

Thin Client Technology Implementation Challenges for Computer Labs in Public Universities (Afghan Case Study)



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ABSTRACT: Computer labs play a significant role in higher education institutions all around the world. In Afghanistan, students of public universities face poor economic situations and cannot activate internet packages or obtain wired or wireless connections from internet service providers. These connections are essential for improving their skills, performing research, completing assignments, and accessing online resources. As a result, the majority of students use faculty, library, or Information Technology Center computer labs for these activities. All computer labs in the four central public universities are designed and implemented using thick client technology. While thick clients have high initial costs, weak security, consume more power, require higher cooling costs, and are difficult to maintain due to the lack of centralized management. This study aims to understand that why public universities use thick client technology in their computer labs and to identify the challenges associated with designing and implementing thin client technology in computer labs. Semi-structured questions were asked from 30 individual's employees of the mentioned universities by using interviews, focus groups, and observations. The findings show that nearly 87% of the targeted population were unaware of thin client technology, while 13% were familiar but they had concerns about thin client such as a single point of failure, poor procurement policy, lack of staff, the unfamiliarity of students and staff, misunderstanding of the structure, and fear of failure of new technology implementation. These concerns were the main factors preventing them from designing and implementing thin client technology for computer labs.

KEYWORDS: Thick Client; Thin Client; Virtualization; Computer Labs; Information and Communication Technology; Public Universities.

I. INTRODUCTION

In higher education institutions, lecturers have historically been expected to follow the "chalk and talk" strategy to transfer information and knowledge to students, who passively listen and receive the information and knowledge transmitted by the lecturers. Generally, we have two approaches to learning: the passive instructional approach, which is not the most effective way for students to learn, and the instructional approach known as active learning, which involves students in the learning process. Active learning transforms the lecturer's role from a "sage on the stage" to a facilitator of student learning, making students more responsible for actively participating in their own learning. This can be achieved through different methods such as active classrooms and the use of Information and Communication Technology (ICT) alongside traditional classrooms [1].

ICT plays a crucial role in education, significantly impacting teaching, learning, and research processes. ICT is rapidly spreading in higher education institutions worldwide and is used alongside traditional classrooms. The use of ICT has empowered and facilitated all these processes. Technologies such as thick clients, thin clients, and mobile devices are used in combination with traditional classrooms. The most well-known of these technologies is the Thin Client (TC) virtualization paradigm, which requires minimal hardware equipment, low upfront costs, provides better security, requires less cooling, reduces power consumption, and has centralized management for easy maintenance. In this context, using TC technology in computer labs is seen as a tool to make learning more attractive, faster, and more effective. providing easy access to online resources and creating a safe learning environment for research and development [2][3][4].

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Computer labs play significant roles in helping students with distance learning, web-based learning, practicing, accessing online resources, and performing assignments. They also provide better service quality to students, staff, and faculty members. The modern roles of computer labs are important and necessary to improve and enhance productivity, academic performance, information, knowledge, and skills, contributing to the success of higher education institutions both in the short term and long term. Besides facilitating learning and research processes, computer labs also play an important role in international university rankings. They provide both academic and general services for students in higher education institutions and are evaluated as a norm in world-ranking universities [3][5].

Generally, there are two primary types of technologies used in the design and implementation of computer labs: thick clients and thin clients. In Afghanistan, central public universities which are located in Kabul Province have designed and implemented thick client technology for various faculties, libraries, and information technology center computer labs. This is because the majority of students cannot afford to activate internet services on their personal computers (PCs) and mobile devices to access online resources, perform assignments, and use higher education learning management systems. Therefore, they use computer labs for the above-mentioned activities. While thick client technology has its benefits and drawbacks, the current situation of public universities presents more limitations than advantages for its design and implementation. For example, public universities do not have enough budget to purchase thick clients for all the above-mentioned departments due to their high initial costs. Additionally, they lack stable and 24/7 power facilities, as thick clients consume more power. Thick clients also have weak security because sensitive information and data are stored individually on traditional PCs, making them attractive targets for attackers and hackers. Furthermore, thick clients require higher cooling costs, and maintenance is not easy due to the lack of centralized management.

