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Acceptance of Desktop Visualization Technology in Education Sectors–A case study of Ncomputing in Tanzania

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ABSTRACT

The improvement of ICT has created many opportunities to the development framework such as financial, health, tourism and education sector. Tanzania as one of developing countries can never avoid such practice of Technology adoption. In this research, we have chosen Technology-Organisational- Envoronmental (TOE) Framework as our reference guidance especially taking into consideration that Tanzania has its specific unique combination which would have significant impact on her ICT readiness. This paper observes critical issues which have been involved in the adoption of Desktop Visualization technology in the Tanzania Education sectors. Among others, we found that only 17% of secondary schools stakeholders are aware of Ncomputing devices. Furthermore, 67% of secondary schools are still using PCs and Laptops in their computer labs and 49 % of secondary school stakeholders do not use Ncomputing because of unfamiliarity of this technology.

KEYWORDS

NComputing, Desktop Visualization, Technology Adoption, TOE and ICT readiness.

1 INTRODUCTION

Information Technology is a valuable tool in enhancing the teaching and learning in schools. With this fact, all educational institutions are trying to acquire sufficient computers to improve computer access for the students and staff for academic and administrative uses. Also, [1] asserts that:

"Computer literacy is not negotiable for any professional in an increasingly computerized environment. Educational institutions should be equipped to provide this new basic training for modern life."

But still many developing countries, including Tanzania, have not yet succeeded to provide sufficient computers in their schools to improve access, partly due to financial constraints and infrastructural issues.

The number of computers in secondary schools in Tanzania is very low, where the average national computer-to-students ratio in secondary schools is 1:200 [2]. Most of the secondary schools being in rural areas are not connected to the national grid. Only 1,107 (24%) secondary schools in Tanzania mainland are connected to the national electricity grid [2]. There are no sufficient skilled IT professional in Tanzanian secondary schools, which is also addressed in the ICT Policy for Basic Education [3].

The above mentioned weaknesses hinder proper use of ICT in the teaching and learning in the secondary schools. This scarcity of ICT resources in schools has resulted into teaching ICT theoretically without students having a touch of the facilities

to practice and explore, and to practice the student-centered learning approach. The advocated use of ICT as a teaching and learning tool has been difficult to be realized as there are no sufficient ICT tools (e.g. computers) to use.

From above, we can group the factors limiting our secondary schools from having sufficient computers in terms of financial constraints, lack of power to most of schools, and insufficient IT staff (for support and maintenance). This calls for a computing model with low-cost computers, which uses low energy and easily manageable (easy maintenance). NComputing technology has got these features as compared to the normal PCs. The problem is how this technology can be adopted in our secondary schools to improve computer access. These products have been in Tanzania for a number of years now, but they are still not popular in our secondary schools; we still see computer labs, for most of the schools, furnished with normal PCs. Why Tanzanian secondary schools are not exploiting the benefits of Ncomputing to improve computer access? Or, possibly the purchasing authorities are not aware of the benefits of NComputing. Then, what can be done to make the implementation of Ncomputing in our secondary schools possible? These uncertainties and desire to improve computer access in Tanzanian schools prompted the researcher to conduct a study on the adoption of Ncomputing in secondary schools.

2 LITERATURE REVIEW

2.1 Technology Adoption

Since the late years of 1990s, development agencies, researcher organizations, business enterprises, academia and individuals started to review and study the way nations and industries acquire and use ICT [18]. Different theories and models evolved which shows procedure and issues which have to be involved in the process of Technology adoption. Few examples are; Difusion of Investment (DOI) theory, Technology-Organisational-Environmental (TOE) framework and Unified Theory of Acceptance and Use of Technology (UTAUT) and [19], [20]. All of these models and theories pose some issues to be involved in a process of adopting technology. Although, a review of common Adoption tools and theories show that, at firm level, TOE framework is considered to be more complete as it includes environmental context and it is also suggested to combine more than one theoretical model in order to achieve better understanding of the IT adoption phenomenon [20]. The grounds of this research are based on the three contexts of TOE framework which are seen in Figure 1. The sub-components are also seen in the box of each context.

The research by [19] points out that the differences in the pattern of IT adoption are attributed to many factors such as government policy, industry lead, and the market opportunity. This suggests that since education sectors in Tanzania mostly serve Tanzanians, hence we have to target the target preferences of the Tanzanians which, among others, includes their culture and enthusiasm of leaders. This is supported by a research conducted by Chae [21] which reported that the type of information provided by accounting systems varied across the countries, that means the style of which people and organizations use information systems is affected by culture. Also the study conducted by [22] suggests that the contents of websites differ significantly across countries.

