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Implementation of Linux-Based POS Solutions: A Low-Cost Alternative for the Retail Sector

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ABSTRACT
This article proposes improvements to Information Technology (IT) systems for retail companies, with an emphasis on comparing Linux and Windows operating systems in retail environments, especially at Points of Sale (POS). It is highlighted that the adoption of a Linux-based POS allows operation on hardware with minimal specifications, eliminating the need for machines with greater computing power. Additionally, the free licensing of Linux makes it a more accessible option compared to proprietary operating systems. Although proprietary systems are recognized for their intuitive interface and user familiarity, their usage entails more robust hardware requirements, additional licensing costs for commercial use, and a steeper learning curve for IT staff training. Thus, the project aims to investigate and implement a Linux-based POS system architecture as a more economical and efficient alternative for small and medium-sized retail companies facing everyday technological challenges. The proposed architecture suggests that adopting Linux-based POS solutions can significantly reduce operational costs, directly impacting profitability and retail efficiency.
Key-words: TT security; operational efficiency; network infrastructure; POS; commerce.

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I. INTRODUCTION

The choice of an operating system for Points of Sale (POS) in the retail sector is a crucial decision to ensure operational efficiency and cost control. Experience accumulated in the IT field demonstrates that selecting the right system can significantly influence the performance of business operations. As technological advancements intensify and the demand for effective solutions grows, it becomes essential to analyze the available options to optimize retail processes. This article investigates the adoption of Linux in POS systems, comparing it with proprietary systems and assessing its impact on operational efficiency and IT system maintenance costs.

This study is relevant due to the need for operational efficiency and cost reduction, highlighting the autonomy and flexibility of Linux, which can prevent costly dependencies on commercial vendors. Understanding the implications of adopting Linux is crucial to helping companies make informed decisions regarding their IT infrastructure.

The objectives of this research are to promote the efficient adoption of Linux in retail POS systems, improve operational effectiveness, reduce costs, and increase autonomy in the IT environment.

Furthermore, the study explores the concept of open-source software in POS systems, a topic that is rarely addressed, highlighting its main advantages. In this way, the work provides knowledge about new solutions for organizations, making it a viable alternative for startup companies with limited resources.

To evaluate the advantages of Linux over Windows, articles from specialized IT magazines, books, and software manufacturer websites were used, establishing a correlation between the pros and cons reported by different authors through a bibliographic research approach.