Beside of the above-mentioned activities which students perform in computer labs, thin client technology is also pretty good option for those classrooms where lecturer tries to teach at once the same topic to all his students, and this technology also used in a computer classroom where lecturer and students share and use common software. Besides, the architecture of a thin client solution follows the hierarchy of an education system, centralized in one server which offer services to all students, and it's only managed by one administrator or lecturer as shown in Figure 1[6].

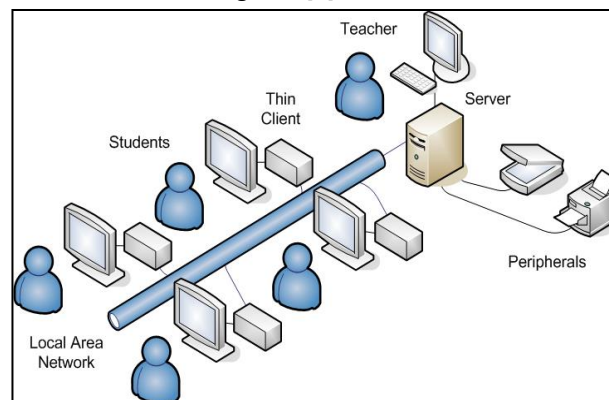


Figure 1: Computer classroom based on thin clients [6].

Designing and implementing computer labs using thin client technology in public universities overcomes some of the limitations associated with thick client technology. Therefore, this technology is an interesting option for the mentioned universities when they want to upgrade their educational computer labs or design and implement new ones.

The objectives of this study are to:

- 1) Determine why public universities use thick client technology in the design and implementation of computer labs.
- 2) Evaluate the challenges associated with the design and implementation of thin client technology in public universities computer labs.

The questions of this study are:

- 1) Why do public universities use thick client technology in the design and implementation of computer labs?
- 2) What are the challenges associated with designing and implementing thin client technology in public universities computer labs?

In order to address the research questions, important information, and vital data were collected from the heads of information technology (IT), library managers, deans and lecturers of computer science faculties of the four central public universities, and the directorate of IT at the Ministry of Higher Education (MoHE) by using the data collection methods of Interviews, focus groups, and observations for answering the core research question and obtain the research objectives. Therefore, a pyramid order of questions

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was conducted in interviews and focus groups. This research study has been conducted to understand and ascertain that why the 4th central public universities (Kabul University, Kabul Medical University, Polytechnic University, and Kabul Education University) design and implement thick client technology instead of thin client for computer labs.

II. LITERATURE REVIEW

A Thin Client or Slim Client, also known as server-based computing, is a small device with an LCD monitor, a mouse, and a keyboard to provide a visual user interface to end-users. This device, which has replaced a large processing unit, offers high performance and has terminals with dual monitor capabilities that are fully expandable as shown in Figure 2. It does not have any moving components such as a hard drive, floppy drive, or CD-ROM. Instead, it uses a centralized server for storing, retrieving, and processing the operating system, data, and applications, as shown in Figure 3[7][8].



Figure 2: Devices used for Thin Client Environment [2].

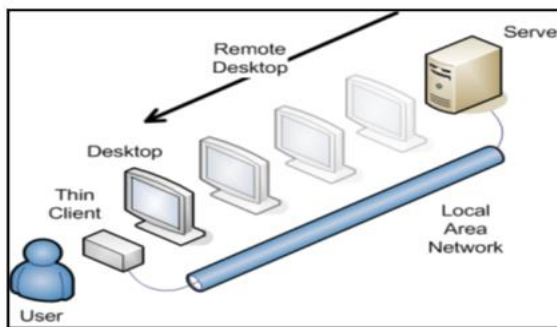


Figure 3: Topology of thin client [6].

Virtualization has simplified the structure, software management, protection, and distribution, and minimized the quantity of hardware equipment. As a result, it reduces power consumption, real estate space, and cooling costs. Over the past ten years, Thin Client has emerged as a leading virtualization paradigm. TC offloads applications and virtual machines (VMs) to the remote server, thereby saving network bandwidth utilization. Many manufacturing organizations worldwide produce TC devices, such as Wyse, Hewlett Packard (HP), 10ZiG, and Nippon Electric Company (NEC). NEC has developed a type of Virtual PC TC framework called the Virtual PC Center (VPCC), which is both easy to use and smart. Table 1 outlines the specialized specifications of the NEC TC [9][10].

