

Kapatamoyo, Musonda; Mbumwae, Victor

## Conference Paper

# ICT in Zambia – Green Informatics on Strategies and Technological Innovations

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## **Title: ICT in Zambia – Green Informatics on Strategies and Technological Innovations**

Keywords: SURF Green ICT Maturity Model, E-waste, Green ICT, Green informatics, Sustainability, Zambia

### **Introduction**

The concept of Green Strategies in the management of the environment has taken center stage world over. Zambia has not been left behind as it has ratified and adopted the concept of 'green economy' or 'green growth' through the declared priority theme for the United Nations Conference on Sustainable Development in 2012 (Rio+20) (Banda & Bass, 2014:3). The definition of green growth adopted by Zambia is "development that makes sustainable and equitable use of Zambia's natural resources within ecological limits through reinforcing the three cornerstones of sustainable development" (UNCSD, 2012: 46). The cornerstones or pillars of sustainable development are the economy, social welfare and environment. In its simplest expression, a green economy is low-carbon, resource efficient and socially inclusive. It is based on a model which underscores both economic growth and social and natural resources development as opposed to the 'brown' economic model which emphasizes economic growth over social and natural (Chileshe & Moonga, 2019). The concept of Green Economy applies much to the ICT sector as ICTs are a major contributor to environmental waste and pollution. The report of the International Telecommunications Union (ITU), the Global E-Waste Monitor 2020 reported that a record 53.6 million metric tons (Mt) of e-waste – discarded products with a battery or plug such as computers and mobile phones - is reported generated worldwide in 2019, up 9.2 Mt in five years. Toxic and hazardous substances such as mercury, brominated flame-retardants (BFR) or chlorofluorocarbons (CFCs) are found in many types of electronic equipment and pose severe risk to human health and the environment if not handled in an environmentally sound manner.

It is therefore imperative that Green ICTs are adopted by institutions in Zambia especially that the demand and use of technology platforms and devices is on the rise. The report on ICT Survey report on ICT Usage by the Zambia Information & Communications Technology Authority (ZICTA,2018) clearly shows an upward trajectory in terms of ICT usage even by users under 10 years. The use of ICTs in the interest of the natural environment and the natural resources regarding sustainability and sustainable development is what is referred to as Green Informatics or IT. Green Informatics is a concern for national and international stakeholders as the world strives to utilize digital transformation as one of the strategies for sustainability. To demonstrate Zambia's commitment and resolve towards Green Strategy adoption across all economic sectors, the new Government elected on August 12<sup>th</sup>, 2021 under the leadership of President Hakainde Hichilema has created a dedicated and first of its kind portfolio called the Ministry of Green Economy and Environment. The ministry is expected to take a lead in climate change mitigation, sustainable energy, food miles, and carbon footprints. In addition, it has the following objectives: to formulate legislation and regulations on carbon and environmental pricing such as carbon tax, carbon price, carbon fee and dividend, carbon finance, emissions trading, climate finance, and ecotax. (Mast, 2021). The ministry was created right on the heels of 26<sup>th</sup> Conference of the Parties (COP26) in Glasgow, Scotland, at which the role of Information and Communication Technology (ICT) in the protection of the environment and combating climate change received significant attention.

To fulfil the above functions, the ministry must implement *Green Informatics* that Andreopoulou (2012) describes as the **utilization of informatics** for understanding the {natural} environment and resources regarding sustainable stewardship. Green Informatics are tools or

services and technologies, that combined with green practices and consumer behavior, contribute to the protection and restoration of the environment. While these are complex issues, the paper focused on ICT (Information Communication Technologies) adoption, sustainable use, and management in institutions.

### **Statement of purpose**

The purpose of this paper is to identify the prominent factors pertaining to implementation of green ICTs in Zambia. Through the following research questions, it identifies strategies and innovations to engender green ICTs.

Q1: What are the general and specific strategies in green ICTs?

Q2: How are green ICT innovations applied?

To answer these questions, we derived the main factors from an extensive literature review and further analysis using the SURF Green ICT Maturity Model (SGIMM). The SGIMM method is applied to prioritize the identified attributes based on their importance and can be used by organizations to identify new strategies or action plans.

The organization of the paper is as follows. We included an extensive literature review and definition of terms that also reveals a dearth of data about Green ICTs in Zambia. That is followed by research method using SGIMM. The data and attributes description section analyze the main attributes and subdomains. The results and discussion summarize key findings.

