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A Survey of Green-Computing Attitude and Technology Deployment in Selected Southwestern Nigerian Universities

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Abstract
The study examined the attitude of selected Nigerian universities towards the adoption of green-computing, assess the extent to which green–computing (g-computing) technologies are deployed in Nigerian higher education institutions as well as the readiness of the universities to adopt green readiness. A cross sectional survey design was adopted for the study, one university each from the federal, state and private universities were selected from the southwestern geo-political zone of Nigeria, the participants of the study who were conveniently sampled were the administrators in the selected universities. A green-computing readiness questionnaire was administered on 120 administrators to elicit information on the attitude of the institution towards green computing, their readiness to adopt it and the level of green- Information Technology (IT) deployed towards the use of g-computing .The resulting data were analyzed using descriptive statistics The result showed that the sampled universities even though possessed good attitude towards g-computing had low level of deployment of green IT technology with low readiness level of adoption of green computing.

Keywords: Green-Computing, Readiness, Adoption, Attitude, Information Technology

Introduction

The rapid growth in the use of information technology have given rise to an increase consumption of electricity (Mmeah *et al*, 2018; Patel, 2017; Sreenandana, Nair & Aneesh, 2020) and has also increased the release of carbon dioxide (CO2), lead ,zinc, chromium and some other trace elements into the environment (Kamarudin, Mohd, Zulkifli, Ishmael, Alan, Lepun & Omar, 2021). The release of these dangerous properties into the atmosphere has contributed immensely to the emission of greenhouse gas which are the result of electronic waste generated from electronic gadgets and computer parts thrown on dung hills (Aodu, Jegede & Ilori, 2019). Nations of the world are gradually keying into the green initiative programme in order to reduce the side effects of computers and its accessories on both the environment and human health. Green technologies are intended to deploy the use of technologies for a cleaner and greener environment (Environmental Protection Agency, 2007).The application of green technology to the different sectors of the economy, the world over is a global trend at combating the effects of climate change on agriculture, the water sector, forestry and the cities. Green technology is a term that describes the utilization of technology and science to reduce human impacts on the natural environment. Under the umbrella of green technology are energy, atmospheric science, hydrology and computing. Green computing can be explained as the practice of using Information and Communication Technology (ICT) resources more efficiently while maintaining or improving overall performance. It can be described as the practice of designing, manufacturing, using and disposing of computers, servers and other subsystems such as monitors, printers and the storage devices efficiently and effectively with very little or no impact on the environment. (Kolbasuk, 2007, Mugugesan, 2008). Other synonyms of green computing are green IT, or ICT sustainability and all these are aimed at maintaining an environmentally sustainable computing. Green computing is personal and also organizational. Individuals and corporate attitudes to green technology are key to its success. Thus in achieving an eco-friendly technology deployment research efforts need to be extended beyond personal green computer practices but organizational and

corporate ones. It was for this same purpose that Mamo (2016) examined the green readiness of government organizations in Ethiopia; very low green readiness was found. Similar situation might be the case in Nigeria; a sister developing country. For an appropriate green computing initiative in Nigeria, it might be necessary to replicate the same study. The government organizations examined by Mamo (2016) were heterogeneous in nature. Findings from such heterogeneous organizations may obscure some salient information, thus in replicating the study, homogenous organizations might be more informative. Thus institutions of higher learning are considered appropriate in this context.

Institutions are increasingly dependent on Information Technology (IT) to facilitate their processes. Teachings and learning are now largely done through the use of IT infrastructures, this was much more the case since the advent of covid-19.The emission from such use of computers and the harmful effects of the disposal of computer parts such as lead, mercury and hexavalent chromium from landfills are very deadly to both the human beings and the environment at large. Most computer parts and accessories are a combination of heavy metals like mercury, lead, chromium, cadmium, which are very good at inducing human poisoning and death when they come in contact with the environment. It has been largely reported in the literature that these heavy metals especially lead and cadmium are capable of causing serious damages to the immune system in both man and animal. (Ebrahimi et al, 2020). Environmental pollution of the air, water and soil caused by heavy metal pollutants which are non-biodegradable, toxic and very dangerous to the human body when consumed through the uptake of food, water and the air.

