

Original Paper

An Assessment of Green Computing Awareness and Adoption in Higher Education Institutions in Zambia: A Case of ZCAS

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Abstract

As the use of Information and Communication Technologies (ICTs) increases in Zambia, there is a general concern about whether the use and eventual disposal of ICT hardware will have minimal impact on the environment. The grooming or modification of behavior of users for the future generation takes place in educational institutions. This paper therefore explored the level of use of ICTs in Higher Educational Institutions (HEIs) with regard to the awareness and adoption of green computing in these institutions. The results indicated that though there is a high level of use in the HEIs, the level of green computing awareness was simply moderate and the level of green computing adoption was low. Therefore, there is need for HEIs, the IT community and the legislative bodies to do more in introducing practices that will promote eco-friendly use and disposal of ICTs in Zambia.

Keywords

HEIs, ICTs, green computing awareness, green computing adoption, eco-friendly

1. Introduction

According to most research findings, Information and Communication Technologies (ICTs) have a significant role in national development (Harindranath & Sein, 2007). Furthermore, ICTs, both traditional media and the new ICTs continue to play a major role in providing access to information that is relevant in almost all the major sectors of the developing countries (Kasigwa et al., 2005). Zambia being a developing country and with its bid to fulfil the (Sustainable Development Goals) such as the reduction of poverty (Delponte et al., 2015), launched the National ICT policy with the aim to embrace ICTs that are deemed to be enablers for social and economic development. The launch of the National ICT Policy of 2005 has seen the growth of use of ICTs even in households as noted in the ZICTA ICT Country Survey Report of 2013 especially in the urban areas like Lusaka and Copperbelt provinces as

shown in Figure 1 (ZICTA, 2014).

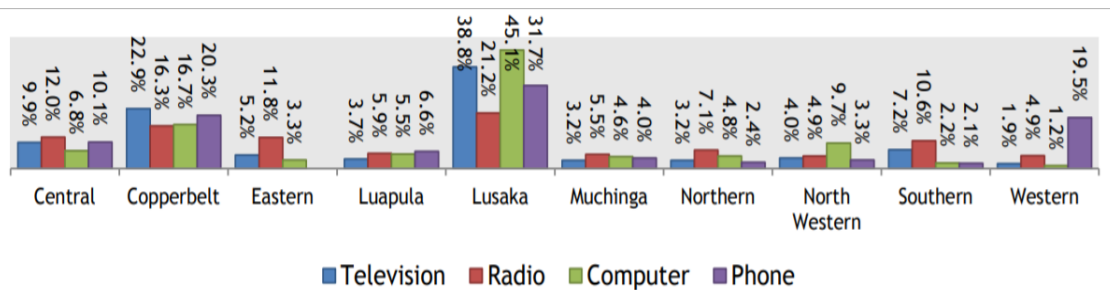


Figure 1. Distribution of Household with Access to ICT Devices by Province

This increase in the use of ICTs in the urban areas means that there is equally an increase in carbon emissions as demonstrated in the World Bank Report on CO₂ emissions in Zambia shown in Figure 2 below (Trading_Economics, 2018).



Figure 2. Zambia-CO₂ Emissions (kt) (Trading Economics, 2015)

Furthermore, this growth of ICTs in the country has led to the inclusion of ICTs in almost all Zambian policy documents (Media, 2014). In view of this, the Zambia Government through the Ministry of Education in 2015 declared that Computer Studies as a subject would be compulsory in Primary Schools (National_Assembly_of_Zambia, 2018).

The introduction of Computer Science in Primary Schools, which is the lower level of education and the concern of the increase in Carbon emissions means that the ICTs education in Higher Education Institutions (HEIs) should then include the sustainable use and disposal of ICTs, which Green Computing covers.

Green Computing is concerned with using and disposing ICTs in ways that reduce the amount of carbon and other hazardous gases that have an adverse effect on the environment (AHMED, 2018). Computing comprises both hardware and software (Freeman, 2016) and (Murugesan, 2008) defines green computing as studying and implementing more eco-friendly practices in the design, manufacture, use and disposal of all ICTs. This includes hardware devices and the associated subsystems such as networking technology and software systems running on these devices, in an effective and efficient manner with no or minimal environmental impact (AHMED, 2018).

1.1 Problem Statement

Several studies suggest that the adoption of green computing can be through the application of the theory of planned behaviour, which describes the relationship between future behavioural intentions in the use of ICTs and their impact on the environment (Asadi et al., 2015). Therefore, there is a better way to modify the future planned behaviour than using the educational system. Currently in Zambia, the government has introduced ICTs at the Primary School level. There is need therefore to develop the future use of these ICTs in ways that have very little environmental impact. This is also the view that there is evidence that the growth of ICTs in Zambia beyond the urban area is definitely expected and this in turn will lead to an increase in carbon emission in the environment.

