pragmatism research philosophy. (Creswell, 2003) argues that Pragmatism is not committed to any one system of philosophy and reality. This applies to mixed methods research in that inquirers draw liberally from both quantitative and qualitative assumptions when they engage in their research. Further the study employed use of explanatory research design whose main aim was to identify any causal links between the factors or variables that pertain to the research problem, thus focusing on why questions and hypotheses of the research. Research instrument used included likert-scale questionnaire, structured interviews and document review. Pilot survey was carried out and Cronbach's alpha test was calculated to test the reliability of instrument to be used to collect data as shown in the table 1below:-

Table 1: *Reliability Test*

Variables	Cronbach's Alpha	N of Items
Direct Effect	.723	4
Enabling Effect	.818	4
Systematic Effect	.714	4
Sustainable environment	.761	6

Clustered sampling was used to group respondent into implementers of green ICT which included; sixty seven (67) ICT Directors in institutions of higher learning, one (1) E-waste Head from NEMA, one (1) ICT Standards officers where sampled using Purposive sampling. Two hundred and one (201) green ICT End users were selected randomly; Sixty seven 67 institutions of higher learning were selected based on 2016 international web ranking whose ranking criteria involved carbon foot print evaluation. The total population target was (270); a sample size of 217 was arrived at using (slovins, 1960) formula. Secondary data was obtained from www.nema.go.ke and www.iso.org/iso/standards_development,ICT Policy, PPOA Policy 2015, E-waste Policy Draft. SPSS Version 21 was used to perform statistical measures such as mean, standard deviation, percentages and in addition multiple regressions was used to test the hypothesis.

III. RESULTS AND DISCUSSION

3.1 RESULTS

The overall objective of the study was to assess green ICT effect on sustainable environment in institutions of higher learning in Kenya. In this section the researcher used the following ranges for analysis interpretation (1-2.4 **Agree**, 2.5-3.4 **Uncertain** and 3.5-5 **Disagree**) and percentages/frequencies for quantitative data and interview themes for qualitative data.

3.1.1 Awareness and Implementation

Previous studies by (Wabwoba,2013) identified that people naturally commit themselves to activities and task they have idea about i.e if people are aware of green ICT they are likely to implement it.The study assessed on green ICT awareness and its level of implementation,status and effective implementation of green ICT management actions.Respondents were asked to indicate there level of awareness of green ICT and the level of implementation of green ICT in there respective institutions of higher learning .Though majority of the respondent are aware of green ICT Management actions findings indicates 45.5% of the respondent where fully aware of green ICT followed by 54.50% who were partially aware this denotes that level of awareness is low.Majority 92.7% of the institutions have partialy implemented green ICT,Only 3.6% have fully implemented and 3.6% have not implemented at all.While most of the institution have green policies followed closely by best practices, standards and strategies there is minimal to no effective use on existing green ICT Management actions as shown in the figure 2.