Readiness is often an offshoot of attitude, the attitude of persons or organization is a starting point for desiring changes, such attitude will then lead to an action to change from what has been existing to embrace the new. The attitudinal disposition of embracing the new is termed readiness in the current study. It also has to do with infrastructural preparedness thus in examining the readiness of institutions it will be needful to examine the attitude of the selected universities towards the adoption of green-computing; assess the extent to which green–computing technologies are deployed in the universities of study; and assess the readiness to adopt green technology in the selected universities

Methods

The study adopted a cross sectional survey research design. Three universities (a federal, a state and a private university) were selected from southwestern geopolitical zone of the country for the study. The participants included university officers such as Heads of departments, Directors of institutes or directorates, Deans of Faculties etc. The university officers were conveniently sampled across the 3 universities. The participants responded to a questionnaire developed by Molla, Cooper & Pittayachawan (2011). The questionnaire was divided into 3 sections namely G-readiness attitude section consisting of 11 items which enquire the disposition concerns and interests of the institutions on green technology, 9 other items enquired on the extent of deployment of green technology while another 3 items elicited information on the extent to which the universities were ready to adopt green technology. The questionnaire was also used by Mamo (2016) to elicit similar responses in Ethiopia. Only 77 questionnaires were returned out of the 120 administered. The resulting data were analyzed using descriptive statistics

Results

To assess the attitude of the institutions under consideration towards Green Computing. One of the major factors on the acceptance and use of technology is attitude followed by commitment and action. As a result, respondents were asked to assess their organizations attitude towards Green Computing. It was obtained that clusterly speaking 66.7% (i.e. 44% agreed and 22.7% strongly agreed) had favourable attitude towards green computing. Similarly, a mean of 3.77 with standard deviation of 3.75 showed a reasonably high level of attitude. The result is as stated (Table 1).

Table 1: Green-Computing Attitude of Selected Universities

S/N		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	μ	σ	Remarks
1.	I am concerned about climate change	2 (2.60%)	2 (2.60%)	1 (1.30%)	37 (48.05%)	35 (45.45%)	4.31	4.03	High
2.	I believe that IT equipment and systems contribute to greenhouse gas emissions	2 (2.78%)	1 (1.39%)	16 (22.22%)	41 (56.94%)	12 (16.67%)	3.83	3.57	High
3.	Our institution is concerned about climate change	0 (0.00%)	7 (9.21%)	15 (19.74%)	35 (46.05%)	19 (25.00%)	3.87	3.61	High
4.	Our institution is concerned about the efficiency of powering our IT infrastructure (Storage Servers, network)	3 (3.90%)	4 (5.19%)	6 (7.79%)	40 (51.95%)	24 (31.17%)	4.01	3.75	High
5.	Our institution is concerned about our IT equipment energy consumption	2 (2.63%)	7 (9.21%)	15 (19.74%)	36 (47.37%)	16 (21.05%)	3.75	3.50	Moderate
6.	Our institution is concerned about the energy consumption of cooling and lighting our data centres	2 (2.67%)	6 (8.00%)	19 (25.33%)	34 (45.33%)	14 (18.67%)	3.69	3.45	High
7.	Our institution is interested in Green IT initiatives of our IT suppliers	1 (1.37%)	7 (9.59%)	23 (31.51%)	28 (38.36%)	14 (19.18%)	3.64	3.39	Moderate
8.	Our institution is concerned about the environmental impact of discarding IT equipment at the end of its life	2 (2.67%)	4 (5.33%)	31 (41.33%)	26 (34.67%)	12 (16.00%)	3.56	3.32	Moderate
9.	Computers can be harmful to the environment	9 (11.84%)	15 (19.74%)	13 (17.11%)	31 (40.79%)	8 (10.53%)	3.18	2.97	Moderate
10.	I am aware of Green IT	4 (5.48%)	6 (8.22%)	19 (26.03%)	30 (41.10%)	14 (19.18%)	3.60	3.36	High
11.	IT professionals should be concerned with controlling the power consumption of IT equipment	2 (2.67%)	4 (5.33%)	8 (10.67%)	37 (49.33%)	24 (32.00%)	4.03	3.76	High
	CLUSTER:	29 (03%)	63(07%)	166 (19.6%)	375 (44%)	192 (22.7 %)	3.77	3.75	**High**