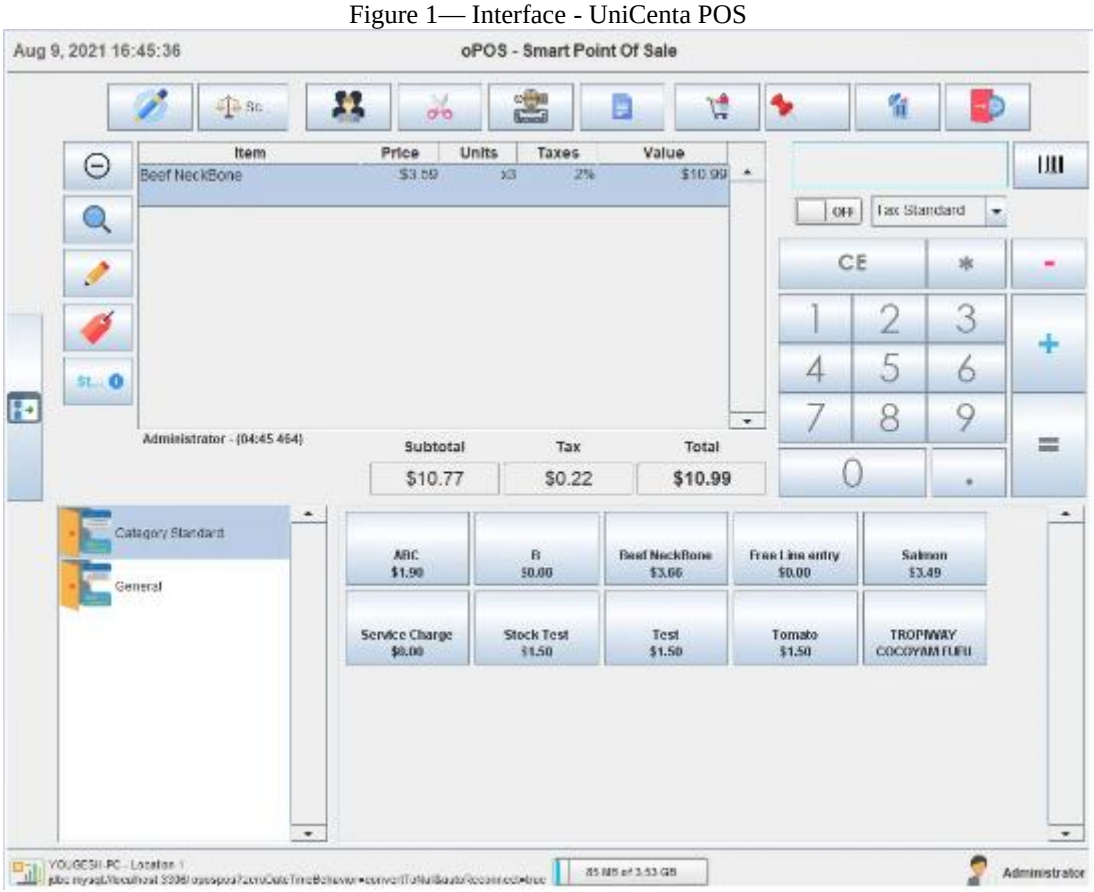
II. MATERIAL AND METHODS

POS System

According to Leal's (2020) theoretical framework, the Point of Sale (POS) system encompasses a complete solution that automates business operations by integrating the issuance of fiscal documents, inventory management, and payment processes. By centralizing essential business data, the POS facilitates detailed monitoring of operations, contributing to efficient financial management. Essentially, a POS includes three main components: Terminal: Equipment that combines cash registers, card machines, and printers for payments;

Software: Installed on computers, it integrates the establishment's inventory and financial sectors; Fiscal Module: Responsible for issuing fiscal documents such as NF-e, NFC-e, and CF-e SAT.

Figure 1— Interface - UniCenta POS



Leal's (2020) states that the POS system, in addition to streamlining sales, offers essential features for financial, inventory, and fiscal management. Crucial functionalities include real-time financial control, automatic issuance of fiscal receipts, integrated logistics for delivery management, instant inventory updates, and an efficient checkout system to provide a satisfactory shopping experience for customers.

Hardware

It is essential to prioritize the minimum hardware specifications for the front-end system to avoid slowdowns that may result in long lines and customer dissatisfaction. For cash registers, also known as POS systems, highly robust hardware is not required. It has been observed that a minimum of 4 GB of RAM and 256 GB of available storage is necessary. Additionally, a dual-core or quad-core processor is essential to ensure adequate performance, based on practices observed in the retail IT sector. Other important considerations include:

Ensuring that the operating system is up-to-date for better compatibility and security.

- Verifying the ability to process simultaneous data, especially during peak sales hours.
- Considering the need for stable connectivity with peripheral devices, such as printers and barcode scanners.
- Evaluating hardware durability and resistance for frequent use in retail environments.

Network

To ensure the correct operation of the system, it is crucial that both the server and cash registers operate within the same network range, ensuring that all information generated at the registers is transmitted to the server through the local network. Each device should have its own IP address. The cash registers do not necessarily need internet-accessible IPs since most processes occur on the local network, such as queries to agreements and data export/import.