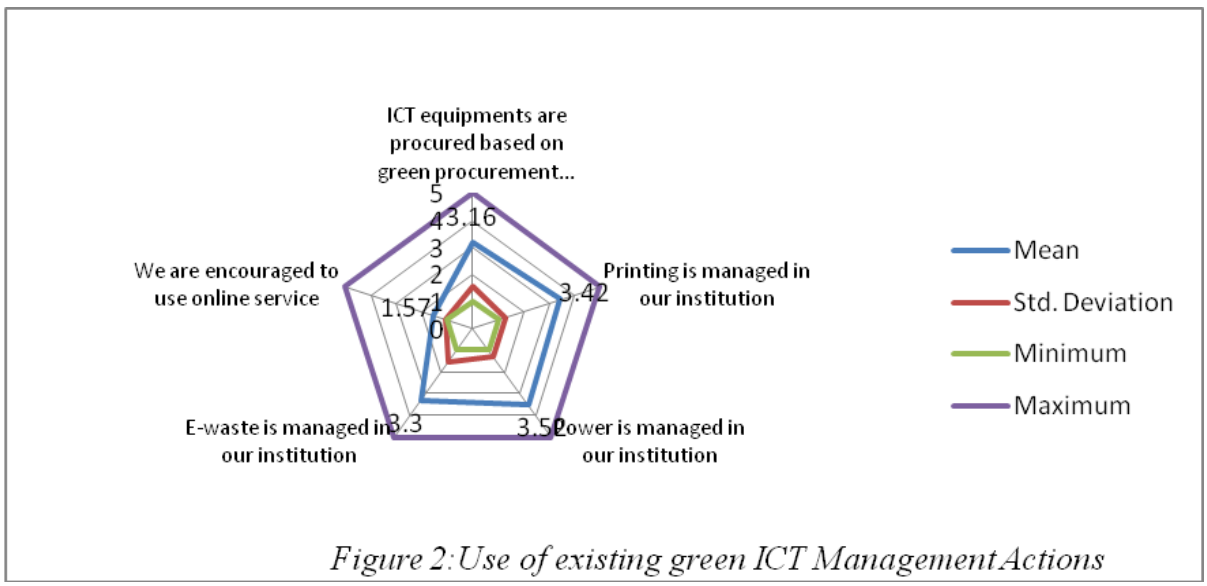

Figure 2:Use of existing green ICT Management Actions

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3.1.2 Green ICT Management Status and Implementation

One predominant theme from interview indicated that some institutions of higher learning have a well established purchasing policy for green ICT. This describes a standard configuration for new desktop equipment. While policy on procurement of ICT equipment which meets green standards (e.g. Energy Star, EPEAT, and WEEE) have not been fully implemented. One regulatory body stated that the policies cannot be fully enforced since WEEE standards are not yet met in Kenya considering it is still a developing country. Some policies on disposal were based on public procurement oversight authority (PPOA) disposal policy and national environment management authority (NEMA) guidelines as discussed in interview analysis above. Disposal policies have been fully implemented though institutional polices on E-waste are in there initial stage of implementation (drafts). Most of the institutions have no power management policies yet but some institutions have guidelines on power management i.e. switch off lights when living office. ICT policies capture the existing ICT applications which have been fully implemented and partially implemented based on E-government requirement. Thus it is more of compliance than use thus leads to partial use. Printing policies have been implemented by at least half of the institutions we interviewed.

3.1.3 Measuring Sustainability

Institutions of higher learning who are members of Kenya green university network reported that they measures sustainability of their green ICT Projects using COBIT5 balanced scorecard. They focus on Financial, Customer, Learning and growth dimensions as shown in table 2.

Table 2: *Measuring Sustainability*

	BSC Dimensions	**Description**
1	Financial Measure	Environmental fines and penalties
		Energy cost
		Disposal Cost
		Capital investment in green ICT initiatives
		Recycling Revenues
		Cost Savings
2	Customer Measures	Electricity consumed
		Parties conforming to green Standards
		Purchase conforming to green regulation
		Equipment recycled and reuse
		Equipment sold for refurbishing
		Heat generated from Equipment refurbished, Equipment bought
3	Learning and Growth	Employees switching off equipment when not in use
		Number of employees aware of green ICT initiatives

3.1.4 Direct Effects

From the analysis of direct effects the findings showed that majority were uncertain with switching off the computer when leaving office and agreed that institution uses centralized ICT system , reuse and recycle of equipments and installs energy saving ICT equipment as shown in figure 3.

