© 2018 IJSRSET | Volume 4 | Issue 11 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology
DOI : https://doi.org/10.32628/IJSRSET173810

An Investigation of the Impact of System Virtualization on Green ICT Deployment in Kenyan Public Universities

Dennis Karugu Gichuki*, Dr. Alice Wechuli Nambiro, Prof. Franklin Wabwoba
Department of Information Technology, Kibabii University, Bungoma, Kenya

ABSTRACT

The activities of public universities in Kenya today are heavily dependent on software and hence, the systems hosting them. This has resulted in an increased hardware acquisition which has led to increased implementation and maintenance costs as well as increased technical difficulties. This threatens the very sustainability of IT implementation. The purpose of this study was to formulate a system virtualization framework for sustainable IT deployment in public universities in Kenya. The study used mixed method. A survey was conducted in four public universities and one University College. The findings showed that system virtualization encourages hardware reduction, improved software reuse and improved security through the use of system virtualization. These findings imply that system virtualization reduces IT deployment costs as well as reduce amount of hardware components to be disposed. Challenges related to green ICT implementation in universities and university colleges include uncertainty in return on investment, limited financial support and limited collaboration. The study recommends that public universities and university colleges in Kenya to focus on a green IT framework in deploying ICT systems to ensure sustainability of the same.

Keywords : System Virtualization, Green ICT, Public Universities and Kenya

I. INTRODUCTION

Green ICT is the study and practice of designing, manufacturing, using and disposing of computers, servers, and associated subsystems efficiently and effectively with minimal or no impact on the environment [1]. It attempts to attain economic feasibility, better system performance and use, while abiding by social and ethical responsibilities. green ICT is therefore concerned with dimensions of environmental sustainability, energy efficiency, the total cost of ownership (TCO), the disposal and recycling costs. The study and routine of planning, assembling, utilizing, and discarding PCs, servers, and related subsystems proficiently and adequately with insignificant or no effect on nature.

Virtualization is the act of decoupling one computing resource from others without impacting the usability across these resources. Rather than connecting the various layers together the OS to the hardware, the application to the OS, and the user interface and data to the host machine, virtualization technologies loosen the direct reliance these parts have on each other [2], [3].

Virtualization enables many applications and operating systems to run concurrently and in isolation on a single physical host machine. This facilitates several virtual machines to share the resources of the physical host machine, which in turn ensures improved utilization, optimization, and resource efficiency [4], [5]. Virtualization on the other hand is a key concept in cloud computing, without it then

there is no cloud, which has enabled the emergency of a new and sustainable industry [4].

The activities of public universities in Kenya today are heavily dependent on software and hence, the systems hosting them. This has resulted in an increased hardware acquisition to match the increasing number of students being admitted. However, absence of proper technology to implement and deploy ICT in public universities has led to underutilization of ICT resources, increased energy consumption and TCO and other technical difficulties. These challenges have led to the need for a green usable IT deployment framework in universities. System virtualization has been said to have the ability to introduce smart management, encourage scalability and promote optimum resource usage [6]. Despite the benefits, system virtualization has mostly been used on servers and not client computers which form the bulk of costs associated with computing deployment. Therefore, the key focus of this study is to employ system virtualization technology towards achieving green usable IT deployment in public universities in Kenya.

Virtualization technologies can provide cost-effective and scalable solutions to a number of infrastructure management problems that occur naturally in data centres. It is a technique through which the hardware resources of a system like processor network, input output (I/O) and storage can be multiplexed through hardware or software portioning, time sharing and simulation emulation into multiple implementation environments, each of which can act as a comprehensive system by itself. A virtualized environment by and large provides a more optimized operating environment that is flexible to go well with varying demands [7].

II. RELATED WORK

While virtualization was introduced several decades ago, it did not pick due to poor hardware performance. With improved hardware performance however, virtualization is emerging as the most promising technique for eliminating e-waste, costs associated ICT deployment and use. The software layer that provides virtualization in virtual machines (VMs) environment is called virtual machine monitor (VMM) or hypervisor. This is a host program that allows a single computer to support multiple, identical execution environments where users are unaware of resource sharing. Besides virtual machines being flexible, secure, easy to manage and configure, which are beneficial, they also increase the performance virtual systems in computing. The major types of virtualization techniques include; full virtualization, para virtualization, pre-virtualization and hardware virtualization.