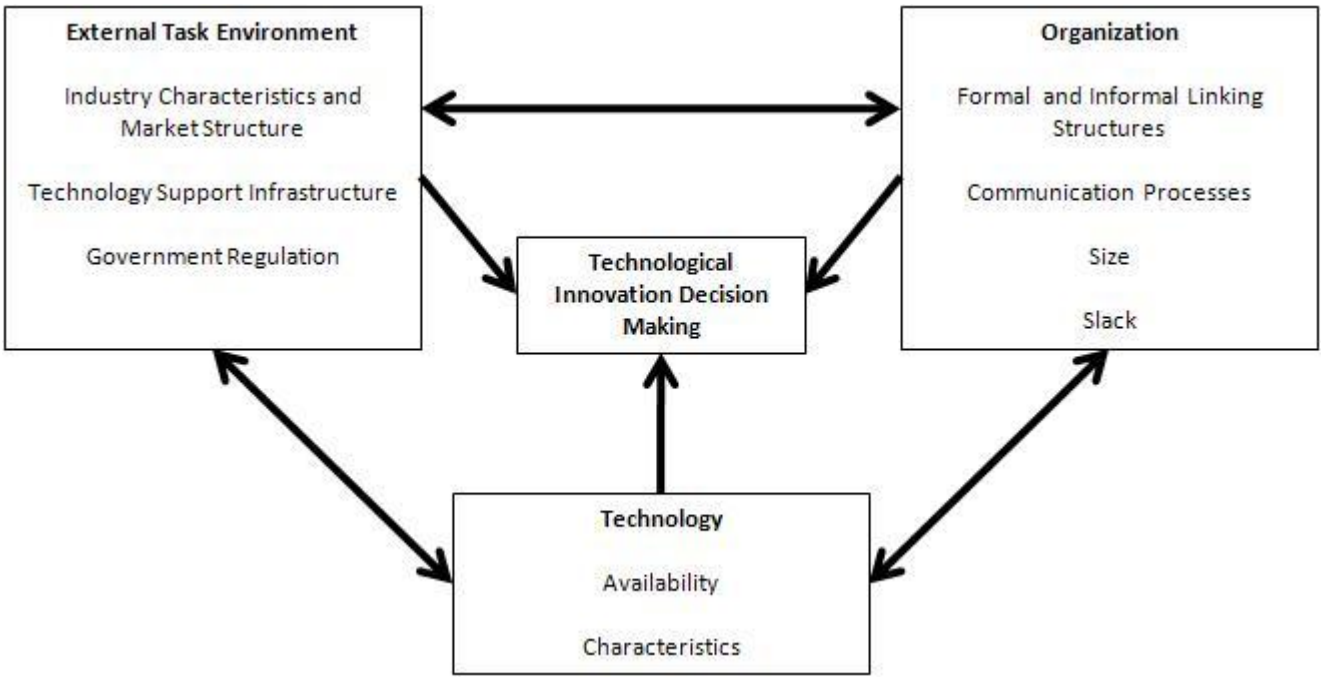

Figure 2. Technology-Organisational-Environment (TOE) Framework (Adopted from [20])

On the other hand, the efforts were also imposed on the assessment on how ready the organization and institutions are for them to effectively utilize the benefits and opportunities posed by the dynamic advances in the use of information technology in business and industry. This situation which is also referred to as e-readiness [18] has its ways of assessing it which have been suggested by several organizations, academic and research institutions. The first assessment tool was undertaken by the Computer Systems Policy Project (CSPP) when they developed a Readiness Guide for living in the Networked World [18]. Later on, several tool came into actions. Some of the common e-reading assessment initiatives are: the United Nations Development Program (developed the Technology Achievement Index), the United Nations Conference on Trade and Development (UNCTAD) (proposed the ICT Development Index), the Centre for International Development at Harvard University (came with Network Readiness Index tool), the Mosaic Group (presented the Framework for assessing the diffusion of the Internet) and the McConnell International (MI) came with their (Net.Go tool) [20]. Despite of the existence of many e-readiness assessment tolls, [18] concludes that they, in general, measure the connectivity; level of infrastructure development; internet access; applications and services; quality of network access; network speed; ICT policy; ICT training programs; human resources; computer literacy and relevant content. Therefore, this research assumes that as far as different sectors in Tanzania operate on the same umbrella in terms of policy, human resources, access of network and others, there is a need to establish to what extent Ncomputing technology fits in to the Tanzania context.

