

# AUDIT OF TECHNOLOGICAL INFRASTRUCTURE AND ITS IMPACT ON EDUCATIONAL QUALITY OF A HIGHER EDUCATION INSTITUTION

## TECHNOLOGICAL INFRASTRUCTURE AUDIT AND ITS IMPACT ON EDUCATIONAL QUALITY OF A HIGHER EDUCATION INSTITUTION

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**Abstract--** Functional obsolescence in computer centers poses a major challenge to providing quality education in public institutions. This research addressed this issue through a technical audit of 272 computers at a higher education institution in Mexico, with the aim of objectively diagnosing the causes of the devices' poor performance and proposing solutions. The results showed that limitations due to processors are minor, and that the main cause of slowness is the use of mechanical hard drives, which generates critical wait times. It is concluded that migrating to solid-state drives is the most effective strategy to restore device performance, highlighting the need for a future renewal plan.

**Keywords--** IT audit, technological infrastructure, functional obsolescence, academic performance.

**Abstract--** Functional obsolescence in computer centers represents a critical challenge for providing quality education in public institutions. This research addressed this problem through a technical audit of 272 computers at a Higher Education Institution in Mexico, with the aim of objectively diagnosing the causes of low device performance and proposing solutions. The results revealed that limitations due to processors are minor, and that the primary cause of slowness is the use of mechanical hard drives (HDD), which generates critical wait times. It is concluded that migration to solid-state drives (SSD) is the most effective strategy to restore device functionality, highlighting the need for a future renewal plan.

**Keywords--** IT Audit, functional obsolescence, technological infrastructure, academic performance.

## INTRODUCTION

The integration of information technologies in higher education faces a critical contradiction: while software development is evolving exponentially and greater processing power is required, public universities are lagging behind in hardware renewal. This creates a performance gap that affects students' technical training (Kasenda et al., 2024).

Because of this, the concept of functional obsolescence is introduced, which refers to devices that power on and operate, but whose response speed is detrimental to the teaching-learning process.

Often, the problem is directly attributed to the processor, ignoring the fact that the limiting factor usually lies in storage technology, such as mechanical hard drives. This bottleneck becomes a barrier when wait times exceed usability thresholds; according to Jakob Nielsen's established principles, any delay longer than 10 seconds directly affects user attention (NNgroup, 2019). In the educational setting, these delays directly affect students' concentration and reduce effective practical time.

With the overall objective of diagnosing the functional status of the computing infrastructure through the technical evaluation of its physical components and the measurement of its operational response times, to determine whether they meet the performance requirements demanded by academic workloads, the following specific objectives were established to carry this out:

- Characterize the installed hardware infrastructure through a technical inventory of critical components (processor, RAM, and storage).
- Quantify the operational performance of the equipment through timed startup tests to determine its efficiency according to usability standards.
- Compare the technical requirements of specialized courses against installed capacity, based on information gathered from faculty members.

This study was conducted at a higher education institution in Mexico, where the computer lab was experiencing slowness, necessitating a diagnosis based on evidence rather than mere conjecture. The research addresses the need to audit 272 devices to determine whether a complete replacement of the assets is necessary or if there is a way to upgrade the devices in a cost-efficient and sustainable manner.

## **DEVELOPMENT**

This audit helps identify the causes of slowness in computing devices, seeking an accurate diagnosis to mitigate the technical barriers that create obstacles in classroom education. This research provides objective and reliable information that facilitates

regarding the appropriate equipment for academic work. Likewise, this audit supports the optimization of investment in computing infrastructure to prioritize corrective actions and validate that available resources are aligned with the actual demands of academic activity at the institute, contributing to the continuous improvement of the services offered at the computer center and strengthening the institution's educational quality.

### **Methodology**

This research employed a mixed-methods approach, combining documentary, applied, and field research. During the documentary phase, the audit strategies to be used were identified, while the applied and field research allowed for the implementation of these strategies to conduct a direct, physical assessment of the technological infrastructure within a higher education institution. Methodologically, a qualitative approach was implemented through interviews with faculty and staff responsible for the area to identify the minimum requirements for providing a quality educational service. Simultaneously, a quantitative approach was used to conduct a technical inventory of existing computing devices and their components, as well as performance tests, providing a detailed diagnosis of the equipment's condition.

The study was conducted in a computer lab at a higher education institution (HEI) in Mexico. It was determined that the building had 11 classrooms for teaching, 10 of which were equipped with computer equipment; therefore, the sample included a total of 272 devices, ensuring a comprehensive evaluation of the installed infrastructure.

