

NComputing Adoption: Issues and Challenges

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Abstract— NComputing Technology is becoming increasingly important and is being used both in academe and business industry because of its capability of saving energy and maintenance costs. However, the adoption of this technology faces with concerns particularly in end users experiences. The paper aimed to examine the collection of some of the issues and challenges facing the NComputing technology adoption in academe particularly in Surigao del Sur State University and offered an initial roadmap to view the challenges and problems for further research. Findings revealed that most of the students were not satisfied with the performance of this technology. But, for technical support, they found it easy to maintain and troubleshoot.

Keywords— ncomputing technology, adoption, qualitative analysis, desktop virtualization, issues & challenges

I. INTRODUCTION

Ncomputing is a technology that allows multiple users to share one computer simultaneously. This means that with NComputing one could have one ordinary desktop computer catering for up to 30 people or more at the same time [1]. The adoption of NComputing technology has gained a lot of benefits and advantages because it reduces hardware and maintenance costs. It also enhances security, productivity, and provides easy maintenance and improves flexibility [2][3][4][5][12]. Despite the impending applications of NComputing both in academe and business sector, there are a number of issues that need to be addressed to successfully adopt NComputing in real life environments. Reference [6] classified the issues into: (a) cost, (b) storage, (c) network, (d) multimedia support, and (e) user experience to NComputing adoption. Reference [7] clarified that using the Virtual Desktop Infrastructure (VDI) which is the heart of NComputing technology will require a major investment in server hardware, and possibly in storage and network infrastructure and Server side problems can affect multiple users. There are some potential barriers to the adoption of this technology such as limited offline capability, increasing data center, user license agreement and bandwidth latency which affect its performance [5]. Reference [8] discussed the three big challenges in desktop virtualization. These were the issue in software licensing terms, uncertain ROI, and end user acceptance. Reference [9], in his study chose Technology-

Organisational- Environmental (TOE) Framework as their reference guide and their paper observed critical issues which have been involved in the adoption of Desktop Visualization technology in the Tanzania Education sectors. Recently, there is an increasing trend in the number of articles on NComputing. This indicates the importance of this technology in both manufacturing and service applications.

This study attempted to examine the primary research question: *What are the issues and challenges of NComputing Technology adoption?* Upon reviewing some of the articles on NComputing, it was found out that there is no paper that exclusively deals with the issues and challenges facing the NComputing technology adoption from an integrated managerial and technological perspective. Realizing the importance of the application of NComputing technology, an attempt has been made in this article to discuss some of the issues and challenges facing this technology adoption both in academe and business sector.

The study used the qualitative research approach to investigate the issues and challenges of NComputing adoption. The respondents were the selected students and technical support teams of Surigao del Sur State University and distributor of NComputing device in the Philippines.

A. Overview of Ncomputing Technology

NComputing virtual desktops have been deployed everywhere, from classroom labs to large VDI deployments

with more than 30,000 workstations. The NComputing solution provides the lowest-cost computing solution both in academe and Small Medium Enterprise, offers protected access to information in hospitals, and resists intense environments in factories. By leveraging a single commodity computer and operating system, NComputing can distribute up to 100 individual user sessions, and reduce its maintenance costs by 75%. NComputing innovation makes it possible for users to renovate existing devices such as laptops and netbook into new virtual clients. It intensifies the capability to address today's top IT priorities such as, supporting mobility, enabling BYOD, and managing Windows OS transitions. NComputing products significantly decrease e-waste due to their size. They are much even lighter and last three (3) times longer than desktop PCs [10]. Figure 1 presents the architecture of NComputing technology.



Fig. 1 Architecture of NComputing

B. Technical Specifications of NComputing Devices

TABLE I
TECHNICAL SPECIFICATION OF L-SERIES NCOMPUTING

Feature	L130	L230	L250	L300	L350
Full Screen Video			✓	✓	✓
High availability login			✓	✓	✓
Rapid Deployment Tools			✓	✓	✓
24-bit color depth		✓	✓	✓	✓
Microphone port		✓	✓	✓	✓
Maximum display resolution	1440 x 900	1440 x 900	1440 x 900	1920 x 1080	1920 x 1200
Video port	VGA	VGA	VGA	VGA	DVI-D
Maximum Users per host*	100	100	100	100	100
Speaker output	✓	✓	✓	✓	✓
Mounting bracket	✓	✓	✓	✓	✓
Low power (3-5W)	✓		✓	✓	✓
USB peripheral support		USB 1.1	USB 2.0	USB 2.0	USB 2.0
Keyboard & Mouse Ports	PS/2	PS/2	USB 1.1	USB 1.1	USB 2.0