2.2 Overview of NComputing

NComputing utilises a computer technology called ‘desktop virtualisation’, where the

resources of one machine are spread to several users. In a technology White paper, [4] claim that many of the concepts behind the NComputing solution are similar to the traditional thin client model; however, NComputing has developed a completely unique implementation that delivers better performance at a lower cost.

Like in thin client technology, Ncomputing uses desktop virtualization technology where a single computer or server can be shared by many users simultaneously. There are a good number of literatures discussing about desktop virtualization and its advantages in education, but it is difficult to get an exact meaning of desktop virtualization due to changing techniques in the way it is done as technology advances. [12] Defines desktop virtualization as the use of software to abstract the operating system, applications and associated data from the user's PC. But from the [5], Desktop virtualization is defined as software technology that separates the desktop environment and associated application software from the physical client device that is used to access it. And from the [6] Desktop virtualization, often called client virtualization, is explained as a virtualization technology used to separate a computer desktop environment from the physical computer.

Factors like high cost of computers, lack of power in most of the schools, maintenance problems and lack of IT personnel, invite a need for low-cost, low-energy computers needing less maintenance. There are several low-cost, low-power computer initiatives, but Ncomputing is chosen in this research mainly due to its lowest cost per seat in setting a computer lab in a school. Desktop virtualization enables a single PC to be "virtualized" (or shared) by many users - with each user getting his/her own computing session [7].

The NComputing solution has three components:

- Access devices that connect the user's monitor/peripherals to the host computer
- Virtualisation software (vSpace), which virtualizes the host computer to create multiple sessions
- User eXtension Protocol (UXP), which transmits the data and video signals between the user and the host computer

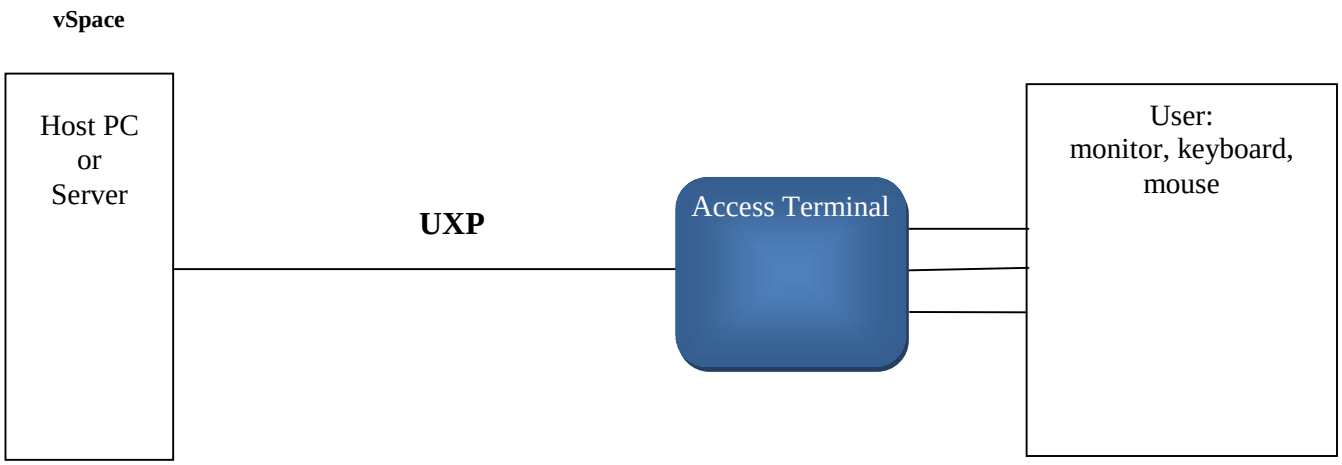

Figure 2. The architecture of Ncomputing (Adopted from [7])

According to [7], the benefits of Ncomputing for education are:

- R educes the per-seat cost of a PC by more than 75%.
- Manages one virtual desktop OS for up to 100 end users, thereby reducing the number of operating systems to maintain by up to 97%.
- Integrates easily with your existing computing infrastructure, replacing costly PCs with simple, small and very durable thin clients.
- Centrally manages Internet filtering software, ensuring a consistent and safe Internet experience.
- Frees up valuable workspace in classrooms and labs.
- Produces less e-waste and utilize less energy.