Therefore, this study intended to assess the levels of awareness of green computing in institutions of higher learning, and based on the level of awareness recommend better ways on how it could be incorporated in the existing curriculum to modify the intended behaviour of future Zambian managers, administrators, educators, users, and policy makers.

1.2 Research Objectives

In order to assess the awareness and the adoption of Green Computing in HEIs in Zambia, the research specifically pursued the following objectives;

- 1) Investigation of the level of use of ICTs in HEIs in Zambia;
- 2) Examination of the relationship between the level of use of ICTs and the level of awareness of Green Computing in HEIs in Zambia;
- 3) Determination of the relationship between the awareness and the adoption of Green Computing in HEIs in Zambia.

1.3 Research Questions

The attainment of the research objectives required providing answers to research questions for each of the objective as follows:

1.3.1 Investigation of the Level of Use of ICTs in Institutions of Higher Learning in Zambia

- 1) What is the extent of use of ICTs in HEIs in Zambia?
- 2) What are the commonly used ICTs in HEIs in Zambia?

1.3.2 Examination of the Relationship between the Level of Use of ICTs and the Level of Awareness of Green Computing in HEIs in Zambia

- 1) What is the impact of the use and disposal of ICTs on the Environment?

2) Does the curriculum include the environmental impact of the use and disposal of ICTs?

1.3.3 Determination of the Relationship between the Awareness and the Adoption of Green Computing in HEIs in Zambia

1) What is the role of National Policy statements on the adoption of Green Computing in HEIs in Zambia?

2) What are the current Green Computing initiatives adopted in HEIs in Zambia?

3) What factors influence purchase of new ICTs in HEIs in Zambia?

4) How are ICTs disposed of in HEIs in Zambia?

1.4 Literature Review

In view of the fact that green computing is a well-researched area, the literature review in this paper focused on addressing the research objectives through three main themes. The first being the Use of ICTs in Developing Countries, which focuses on the change in land scale on the use of ICTs in Education and Developing Countries and its effects on the environment. The second theme was Green Computing Awareness, which focused on the level of awareness and factors affecting the level of awareness of Green Computing in HEIs in developing countries. Finally, the third theme was Green Computing Adoption, which focused on the factors that affect the adoption of Green Computing in HEIs in developing countries.

Table 1. Green Computing in HEIs in Developing Countries

Author	Title/Concept	Theme
(Abugabah & Abubaker, 2018)	Green computing: Awareness and practices: attempts to measure the level of green computing knowledge and awareness of university students at the College of Technological Innovation, Zayed University, Abu Dhabi, United Arab Emirates	Green Computing Awareness
(Torre et al., 2017)	On the Presence of Green and Sustainable Software Engineering in Higher Education Curricula: Explored the current state of teaching sustainability in the software engineering community,	Green Computing Adoption

	<p>motivations behind the current state of teaching and the further improvements that can be implored.</p>	
(Freeman, 2016)	<p>Saving the Planet: An Assessment of Green Computing Practice among Tertiary Institutions in Ghana: Explored the factors affecting the adoption of Green computing in higher institutions in Ghana</p>	Green Computing Awareness
(Semakula & Samsuri, 2016)	<p>Green Computing Knowledge among Students in a Ugandan University: Attempted to establish green computing awareness levels of students among Islamic University in Uganda (IUIU) and further establish the relationship between awareness and the level of computer experience</p>	Green Computing Awareness
(Teknologi & Johor, 2015)	<p>Green Computing: The Overview of Awareness, Practices and Responsibility Among Students in Higher Education Institutes: attempts to measure the awareness, practices and responsibility carried out by students towards green computing in institution of Higher education.</p>	Green Computing awareness/Green Computing Adoption
(Calero & Piattini, 2015)	<p>Introduction to Green in Software</p>	Green Computing Adoption

Engineering: recognizes the critical role of technology as well as the importance of promoting Innovation, especially in developing countries and proposes ways to create enabling frameworks in the adoption of green computing that support green economy in the context of sustainable development and poverty eradication

(Deng & Ji, 2015)

Organizational Green IT Adoption: Concept and Evidence: provides a holistic review and explanation of why organizations adopt green computing

(Asadi, et al., 2015)

Theoretical Model for Green Information Technology Adoption: suggested a green computing theoretical framework through monitoring the decision maker's intention for the adoption of Green IT and sustainability that identifies the key factors for the adoption of green information technology

(Thaqi, 2015)