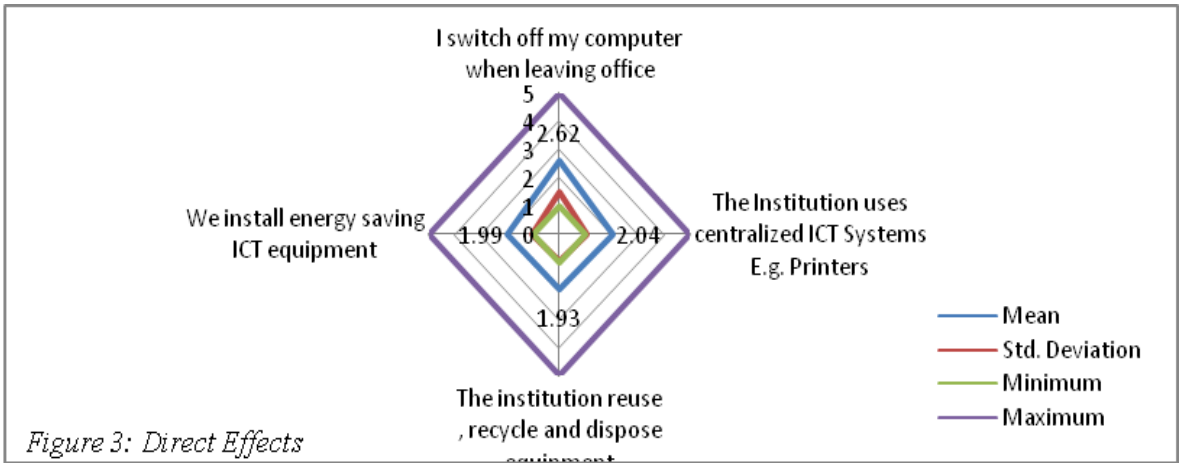

Figure 3: Direct Effects

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3.1.5 Enabling Effects

From the analysis of enabling effects the findings showed that respondent agreed that they read online materials, the institution experience problem relating to low quality paper while using printer's institution allows employees to work remotely and were uncertain in regards control of office temperature by building control system as shown in figure 4.

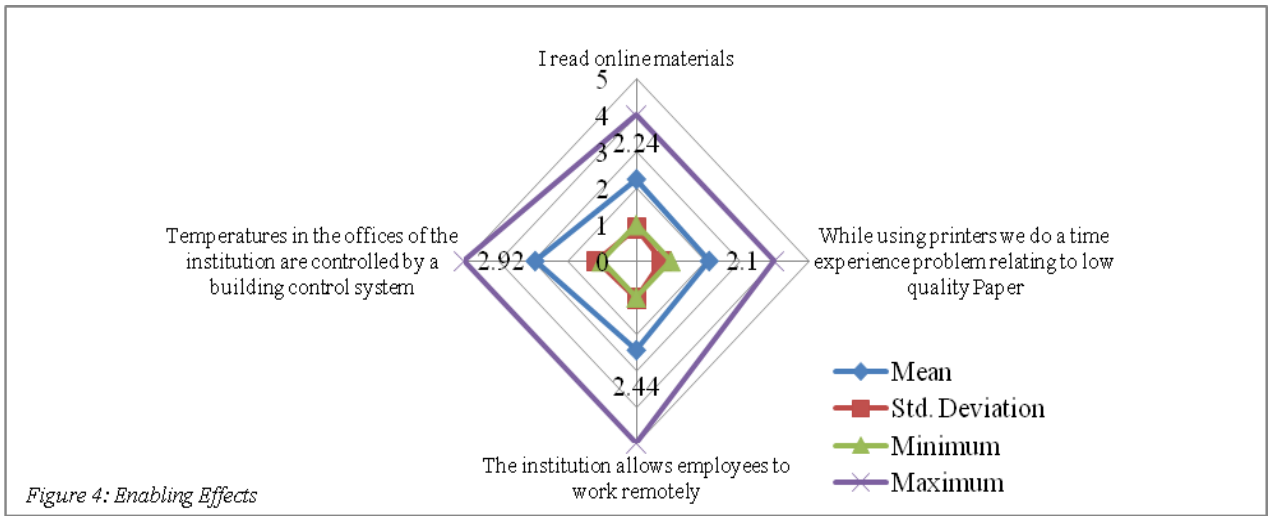

Figure 4: Enabling Effects

3.1.6 Systematic Effects

From the analysis of systematic effects findings showed that the respondents were uncertain of institution using information to report on institutional activities and progress , agreed on upgrading of software's include hardware obsolesce and disagreed on institutions providing laptops for heads of department and recruiting employees using online system as shown in figure.