### **Review of literature**

A review of related works reveals different models that have been applied in evaluation of Green ICTs (Information Communication Technologies) and informatics.

SURF, which is a Dutch higher education and research partnership for ICT developed the SURF Green ICT Maturity Model (SGIMM), adapted from the Capability Maturity Model. Hankel, Oud, Saan, and Lago (2014) posited that SGIMM consists of four domains covering both negative and positive impacts and aspects of ICT. (p.2) By stakeholders scoring different attributes, SGIMM is self-assessment tool that enables organizations to agree on the status quo and to define actions for improvement. (p.2) SGIMM's foundation is the Capability Maturity Model (CMM), first introduced as the Capability Maturity Model for Software (CMM). CMM is a framework that describes the key elements of an effective software process. The CMM describes an evolutionary improvement path from an ad hoc, immature process to a mature, disciplined process; and practices for planning, engineering, and managing, software development and maintenance. (Paulk, et. Al, 1993)

The field of Green ICT is associated with minimizing the negative environmental impacts of ICT and optimizing the positive impacts of ICT. Even though the global environmental impact of ICT itself is significant (2%), making something else more efficient has a much larger effect (potential reduction of 16% of the global footprint) (Andreopoulou, 2012). While both aspects are widely recognized and can be understood on an abstract or global level, it is often difficult for individuals or organizations to apply them. The SURF Green ICT Maturity Model (SGIMM) was created to address this issue. The SGIMM is designed to give organizations insights into the maturity of Green ICT of the organization. It is set up as a self-assessment tool that quickly enables organizations to have an internal dialogue, to gain agreement on the status quo and to define actions for improvement (Hankel, 2014). By letting several individuals within an organization score the attributes and discussing these scores with the participants an

organization can identify weak and strong Green ICT aspects. At its core, SGIMM borrowed from the Capability Maturity Model a framework with five maturity levels for quality and process improvements. The five levels are (1) initial, (2) repeatable, (3) defined, (4) managed and (5) optimizing. At the lowest level, the initial level, the organization does not provide a stable environment for the activity. At this level, the process is ad hoc. However, at the highest level, which is the optimizing level, the entire organization is focused on continuous process improvement (Center for Sustainable Systems, 2011).

Further inspiration was drawn from the work done by Donnellan and Curry (2011). The SGIMM conceptually consists of four domains covering negative and positive impacts and aspects of ICT. Each domain consists of attributes that have a definition, factors involved and descriptions of each of the five maturity levels mentioned above. Three domains and attributes are applicable to any organization, being: “Green ICT in the Organization,” “Greening of ICT” and “Greening of Operations with ICT” while the fourth domain is sector-specific and covers “Greening of primary processes with ICT.”

Green informatics is a recent topic of academic inquiry. Some prominent green informatics scholars include Andreopoulou. Andreopoulou (2012) elaborated Green Informatics as “ICT tools, services, and technologies in combination with green practices and green behavior either for the ICT industrial sector or the ICT user/citizen that contribute not only to the protection and restoration of the environment but also to the enhancement of the quality of human life. So, the notion of “Green Informatics” has become synonymous with eco-friendly techs and software tools such as Virtualization, Recycling and Telecommuting.” The focus of these tools was on how they contribute to environmental sustainability in numerous ways. Radu

(2016) agreed with this view of green informatics as tools. However, the author expanded the reviewed tools to include green software and green hardware (p. 3). This was a further extension of Calero and Piattini (2015) concept that made a distinction between “green in IT (Information Technology)” and “green by IT.” (Radu, 2016, p. 3). Airehrour et. Al. agreed with Andreopoulou (2012) but expanded the definition to include the role green ICT play in “energy consumption reduction, the rise of environmental awareness, environmental issue communication and environmental monitoring systems to protect natural ecosystems.” (p. 260)

In 2012, Paul and Kumar described a concept that closely resembles green informatics. They called it Green Information Science (GISc), described as an “interdisciplinary domain incorporated in Green Computing and Technological fundamentals and Information Science principles.” (p. 292). As an interdisciplinary area, GISc relies on “electronics, computer and information studies for healthy information architecture designing.” (p. 293)

### **Definition of terms**

*Green IT practices* refer to those practices that deal with issues of material and energy resource consumption, environmental pollution, disposal and recycling, and related processes (Ainin et al, p. 1931)

However, *greening the ICT* refers to practices and behaviors that have a significant contribution in reducing carbon dioxide emissions and minimizing the adverse effects of these ICTs to the environment. (Sathivelu et. al., 2020) Green IT products and practices are focused on achieving pollution prevention, product stewardship, and sustainable development (Chen et al., 2009).