E-Waste Management & Clean Technologies: Suggests that designing and developing more clean technology will help

	in e-waste reduction which is a growing concern	
(Kozma & Vota, 2013)	ICT in Developing Countries: Policies, Implementation, and Impact: Examines the reasons used by government to justify the huge investment in the implementation of ICT in developing countries	ICTs in Education and Development
(Sarkar, 2012)	The Role of Information and Communication Technology (ICT) in Higher Education for the 21st Century: Observes that ICTs have had and will still have a huge impact of the education practices in considerable years to come	ICTs in Education and Development
(Dookhitram et al., 2012)	Green Computing: An Awareness Survey among University of Technology, Mauritius Students: attempts to determine the level of green computing awareness among the students of University of Technology, Mauritius	Green Computing Awareness
(Burcea, et al., 2010)	Environmental impact of ICT and implications for e-waste management in Romania: Focuses on the main environmental impact of e-waste and the impact of the international legislative bodies in addressing e-waste	Green Computing Awareness
(Houghton, 2009)	ICT and the environment in	ICTs in Education and

	<p>developing countries: Development opportunities and developments: Reviews the role of Internet and ICT related research can be used to develop environmentally sustainable models for economic development</p>
(Kasigwa et al., 2005)	<p>The Role of ICTs and their Sustainability In Developing Countries: Through the use of critical discourse analysis the paper illustrates the level of involvement of ICTs in the socioeconomic development in developing countries</p>
(Martinez-Frias, 2003)	<p>The importance of ICTs for Developing Countries: Stress the importance of investing ICTs and having deliberate policies that will have allowance for increased use of ICTs for future development</p>

The observations from the literature suggest the following regarding each of the three themes:

- **ICT in Education and Development:** Most of the research alluded to the fact that there has been a growth in the use of ICTs in the past decade and most of this growth has been in developing countries. This has led to the adoption of ICTs in Higher Educational Institutions. Most of the developing countries had deliberate policies that allow the governments to invest in future ICTs infrastructure or promote an enabling environment for the ICTs market to thrive. This is because there has been research that links the use of ICTs and the national economic growth.
- **Green Computing Awareness:** Research showed that there was high awareness in developed countries like Romania especially in higher educational institutions. There was a moderate level of awareness in Middle Eastern countries. Finally, the level of awareness in developing countries was very low. Therefore, the more developed a country is, the higher the level of green computing awareness.
- **Green Computing Adoption:** The research showed that the level of adoption of green computing

in developed countries is very high while very low in the Middle Eastern and developing countries. Part of the reason alluded to the strong legislation guidelines in the developed countries on the use and disposal of ICTs, which are an effective way to influence the planned future behaviour of a country. However, the main gap in the literature review was mainly that there was no literature that focussed on Zambia or even the sub-Saharan countries apart from one paper on e-waste management in Zambia and Zimbabwe, which was also simply a desk research. There was however, a paper by Freeman on HEIs in Ghana and another from Uganda.

2. Method

In order to provide the answers to the questions posed and achieve the objectives of this research, the researcher used the quantitative method to measure the main factors that influence the awareness and adoption of green computing in higher educational institutions. This was through the preparation of questionnaires using Google Forms, which were distributed to both the students and staff communities at ZCAS through randomly selecting the respondents, via email and the WhatsApp application. The research consisted of a total of 120 respondents, 94 students and 26 members of staff including lecturers. The resulting data collected and its analysis is discussed in the next section. Heuristic methods were also deployed in exploring the concepts further, with further review of other literature for obtaining more background information.

3. Result

The data analysis was categorised into three main themes that were addressing the research objectives and providing answers to the research questions.

3.1 Use of ICTs

According to the results from the data collected, all the respondents were using some type of ICT with only 2.1% using only one of type device. For the majority of the users, they were using between 2 (29.5%) to 3 (37.9%) devices as shown in Figure 3 below;

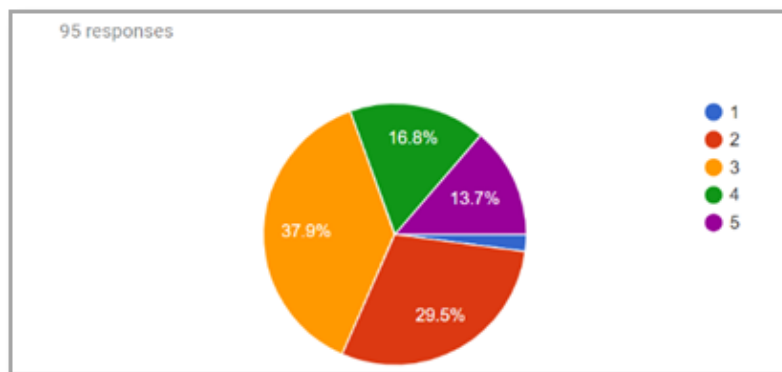


Figure 3. Number of ICTs the Respondents Own

Furthermore, the most used devices among the respondents were laptops and mobile phones owing to the fact that every respondent owned both a laptop and a mobile phone as shown in the Figure 4 below;