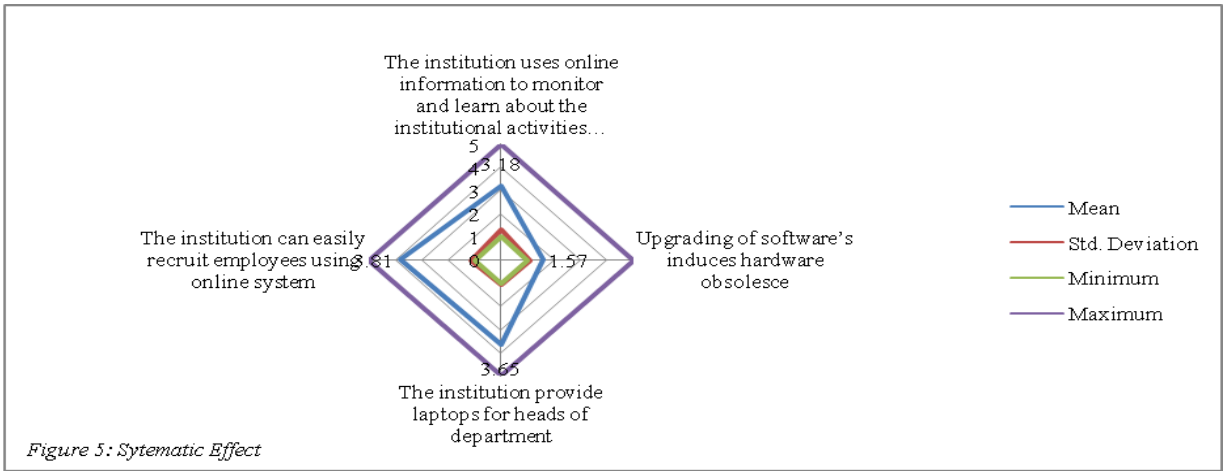

Figure 5: Sytematic Effect

3.1.7 Sustainable Environment

The researcher sought to analyze how direct, enabling and systematic effects affect sustainable environment. From the finding indicates that the respondents agreed that telecommunicating and teleconferencing affect environment by reducing air pollution from motor vehicles and disagreed on operating ICT equipment in standby mode causes consumption of energy, High quality printers stimulate demand for high quality paper, increasing pressure on forest and paper making, though it was uncertain that green ICT managed control system affect the environment, Implementation of green ICT lead to new critical infrastructure and disposal of ICT equipment affect the environment, as shown in the figure 6 .

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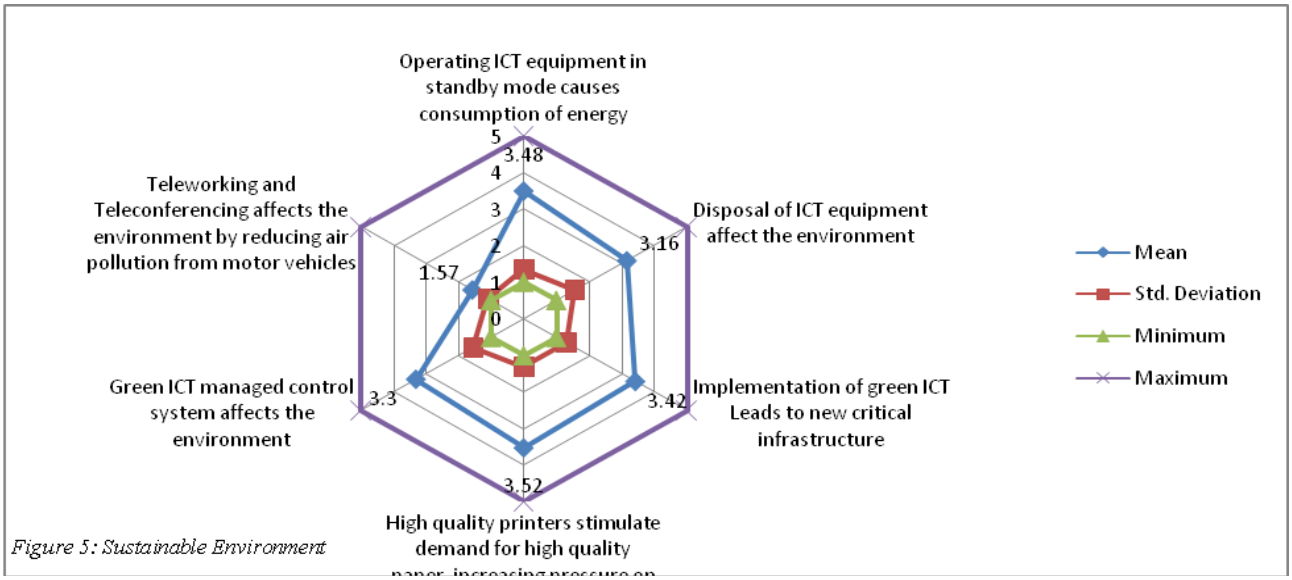