TABLE III
TECHNICAL SPECIFICATION OF N-SERIES NCOMPUTING

FEATURE	N600
GENERAL	
System on Chip	Yes
DRAM Memory	1 GB
GRAPHICS CAPABILITY	
Primary display	Up to 1920x1200
Secondary display	Up to 1920x1200
DDC/EDID support	Yes
Display interface	2 x Display Port
Video port adapter options	Display Port to VGA, DVI-D, or HDMI
Monitor rotation	Yes, independent rotation of each display
VIDEO	
Playback	Full HD 1080p (client-side rendering with hardware acceleration, both monitors)
CODECS	
Client-side rendering	H.264, MPEG-4, VC1
FLASH VIDEO	
Playback	Full HD 1080p (server-side rendering with hardware acceleration)
POWER MANAGEMENT	
Power	13.5 W max
Instant on	Yes
Wake on LAN	Yes

TABLE IIIII
TECHNICAL SPECIFICATION OF M-SERIES NCOMPUTING

FEATURE	
UP TO 45 USERS PER HOST	Fewer PCs to manage and lower computing costs per user
ETHERNET CONNECTED	Connect at distance with Ethernet
NUMO 2 SOC	Second generation Numo device provides full screen video streaming
VSPACE SERVER	Simple to install, easy to configure and no complicated hypervisors (nor their annual license fees) to manage, but if desired vSpace runs great on a hypervisor
HARDWARE	
KIT CONTENTS	M300 Kit includes three M300 client devices*, power supply with power cord, vSpace Server software installation CD/license and User's guide, Quick Install Guide and VESA screws **
SIZE	Primary client: 160mm(w) x 120mm(d) x 35mm(h) Satellite client: 120mm(w) x 99mm(d) x 33mm(h)
WEIGHT	M300 primary client device: 0.21 kg / 0.46 lbs M300 satellite client device: 0.12 kg / 0.26 lbs
KIT SHIPPING WEIGHT	0.96 kg or 2.1 lbs (includes 3 client devices, power adapter, documentation, etc.)

C. Current State of NComputing Adoption in Academe

A study conducted by [11] on the adoption of desktop virtualization technology using Ncomputing in education sector. The researchers have selected technology Organizational Environmental (TOE) structure as their guide for their study. Their research examined vital concerns in the implementation of Desktop Virtualization Technology in their education sector. They found out that majority of the schools in Tanzania were still using desktop computers and laptops and most of the schools stakeholders were not familiar with the technology [12].

The Government of India is one of the recipients of NComputing Technology to increase their contact and control in the field of ICT education. Around 2622 schools have been provided by 22 seats computing laboratories with the use of 20 units of X550 NComputing devices, two desktop computer and one UPS and two printers [13].

In the Philippines, NComputing has already deployed their different products among schools and universities. More than 300 units of various NComputing products were implemented and used in school laboratories of Misamis University in Ozamiz City. Ncomputing company was able to provide the support and customer care the university needed [14]. The Adventist University of the Philippines was able to set up roughly 200 users of NComputing workstations and all their NComputing devices were functioning properly. Naga Foundation College is using X550 model of NComputing access device for more than 6 years until now. Vineyard International Polytechnic College installed 25 NComputing products in their computer laboratories and all the units are working completely that satisfy the needs of their students and they found them fast, maintenance free and reasonable to purchase. According to the administrator of Princeton Science High School of Batangas, the implementation of these products to their school provides many benefits due to its performance and affordable price. A high speed server connected with 25 users is so remarkable that it performs like a desktop PC [15]. NComputing technology can accommodate 50 users simultaneously in a main server. The university is highly convinced with NComputing technology and that is the reason behind why they have deployed more than 300 NComputing users in the entire university [16].

D. Factors affecting the adoption of NComputing

Reference [17], clarifies that the variations in the prototype of IT adoption are attributed to a lot of aspects e.g. industry

lead, market opportunity and government policy. According to the study of [9], culture and willingness of leaders were some of the factors affecting the adoption of NComputing. This study was supported by [18], in which he emphasized that the way of which people and society utilized information technology was greatly influenced by their culture. Another compelling factor that affected the adoption of NComputing according to [9] was the lack of knowledge in technology. There were a lot of factors that affected the adoption of NComputing technology such as attitude, external and internal factors such as financial capability of a certain organization.