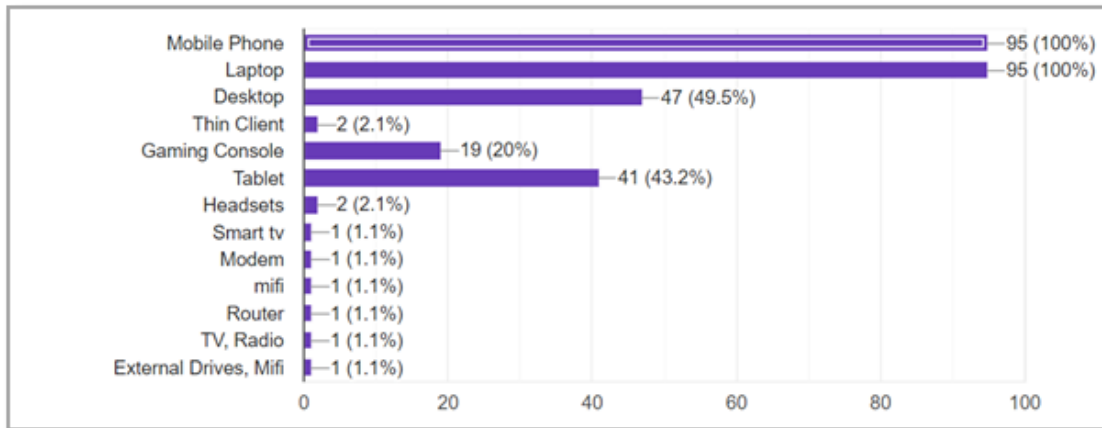


Figure 4. The Type of the Device Used

These results show that the level of use of the ICTs in higher educational institutions in Zambia is very high and most of the students use the ICTs for educational purposes (95.8%) given that ZCAS emphasizes on the use eLearning as a mode of learning as shown in Figure 5 below;

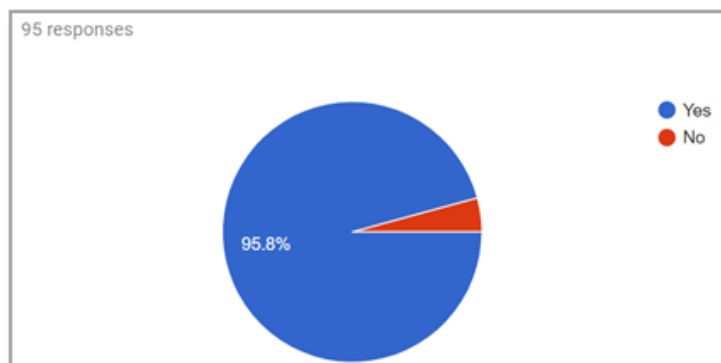


Figure 5. Use of ICTs for Educational Purposes

3.2 Green Computing Awareness

Though the level of use is very high, the general observation was that there was moderate awareness of what green computing was as demonstrated in Figure 6 below that shows that 68.4% of the respondents did not know what green computing was.

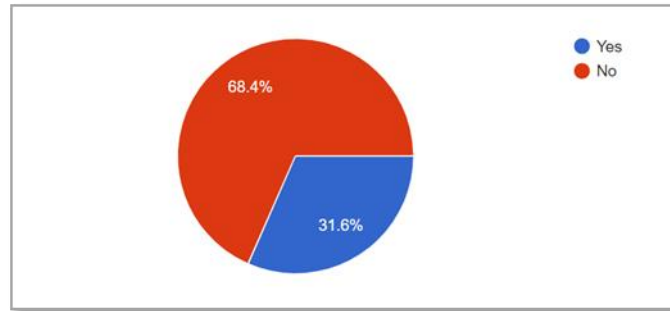


Figure 6. Aware of Green Computing

Furthermore, the results showed that a moderate number of users were neutral on whether during their use, the ICTs contributed to carbon emissions in the environment, followed by an inclination towards an indication that the ICTs did not contribute to Carbon emissions in the environment as indicated in Figure 7 below.