Ncomputing has two main limitations. Firstly is Reliability where all the services relies on a single point hence failure may result to huge risk. Therefore it is highly recommended to use reliable UPS, automatic backup system and have an additional computer with enough capabilities to be used as a temporal server to reduce this risk [8]. The second limitation is performance. This is the main disadvantage of a thin client solution as pointed out by [8] especially in the areas of Streaming multimedia motion graphics (animations, slide effects, etc.), applications requiring a powerful graphics card (everything related to games and 3D rendering), and latency-sensitive applications (where the time it takes an event to reach the client through a network is critical). [9] asserted that network quality matters a lot in the performance of server based computing especially on multimedia applications. For education purposes, we don't expect such high multimedia requirements, and if needed, high specifications computers with Ncomputing, and using fewer users per host can lead to good multimedia performance.

2.3 Computer access in Secondary Schools in Tanzania

There were 4,528 government and non-government secondary schools with a total 1,884,272 students in 2012 [2]. With the same figures, there were a total of 9,439 functioning computers used for training purposes. This gives us a computer to student ratio of 1:200, which is very low. This suggests how it has been difficult to implement the objective of the ICT Policy for Basic Education [3], which asserts that;

"Ensure that there exists equitable access to ICT resources by students, teachers and administrators in all regions and types of educational institutions and offices".

Most of the secondary schools are not connected to the national grid. Only 1,107 secondary schools are connected to the national grid [3]; which is just 24% of all schools. For schools with ICTs, maintenance and technical support is mainly carried out by teachers and/or ICT technician in the school either full time or part time [10]. This demands the use of a technology which needs less maintenance. [10], furthermore, during the interviews noted that the Government of Tanzania can only provide a minor part of the funding required for the ICT in education program, with major part of this component mainly dependent on donor support.

2.4 NComputing Limitations in Education Sectors

[11], in their research on 'Thin Client technology in schools', findings showed that all schools experienced problems delivering some multimedia applications and content over the Thin Client networks, as also supported by [12] who judged out that Thin client/server architecture is not suitable for delivering multimedia content. But in the same research, Becta [11] found that newer networks and terminal were better at handling multimedia. This shows that there have been improvements in handling multimedia in all new thin clients, including Ncomputing.

Besides the performance issues, [13] talks about user acceptance, by saying that 'No matter how well documented the benefits of Thin Clients may be, there is still an issue of acceptance to be addressed.' This is a problem, which can limit the adoption of Ncomputing in secondary schools, and it can be dealt with by raising awareness and doing comprehensive on-site tests of the technology.

3 RESEARCH METHODOLOGY

Mixed sampling [14] was employed in the course of selecting the sample. For information not aimed at obtaining results for purposes of generalization to the entire population, non-probability sampling was used, and for those aimed at generalizations, probability sampling was used [15].

The main sources of data obtained for analysis in this study were Ncomputing products supplier, Government Procurement Services Agency (GPSA), MOEVT and PMO-RALG (national level management of secondary schools), Regional and District Educational Offices and in Secondary schools.

In Tanzania, so far there is only one supplier of Ncomputing products, Soft-Tech Consultants Ltd., authorised by the manufacturer (i.e. Ncomputing inc.) to sell and install Ncomputing devices in Tanzania through a single distribution company, Redington Tanzania Ltd. [7]. Using purposive (non-probability) sampling, this company (supplier) was selected to participate in this study. In Tanzania, secondary schools are managed by MOEVT and PMO-RALG at the national level. Using purposive sampling, respondents from the ICT and secondary education departments for both MOEVT and PMO-RALG were targeted, and sent questionnaires.

Since Tanzania mainland is a huge country with more than 25 regions and 159 district councils [16] and a total of 4,528 secondary schools [2], then it is difficult to survey in all secondary schools in all regions in the presence of time and cost constraints. Hence, a 10% of all regions were found reasonable for a sample, which approximates to 3 regions. Dar es Salaam was first selected by convenience sampling to be automatically included (because it is easily reachable), and the remaining 2 regions were selected randomly from the remaining 24 regions, with the result being Mwanza and Mtwara regions. For this study, these 3 regions were kept as the main sample, selecting samples of districts and schools within these regions. We targeted three regions as follows:

- Ilala and Kinondoni from Dar es Salaam region;
- Mtwara Municipal and Mtwara Rural from Mtwara region; and
- Ilemela and Kwimba from Mwanza region.