Figure 5: Sustainable Environment

3.1.8 Hypothesis

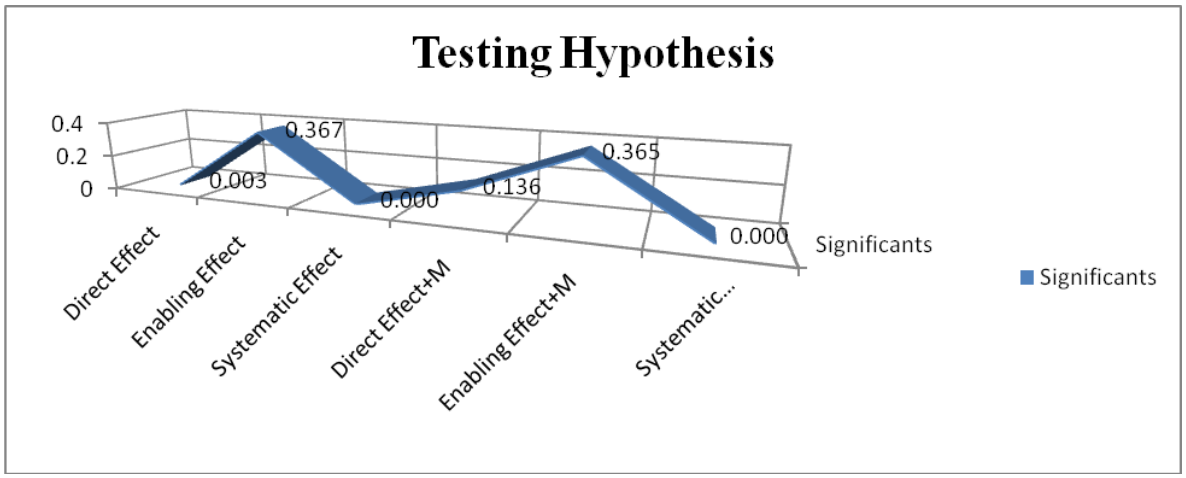
H1: Direct effect of green ICTs has a significant role on sustainable environment in institutions of higher learning in Kenya.

H2: Enabling effect of green ICTs has a significant role on affects on sustainable environment in institutions of higher learning in Kenya.

H3: Systematic effect of green ICTs has a significant role on affects on sustainable environment in institutions of higher learning in Kenya.

H4: Green ICTs management has a significant role on the relationship between green ICT effect and sustainable environment in institutions of higher learning in Kenya.

Based on the stated hypothesis the finding indicated direct effect (P=0.003<0.05) and systematic effect (P=0.000<0.05) were significant and enabling effect (P=0.367>0.05) was insignificant while introducing the green ICT management (P=0.000<0.05) this proves that its existence and implementation is of great significant in systematic effects hypothesis that was greater than 0.05 was rejected as shown in figure 7 below.