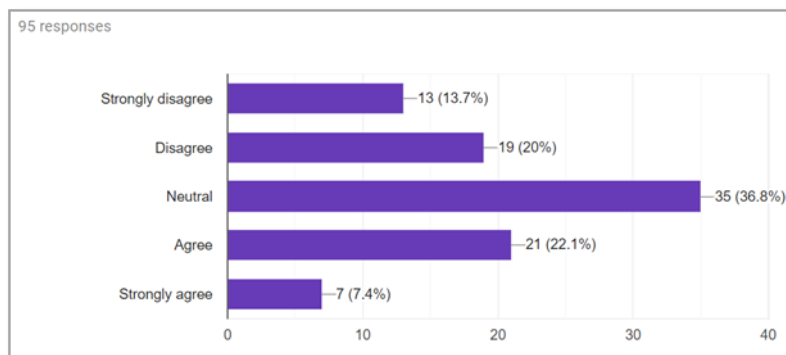


Figure 7. ICTs Contribute to Carbon Emissions to Our Environment

However, the results showed that most of the users thought that the ICTs could produce toxic waste if disposed of into the environment as shown in Figure 8 below.

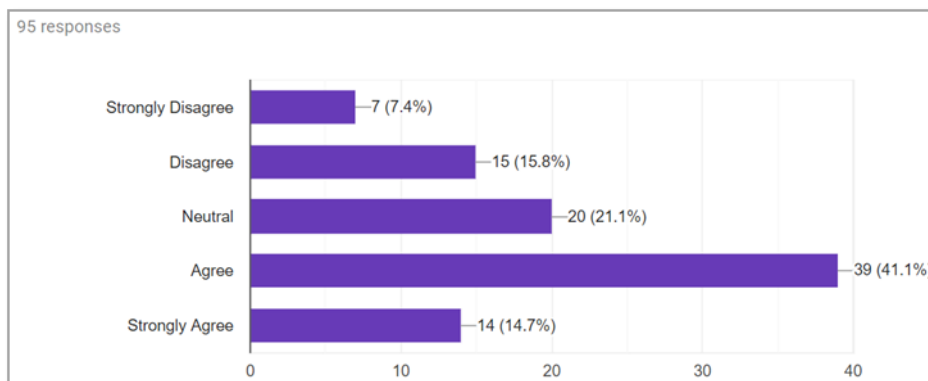


Figure 8. ICTs Can Produce Toxic Waste if Disposed of into Our Environment

Most of the users generally agreed that the use of ICT devices with high specifications might result in using more energy to power the devices as shown in Figure 9 below.

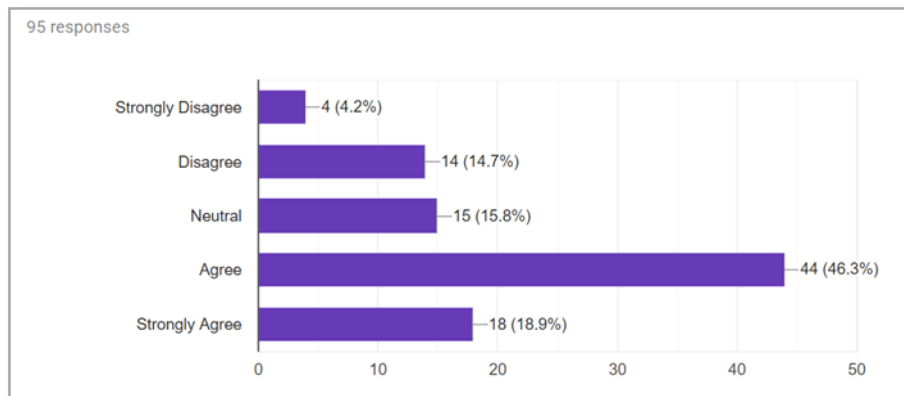


Figure 9. Power Consumption of an ICT Device Is Directly Related to the Specifications of the Device

In addition, a moderate number of respondents agreed that reducing power consumption when using ICTs (reducing the brightness of the screen or putting your PC to sleep when not in use) reduces the amount of radiation in the environment that has a negative effect on our ozone layer. However, there was a significant number of respondents (35%) that remained neutral on the issue as shown in Figure 10 below.

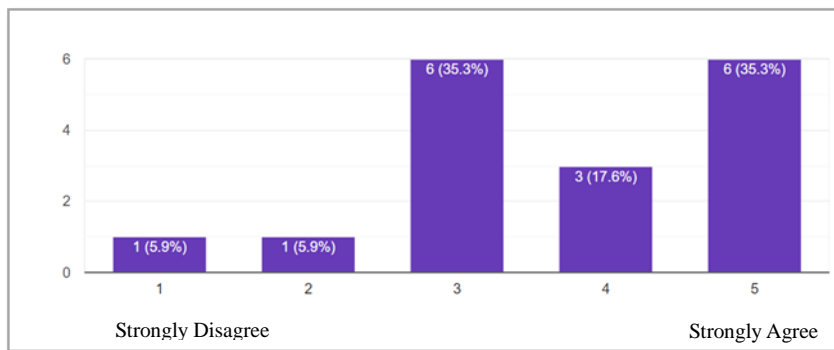


Figure 10. Reducing Power Consumption When Using ICTs Reduces the Amount of Radiation in the Environment

3.3 Green Computing Adoption

Despite the moderate awareness level of green computing, its adoption on the other hand is extremely low as observed from the fact that most users of ICT equipment concentrate more on other specifications instead of checking whether the equipment meets the Eco-design Directive 2009/125/ and EC Energy Labelling Directive 2010/30/EU as shown in Figure 11 below. This is despite the fact

that the same respondents were aware of the heating from ICT equipment, which contributes to radiation in the environment as earlier shown is Figure 10.