Modern data centers are energy intensive and this seems to increase at an alarming rate. Fortunately, server management strategy can significantly reduce the data center energy consumption since the average server utilization is quite low in a typical data center [8]. There are several types of virtualization technologies which include; server virtualization, storage virtualization, network virtualization and desktop virtualization among others. According to [9] different virtualization technologies use different kind of virtual machine monitor or hypervisor so the performance is also varied. Though par virtualization performance was slightly better than full virtualization, full virtualizations strength on par virtualization is superior security, its cleanliness diagram, heterogeneity OS support and hardware advancement get the attention of the enterprise to switch to the full virtualization [9].

Virtualization technology not only enables consolidating multiple systems on a shared single physical machine, but also acts as an enabler technology for cloud computing [2]. Each VM is completely separated from the other VMs and hence, it can be moved to other machines. Complete separation of each VM simplifies load balancing,

dealing with hardware failures and enhances scalability [10]. In addition, sharing resources promises a more efficient usage of the available hardware [10]. However, the sharing of the same physical resources by VMs influence each other's performance.

III. METHODOLOGY

Survey and quasi-experiment designs were used in this study. According to Kumar [11] quasi-experimental study is also known as semi-experimental study because it has the properties of both experimental and non-experimental studies. Kothari [12] argues that an experiment is an investigation in which a factor or a variable under test is isolated and its effect(s) measured. According to [13], experimental research seeks to determine if a specific treatment influences an outcome. The impact is assessed by providing a specific treatment to one group and withholding it from another and then determining how both groups scored on an outcome.

IV. FINDINGS AND DISCUSSION

Hardware Reduction

On practical based techniques and via questioning protocol and think-aloud-protocol, a focus group was guided to interact with virtualized systems noting the amount of hardware exposed to the user. The following question was asked, "*By what percent do you think system virtualization has reduced the amount of hardware exposed to the user?*" the table below summarizes the findings.

TABLE I. HARDWARE REDUCTION

		Frequency	Percent
Valid	0% to 20%	0	0.0
	21% to 40%	1	7.6
	41% to 60%	3	23.1
	61% to 80%	3	23.1
	Above 80%	6	46.2
	Total	13	100

The response tabulated in table above indicates that the 46.2% expert users of system virtualization agreed that the technology has reduced the hardware exposed to the user by above 80.0%, 23.1% agreed that the technology reduced hardware exposure by between 61% and 80%, 23.1% agreed that the technology reduced hardware exposure by between 41.0% and 60.0%, a paltry 7.6% agreed that the technology reduced hardware exposure by between 21.0% and 40.0% while there was no response registered for the 0.0% to 20.0%. This was noted through question protocol and thoughts elucidated by the respondents.

This implies that system virtualization maximizes hardware used which in turn cuts down hardware components, with the average hardware reduction being above 60%. This in turn cuts down the cost of power consumption, maintenance costs, reduced carbon emission and unnecessary disposition, floor space overhead and allows quick addition and multiplication of hardware resources.

Software Reuse

On practical based techniques and via questioning protocol and think-aloud-protocol, the focus group was guided to interact with virtualized systems noting the reusability of software and software exposed to the user. The following question was asked, *"By what percent do you think system virtualization encourages software reuse?"* The table below summarizes the findings.

TABLE II. SOFTWARE REUSE

		Frequency	Percent
Valid	0% to 20%	1	7.7
	21% to 40%	1	7.7
	41% to 60%	4	30.8
	61% to 80%	3	23.0
	Above 80%	4	30.8
	Total	13	100

The responses tabulated in table above indicates that the 30.8% expert users of system virtualization agreed that the technology has increased software reusability by above 80%, 23.0% agreed that the technology increased the software reuse by 61% to 80%, 30.8% agreed that the technology increased the software reuse by 41.0% to 60.0%, a paltry 7.7% agreed that the technology increased software reuse by 21.0% to 40.0% while 7.7% agreed that system virtualization increased software reuse by 0.0% to 20.0%. This was noted through questioning protocol and thoughts elucidated by the respondents.

This implies that system virtualization allows software to be portable to any platform without undue cost, since the software are installed in the servers on which all terminal access and share the same software resource running at the same speed with similar services. This was captured from experts through think-aloud protocol which also pointed that the process reduces cost of software through licensing, installation and configuring, access as well as flexibility to software. This contributes to a reduction in costs of purchasing software for each individual hardware device as well as reduce time required to configure software since this is done centrally.

Security Concerns

On practical based techniques and via questioning protocol and think-aloud-protocol, the focus group was guided to interact with virtualized systems noting the security aspect of the user data. The following question was asked, *"How secure do you think system virtualization is?"* The table below summarizes the findings.