Table 1. NEC thin client specifications [9].

Name	Specifications
Processor	Intel Celeron N2920 1.86 GHz quad core processor
Memory	16GB Flash / 2GB RAM DDR3
Interface	USB 2.0 port × 3, USB 3.0 port × 1, Microphone × 1 Headphone × 1. In, Ethernet port, DVI-I ports (Dual Monitor Supported)
Network	1000/100/10 BASE-T Gigabit Ethernet, IEEE 802.11 ac/a/b/g/n (Optional)
Video	Max. 1920 x 1200
Power Supply	Power Supply AC 100V -240V +/- 10%, 50/60Hz
Physical Specifications	Width: 39.5 mm (1.56 inches), Depth: 103 mm (4.06 inches), Height: 143 mm (5.63 inches)
Certifications	CE, VCCI, FCC Class B, and C-Tick
Operating System	Microsoft Windows 8 Embedded Standard (WES)
Client Software	Internet Explorer, Windows Media Player 11, RDP Client (Protocol version 8.0), Citrix Receiver 14.2, VMware Horizon View Client 3.2

Since 2011, Jazan University has been the first university among all universities in the Kingdom of Saudi Arabia to successfully implement Thin Client technology for students enrolled in E-Learning and Distance Learning courses. The architectural overview of Jazan University's VPCC environment is shown in Figure 4. Currently, all labs equipped with TC technology are operating with high performance, effectively and efficiently. The most significant advantage of these labs is that administrators can control each

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lab remotely from one central site. Jazan University has achieved enormous benefits after the successful design and implementation of TC technology in labs. Some of the advantages are mentioned here such as, reduced upfront costs, effortless and simplified configuration of TC terminals, easy management compared to traditional PCs and client-server systems, and robust security because critical information is stored in a remote location, with only screen and console information sent over the link [2].

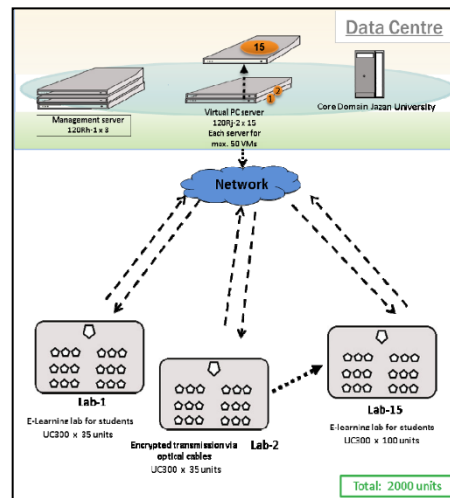


Figure 4: Architectural design of VPCC for Jazan University [2].

Reed managed service organization that provides Wyse technology services replaced all of its 4,500 traditional PCs with thin clients and implemented virtualization technology in the data center. In one year, the mentioned organization has saved as follows [11]:

- Reduced 5.4 kWh of energy consumption;
- Cut 2,800 tonnes of CO2 emissions;
- Cut in half the number of storage drives;
- Reduced the servers by a factor of 20;
- Cut the annual IT budget by a fifth.

In Nairobi County, the process of adopting thin client technology in public universities faced numerous challenges. The main challenges included a lack of qualified and professional ICT employees, user struggles with technology changes, insufficient support from top management, and a lack of financial resources needed for initial procurement, installation, configuration, personnel training, maintenance, and future enhancements. Additionally, there were various barriers to adopting thin client technology in the libraries of Nairobi universities, such as the high cost of hardware and software, a shortage of trained personnel, and the poor attitudes of librarians.[12].

Thin client technology deployment in developing countries faces some constraints that hinder its adoption, such as [13]:

- Abnormal power supply;
- Unfamiliarity of users with TC technology;
- Low levels of computer literacy;
- Inadequate government policy on ICT sectors.