The second objective was to assess the green IT technology deployed by the institutions. adopted by the institutions covered in this study. Around 46 % (when we sum moderate extent (15.44%), great extent (14%) and very great extent (11%)) of the respondents agreed to their institutions deploying Green IT technologies in all. However 26.41% had no idea of relevant Green IT technologies. Cloud computing and server consolidation and virtualization were the least deployed. The study result found out that the adoption of other green IT technologies is very low as shown in Table 2.

Table 2: G-Readiness Technology Deployment in the Selected Universities

S/N	Our institution has the following technologies deployed	Not at all	Small extent	Moderate extent	I don't know	Great extent	Very great extent	μ	σ	Remarks
1.	Server consolidation and virtualization	15 (22.73%)	11 (16.67%)	11 (14.29%)	28 (42.42%)	9 (13.64%)	3 (4.55%)	3.18	2.93	Low
2.	Thin-Client and Desktop Virtualization	10 (16.95%)	14 (23.73%)	18 (23.38%)	25 (42.37%)	4 (6.78%)	6 (10.17%)	3.22	2.97	Low
3.	Cloud computing	19 (29.23%)	17 (26.15%)	12 (15.58%)	12 (18.46%)	11 (16.92%)	6 (9.23%)	2.96	2.73	Low
4.	Print optimization	11 (16.18%)	17 (25.00%)	9 (11.69%)	19 (27.94%)	17 (25.00%)	4 (5.88%)	3.34	3.08	Low
5.	Data centre airflow management	10 (16.95%)	14 (23.73%)	18 (23.38%)	20 (33.90%)	8 (13.56%)	7 (11.86%)	3.30	3.04	Low
6.	Upgrades to more efficient UPS	14 (21.88%)	11 (17.19%)	13 (16.88%)	20 (31.25%)	10 (15.63%)	9 (14.06%)	3.36	3.10	Low
7.	Install more energy efficient lights	7 (10.14%)	10 (14.49%)	8 (10.39%)	17 (24.64%)	17 (24.64%)	18 (26.09%)	4.05	3.74	Moderate
8.	High efficiency stand-by power system	7 (10.00%)	12 (17.14%)	7 (9.09%)	22 (31.43%)	14 (20.00%)	15 (21.43%)	3.90	3.59	Low
9.	Computers that have functions to monitors workloads and to shut down components when unused	20 (30.30%)	11 (16.67%)	11 (14.29%)	20 (30.30%)	7 (10.61%)	8 (12.12%)	3.09	2.85	Low
	CLUSTER	113 (16.93%)	117 (16.96%)	107 (15.44%)	183 (26,41%)	97(14%)	76(11%)	2.40	2.38	Low

The third objective of the study assessed the readiness of institution of the respondents to adopt Green IT and the result is as stated in Table 3. The table depicts low readiness for adoption when "agreed" and "strongly agreed" on financial term (31%), on the ground of institutional skills (37 %) as well as general readiness shows (34%). The cluster percentage of the readiness for adoption was also 48 .56 % (i.e. 33.33% +15.23%).

