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Streamlining ICT Network Resources, Processes and Operations through a Centralized Management System: A Development and Evaluation

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Abstract: This study aims to provide an inventory and monitoring system for the ICT Network and Telecommunication Department at Lyceum of the Philippines University Cavite. As it streamlines the management and documentation of network equipment and IP addresses under a single, centralized system, it incorporates integrated management features to carry out and improve network resource management operations. The development of the system was presented with the use of the Agile Model, which illustrates the client's workflow, allowing for changes and discussions based on the client's feedback; the model involves planning, design, implementation, testing, and evaluation, allowing continuous improvement, and providing high-quality systems that met the client's requirements. In addition, the system's components were tested for unit functionality and browser compatibility by the technical adviser, (2) administrators, and (5) IT experts. Furthermore, the system also underwent an evaluation process based on ISO 25010 to measure its Compatibility, Usability, Reliability, Functional Suitability, Security, Portability, Maintainability, and Performance Efficiency, participated by (1) a technical adviser, (2) administrators, (10) IT Experts, and (10) end users. The findings revealed that the system was fully operational and could carry out its designated functions, with an average result of 98.93% passing rate. No component failed during testing in the presence of the specified test respondents. From the responses of the determined evaluators, all aspects of the system are deemed “Highly Acceptable.” The implications of these findings indicate that the ICT Network Resource Management System for LPU Cavite has met the requirements and expectations set forth. The system's compliance with ISO 25010 requirements, successful test results, and high-end user acceptability highlight its potential to enhance the management and monitoring processes, leading to more efficient and effective management for the university’s ICT network and telecommunication department.

Keywords: ICT, Network Management System, ICT Network Resources, Streamlining ICT Resources

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INTRODUCTION

The Information and Communications Technology Department, or ICT-D, is crucial in all aspects of our organization. Within the Lyceum of the Philippines University Cavite ICT-D are five internal units, each with unique functionality, roles, and responsibilities. The administrator and support assistant of the Network and Telecommunication Services unit faces a myriad of challenges daily. One of the critical issues we are currently grappling with is the complexity of managing the inventory of network equipment, and VLAN deployed in the network. We use multiple systems to monitor these inventories, often necessitating the opening of different platforms. The network equipment data, for instance, are stored together with other non-network equipment, making it difficult for the network unit to focus solely on the equipment they need to monitor. This is where the proposed centralized management system comes in, consolidating all relevant data for the Network and Telecommunication Services unit in one system.

The LPU Wi-Fi service, one of the many ICT-D-supported services, is a vital resource for all students and faculty, enabling them to connect to the internet. However, if not monitored properly, it can pose significant risks. For instance, an attacker could obtain information from a user, especially if the two share an IP address (Bahar, 2022). This scenario led to the department locking out numerous accounts when they detected IP addresses used by an unusual number of devices. It is crucial to manage our network resources effectively to ensure the network equipment functions optimally and to prevent downtime in the network service.

REVIEW OF RELATED LITERATURE

Malapit et al. (2019) created a web-based system for managing the physical plant and facilities of the Lyceum of the Philippines University - Cavite. This system attempts to automate the administration of campus plant equipment. The system offers features for submitting repair requests, managing inventories, scheduling vehicles, and booking venues. The system prioritizes management systems and also saves diverse data. The system was designed with a specific emphasis on network resources. Ampeloquio et al. (2019) created a user-friendly web-based inventory management system named INCAMS to enhance the present manual registration of supplies in chemistry laboratory design. The system has a comprehensive inventory of resources, a notice functionality for urgent conditions or restocking requirements, information about loaned goods, and a time return feature. Both systems efficiently handle their assets. However, the designed system exclusively focuses on the equipment under the authority of the ICT Department, while the study controls the tools and equipment in the chemical laboratory.

LOCUS is a class scheduling management system developed by Binaday et al. (2019) specifically for LPU-Cavite. Its purpose is to provide a computerized and efficient method for establishing and maintaining schedules and programs across various departments and colleges within LPU Cavite. The created system contains a corresponding feature for managing LOCUS's timetable. The system has a scheduling function that assigns equipment for maintenance. FYLAX: A web-based document management system for Lyceum of the Philippines University Cavite, developed by Mangaldan et al. (2018), focuses on efficiently storing papers in various formats such as pptx, docx, and pdf. Users can alter their files by renaming, deleting, moving, or downloading them. Before being posted into the system, the administrator must approve the documents. The system that has been created also can store, manage, monitor, and change records of network equipment, VLANs, and temperature. The research primarily focused on the storage and monitoring of papers.