E. Issues and Challenges of NComputing Adoption

According to [19], he found out that there was an issue on the use of Thin Client particularly in the multimedia application. This findings was also supported by [20] who stressed that Thin Computing was not the best in multimedia applications. Reference [21] discussed on the issue of user acceptance of Thin Client. Since only one server is used in NComputing, there is a greater chance that lags will be experienced by the end users because the speed of the server is a critical issue that determine the performance of NComputing working environment. Another issue is the selection of the type and model of NComputing product which plays an important role that affects the performance of the technology. Moreover, earlier versions and models of NComputing devices seem to be slower compared to the new ones.

II. METHOD

A. Research Design

This study utilized a qualitative research approach. In fact, this approach allows the researcher to discover the trend of knowledge considering the limited number of studies regarding the issues and challenges of NComputing adoption particularly in the Philippines. In addition, qualitative method is the best approach in order to find the exact answer for the research question, **“What are the issues and challenges of NComputing Adoption?”** using interview as a tool for gathering the data. This approach does not consist of numbers or quantifying of data; instead, it will be taken from face to face interviews and interpretation made by the author [22].

B. Data Collection Method

Interview was chosen as a data gathering procedure for this study. The researcher used interviews because this method is very applicable in order to answer the question “What are the issues and challenges of Ncomputing Adoption in Surigao del Sur State University?” Considering that Ncomputing is a comparatively new topic and there are only few researches conducted that deal with the research problem. The qualitative approach will be selected for achieving the objectives of this study, due to its nature to give a thorough comprehension of the research problem [23]. It is more personal than questionnaires, thus letting the interviewer to connect with the interviewee and acquire an improved understanding of the key informant’s environment. An interview could be structured, which resembles a questionnaire with very firm proper questions, semi-structured, which allows for more stages of interaction and the questions are not so formal, and unstructured, which is more like a discussion, with no formal questions [24]. Face to face semi-structured interviews will be used in this study.

C. Data Gathering

The researcher interviewed Twenty (20) students coming from the four (4) different colleges which are the College of Education, College of Engineering Computer Studies and Technology, College of Arts and Sciences and College of Business Management. They were asked on their experiences in using the NComputing technology; there were acceptability issues and challenges in relation to Ncomputing adoption and what were the barrier/issues they encountered while using the technology. Furthermore, they were also asked if these issues were addressed by the administration. The researcher then interviewed four (4) university technicians who were in charge of the NComputing implementation. Besides, the CECST College Dean and ICT Director were also interviewed by the researcher. They were asked regarding the issues and challenges of NComputing Adoption in the university. The interview was recorded via android phone in order to properly review and transcribe the data. Consequently, data analysis will be established. Table IV presents the distribution of key informants.

TABLE IVV
DISTRIBUTION OF KEY INFORMANTS

Respondents	Number of Respondents
College of Engineering Computer Studies and Technology	5
College of Teacher Education	5
College of Business and Management	5
College of Arts and Sciences	5
Technical Support	4
CECST College Dean	1
ICT Director	1
Total	26

D. Validity and Reliability

This interview guide was adopted from the study of Llewellyn et. al [25]. This was used by the authors throughout their studies and the validity and reliability of this interview guide were already tested.

III. RESULTS AND DISCUSSIONS

A. Students Experiences Issues

Students as respondents of the study spoke about their experiences in using NComputing technology. Majority of them were disappointed with regards to the performance of the computer they have used.

“The computer together with the application programs especially loads slowly especially if many of us are using NComputing”

Another group of respondents opened;

“This technology is not applicable for us computer science students because we oftentimes experience lag especially when we used visual studio programming.”

Their classmates added;

“This technology is only suitable for internet browsing and for office application.”

The contention of dissatisfaction of key informants regarding their experiences in using NComputing technology pointed out as a major issue and should be correctly addressed in the adoption of this technology. The present experiences of students in using Ncomputing technology have a big impact to the success of Ncomputation adoption. The research study on

this account concluded that Students' experiences of Ncomputing is an issue that must be considered and addressed especially for the students who have used this technology for internet browsing, according to them.

"It's Ok to use this technology for internet browsing only."

B. Technical Support Issues

The Technical support team expressed dissatisfaction on the performance of the NComputing in terms of speed. However, they expressed that it is easy and convenient to maintain and troubleshoot NComputing. All the participants in technical support experienced difficulty in installing and setting –up the NComputing. They thanked YouTube website because they used it as their references every time they had questions with regards to the procedures in installing the software. Also they explained that there were software compatibility issues that they encountered in this technology. It means that software will run on the server side but did not on the user or client side. They also noticed that upon using the L300 series of NComputing product, the usb port attached to it oftentimes malfunctioned and they needed to restart the server to solve the issue. All of them agree that server and network devices play a crucial role in the operation of the technology. Because once the server or switch will down, all the operation will be affected. Indeed, three of the technicians explained that-