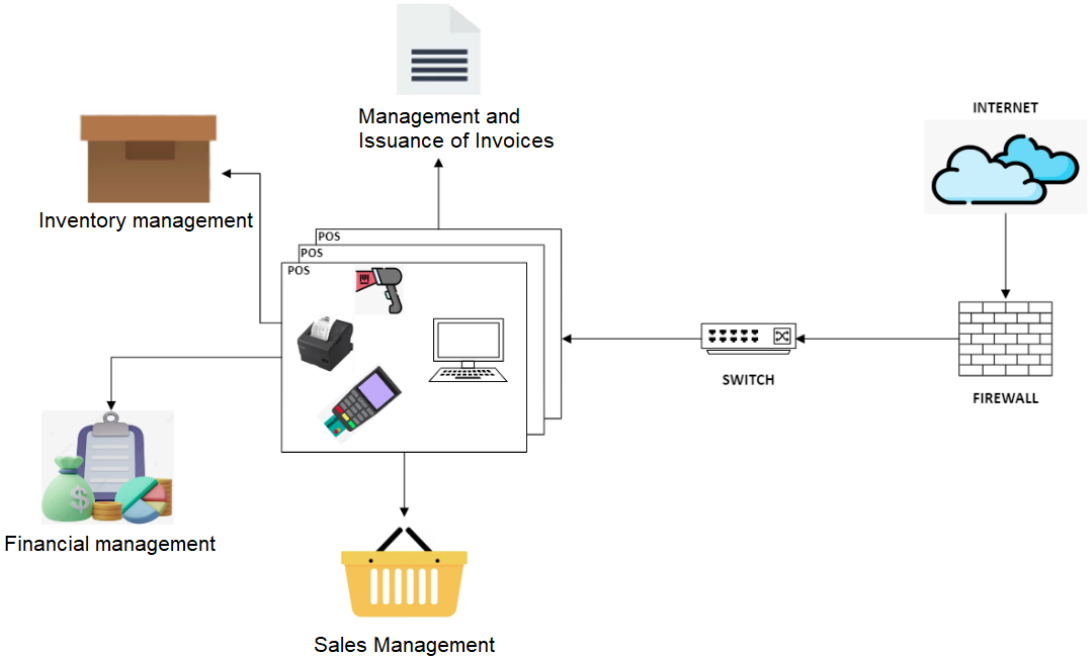
Additionally, it is essential to use a firewall to protect the network. The firewall acts as a security barrier that monitors and controls network traffic, allowing or blocking traffic based on a set of predefined security rules. This helps prevent unauthorized access and protects sensitive data transmitted between the registers and the server. The firewall should be configured to allow only necessary traffic between devices on the local network and to block any unauthorized external access attempts.

After a sale is completed at the register, the records are sent to the front-end server, which subsequently transmits them to the back-end system (ERP), which can be on the internal or external network. If the ERP is outside the internal network, it will be necessary to configure the system server to communicate with the internet.

It is the responsibility of the establishment's infrastructure team to configure the internal network properly, ensuring the integrity and security of communications between devices and point-of-sale systems.

Figure 2 presents the architecture of a POS system. The firewall is crucial for protecting the system against unauthorized access and filtering data traffic. The switch enables the efficient connection of multiple devices within the same local network, while the internet links are essential for the overall connectivity of the system. Together, these components form a solid infrastructure, ensuring secure and efficient operation in the commercial environment.

Figure 2 – Architecture of a POS system



The POS system is traditionally composed of a desktop, which serves as the central processing unit, a barcode scanner to facilitate the quick identification of products, a receipt printer to issue purchase receipts, and a card machine to process electronic payments. This combination of devices enables an efficient and integrated operation, enhancing the shopping experience for both employees and customers.

Operational Systems

According to Hasnain & Rafi (2019), there is no inherently superior operating system; each OS has distinct characteristics and features. The authors state that, in terms of hardware, Unix-like systems are lighter and require less powerful processors to run.

Linux is a Unix-based operating system initially developed for desktops, but it is now widely used on servers, smartphones, and other devices, including ATMs. Its open-source nature allows anyone to freely create and distribute applications. Composed of a kernel that facilitates communication between programs and the processing unit, Linux offers a variety of distributions tailored for different users and needs, such as Ubuntu for beginners and Slackware for advanced users.