*Green ICT in the organization* refers to the business logic for using green IT for operational or technical advantages. Bottom-up pollution-prevention programs have saved companies. (Hart, 1997)

*Greening of operations* entails organizations utilizing their purchasing and supply activities to promote sustainable development or enhancing their environmental responsibility. (Holt, 2003; Walker, et. Al., 2009)

### **Research method & Findings**

In this section the methods used to collect data for the study and further analysis to develop the research model are explained. The research employed an online survey method via Qualtrics to collect the appropriate data. A survey was sent out to key stakeholders in units with which the Ministry of Green Economy and Environment interacts. Borrowing from the SURF Green ICT Maturity Model (SGIMM) the data was aggregated into three main attributes as follows: a) Green ICT in the organization; b) Greening of ICT; and c) Greening of operations with ICT. The attributes were further disaggregated into subdomains.

- a. *Green ICT in the organization* focused on Green ICT Strategies; Governance of ICT services; Green ICT Procurement; E-waste Policy; Green ICT in Information Management and Architecture; Community collaboration and Green ICT supply chain management.
- b. *Greening of ICT* focused on housing of infrastructure; computing infrastructure; network infrastructure; storage infrastructure; end user ICT equipment (PCs (personal computers), printers, etc.); and software and ICT services.



- c. *Greening of operations* with ICT focused on travel reductions with ICT; area reductions with ICT; energy reductions with ICT; paper reductions with ICT; and feedback and decision support.

Although the SGIMM is not a statistically based methodology which depends on the sample size. Decisions can be made by this method from few responses as it relies on experts for data gathering. In this research **23** experts participated. They were selected for seniority and proximity to decision making on ICT adoption and management.

The respondents ranked the attributes and sub domains based on their importance using **the 5-level scale**. Level 1 signified a lack of evidence of the attributes or subdomains, while level 5 meant that the organization or unit had fully operationalized that attribute or subdomain. Each attribute and subdomain were defined in detail and left no doubt in the respondents as to the intent or context. The respondents ranked from the attributes and subdomain from level 1 to level 5. The tables present aggregate data.

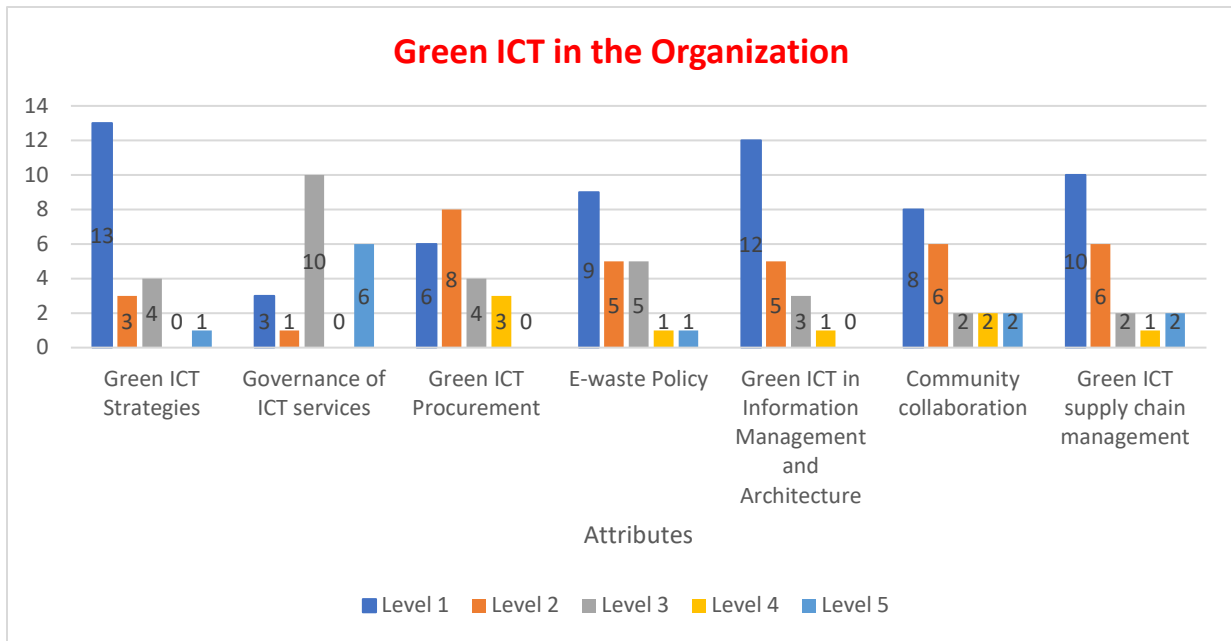
The research also employed *relational analysis* which begins with the act of identifying concepts present in each text or set of texts. Relational analysis is a technique used to explore the relationships of identified concepts in a text. It is a qualitative research technique that involves non-statistical methods of analyzing information. This type of research takes non-statistical methods to explore the relationships of concepts found in groups of text. In this regard, the method followed the following steps: a) Identify the question; b) Determine the information to use in the research; c) Look for the patterns within the words; d) Determine any relationships between concepts found in the words; and e) Perform in-depth analyses. (VanBaren, 2021)