The responses tabulated in the table above indicate that the 38.5% expert users of system virtualization agreed that the technology is secure to the user data by 41.0% to 60.0%, 30.8% rated the technology to be 61.0% to 80.0% secured, 23.1% rated the technology to be 21.0% to 40.0% secured, 7.6% rated the technology to be 0.0% to 20.0% secured, while no response was captured indication that the system virtualization is above 80% secured. These responses were noted through questioning protocol. This implies that system virtualization although secure, a lot need to be done to gain the confidence of the users.

TABLE III. SECURITY CONCERNS

		Frequency	Percent (%)
Valid	0% to 20%	1	7.6
	21% to 40%	3	23.1
	41% to 60%	5	38.5
	61% to 80%	4	30.8
	Above 80%	0	0.0
	Total	13	100

Think-aloud protocol on the same focus group forum indicated that the technique used to implement virtualization contributed to security concerns for instance it was noted that the systems on a virtual platform on hypervisor level 1 more vulnerable to security threats than hypervisor level 2 platform. It was noted that the interaction with hypervisor level 1 is faster, has reduced performance overhead but it was proved to be less secured platform. The interaction on hypervisor level 2 proved to have higher performance overhead, very slow but very secure.

V. CONCLUSION

Not only does virtualization improve better server management, it also offers significant costs and operational benefits. For example, hardware reduction contributes to significant costs reduction, e-waste reduction as well as time required to configure the hardware components. It therefore worth noting that ICT deployment related savings with virtualization can be substantial.

Virtualization has shown great potential in enhancing green ICT deployment in public universities in Kenya.

Through intensive measurements, the paper obtained critical statistics for reduced e-waste, efficient energy consumption, and reduced maintenance effort. In a nutshell therefore, the role virtualization plays in relation to green ICT deployment cannot be gain stated.

VI. RECOMMENDATIONS

System virtualization offers a great opportunity of sustainable IT deployment in public universities. It is therefore recommended that public universities adopt proper approaches of deploying ICT through virtualization. The success of this will be greatly influenced by virtual applications performance.

VII. REFERENCES

[1] S. Murugesan, "Harnessing green IT: Principles and practices," *IT professional 10.1,* pp. 24-33, 2008.

[2] H. Jin, "Desktop virtualization: Path to pervasive computing in cloud computing era," in *6th International Conference*, Port Elizabeth, South Africa, 2011.

[3] V. Vijay, V. Chitra and D. Priya, "Desktop Virtualization Solutions - A Comprehensive Survey," *nternational Journal of Advanced Computer Research,* vol. 3, no. 3, pp. 114-122, 2013.

[4] VMware Inc., "How VMware virtualization right-sizes IT infrastructure to reduce power consumption," 2009.

[5] V. Motochi, S. Barasa, P. Owoche and F. Wabwoba, "The Role of Virtualization towards Green Computing and Environmental Sustainability," *International Journal of Advanced Research in Computer Engineering & Technology (IJARCET),* vol. 6, no. 6, pp. 851-858, 2017.

[6] R. J. Row, "Utilizing Computing Power more effectively," *Bright Hub,* 2011.

[7] M. Chebiyyam, R. Malviya, S. K. Bose and S. Sundarrajan, "Server Consolidation: Leveraging the Benefits of Virtualization," *Infosys Research, SETLabs Briefings,* vol. 7, no. 1, pp. 65 - 75, 2009.

[8] N. Fernandes, M. Moreira, I. Moraes, L. Ferraz, R. Couto, H. Carvalho, M. Campista, L. Costa and O. Duarte, "Virtual Networks: Isolation, Perfomance and Trends," *Annals of Telecommunications,* vol. 66, pp. 339-355, 2011.

[9] S. Suresh and M.Kannan, "A Performance Study of Hardware Impact on Full Virtualization for Server Consolidation in Cloud Environment," *Journal of Theoretical and Applied Information Technology,* vol. 60, no. 3, pp. 556-567, 2014.

[10] VMware, "A Performance Comparison of Hypervisors," 2007.

[11] R. Kumar, Research Methodology: A Step-by-step Guide for Beginners, SAGE Publications Ltd, 2014.

[12] C. R. Kothari, Research Methodology: Methods and Techniques, Mumbai: New Age International (P) Ltd, 2010.

[13] J. W. Creswell, Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 3rd ed., California: SAGE Publications, Inc., 2009.