Linux distributions are typically available for free on maintainer websites, with over 80 versions available for download in ISO format. One of Linux's significant advantages is its efficiency on older computers with lower computational power (Hasnain & Rafi, 2019), eliminating the need to upgrade hardware or use outdated Windows versions. Additionally, Linux provides robust security, being less vulnerable to viruses and malware

that commonly affect systems like Windows and OS X. OS X systems have the unique feature of being developed by the same company that manufactures the hardware (Hasnain & Rafi, 2019), minimizing OS performance issues with hardware. However, older versions can lose support and updates over time.
A study conducted by Awan (2022) among Linux and Windows users indicates that, among programmers and engineers, 60% of respondents use Linux, while 16% use Windows systems. Among general users, 40% use Linux, and 20% use Windows.

Table 1 - Advantages and Disadvantages between Linux and Proprietary Systems

Reliability: Linux is known for its ability to operate for years without failures, while Windows may require more frequent reboots.	**Software Compatibility**: Some popular software applications, especially those aimed at consumers, are only available for Windows and do not have versions for Linux.
Process Management: Linux manages simultaneous processes more efficiently, which helps maintain system stability. Windows, on the other hand, may experience stability issues when handling a large number of simultaneous processes.	**Learning Curve**: Linux may have a steeper learning curve for new users, especially those accustomed to Windows.
Flexible Configuration: Configuration changes in Linux can be made without interrupting other services, unlike Windows, where some configurations require reboots.	**Hardware Support**: Although Linux works well on a wide range of hardware, some specific devices may have more limited driver support compared to Windows.
Hardware Efficiency: Linux is lightweight and performs well on almost any computer, regardless of the hardware. Windows, on the other hand, often requires hardware upgrades to accommodate its increasing demands.	**Technical Support**: Although there is a vast community of support for Linux, official and specialized support can be harder to find or more expensive compared to Windows support.
Cost-Benefit: Linux is generally free and has a lower total cost of ownership. Even with paid support, Linux is more economical than Windows, which has higher licensing and software costs.	**Hardware Compatibility**: Although Linux supports a wide variety of hardware, compatibility issues may arise with certain drivers, especially for video cards, Wi-Fi adapters, and peripherals.

Linux in Corporate Environments

In corporate environments, Linux offers several advantages, including system customization with different text editors, interfaces, and programs, allowing it to adapt to the specific needs of each company. Additionally, Linux is highly compatible with various hardware, thanks to its timely and precise updates, which eliminate common errors and improve system stability.

One of the major advantages of Linux is its security. The system is designed to identify and resolve issues quickly, which helps minimize damage and data loss. Compared to operating systems like Windows, which can consume more resources and experience degraded performance with the installation of many programs, Linux stands out as a robust and efficient solution, especially in corporate environments. Although it is not completely immune to vulnerabilities, Linux has management and patching processes that are generally more effective, with various vendors continuously working to fix vulnerabilities.

III. RESULTS

The Linux operating system is known for its reliability, operating for years without failures, and its ability to manage a large number of simultaneous processes efficiently, maintaining system stability. Additionally, it allows configuration changes without interrupting other services.
Linux stands out in terms of security due to its multi-user design, where only the administrator has administrative privileges, limiting access to the kernel. Administrators have full control and a clear view of the file system. Linux is lightweight, flexible, and scalable, running well on almost any computer without the need for frequent hardware upgrades.
In terms of cost, Linux is generally free and offers excellent cost-benefit, even with paid support. It also provides freedom of choice, allowing the combination of products and protocols as needed, without commercial restrictions.

IV. DISCUSSION AND CONCLUSION

The study highlighted that adopting POS systems based on Linux is a viable alternative for small retail businesses, as they often have limited budgets, which leads to greater savings and operational flexibility. However, challenges such as the steep learning curve and the need for specialized technical support must be considered during implementation.

For small companies looking to expand their system architecture, a low-cost alternative is implementing an open-source ERP system. Integrating an open-source ERP system with the POS network can enhance operations by connecting sectors such as inventory, logistics, and distribution centers.

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