At each district level, respondents were those responsible on matters concerning computers in secondary schools. The last sample was at the school level. From the 6 districts above, the researcher aimed at getting information from schools with computers and those without computers for training purposes; from both government and non-government secondary schools. The selection of the schools was done randomly, making a minimum of 4 schools per district. At every school, the respondents were the head of school and one teacher responsible for ICT issues in the school.

4 RESULTS AND DISCUSSIONS

4.1 Available Types of Computer Systems in Secondary Schools

Personal computers are the main types of computer systems used in secondary schools in Tanzania as seen in Figure 3 where 67% of secondary schools are using PCs in their computer labs followed by laptops.

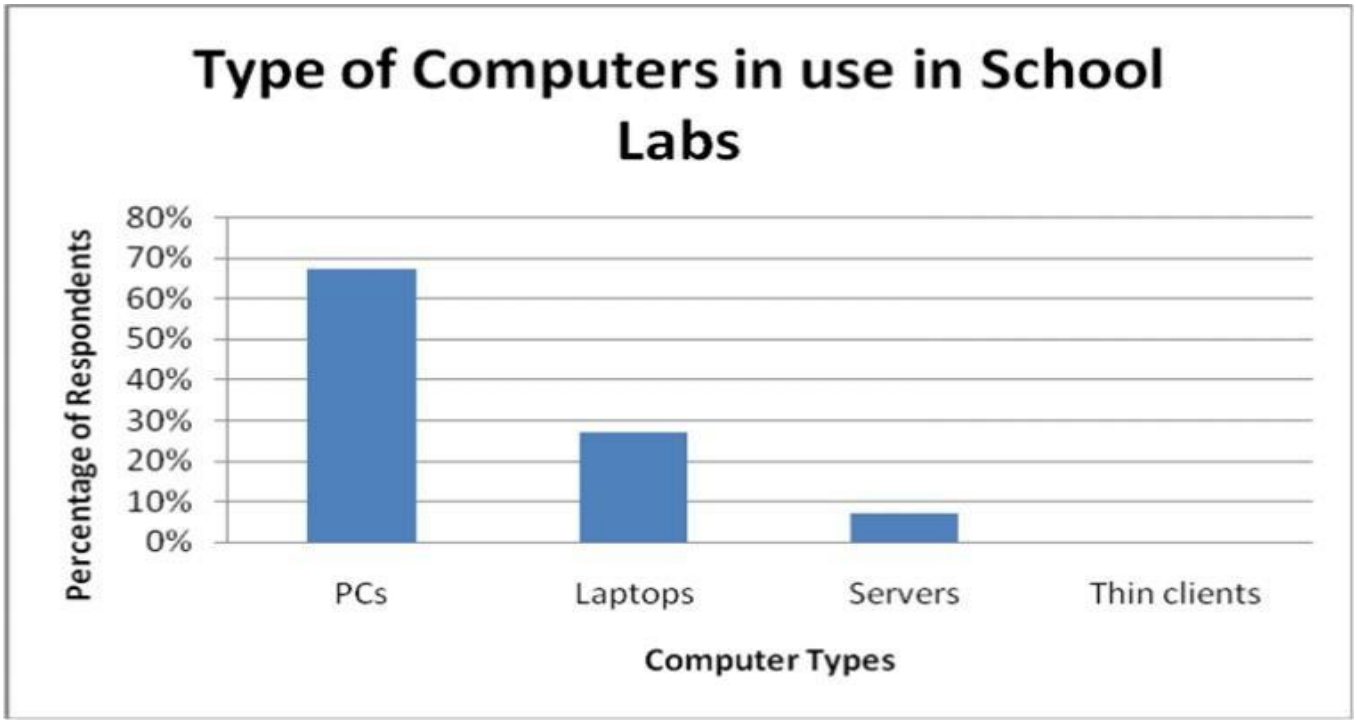

Figure 3. Respondents Knowledge of Ncomputing

Most of authorities and schools are not conversant with Ncomputing technology despite of a number of benefits such as low-cost, low power consumption, easy management, less e-waste [6].

These benefits have been so critical in several other developing countries, like India, Macedonia, New Zealand, South Africa, Swaziland, Uruguay, Ghana, Morocco, and Senegal according to our literature review [8].