## Data and attributes description

Profile of respondents: 23 detailed questionnaires were received from managers of varying sizes of operations as follows: 13 from organizations with less than 100 employees; 9 from organizations with 100 - 500 employees; and 1 from an organization with over 500 employees. 15 came from a government department; 1 from a non-profit organization; and 5 from the private sector. In the analysis, two questionnaires proved unusable.

Results from the first segment are tabulated in Table 1 below.

Table 1



The first segment of the questionnaire was *Green ICT in the organization* that focused on Green ICT Strategies; Governance of ICT services; Green ICT Procurement; E-waste Policy; Green ICT in Information Management and Architecture; Community collaboration and Green ICT supply chain management. Table 1 above shows the scoring of attributes. The data shows that the majority of institutions were at level 1 for the following attributes: Green ICT Strategies; E-waste

Policy; Green ICT in Information Management and Architecture; Community collaboration and Green ICT supply chain management. The data further shows that they did better in Governance of ICT services and Green ICT Procurement attributes.

To investigate the Green ICT Strategies, respondents were asked if their ICT departments operated according to a Green ICT strategy. The research reviewed evidence of the following factors from SGIMM: the strategy itself, use of a strategy, accessibility to one and progress on formulation of a strategy. Sixty-one (61) percent of the respondents confirmed that they did not have a Green ICT strategy, nor used one, nor had access to one, lastly, they were not working on formulating a Green ICT focused strategy.

For the E-waste Policy, the research asked respondents whether an E-waste policy was in use to reuse or recycle ICT equipment. The research reviewed evidence of the following factors from SGIMM: availability of a policy, its implementation and scope. The majority (42%) confirmed that they did not have an e-waste policy and did not account for the scope of e-waste in their organizations. Twenty-three (23%) percent confirmed that some basis principles of reuse and recycling are deployed in their institutions. Another 23% added that their institutions have a policy that gives clear directions of disposal of ICT equipment at the end of its life.

For the Green ICT in Information Management and Architecture, the research asked respondents how sustainability is considered in information management and architecture. The research reviewed evidence of the following factors from SGIMM: monitoring sustainability in ICT, directives on sustainability and green in ICT in enterprise architecture. The majority (57%) confirmed that they did not routinely monitor sustainability in ICT and lacked any official directives on sustainability of the enterprise systems. Twenty-three (23%) percent added that

their institutions have basic architecture principles in place and some monitoring of sustainability of ICT is conducted.

For Community collaboration, the research asked respondents how the ICT department collaborates on sustainability issues with outside organizations. The research reviewed evidence of the following factors from SGIMM: knowledge sharing; resource sharing and sharing project. The majority (40%) indicates that collaborating with other departments was not routinely done. A sizable number (30%) did indicate that their organizations do look outside to learn about suitability and green UCT best practices. The rest of the respondents (30%) showed evidence of sharing knowledge on ICTs with outside partners, collaborating on resource sharing, and working on reducing environmental impacts collectively with others.