Different techniques were used for data collection depending on the nature of the data. In the case of the audit, direct technical observation was used, implementing two key instruments for collecting quantitative data: an inventory matrix to record the status of the computing devices and a timing test to measure the operating system's response times, thereby validating the equipment's capacity to handle academic workloads.

For data processing and analysis, the information was transferred to spreadsheets to generate descriptive statistics. In conducting the performance evaluation, three

efficiency categories based on the timed response times: fast (0–40 seconds), good (41–80 seconds), and slow (81 seconds or more). This scale was established based on Jakob Nielsen’s usability principles, which state that wait times exceeding 10 seconds cause a loss of attention; under this criterion, it was determined that a wait time exceeding 80 seconds represents a critical barrier to the start of the learning session.

## ANALYSIS AND DISCUSSION:

### Minimum Hardware Requirements for Classroom Use.

To determine classroom requirements for work, teaching staff were consulted directly regarding the technical needs of the courses they teach. Analysis of the interviews allowed us to establish a basic hardware profile with which students can carry out their academic activities without any problems.

It was found that some courses require only moderate resources. However, those requiring specialized software face a critical limitation, as these applications cannot run properly on the available computers, thereby imposing a greater technical burden. The use of integrated development environments for mobile and web programming, such as Android Studio, Code, and NetBeans, was noted; these require intensive memory allocation for real-time code compilation and debugging.

In addition, faculty members identified the critical use of network visualization and simulation tools such as Packet Tracer and VirtualBox, as well as software focused on network security auditing and industrial simulation. The use of these applications, combined with the operation of database management systems such as SQL Server, causes the processing and storage resources of conventional computers to become overloaded.

After analyzing the results obtained, Table 1 was generated, which compiles the minimum hardware and software requirements necessary for academic workloads.

**Table 1.** *Minimum hardware and software technical requirements for academic workloads.*

Requirement	Specification
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Processor	4th generation Intel i3 or higher.
RAM (GB)	8 GB or higher.
Storage (GB)	500 GB (SSD technology recommended) or higher.
Operating Systems	Windows 10 and Linux
Software	<p><b>Development:</b> Android Studio, Flutter, NetBeans, Visual Studio Code. <b>Simulation and Modeling:</b> ProModel, Arena, Simio, Packet Tracer, GeoGebra.</p> <p><b>Infrastructure and Networks:</b> SQL Server, VirtualBox, Nmap, Nessus.</p> <p><b>Others:</b> Office suite and basic compilers.</p>
Network Connectivity	50 to 150 Mbps (Dedicated bandwidth per classroom)

**Source:** Prepared by the author.

### Hardware Infrastructure Assessment.

With the primary objective of establishing an accurate diagnosis of the technological infrastructure, a technical inventory was conducted on the 272 active devices in the computer center. The evaluation of critical components such as the processor, memory, and storage revealed that the infrastructure is functional for basic tasks but lags technologically in meeting all the aforementioned requirements.

In terms of processing, it was found that the infrastructure is supported by two base models: the 4th-generation Intel Core i3-4150 with 143 devices and the 3rd-generation i3-3220 with 99 devices. However, other technologies were identified, including a group of 23 computers with Pentium Dual Core processors and a group of 6 units with 6th-generation i3-6100 processors; a single i3-3223 model was also present. These types of devices provide support for office tasks and structured programming; however, they have inherent performance limitations when running virtual machines in robust development environments.

In the area of memory and storage, regarding volatile memory, a significant gap was observed compared to the aforementioned requirements. Given that the minimum requirement is 8 GB of RAM, the survey showed that only 14 devices meet this requirement; the majority have between 4

and 6 GB, which becomes quickly overwhelmed when running multiple applications. Similarly,

, 100% of the storage units use mechanical technology, a factor that directly affects system response times.

The review of the software environment indicates good control over system maintenance. It was verified that 270 devices have some form of antivirus software enabled, while only 2 lack it. Similarly, 239 devices keep their operating system up to date. This data allows us to rule out that performance is being affected by a lack of updates or the presence of malware.

Table 2 below shows the collected data, breaking down the hardware specifications and security status of the devices.

**Table 2.** *Technical characterization of the hardware components in the audited infrastructure.*

Aspect	Number of devices: 272					
RAM	<b>1 GB</b>	<b>2 GB:</b>	<b>4 GB</b>	<b>6 GB</b>	<b>8 GB</b>	
	1	7	78	172	14	
Storage	<b>150 GB:</b>	<b>256 GB:</b>	<b>500 GB</b>	<b>512 GB</b>	<b>1000 GB</b>	
	2	1	21	96	152	
Antivirus	<b>They have antivirus</b>			<b>Does not have antivirus</b>		
				2		
Updates	<b>All updates</b>			<b>Updates Pending</b>		
	239			33		
Processors	<b>I3-3220</b>	<b>I3-4150</b>	<b>I3-6100</b>	<b>Dual-Core Pentium Core E5700</b>	<b>Dual-Core Pentium E2200</b>	<b>I3-3223</b>
	99	143	6	20	3	1

**Source:** Author's own work.

### System boot time evaluation.

To measure the actual impact of functional obsolescence discussed in the previous section, timed performance tests were conducted simulating real-world device usage conditions. The test involved recording the time elapsed from physical power-on to the display of the home screen.