3.2 Discussion

3.2.1 Direct Effect

Findings in figure 3 indicates users switch off their computers when not in use but according to the findings from interview carried out indicated that there is improper power management; this involves utilizing the power more than it is required. It can be due to human negligence of utilizing the power more than their requirements e.g. not switching off lights, computers and laptops when they are not using them and it can be due to the inefficient design of the electronic devices .e.g. consuming a lot of power to operate or not able to recognize when the system is in idle state. Vickery (2012) confirmed using (Hilty,2008) framework that power consumption affects the environment this is in agreement with research done by (Singh, 2014) whereby improper management of power leads to huge power bills and a great increase in the amount of greenhouse gasses in the atmosphere due to carbon emissions thus contributing to global warming. The researcher used(jouma&Kandry,2012) measures for average power consumption per ICT equipment and multiplied with

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Kenyans emission factors (kgCO2/kWh) 0.332297783 (ecometrica, 2011) in order to arrive at average carbon emission from ICT Components and the finding showed that total carbon emission for that institution was 50760.14784 kgCO2/kWh.Further the findings indicated that they install energy saving ICT equipment this is part of strategy of utilizing power this lead to a thirty percent 30% reduction in the power consumption of equipment whilst doubling the computing resource available.

From the interview we carried out techno trash from obsolete electronic or electrical device are disposed based on procurement bidding process where some donate them and sell the rest to recycling institutions and others reuse and recycle. (Masele et al., 2013) claimed that disposal of ICT equipment through tendering procedures might be out of good will; especially for ICT, it consequently has serious negative environmental effects a set of computer contributes to 108kg of waste (EITO,2002). This is because, in those auctions, anyone (from internal or external) can buy the used ICT product for his/her own intended use. As a result, some users end up taking just small parts of the bought product and the rest is thrown away in very unfriendly manners. Yet with this procedure, it is difficult to monitor the end of life use (disposing off) of the purchased item. The framework denotes that disposal of equipment affects the environment which is in agreement with the research carried out by (Vickery, 2012), and according to quantitative findings of the research end-user were uncertain on whether disposal of equipment affect the environment while the findings. This is an indicator that there is awareness gap on disposal of ICT equipment.

3.2.2 Enabling Effect

Vickery (2012) confirmed that green ICT helps the institutions in reducing environment deterioration by providing a number of valuable benefits such as optimization where intelligent lighting systems can be used in buildings and urban environments to save energy. Dematerialization and substitution where employees were able to use online materials thus replacing physical material to lower effect on the environment also experts far away from each other can work together and it reduces the environmental effect caused by travelling this agrees with the findings in figure 4 where respondents read online materials and are allowed to work remotely. Carbon emission from one institution of higher learning as shown in table 3 below.CO2 emission=Activity data(kg/litres per km/etc)*emission factor(CO2 Per unit)

Table 3: CO_2e (CO_2 equivalent) Emission Calculation on Campus

		Activity Data Jan-August 2016	Carbon Emission Factor	Carbon Emission CO_2E KG
1	Total Electricity consumption	5,851,666 kWts 0.332297783 (kgCO2/kWh)	0.332297783	1944495.6
2	Total fuel consumption for institutional cars	93567.16 litres Diesel: 1litre = 2.68kg CO2	2.68kg CO2	250759.99
3	Total fuel consumption for staff owned cars	28 litresx400 No Diesel: 1litre = 2.68kg CO2	2.68kg CO2	30016
4	Fuel Consumed by Motorbike in campus	28 litres x(40 No) Petrol: 1 litre = 2.31kg CO2	2.31kg CO2	2587.2
	Total			2,227,858.79

From the findings in the table above carbon emission of 2,227,858.79 CO_2E KG from one institution is a lot hence enabling effect of green ICT should be fully utilized so as to reduce carbon emission. Average carbon dioxide emission resulting from power consumption of ICT Component from the same institution in a period of 1280 hours*(**50760.14784** kgCO2/kWh) is **2,707,207.88** kgCO2/kWh. Comparing carbon emission for the two carbon emission from ICT components is much higher by 479, 349.1 kgCO2/kWh, this was due to assumption made was that computers are used for eight (8) hours per day for 160 days. Consumption of electricity would vary when students are on session and off session

3.2.3 Systematic Effect

Further the finding in figure 5 it disagreed with the use of green ICT to monitor and learn about the institutional activities and progress and the institution do not provide laptops for heads of department the finding showed that majority of heads of department uses their personal laptops tablets for their convenience hence reducing hardware in the institutions. Hilty (2008) states that upgrading of software's induces hardware obsolesce which is in agreement with the findings.