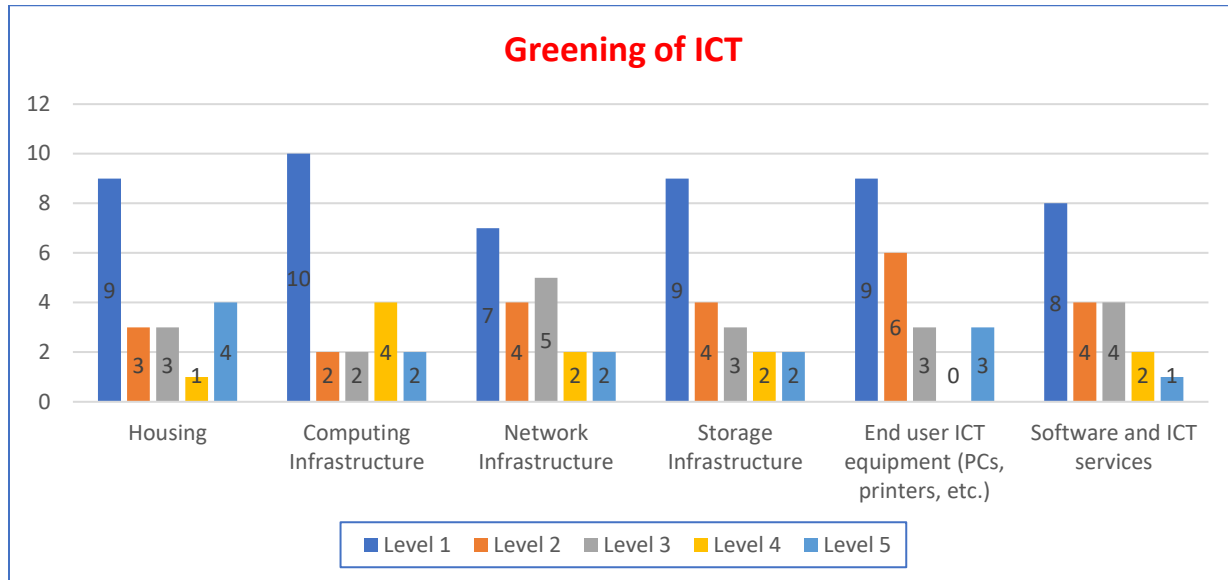
For Green ICT supply chain management, respondents were asked to about the environmental impact of the supply chain in collaboration with suppliers and users. The research reviewed evidence of the following factors from SGIMM: awareness and optimization. These factors asked respondents to state whether their units were aware of the entire chain of energy and resource use required of all ICT devices in their custody and purview. Most respondents (48%) indicated that they did not consider the impact of the entire supply chain that includes suppliers and users, on their decisions or actions. However, a sizable number (29%) indicated that they are aware of the impact their actions have on the supply chain and perform ad hoc optimization. The rest (22%) were aware of the environmental impacts of their own activities and worked to reduce the detrimental impacts. They actively engaged suppliers and users to achieve optimization, and had monitoring mechanisms for energy and resource utilization.

Governance of ICT services was measured by the level of control on ICT services of the ICT department. The research reviewed evidence of the following factors from SGIMM: involvement, scope, overview, and catalogue. The majority of respondents (50%) indicated that they control ICT services and equipment; are involved in decision making for new ICT services and support standardization of the use of those services. They also indicated that they routinely perform asset management, including monitoring the environmental impact. A further 30% were closely involved in decisions to procurements and design of new ICT services. They also supported standardization across the institutions to optimize efficiencies and limit adverse environmental impacts.

To measure Green ICT Procurement, respondents were asked whether environmental impact was a consideration during purchases of ICT equipment and services. The research reviewed evidence of the following factors from SGIMM: monitoring energy consumption during use, energy consumption during production, end of life planning, long term investment and device refresh timelines. Twenty-eight (28%) percent stated that they had no criteria for energy and resource consumption when ordering new ICT services and equipment. A sizable number (38%) of respondents indicated the energy and resource consumption are important criteria when procuring new ICT equipment and services. To the other 33%, energy and resource consumption was a necessary criterion for procurement of new ICT services and equipment. In addition, they factored these attributes in the life cycle of the equipment.

Results from the second segment are tabulated in Table 2 below.

Table 2



The second segment of the questionnaire was *Greening of ICT* focused on housing; computing infrastructure; network infrastructure; storage infrastructure; end user ICT equipment (PCs, printers, etc.); and software and ICT services. Table 2 above shows the scoring of attributes. The data indicates that these institutions were mostly at level 1 for all attributes. However, a further dive into the data shows that organizations are actively greening their ICT operations.