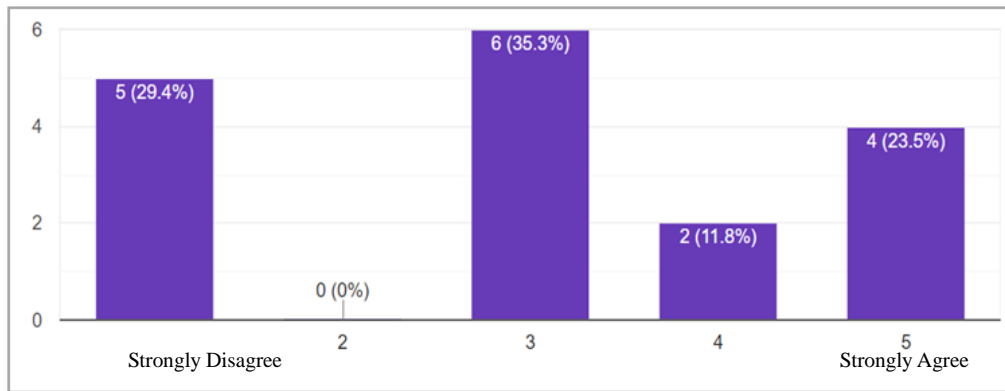


Figure 11. Other ICT Specifications vs Eco-Design Directive 2009/125/ and EC Energy Labelling Directive 2010/30/EU

Most of the ZCAS staff (58.7%) agreed in principle that auction sales are eco-friendly way of disposing of old ICT equipment. At a personal level, the majority of respondents either sell the ICT device (31.6%) when it is no longer in use or simply pass it on to a friend or relative.

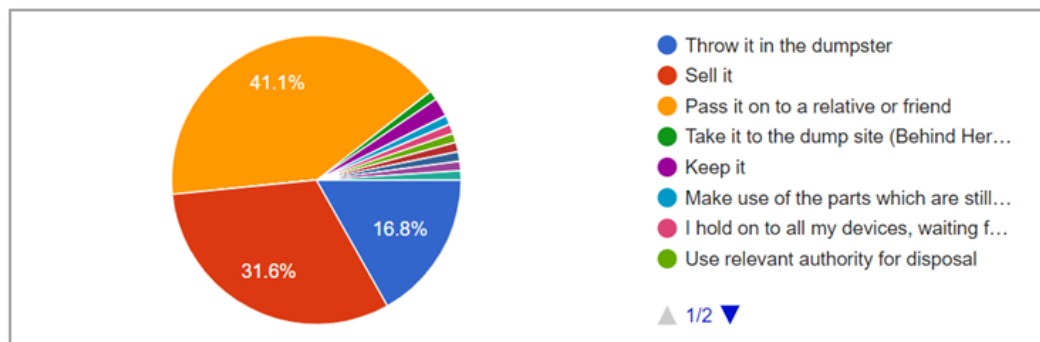


Figure 12. Ways of Disposing of ICT Devices That Are no longer in Use

The results also showed that the recycling of and refurbishing ICT devices (68.8%) can help prevent them becoming e-waste that has a negative impact on our environment. In addition, 68% respondents agreed that the use of virtualisation and other cloud-based solutions could help in reducing the amount of toxins emitted into the environment.

There was also an overwhelming response from the students (55.8%) that the issue of eco-friendly use and disposal of ICTs was not covered in any of the courses that students were taking at ZCAS as demonstrated in Figure 13 below.