4.2 Recommendations for Ncomputing Technology usage

More than 82% of all the respondents do not know what Ncomputing is. This situation might have been caused by a number of reasons. For those who aware of the technology, they do recommend using it in secondary schools.But, as seen in figure 5, less than 10% of respondents recommended to purchase Ncomputing for use. This is less than 17% which

were found to be aware of Ncomputing. This sends a message that there is a portion of respondents who seem to be aware of Ncomputing technology but they are not confident in recommending a purchase of Ncomputing neither any Thin Client technology.

Figure 4. Respondent's recommendations feedback for Computer type to use

4.3 Future Expectances on Computer types

In part 4.2, 92% of respondents recommended deploying Ncomputing in Tanzania Secondary School labs. In overall, 87% respondents still are expecting to buy more PCs and Laptops rather than Ncomputing in their plans as seen in Figure 5.

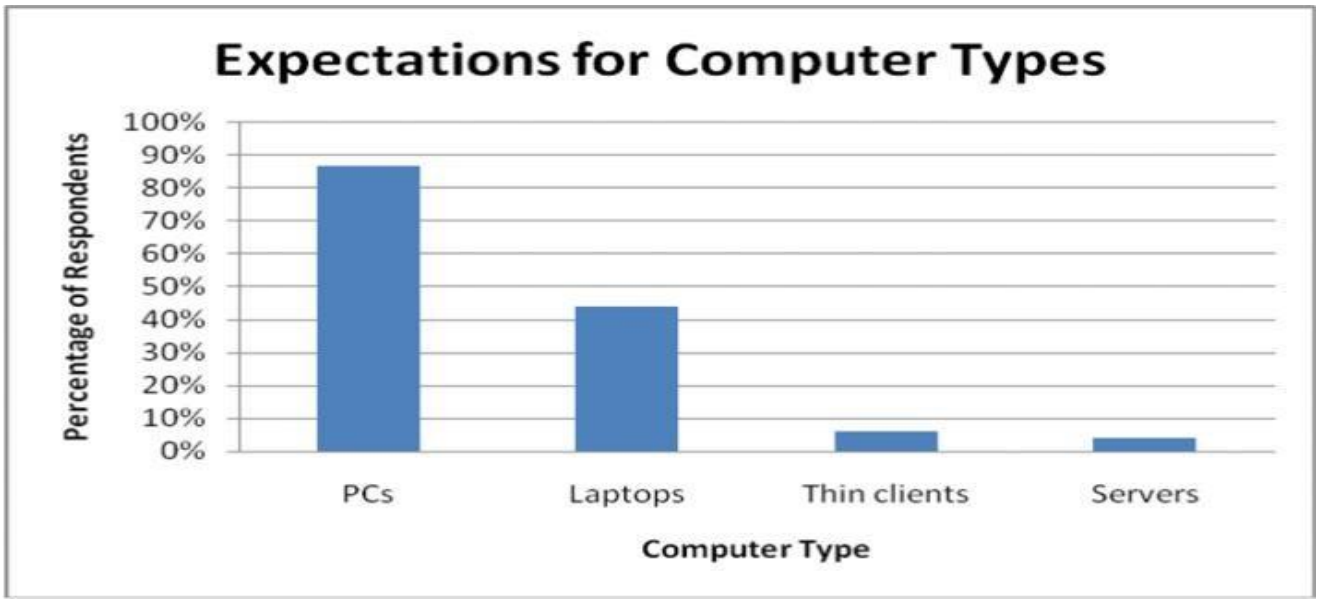

Figure 5. Respondents Expectances on the future computer type to be used

4.4 Reasons for not using Ncomputing

The above findings show that Ncomputing is still not well known to authorities and people responsible in making computer purchasing decisions. Even those who are aware of the existence and benefits of Ncomputing are still uncertain in making decisions of adopting Ncomputing, that the part of 17% respondents who recommended Ncomputing in secondary schools in does not recommend the use of Ncomputing, or even thin clients in their plans of buying computers in the near future. It seems that they are just afraid of a technology which they just know the benefits theoretically, such that they don't want to take risks. Some reasons given by respondents why they have not bought Ncomputing when bought computers for secondary schools recently were: I don't know what Ncomputing is, Ncomputing are not available, and not sure if Ncomputing are good for us as seen in Figure 6.