For housing, respondents were asked about the resource and energy efficiency of the housing for infrastructural equipment. The research reviewed evidence of the following factors from SGIMM: design, energy sources, operation, monitoring, and awareness. Even though forty-five (45%) percent indicated that in general, there were no policies in place that optimized for resource or energy efficiency; the rest of the respondents indicated that they did. Specifically, 15% stated that initiatives to decrease energy consumption of the housing facilities are

integrated in the regular organization. Another 15% stated that resource and energy efficiency is part of the regular plans with key performance indicators. To the rest, 25%, housing facilities for ICT equipment is crucial to their operations. They have facilities with climate control that are tailored according to the actual load and adapt dynamically if changes occur. The facilities are optimized for energy use, while reuse of excess energy and heat is considered as well.

Computing infrastructure was measured by the level of resource and energy efficiency in computing infrastructure. The research reviewed evidence of the following factors from SGIMM: hardware capacity, turn capacity (on/off), usage capacity, asset management, monitoring, and awareness. Most (50%) respondents indicated that they are not aware of policies aimed at optimization for resource and energy efficiency. The other half ranged from planning for resource and energy use, to implementing feedback loops that gave data on optimization. Computing power was factor in their operations.

To measure Network Infrastructure, respondents were asked about the resource and energy efficiency of the network infrastructure. The research reviewed evidence of the following factors from SGIMM: equipment configuration, routing, network architecture, asset management, monitoring, and awareness. Thirty-five (35%) percent indicated that they were not aware of any policies to optimize resources and energy efficiency. Twenty (20%) percent indicated that as individuals, they apply measures to decrease energy consumption, even though that was not supported by organizational plans. In this regard, networks are configured without must consideration to energy consumption if the equipment meets capacity needs. The rest included resource and energy efficiency on the network infrastructure in the calculations of key

performance indicators (KPIs). They aimed to optimize hardware design, energy saving functions and traffic routing.

To investigate the Storage Infrastructure, respondents were asked about the resource and energy efficiency of the storage infrastructure. The research reviewed evidence of the following factors from SGIMM: hardware capacity, data life cycle management, data storage optimization, asset management, monitoring, and awareness. An overwhelming number (45%) of respondents confirmed that policies to optimize resources and energy efficiency did not exist in their units. Twenty (20%) percent confirmed monitoring of energy consumption, with cost savings as a factor. The other 25% ensured that storage capacity was adequate and not under stress, and had systematic monitoring mechanisms of data types, usage and adaption.

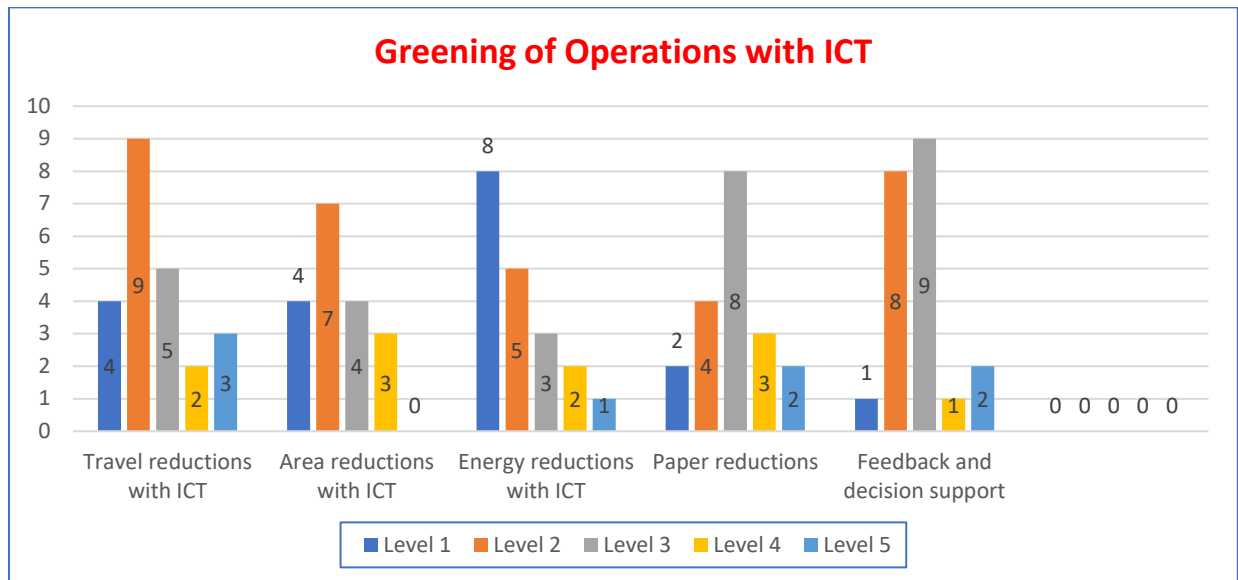
For End user ICT equipment, the research asked respondents were asked about the resource and energy efficiency of the End user ICT equipment. The research reviewed evidence of the following factors from SGIMM: the types of equipment provided, power management, management of secondary resources such as toner, monitoring, and awareness. Forty-two (42%) percent claimed that no polices were in place that optimize for resource and energy efficiency. However, a common refrain from most respondents was that despite the lack of policies to optimize resources and energy efficiencies, most people practice money saving approaches such as turning off PCs at night and removing printers from personal desks and centralizing them. At the same time, some high-level monitoring is done for reporting. Fourteen (14%) percent indicated that they adhered to the latest standards and labels. They considered all possible ways for energy savings.