"The NComputing technology decreases the maintenance costs but it is a failure on the user side"

C. Management Issues

The organizational support was very strong in regard to the adoption of this technology considering the many advantages and benefits that they gained from this technology. They are always very supportive to whatever innovations and adoptions of new technologies as long as it has to undergo a correct protocol and procedure. Actually, they encourage the IT experts and faculty from the university to benchmark from other universities and industry and apply the good practices they learned from it for the welfare of the school. According to one of the participants who is the CECST College Dean, he said:

"The management has positive outlook to whatever proposals with respect to IT as long as there is a proposal submitted because we have money"

The participant in the management aspect revealed that there was no barrier in the adoption of Ncomputing in the university because it saves them maintenance costs. Nevertheless, he pointed out that the major issue on this technology is on the government procurement procedure. According to him:

"Once the NComputing server is down, the time element to which its whole operation will be restored will take longer because it will still undergo bidding processes in order to purchase the defective item. All of these items must be placed in the project procurement management plan and reservation of items such as processors and motherboards in order to back up the NComputing server is not allowed."

D. Result Analysis

The purpose of this study is to identify the major issues and challenges that impact the adoption and use of NComputing technology in the university. In this study, all the respondents

agreed that the performance of this technology is poor compared to a desktop computer. It means that the majority of the students are not satisfied in using it. Also, the majority of the participants agreed that Ncomputing is only suited for internet browsing and encoding of documents. The majority of BSCS students agreed that Ncomputing is not appropriate to be installed in the computer laboratories because of its poor performance in running programming languages, computer graphics, simulations and other multimedia application which is required in their course. Findings revealed that all of participants in technical department experienced relief from maintaining the Ncomputing both in hardware and software aspects. They all agreed that their job in fixing and troubleshooting the server became easier and faster.

Thus, it saves them time and energy in doing the task. However half of the technicians are not aware that there are upgraded and new models of Ncomputing devices that are much better in terms of performance compared to the old ones. This is the reason that they will not recommend this technology to their friends who are working in other institutions and company. Additionally, they all agreed that configuring and installing the NComputing set-up could be difficult at first. But once you are familiar with it. It seems to be easy on their part to manipulate it later. Findings revealed that the role of management is very crucial in determining the success of NComputing adoption. It is found out that the management is very supportive in the adoption of this technology because of the many benefits NComputing technology has to offer to the university.

E. Addressing the issue on the performance of NComputing

The role of the management is very crucial and plays a vital role in determining the success and failure in the adoption of Ncomputing technology. Government procurement issues should be resolved and addressed properly because it is the major cause of delay in the rehabilitation of Ncomputing operation. Proper training and exposure of technical support to this technology are issues that need management support. There are several issues related to the Ncomputing adoption and usage that the management needs to look into. Some of these are choosing the right project manager, securing and housing the server away from its destruction.

F. Ncomputing Implementation Strategy

To address the issues with respect to the poor performance experienced by the students regarding the use of NComputing, the ICT Director must adopt a strategy for the design and implementation of this technology. The ICT director who is in-charge of the implementation of NComputing must select the best NComputing solution that is already available in the market today. Upgrading the servers in its optimum level will be a great help to solve this issue. Another challenge that the management will look into is to upgrade its network infrastructure. The use of SSD hardisk, Gigabit network devices and category six (6) cables will improve the speed and performance of a network and the transmission of data from the client to the server. Ncomputing should not be used in computer science students' computer laboratory, but a diskless technology can be best used in running multimedia and programming languages instead.

IV. CONCLUSIONS

In this paper, the researcher had identified the major issues and challenges affecting the usage and adoption of NComputing Technology in the university. The successful adoption of NComputing requires the management support for a new implementation strategy that will improve the performance of this technology. The findings of this paper will require the management to select the best NComputing solutions which are already available in the market nowadays.