3.2.4 Rejected hypothesis

Hankel (2014) argues that the effects mentioned in the (Hilty, 2008) framework may not include all effects ICT might have, but it captures the mostly mentioned and important ones. Hankel(2014) further argues that (Hilty,2008) framework has conceptual overlap between effects though it gives a starting point for further analysis. The researcher carried out an interview further to explore on the rejected hypothesis (Enabling effect) according to (Hilty,2008) framework and used (Hankel,2014) framework, which mostly focused on second order effects so as to compare the results of qualitative data with quantitative data, critical issues from the interview included:-

Incomplete substitution of ICT solutions :- i.e. people can work remotely but still lack adequate resources to work remotely e.g They travel for meeting because there are no teleconferencing equipment or due to lack of enforcement of policies in regards to use of ICT application, Also the need of tangible evidence(hard copy) according to ISO procedures in institution of higher learning required this leads to printing, Researcher lacked motivation to upload journals and papers in the local websites, Some institution is unable to subscribe to online journals and books since they find it expensive hence they purchase print and produce copies, Some secured sites most prompt printing than saving online copy and low bandwidths that can allow download which exits certain limits. Hankel (2014) framework states that substitution effects are more targeted towards changing goods G used in an action. Non-ICT goods are replaced by ICT goods that may or may not deliver the same output O. Whether an actor accepts this alternative action A* depends on the balance between change in quality and functionality and the achieved reduction in time, cost and environmental impact: as shown in the formula below:-

wT(AT - A*T) + wC(AC - A*C) + wI(AI - A*I) > wO(AO - A*O)

Induction and re-materialization: In regards to printing they stated that quality printing papers are imported and hence recycled papers leads to low quality papers which lead to frequent paper jams.By intensifying competition, integrating market and driving down prices technology has provided new opportunities to consume both tangible and intangible goods and services. Internet increases the reach of consumers in terms of choice and geographically i.e. document access through web, allowing for a print paper copy in just a few mouse clicks. In E-learning one can study at comfort zone where a student's finds that he/she cant access research journals that relates to their area of study they will still have to travel to various institutional libraries to accessed subscribed journals .This might have social beneficial effect, transport implication are problematic. Induction and rematerialization effects in (Hankels, 2014) framework equal an increase in other actions (B-Z) caused by a functional change in action A*. In other words, the difference between A*O - AO had some impact that lowered the thresholds θB .. θZ to a point that these other actions are carried out more often compared to using action A.

c) Lack of realizing benefits of Optimization: - From research finding there is uncertainty on use of intelligent lighting systems in institutional buildings. This is as a result of clear policy framework on power management where institutions are only concerned when power expenses exceed the expected budget not bothering on global warming effects. Hankel (2014) framework states that in optimization effects, optimizing an action more or less means doing something more efficient and in the context of this framework it means keeping the output the same while reducing time, cost or environmental impact. Goods are not changed but for example the usage is made more efficient or their longevity is extended. In formula 1 this means that A*O -AO equals to zero, but (a combination of) the other factors, for example AT - A* T, should be greater than zero to make an actor choose A*. Note that if time or costs are reduced in A* but the increase of impact because on average the extra time and capital will be reinvested in some non-zero impact activity. So for an optimization effect to be environmental friendly (and to avoid some rebound effects), the following should hold, where Iavg is the average impact per unit of time or capital in general:

AI - A*I > Iavg(A*T - AT) + Iavg(A*C - AC)

It is north worthy that in regards to the rejected hypothesis the research agrees with the study done by (Ernest &Young, 2012) in that enabling effect of green ICT Solution are vastly different and a single evaluation methodology cannot be applicable, Thus the researcher recommends that enabling effects assessed using (Hitly,2008) framework can be further explored using (Hankels,2014) framework for analyzing enabling effects

3.2.5 Policy Implementation Barriers Analysis

From the findings it showed five barriers to policy implementation which agrees with the research done by (Spratt, 2009).