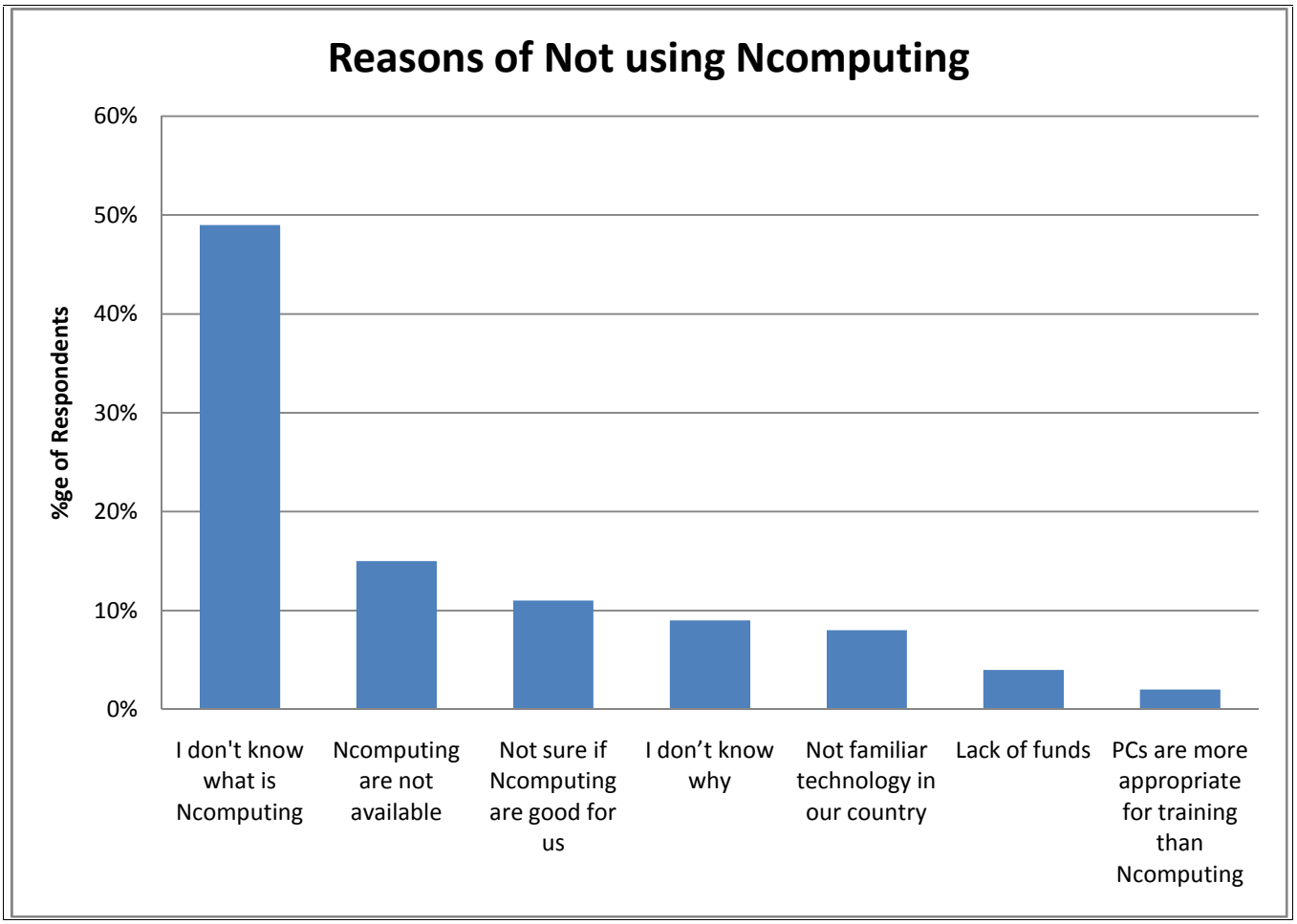

Figure 6. Reasons for not buying and use Ncomputing for Secondary Schools

Figure 6 justifies the unawareness of Ncomputing to most schools and authorities. These findings on Ncomputing awareness seem to be in line with what [17] pointed out that:

"Although low-power PCs exist they are not yet well known especially in developing countries. The absence of publicly-available comparative research about the features and advantages of the various products had

effectively made informed purchasing decisions for schools in Africa practically impossible."