Software and ICT services were measured by the plans for resource and energy efficiency of software applications and their development process. The research reviewed evidence of the following factors from SGIMM: development, configuration, asset management, monitoring, and awareness. Most respondents (42%) indicated that they are not aware of policies aimed at optimization for resource and energy efficiency as a result most software is developed or bought without considering their energy consumption or the impact on hardware. Across the rest of the sector, respondents reported that they integrate energy savings in their software and ICT services, pay attention to the use of equipment and services, and lastly, their units sought out the latest functionalities to optimize energy efficiencies.

Results from the third segment are tabulated in Table 3 below.

Table 3



The third segment of the questionnaire was *Greening of operations* with ICT focused on travel reductions with ICT; area reductions with ICT; energy reductions with ICT; paper reductions

with ICT; and feedback and decision support. Table 3 above shows the scoring of attributes. The data indicates that these institutions had better outcomes for some attributes.

For Travel reductions with ICT, the research asked respondents were asked whether ICT is used to enable travel reduction of everyone within the organization. The research reviewed evidence of the following factors from SGIMM: collaboration tools, planning, teleworking, and travel decisions. In 9% of the cases, respondents reported that they did not deliver services that facilitated reduced travel. Thirty-nine (39%) percent stated that their ICT departments rendered some limited services to reduce travel, but only due to demands within the organizations, hence had minimal support in design and implementation of these programs. However, of the remaining 43%, their programs varied from creating some opportunities for flexible working arrangements and that high-level monitoring to see the impact of these arrangements; to proactively creating services that reduce travel. The solutions included services that allow distance working and online collaboration

Area reductions with ICT services were measured using ICT to enable the reduction of area use in buildings. The research reviewed evidence of the following factors from SGIMM: individual working area, collective working areas, and total available areas. Twenty-two (22%) percent respondents indicated that their units did not deliver services that help reduce area use. In general, there was minimal support for designing and planning of area use. Thirty-eight (38%) percent of departments only did this when their organizations demanded. Another 38% closely monitored use for optimization and actively promoted services that reduced are use, including in partnership with others.

For Energy reductions with ICT, the research asked respondents were asked whether ICT is used to enable the reduction of energy consumption of the organization. The research reviewed evidence of the following factors from SGIMM: lighting, heating, power use, non-ICT equipment, monitoring, and awareness. Forty-two (42%) percent indicated that their units did not deliver services that help reduce energy consumption in the whole organization. Twenty-six (26%) stated that there was minimal support for smart use of lighting, heating, and non-ICT equipment. However, 15% indicated that schemes are in place to minimize energy consumption during out of office hours. They also used ICTs to map the total energy use in the entire organization.

Paper reductions with ICT services were measured by how much ICT is used to enable the reduction of the use of paper by digitizing business processes. The research reviewed evidence of the following factors from SGIMM: use of paper, digitization of processes, monitoring, and awareness. Ten (10%) percent of respondents did not have programs or services to reduce paper consumption. Twenty-one (21%) percent claimed their units provided minimal support for digital workflows. Most (42%) respondents indicated that their units have workflows that are digitized. In addition, they actively promote services that help reduce paper consumption by designing processes that are primarily digital. The use of these services receives high level monitoring for reporting. The rest, 26%, promoted ICT services that reduced paper use, and had leadership that proactively promoted digitalized business process.