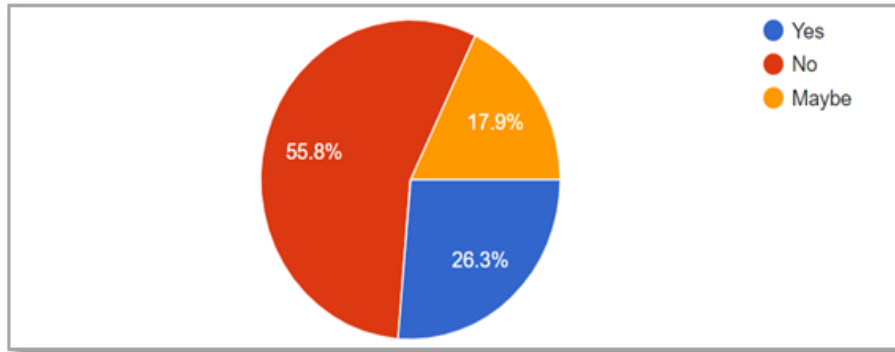


Figure 13. Eco-Friendly Use and Disposal of ICTs Covered in a Course in Your Programme

The results also intimated that the IT community in Zambia had not done enough in educating the ZCAS community of the eco-friendly use and disposal of ICTs as shown in Figure 14 below.

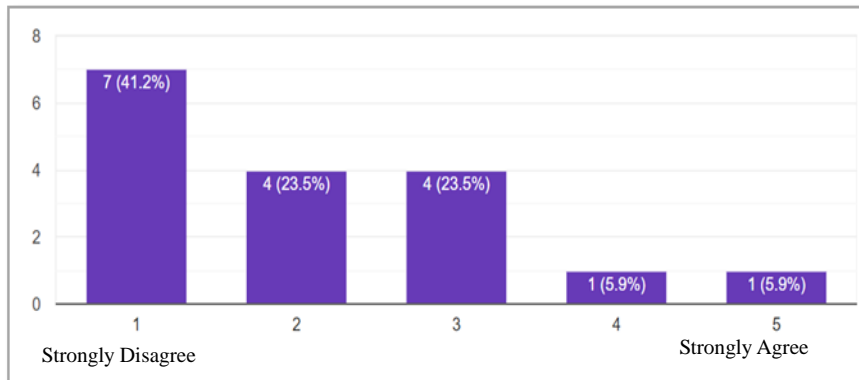


Figure 14. IT Community Is Doing Enough in Educating the ZCAS Community of the Eco-Friendly Use and Disposal of ICTs

Finally, most of the respondents indicated that they had not come across any legislation or regulation in Zambia that emphasised on the eco-friendly use and disposal of ICTs as shown in Figure 15.

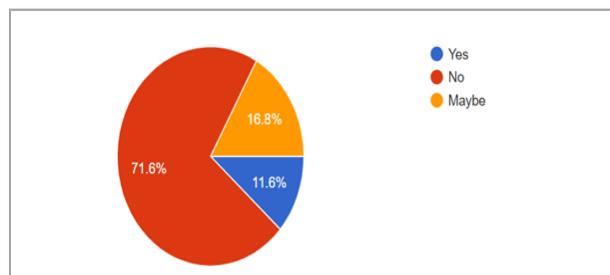


Figure 15. Have You Come across Any Law or Regulation in Zambia That Emphasizes on the Eco-Friendly Use and Disposal of ICTs in Zambia?

4. Discussion

The results in the previous section showed that there was a high level of use of ICTs by users in HEIs and most of them were used for educational purposes. The level of use however, did not mean that the users were aware of green computing. The results demonstrated that the level of awareness of eco-friendly use and disposal of green computing was very moderate to minimal. That could be seen from the fact that the users did not believe that the use of ICTs could contribute to carbon emissions in our environment; however, users were concerned about the possible effect of e-waste disposal on the environment.

That simply showed that respondents lack in-depth sensitization on the overall effects of the use and disposal of ICTs on the environment. In addition, most of the respondents were more aware of green computing aspects that have a direct effect on the immediate environment or have an economic impact. An example of this was the fact that the respondents were aware that the emitted heat from the ICT devices has a negative effect on the environment. The research also illustrated that more needed to be done to ensure adoption of green computing in HEIs.

The results showed that the adoption was low at personal level when it came to paying particular attention to the eco-design or energy labelling of the devices over other specifications of the ICTs. At institutional level, there was need for ZCAS to include the Eco-friendly use and disposal of the ICTs as an important and accepted tool for learning in the curricula. That would be in line with the theory of planned behavior that would enable HEIs to help the students become more concerned about not only their immediate environment but also their immediate environment, the nation, and the earth at large to be in line with the principle of Reduce, Reuse, and Recycle.

The IT community, in this case the ICT Association of Zambia, would as well need to adopt green computing as an area that needed inclusion in their agenda as most of the IT professionals and those to be IT professionals will adopt eco-friendly IT practices as a requirement by their professional body. Finally, the Zambia Environmental Management Agency (ZEMA) would require developing and implementing a deliberate policy on the eco-friendly use and disposal of ICTs in Zambia. This would go a long way to bring about the awareness and adoption of green computing in Zambia just like the National ICT Policy has led to the adoption and use of ICTs in almost all the sectors in Zambia.