4.5 Obstacles Limiting Secondary Schools from Implementing Ncomputing

Lack of awareness is the most limiting factor for schools not implementing Ncomputing, as it can be seen from figure 7 since 59% claims that it is a new technology to them. Reasons given for Ncomputing not being common in secondary schools in Tanzania all can be interpreted as not knowing the existence of this technology and its benefits to most of the schools and managing authorities. For example, reasons like Ncomputing being expensive and lack of funds shows that it is not known by the schools and authorities that Ncomputing saves a considerable cost as compared to PCs.

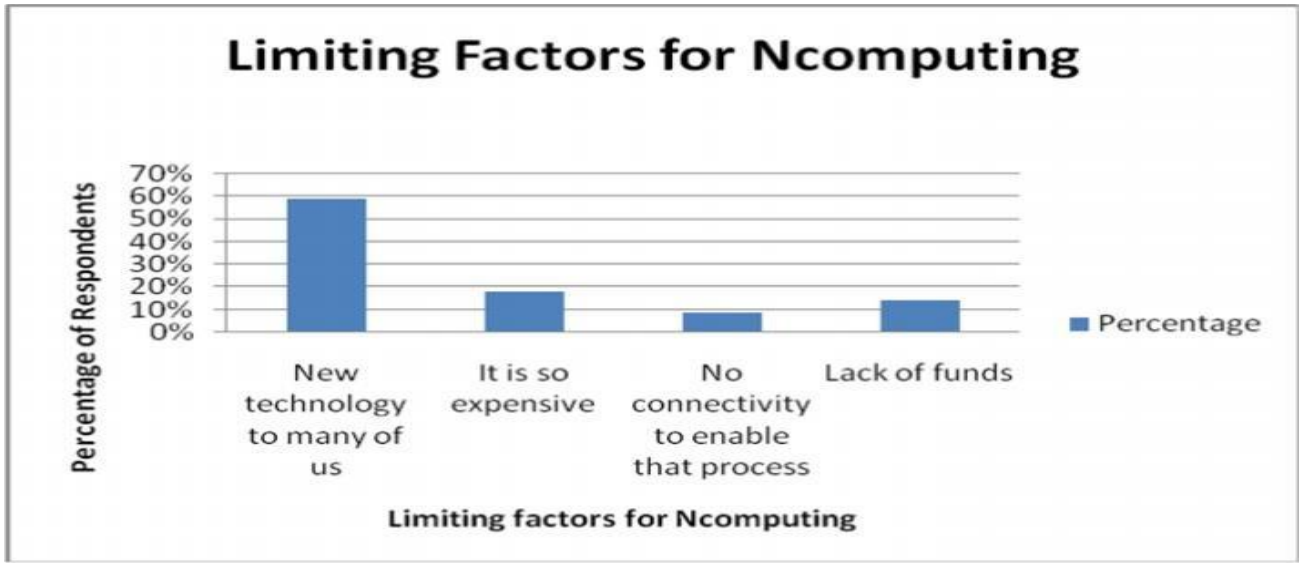

Figure 7. Reasons for Ncomputing not opted in Secondary Schools in Tanzania

5 CONCLUSIONS AND FUTURE RESEARCH

This paper presents an overview of how Desktop Visualization technology is perceived by the stakeholders of Education sectors in Tanzania. It started by researching the overview on Technology Adoption and Ncomputing technology followed by the research on the current status of deployment of Ncomputing in Education Sectors. Theoretically, the TOE framework was used to assess the acceptance issues by these stakeholders. The acceptance on the case of Tanzania shows that currently, 67% of secondary schools are using PCs and Laptops in daily lives. On the other hand, the purchases on the previous 5years are also dominated by PCs which accounts to 80% as compared to other computer types. Also, this research found that 17% understands the mode of operations on Ncomputing but less of them seem to recommend to deploy Ncomputing for future use while 87% expecting to buy PCs for future. 49% of stakeholders claim that they don't opt for Ncomputing because it is not familiar to them and that 59% of them says that the limiting factor which hinders them in using Ncomputing is due to its technological unfamiliarity. The future research will stick to the investigation on the extent to how

Ncomputing offers economical advantages in the education sectors of Tanzania.

This research is dealing with only Ncomputing technology; there might be other slight different results for the case of another technology or the same technology in the other sectors. We suggest the future research to concentrate with ICT readiness by trying to assess how ready Tanzania companies are they in order to successful acquire and assimilate a specific technology or in a specific sector.

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