Conflicting/intersecting policies/Other Act:-National policies include broad and general language and are not always supported by operational or local policies and guidelines. Public procurement and Asset Disposal act (2015) Section 5: The act shall prevail in case of any inconsistency between this act and any other legislation or government notices or circulars, in matter relating to procurement and asset disposal expect in cases where procurement of professional services is governed by an Act of parliament applicable for such services. In terms of disposal of hazardous material NEMA Act precedes PPOA act.

Low motivation and commitment: - Motivation and commitment can facilitate the policy implementation process .Personnel in institutional of higher learning in Kenya lacked motivation as a result of different priorities, a lack of incentives, and limited resources this is in tandem with survey done by (Suryawanshi& Narkhede, 2015) revealed that lack of motivation and rational for adopting green polices among the implementers in higher education institutions in India is a challenge.

Implementation at multiple levels:-Policy roll out often meets some level of public resistance or low engagement that challenges effective implementation. Finding showed that cascading policies from government level to institutions level lead to some resistance.

Discrimination:-These issues contribute significantly to the success/failure of policy implementation .Findings denote that majority of the gender formulating policy were men and female where less represented.

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Policy formulation versus implementation:-Most of the institutions of higher learning have policies formulated as a government requirement and have not been implemented as a result of lack of resources to implement. Some policies have not been implemented effectively due to lack of clear link between the actual use and integration of greening with ICT in key policy.

IV. CONCLUSION

The theoretical framework for this research is based on the ICT impact analysis framework developed by Hilty (2008).Analysis shows that direct and systematic effect of green ICT are significantly affect sustainable environment and enabling effect was insignificant. Enabling effect was subjected it to the second theoretical framework by (Hankel, 2014) where qualitative data was used. Finding showed that enabling effect affects sustainable environment. The green ICT effect negatively affect sustainable environment, this is as a result of obstacles such as low awareness, lack of motivation and commitment, discrimination, implementation at multiple level; Policy formulation and implementation. IHL is not in forefront of integrating greening with ICT in policy areas, a positive general ICT Policy has resulted in a particular use of greening with ICT solutions. Meanwhile the procurement and environmental department have integrated greening with ICT in accordance with guidelines and policies of the national standard body (KEBS), national environment regulator (NEMA) and public procurement oversight authority (PPOA) policies. The IHL have green ICT topics integrated in several course curricula's but currently there are no specific courses for green ICT. Kenya green university network(KGUN) are investing in greener campuses, where they encourage use of solar panels as alternative source of power also the use of green building, though they are still far behind higher education sector in developed nations like USA and UK they are ambitious that in the coming future they will achieve the main goals in KGUN.

To minimize negative and to maximize positive green ICT effect on sustainable environment there is importance to review frameworks of existing strategies, polices, standards and best practices. Since this was an indicator that green ICT management action have great significance on relationship between green ICT effect and sustainable environment.

Limitations of the study included, fear of top management hence other institution opted fully not to respond. Secondary data, which included policy drafts, may have been incomplete and long overdue. Many institutions of higher learning in Kenya have not clearly defined green ICT where the researcher had to visit two regulatory bodies NEMA and KEBS for further clarifications.

Institutions of higher learning in Kenya have implemented green ICTs to some degree, some have adopted a planned policy, and others are implementing it partially as their ICT systems advances. A more detailed study can be conducted to establish green ICT maturity levels, benchmarking of green ICT and auditing of green ICT management in institutions of higher learning in Kenya. Finally a comparative research can be done on effects of green ICT in institutions of higher learning in Kenya. This will give a comprehensive recommendation and conclusion on green ICT management actions framework that need to be adopted to ensure all institutions of higher learning maximizes the benefit green ICT.

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