III. STUDY

In this study, the researchers interviewed 30 technical, professional, and expert male employees from four central public universities. These participants included heads of IT, library managers, deans and lecturers from computer science faculties, and members of the IT directorate at the Ministry of Higher Education (MoHE). Their ages ranged from 28 to 51 years. Ninety percent of them graduated from computer science faculties; 70% had master's degrees, and 30% had bachelor's degrees. Ten percent graduated from various other faculties and worked in different positions within faculty and library computer labs. They had between 3 and 17 years of experience.

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IV. FINDING

A. Structured Questions Data Analysis

As mentioned earlier, semi-structured questions were used in the interviews and focus groups. First, the data from the structured questions are analyzed, as shown in Table 2:

Table 2. Structured questions data analysis.

No.	Questions	Answers	Number of participants
1	Do you have computer labs for students?	Yes	29
		No	0
2	Which technology did you use in your computer labs?	Thick Client	29
		Thin Client	0
3	Do you know about the drawbacks of thick technology?	Yes	4
		No	26
4	Do your computer labs are connected to network?	Yes	29
		No	0
5	Why do you use thick client technology?	It is famous and heritable	30
		It is better than others	0
6	Do you know about other technologies especially thin client which are used in the world?	Yes	4
		No	26
7	Do you have enough staff to run and maintain your existing computer labs?	Yes	0
		No	29
8	Do your organizations have isolated/separate department for investigation of new technology and its adoption?	Yes	0
		No	30

Table 2 illustrates that almost all universities have computer labs for students. They use thick client technology in their existing computer labs due to its traditional use and student familiarity. All computer labs are connected to the network. Eighty-seven percent of the targeted population were unaware of thin client technology; therefore, they did not know about the drawbacks of thick client technology. There was insufficient staff to run and maintain the existing computer labs. None of the four central public universities had separate IT research departments to investigate and adopt new technologies. Therefore, their staff needs continuous training to become aware of and adopt new technologies according to their organizational needs. For some questions, the answers were provided by a group of 30, including one person who was the director of IT at the MoHE. Consequently, some answers were not related to the mentioned department. For other questions, the answers were provided by a group of 29 staff members from all four central public universities.

B. Unstructured Questions Data Analysis

To measure the data from unstructured questions, the researchers first operationalized the concept of "thin client technology implementation challenges for computer labs" and specified different indicators and measurement scales for each indicator, as shown in Table 3.

Table 3. Operationalization of thin client technology implementation challenges for computer labs concept.

Concept	Indicators	Measurement Scales
Thin client technology implementation challenges for computer labs	Familiarity with TC	Ordinal Scale Not, Slightly, Moderately, Very, Extremely Familiar
	Shortage of research department	Ordinal Scale No, Minimal, Moderate, High, and Very High Support

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	Lack of staff	Ordinal Scale
	Training Needs	Ordinal Scale
	Poor Procurement policy	Ordinal Scale
	Dependent to server	Ordinal Scale
	Familiarity of students	Ordinal Scale
	Fear from failure	Ordinal Scale

To analyze the collected data, the data are presented in Table 4 and visualized as shown in the mentioned table and Figure 5, as follows:

Table 4. Qualitative data analysis.

Concept	Indicators	Participants' Answers				
		No	Minimal	Moderate	High	Very High
Thin client technology implementation challenges for computer labs	Familiarity with TC	26			4	
	Training Needs					30
	Lack of Staff					30
	Poor Procurement Policy					4
	Shortage of Research					30
	Single Point of Failure					4
	Misunderstanding					4
	Familiarity of Students	30				
	Fear from Failure				4	