For Feedback and decision support the research asked respondents were asked whether ICT is used to give the organization detailed feedback and decision support on energy and resource consumption. The research reviewed evidence of the following factors from SGIMM:

integration of monitoring data, and decision support. Only 5% came from units that did not support any collection and integration of monitoring data. The majority (80%) indicated that their units supported collection and integration of monitoring data on energy and resource consumption. The data helped them develop tools to present the data meaningfully for decision support.

## **Discussion**

The research was premised on two questions: “what are the general and specific strategies in green ICTs?” And “how are green ICT innovations applied?” To address these research questions, this study has highlighted dominant strategies and innovations in Zambia in terms of ICT use as its main contribution. The paper investigated the *strategies and technological innovations* that either minimize the negative environmental impacts of ICT or optimize the positive impacts of ICT in Zambia. In a developing country context, the links of ICT with the environment are complex.

The deployed maturity model was designed to identify areas of improvement or bottlenecks. The analysis shows the major findings in two attributes: *Green ICT in the organization* and *Greening of ICT* to be more negative or under appreciated. Conversely, the analysis shows that the third attribute - *Greening of operations* - is actively done, has organizational support and is monitored for decision making. Consequently, this ICT growth has adverse environmental impacts through use and disposal of ICT products in the form of e-waste and higher energy consumption. It is worth mentioning that even though organizations adopt green ICTs, they are still using existing technologies, often procured, as needed, or donated, from

a myriad of suppliers. Consequently, the assumed benefits of ICTs may be inadequate for some organizations.

Human behavior plays a significant role in determining environmental impacts. As observed, ICT is considered a solution to reinforce environmental protection, to mitigate the adverse impacts created in the environment by human activities, and to address key environmental challenges such as climate change and sustainability. For example, since the Covid-19 pandemic started, human work behavior has changed, affecting e-commerce, teleworking, telehealth, paperless office, and smart manufacturing.

This data will aid the decision-makers as it forms a baseline. The issues presented in the paper are highly relevant to any decision-maker, who naturally tend to have lofty expectations for ICTs' potential to positively impact the environment. For example, in Zambia, enormous quantities of e-waste are generated annually, most of which is imported into Zambia, second hand or refurbished electrical and electronic equipment that lacks the confirmatory testing for functionality. The research demonstrates that such unmonitored and unregulated ICTs have adverse effects on the environment.

By applying the SGIMM methodology, organizations can perform analyses of their practices and classify or prioritize their own action plans. Organizations ought to develop plans that help reduce their costs by monitoring their ICT energy usage, minimizing energy consumption, tracking environmental information about their service deliveries, providing the user with appropriate information to make them capable of taking green decision more conveniently and effectively. Further, well-articulated policies will foster teamwork leading to

such activities as improved teleworking through collaboration, group document management, and knowledge management or sharing.

## **Conclusion**

As stated earlier, Green Informatics, within the realm of Information and communication technologies (ICTs) is a recent academic inquiry. ICTs have been known to have an impact on the environment and economic activities. Monitoring of the key performance outcomes of ICTs leads to increased and sustainable consumption of ICT products and services. As organizations make huge investments in the sector with large expectations for economic and environmental improvements, they should not neglect human behavior attributes. Providing real time green informatics to users and key stakeholders will cause them to optimize efficiencies in ICTs. Zambia has embraced green and sustainable approaches to environmental management and resource utilization which also includes the consumption of ICTs. The national policy guiding framework which has seen the establishment of a dedicated Ministry of Green Economy provides the framework that will provide guidance to other sector activities to align to strategies of keeping the environment clean, green and health.

The research paper has attempted to give a general overview of existing practices in terms of Green ICTs adoption in institutions. It has been shown that most institutions are yet to map out Green ICT Strategies to guide their institutions towards development, adoption and implementing of policies for a green and sustainable environment.

As posited by Zambian researchers on the topic of Green Economy, the success of the transition from a brown to a green economy and the realization of a smart Zambia as envisioned in the country's development goals will largely depend on the active participation of all

stakeholders (Banda, October 4, 2017). The collaboration among the Ministry of Green Economy, the Zambia Information & Communications Technology Authority (ZICTA), Zambia Environment Management Agency (ZEMA), Zambia Bureau of Standards (ZABS), Smart Zambia Institute and the Information & Communications Technology Association of Zambia (ICTAZ) are pivotal towards establishment of policies, practices and sensitization strategies on Green ICTs in the country. Manufacturers and resellers of electronic equipment are expected to increase awareness of the need for safe disposal of electronic devices.

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