Table 3: Universities Readiness to adopt Green IT

S/N		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	μ	σ	Remarks
1.	Our institution has the financial resources to adopt Green IT	7 (10.14%)	11 (15.94%)	20 (28.99%)	23 (33.33%)	8 (11.59%)	3.20	2.97	Low
2.	Our institution has the necessary skills to adopt Green IT	3 (4.29%)	10 (14.29%)	20 (28.57%)	25 (35.71%)	12 (17.14%)	3.47	3.22	Moderate
3.	In my opinion our institution is ready to adopt Green IT	8 (11.11%)	5 (6.94%)	25 (34.72%)	22 (30.56%)	12 (16.67%)	3.35	3.11	Low
	CLUSTER:	18(08%)	26(12.4%)	65 (31%)	70 (33.33%)	32 (15.23%)	3.34	3.26	Low

Discussion

Most of the respondents have a good attitude towards the practice of g-computing. This finding supports the findings by Mamo (2016) that organizations in Ethiopia were well disposed and have good attitudes towards g-computing which was revealed by their readiness to adopt environmentally friendly IT initiatives. The attitude may be as a result of butting environmental changes which were due to climatic changes that are traceable to these activities of improper and old ways of using and disposing computer parts. Another study in Birnin-Kebbi, the northern part of Nigeria revealed a very low level of awareness of the possibility of green computing which results in poor attitude towards its practice (Abdulkadir and Augie, 2020).The study of Abdulkadir and Augie was conducted in Nigeria (though a sister developing country) the discrepancy may not be as a result of country differential but perhaps as a result of lower educational level of the respondents in the study area in Nigeria. The result was also different from the current study possibly because it was conducted among principal officers of universities with supposed higher level of awareness. To enhance better attitude Batlegang (2012) in a study of Botswana students' use of green computing having discovered a low level of green computing knowledge advocated that the level of awareness be elevated to encourage better attitude. It would seem that attitudinal problem was not the case in the current study .Most of the needed technologies for a well-developed g-computing infrastructure were yet to be deployed by the institutions under study. This may be as a result of paucity of funds. Nigerian higher institutions of learning are largely underfunded and much of the financial allocations are often channeled towards the payments of salaries. The needed architecture for the adoption of g-computing are sometimes not such that can be acquired by the institutions without the interventions of the government, this may also be a reason why the level of adoption is low. Another observation in the study was that a significant percentage of the respondents were largely ignorant of the appropriate technology to be deployed for green computing. Such ignorance would necessarily impede deployment even when affordable.

The adoption of green IT is usually in phases. (Ribeiro, Tommeasetti, Gomez, Castro and Ishmael., 2021;Bokolo and Noraini,2015) divided these phases into three. Most of the developing world are still at the early stage of adoption and relatively slow due to the challenge of funding. Adoption is a function of awareness and since the level of awareness has been adjudged to be low (Mamo,2016; Batlegang ,2012) it should expected that the level of deployment of technology for green readiness will equally be low. As the concept becomes widely known and accepted, it is envisaged that the adoption level will also increase. Green IT Technology is the technology for reducing energy consumption of data center, IT assists, cooling systems and optimizing energy usage and using IT to reduce institutional environmental foot print. Green ICT technology readiness can be measured by assessing the extent to which an organization has green business infrastructure and green power sources, development of green IT standards across the enterprise, server consolidation and virtualization, extent that application and technologies are retired for greener technologies and extent of solutions development to support enterprise wide green initiatives. The readiness to adopt g-computing is also averagely low, respondents returned low financial and skills readiness and ultimately were of the opinion that their institutions were yet to be ready for Green IT adoption. Mouakket and Aboelmaged (2021) identified three strong determinants in organizational IT adoption as management support, resource commitment and quality of human resources. It would seem that resource commitments (with respect to finance) and quality of human resources were the impeding factors for Green IT adoption in the current study. The result of this study needs be however interpreted with caution as it was limited to southwestern zone of the country. Subsequent study would need to investigate all the six geopolitical zones of the country to ensure generalizability.

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