Three efficiency levels were established: fast (0–40 seconds), considered the optimal standard; average (41–80 seconds), a functional range but with latency; and slow (81 seconds or more), considered a critical timeframe.

The collected data show that performance is mostly inefficient. Only 67 devices manage to display the login interface within an optimal range. In contrast, a total of 205 devices exceed this threshold, with times ranging from 41 seconds to over 2 minutes, just for entering credentials.

The consolidated results of this test are shown in Table 3, where they are categorized according to their level of efficiency.

**Table 3.** *Results of the operational performance timing tests.*

Performance Category	Time Interval	Number of Teams	Percentage of Total
Fast (Optimal)	0–40 s	67	24.6%
Fair (Functional)	41–80 s	110	40.4%
Slow (Critical)	> 81 s	95	35.0%
Total		272	100%

**Source:** Author's own work.

### **Multidimensional Interpretation of the Findings**

The analysis of the findings from the physical inventory and chronometric tests reveals a critical discrepancy between the basic capabilities that devices should have and the perceived performance during academic operations.

The presence of access times exceeding 80 seconds in 35% of the devices is due to the physical limitations of mechanical hard drives. Tilanhun's (2023) technical analysis corroborated this finding by establishing that the access latency of an HDD is approximately 15.78 ms, compared to 0.031 ms for a solid-state drive (SSD). This demonstrates that solid-state technology is approximately 509 times faster in initial read response. According to Kasenda et al. (2024), while a mechanical hard drive can reach an average of between 100 MB/s and 150 MB/s, modern SSDs exceed 500 MB/s. With this capacity, the audited devices suffer from a bottleneck that negates the processor's power, thus causing significantly slower boot times. While RAM capacity is a critical factor in multitasking performance, chronometric evidence from the boot system isolates the storage device as the critical component during the operational phase. This technical latency creates a significant pedagogical barrier. The research by Hertzum and Hornbæk (2023) cites slow system performance as the primary cause of user frustration, representing the most frequent category of incidents. Their study determines that these periods

of frustration result in a loss of 11% to 20% of effective time out of a total work session. According to Jakob Nielsen's usability engineering principles, the maximum limit for maintaining user attention is 10 seconds (NNgroup, 2019). Furthermore, according to Hertzum and Hornbæk (2023), these types of problems tend to be recurring; the student enters a cycle of "learned frustration" and a sense of lack of control that degrades the quality of the teaching-learning process.

From a resource management perspective, the assessment demonstrates the need for a complete upgrade of the audited devices. Tilahun (2023) states that SSD migration is a justifiable investment that offers superior performance. It is important to make a technical distinction regarding the identified devices.

Regarding devices running on Pentium Dual Core and 3rd-generation Intel Core i3 processors, while migration to SSD will drastically improve their boot times and response times for office tasks and web browsing, if you wish to keep them, it is recommended that they be used for the aforementioned activities.

## **CONCLUSIONS.**

The technological infrastructure audit conducted at the Higher Education Institution demonstrated that the devices do not face terminal obsolescence, but rather functional obsolescence. While Intel Core i3 processors have sufficient processing capacity for various academic workloads, the use of mechanical hard drives is identified as a critical factor affecting performance, causing latency times that impact students' learning process.

It is concluded that the investment in upgrading to solid-state drives is entirely justified. This upgrade will eliminate the bottleneck, reducing boot and load times from minutes to seconds, which directly impacts student performance. Additionally, expanding RAM is considered a complementary measure to improve performance.

In the case of devices with processors that do not meet the specifications established by the teaching staff, migrating to SSDs would drastically improve their performance. Therefore, if the institution wishes to retain these devices, it is recommended that they be assigned to office tasks and web browsing.

Finally, this investment will extend the devices' useful life. However, the institution is advised to plan ahead for the replacement of this equipment to provide quality service to its students. It should be noted that, based on the information and technical evidence gathered in this study, the institution proceeded to replace the computer equipment, successfully eliminating the identified technological barriers and ensuring a high-quality learning environment for students.

### **FUTURE WORK**

As a follow-up to this research, a post-implementation evaluation is proposed to empirically validate the reduction in processing times following the equipment replacement and its impact on user satisfaction.

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