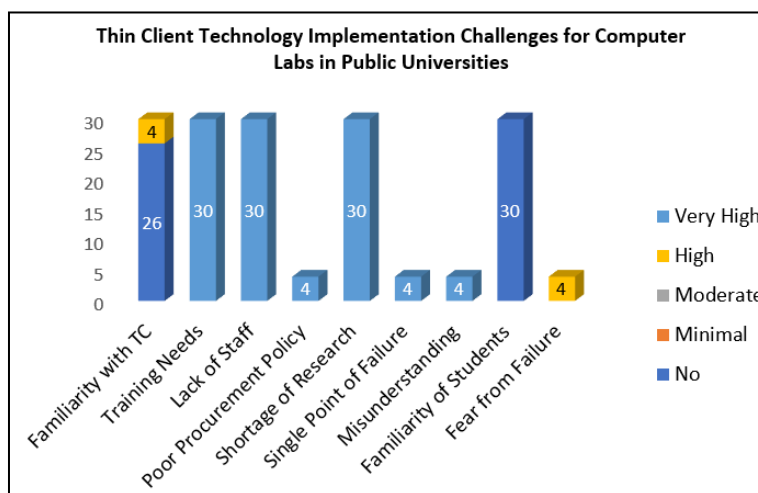


Figure 5: Visualized form of qualitative data.

Table 4 and Figure 5 illustrate several key challenges regarding thin client technology implementation in computer labs. First, among the 30 participants, 26 were not aware of or familiar with thin client technology, while only 4 were familiar with it. All participants stated that current IT-related staff need training on both current and new technologies. Almost all participants indicated that the current staff is insufficient for daily activities. Only 4 participants who were familiar with thin client technology mentioned that the current procurement policy is inadequate. There were no isolated IT research departments in universities or the MoHE to investigate and adopt new technologies. Those familiar with thin client technology noted it as a single point of failure. There was also a misunderstanding among the familiar participants about thin client implementation architecture. Some stated that thin client technology requires a separate and well-equipped server room in each faculty. All participants mentioned that students and staff are not familiar with this technology and that there is not enough staff to train them. Finally, those who were aware of thin client technology expressed a fear of implementation failure.

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V. RESULTS

The article discusses the challenges of implementing thin client technology in computer labs at public universities. It highlights that students at these universities face poor economic situations and cannot activate cellular bundles on their SIM cards or obtain wired or wireless connections from internet service providers to their homes. These connections are essential for improving their skills, performing research, completing assignments, practicing, using higher education learning management systems, and accessing online resources. As a result, the majority of students use computer labs in faculties, libraries, or IT centers to perform the aforementioned activities. This study shows that almost all faculties, libraries, and IT centers at the four central public universities have computer labs for their students. All the computer labs are designed using thick client technology, and there are plans to design and implement future computer labs with the same technology. The main reason for using this technology is its familiarity; both staff and students are accustomed to it. Additionally, 26 members of the targeted population were not aware of thin client technology. There were no dedicated IT research and adoption departments in the universities or the MoHE to explore new technologies. Moreover, the administrative structures were insufficient and did not align with the current situation, necessitating continuous training to raise awareness about new technologies and their benefits.

The findings of the study show that 13 members of the targeted population were familiar with thin client technology, but there were many reasons why they were unable to design and implement it in their computer labs. These reasons included fear of implementation failure, misunderstandings about the infrastructure of thin client technology, unfamiliarity among students and staff, a single point of failure, lack of staff for training, operation, and maintenance, and a poor procurement policy for failure recovery. Therefore, the design and implementation of thin client technology face significant challenges.

VI. CONCLUSIONS

Thick client technology is the most popular, traditional, and familiar form, and all students, staff, and lecturers are accustomed to it. Because of this, public universities design and implement their computer labs using thick client technology. Almost 87% of the targeted population were not aware of thin client technology, while 13% were aware but had some concerns. These concerns included a single point of failure, a poor procurement policy, lack of staff, unfamiliarity among students and staff, misunderstandings about the infrastructure, and fear of failure in implementing the new technology.

VII. FUTURE WORK

To further explore the implications of our findings, we recommend that the directorate of IT at the MoHE create a realistic staff structure within their directorate and all IT centers at public universities. An isolated IT research and adoption center should be established at the level of the MoHE or in all universities. Professional and experienced staff should be hired in all IT centers, and for urgent purchases, the procurement policy must be simplified. Continuous training should be conducted to improve the skills and familiarity of students and staff with new technologies. Finally, to enable the rapid implementation of thin client technology in the computer labs of public universities, the current thick client-designed computer labs should be moved to provincial public universities that still lack computer labs, while thin client technology should be implemented in the universities from which the thick client labs have been relocated.

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