REFERENCES

- [1] "What is NComputing?", Zedwiztech, 2011.
- [2] S. Ahmed and K. Moukali, "An Efficient Implementation of Thin Client Technology for E-learning in the Jazan University", *IEEE*, 2014.
- [3] J. Adams, "Top 5 Benefits of Desktop Virtualization", *Whitehatvirtual.com*. [Online]. Available: <http://www.whitehatvirtual.com/blog/bid/334816/top-5-benefits-of-desktop-virtualization>. [Accessed: 05- Feb- 2017].
- [4] D. Pfeiffer and D. Pfeiffer, "Benefits of Desktop Virtualization | Devon IT", *Devonit.com*, 2017. [Online]. Available: <http://www.devonit.com/blog/four-prominent-benefits-desktop-virtualization>. [Accessed: 05-Feb- 2017].
- [5] "Desktop Virtualization", *Capgemini*, 2017. [Online]. Available: https://www.capgemini.com/resources/resource/pdf/Desktop_Virtualization.pdf. [Accessed: 05- Feb- 2017].
- [6] J. Brodtkin, "5 virtual desktop pitfalls", *Network World*, 2017. [Online]. available: <http://www.networkworld.com/article/2206096/computers/5-virtual-desktop-pitfalls.html>. [Accessed: 05- Feb- 2017].
- [7] L. Harbaugh, "The Pros and Cons of Using Virtual Desktop Infrastructure", *PCWorld*, 2017. [Online]. Available: http://www.pcworld.com/article/252314/theros_and_cons_of_using_virtual_desktop_infrastructure.html. [Accessed: 06- Feb- 2017].
- [8] V. King, "3 Big Challenges to Desktop Virtualization & 6 Things You Can do", *Whitehatvirtual.com*, 2017. [Online]. Available: <http://www.whitehatvirtual.com/blog/bid/223456/3-big-challenges-to-desktop-virtualization-6-things-you-can-do>. [Accessed: 05- Feb- 2017].
- [9] R. Michael, "ACCEPTANCE OF DESKTOP VISUALIZATION TECHNOLOGY IN EDUCATION SECTORS– A CASE STUDY OF NCOMPUTING IN TANZANIA", *The International Journal of E-Learning and Educational Technologies in the Digital Media*, vol. 1, no. 2, pp. 81-91, 2015.
- [10] "About NComputing | NComputing", *Ncomputing.com*, 2017. [Online]. Available: <https://www.ncomputing.com/en/company/overview>. [Accessed: 29- Jan- 2017].
- [11] T. Uy, "NComputing Technology", *The International Journal of Computer Science*, vol. 2, no. 4, pp. 56-60, 2015.
- [12] D. Couzens, D. Kurteva and J. Anderson, *NComputing Celebrates African ICT Education Successes at eLearning Africa*, 1st ed. 2013.
- [13] "NComputing and C-DAC deliver affordable, high performance computer labs to 2622 schools in Haryana | NComputing", *Ncomputing.com*, 2017. [Online]. Available: <https://www.ncomputing.com/en/news/press-release/ncomputing-and-c-dac-deliver-affordable-high-performance-computer-labs-2622>. [Accessed: 24- Jan- 2017].
- [14] "Misamis University Official Site - Ozamiz City", *Mu.edu.ph*, 2017. [Online]. Available: <http://www.mu.edu.ph/>. [Accessed: 09- Feb- 2017].
- [15] "Ncomputing | Ncomputing Philippines Authorized Distributor, Importer & Integrator", *Ncomputingph.com*, 2017. [Online]. Available: <http://ncomputingph.com/>. [Accessed: 09- Feb- 2017].
- [16] "Saint Louis University, Baguio City, Philippines", *Slu.edu.ph*, 2017. [Online]. Available: <http://www.slu.edu.ph/>. [Accessed: 09-Feb- 2017].
- [17] I. Hong and M.S. Kang, "An International Comparison of Technology Adoption: Testing the UTAUT model", *The Journal of Information & Management*, vol. 48, pp.1-8, 2016.
- [18] J. Chae, "The consideration of cultural differences in the design of Information Systems", *The Journal of Information and Management*, pp. 669-684, 2017.
- [19] R. Becta. "Thin Client technology in schools. Coventry, UK: Becta", 2015.
- [20] J. Ndwe. "An Investigation Into the Viability of Deploying Thin Client Technology to support Effective Learning in a Disadvantaged, Rural High School Setting". Grahamstown, South Africa: Rhodes University. (2015)
- [21] P. Doyle and M. Deegan, "Case Studies in Thin Client Acceptance". *ICIT Journal*, vol. 3, no. 1, pp. 48-54, 2009.
- [22] J. Creswell, *Research design*, 1st ed. Thousand Oaks, Calif.: Sage Publications, 2003.
- [23] N. Walliman, "*Research Methods: The Basics*", vol. 3, no.5, pp. 5-10, 2013.
- [24] "Approaches to Qualitative Research in Mathematics Education", *Google Books*, 2017. [Online]. Available: [Accessed: 29- Jan- 2017].
- [25] S. Llewellyn, R. Procter, G. Harvey, G. Maniopoulos and A. Boyd, "Facilitating technology adoption in the NHS: negotiating the organisational and policy context – a qualitative study", *Health Services and Delivery Research*, vol. 2, no. 23, pp. 1-132, 2014.