References

- Abugabah, A., & Abubaker, A. (2018). *Green computing: Awareness and practices*. Istanbul, IEEE.
<https://doi.org/10.1109/CATA.2018.8398646>
- AHMED, A. I. (2018). Understanding the Factors Affecting the Adoption of Green Computing in the Gulf Universities. *International Journal of Advanced Computer Science and Applications*, 9(3), 304-3011. <https://doi.org/10.14569/IJACSA.2018.090342>
- Asadi, S., Hussin, A. R. C., Dahlan, H. M., & Yadegaridehkordi, E. (2015). THEORETICAL MODEL FOR GREEN INFORMATION TECHNOLOGY ADOPTION. *ARNP Journal of Engineering and*

- Applied Sciences*, 10(23), 17720-17729.
- Burcea, S. G., Ciocoiu, C. N., & Tartiu, V. E. (2010). Environmental impact of ICT and implications for e-waste management in Romania. *Economia. Seria Management*, 13(2), 348-360.
- Calero, C., & Piattini, M. (2015). Chapter 1: Introduction to Green in Software Engineering. In *Green in Software Engineering*. Springer International Publishing Switzerland 2015. <https://doi.org/10.1007/978-3-319-08581-4>
- Delponte, L. et al. (2015). *ICT in the developing world*. Brussels: European Parliamentary.
- Deng, Q., & Ji, A. S. (2015). *Organizational Green IT Adoption: Concept and evidence*. Ottawa, Sustainability. <https://doi.org/10.3390/su71215843>
- Dookhitram, K. et al. (2012). *Green Computing: An Awareness Survey among University of Technology, Mauritius Students*. Pointe-aux-Sables, ResearchGate.
- Freeman, E. (2016). *Saving the Planet: An Assessment of Green Computing Practice among Tertiary Institutions in Ghana*. Accra, INCEDI.
- Harindranath, G., & Sein, M. K. (2007). *REVISITING THE ROLE OF ICT IN DEVELOPMENT*. São Paulo, ResearchGate.
- Houghton, J. (2009). ICT and the environment in developing countries: Opportunities and developments. *Rev6*, 8. <https://doi.org/10.1787/9789264077409-8-en>
- Kasigwa, J., Williams, D., & Baryamureeba, V. (2005). The Role of ICTs and their Sustainability In Developing Countries. *Sustainable Information and Communication Technology Development*, 4, 78-89.
- Kozma, R. B., & Vota, W. S. (2013). ICT in Developing Countries: Policies, Implementation, and Impact. *Handbook of Research on Educational Communications and Technology*, 885-894. https://doi.org/10.1007/978-1-4614-3185-5_72
- Martinez-Frias, J. (2003). The Importance of ICTs for Developing Countries. *Interdisciplinary Science Reviews*, 2003(1), 10-14. <https://doi.org/10.1179/030801803225010304>
- Media. (2014). The Future of ICT Education in Zambia—Part II. Retrieved from <https://camara.org/blog/2014/09/11/future-ict-education-zambia-part-ii/>
- Ministry_of_Communications_and_Transport. (2017). *National Information and Communication Technology Policy*. Lusaka: Ministry_of_Communications_and_Transport.
- Murugesan, S. (2008). Harnessing Green IT: Principles and Practice. *IT Professional*, 10(1), 24-33.
- National_Assembly_of_Zambia. (2018). *Debates-Thursday, 12th November, 2015*. <https://doi.org/10.1109/MITP.2008.10>
- Sarkar, S. (2012). The Role of Information and Communication Technology (ICT) in Higher Education for the 21st Century. *The Science Probe*, 1(1), 30-40.
- Semakula, I., & Samsuri, S. (2016). Green Computing Knowledge among Students in a Ugandan University. *IEEE*, 199-204. <https://doi.org/10.1109/ICT4M.2016.049>
- Teknologi, U., & Johor, S. (2015). Green Computing: The Overview of Awareness, Practices and

- Responsibility Among. *Journal of Information Systems Research and Innovation*, 9(3), 28-36.
- Thaqi, L. (2015). *E-Waste Management & Clean Technologies*. Kavala, HAICTA.
- Torre, D. et al. (2017). *On the Presence of Green and Sustainable Software Engineering in Higher Education Curricula*. Ithaca, Cornell University. <https://doi.org/10.1109/SECM.2017.4>
- Trading_Economics. (2018). *Zambia—CO2 emissions (kt)*. Retrieved November 14, 2018, from <https://tradingeconomics.com/zambia/co2-emissions-kt-wb-data.html>
- ZICTA. (2014). *2013 ICT COUNTRY SURVEY REPORT—ZAMBIA*. Lusaka: ZICTA.