Shafik et al. (2020) comprehensively explored the proposed approaches and limitations to assist scholars in formulating, modeling, or devising novel concepts prioritizing improved resource management strategies over existing methods. The research highlighted job automation, real-time monitoring and reporting, and interaction with other systems to optimize workflow and enhance productivity. The research in question primarily concerns developing novel ideas for systems that manage resources. A review and recent challenges on optical network management and control discuss the most cutting-edge control strategies, including intent-based networking, the observe, decide, and act-based technique for autonomic optical networks, as well as the zero-service approach to management (Andriolli et al., 2021).

The Design of the College Network Security Management System based on the SNMP Management Model (Cheng, 2020) focuses on outlining the architecture of the network management device module, the information collection module for network equipment operation, and the network status monitoring module. This model is based

on the Simple Network Management Protocol (SNMP) management paradigm. The software comprises a module for monitoring network traffic and various essential system activities. This study may aid developers in establishing the most effective solutions for developing network security since it involves monitoring the network server inside the system. The study aims to elucidate the structure of network management and develop network security management systems using the Simple Network Management Protocol. Network Management Using SNMP (Namrata et al., 2020) aims to use SNMP for network design, obtaining important system qualities, including RAM utilization, CPU usage, and storage capacity from the device to be monitored, storing the system value systems in a database, and presenting data using the dashboards tool, as well as security protocols monitoring comprises trace and records of network parameters. The network measurements include data transmission rate, user-time percentages, device downtime, device uptime, response time to users, and error rates. Gavrilov and Kavalerov (2022) conducted a study on Mobile Ad Hoc Network Management and Routing Efficiency. The study aims to monitor and manage ad hoc networks if they are a consequential source of network traffic. Routing protocols in ad hoc networks have varying effects on network management, quality of service, and performance. The SNMP protocol might be used for wireless ad hoc networks.

Wang et al. (2019) developed a network data management model using Naïve Bayes classifiers and deep neural networks for heterogeneous wireless networks. The study seeks to monitor and regulate large amounts of data and information. When dealing with network attacks or invasions, it is necessary to prioritize data management issues and develop a detection method. This network instruction detection system aids in the identification of previously unknown and unanticipated assaults in management stations that exploit a security weakness. The developers additionally address the system's security and ensure that attackers cannot easily infiltrate the inventory management system. Khan et al. (2018) explained in Understanding Autonomic Network Management: A Look into the Past, A Solution for the Future the necessary parts of architectural architecture, presenting the key obstacles that must be overcome to implement a wholly autonomous network management system, deploy intelligent software agents throughout the mobile network architecture's hierarchical tiers. Agents will execute several cognitive levels of the control loops and provide learning algorithms for various managing tasks.

Aboubakar et al. (2021) examined the growing popularity of the Internet of Things (IoT) and its impact on our daily lives. The study also highlights how intelligent devices, such as smart sensors and actuators, have significantly enhanced our lives, including intelligent agriculture. Nevertheless, overseeing IoT networks has grown more difficult because of varied and limited devices that transmit data via unstable radio channels and are often deployed in hostile circumstances such as war zones. These difficulties result in network performance concerns, such as high energy consumption due to device failures. The study conducted by Tyata and Barsoum (2021) analyzed the advantages and disadvantages of different network management strategies. It also identified potential research areas for network management protocols in network automation, network assurance, and network analytics within the Internet of Things (IoT) context. The Network Management System for IoT Based on Dynamic explores network management solutions for IoT networks using an edge computing architecture. The system establishes connections between monitored devices using the SNMP protocol and a SOAP protocol gateway in conjunction with a management application. The network facilitated the identification and study of crucial network management system projects for IoT networks, including provisioning and identification, setup and administration, monitoring and diagnosis, and software updates and maintenance.

Objective of the Study

The project aimed to develop a web-based ICT network resource management system for ICT-D that would make managing different network resources more accessible and efficient for the Lyceum of the Philippines' Cavite Campus.

Specifically, the project aimed to:

1. Create a network management system that includes the following features:
    1.1. An end-user account to access the system.
    1.2. An inventory system of VLAN (Virtual local area network) and Network Equipment that provides an add, update, archive, and generate report function.
    1.3. A tabular report for preventive maintenance schedule and the capacity to schedule maintenance for each network resource.
    1.4. The dashboard will show the temperature and humidity of the data center as manually input.
    1.5. Automated email notification once the temperature is at a critical level.

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1.6. A record of suppliers and their respective contact people.
1.7. A dashboard for the web server and a web console for accessing the server.
1.8. A system for creating a cron backup of the system.

2. Create the project using HTML and Bootstrap as the front end, PHP and JavaScript as the backend, and MySQL for the database. The system can be accessed using any web browser and runs on desktop computers, laptops, and mobile phones.
3. Test and improve the system based on Functionality and Compatibility Tests.
4. The system's performance was evaluated and measured using ISO 25010 criteria: Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability.

METHODOLOGY

System Design

The system comprises various user types, each with a distinct role and level of system access. Administrators, referred to as "admins," possess the highest level of access and can perform all system functions, including managing inventory, managing user access, accessing the web console, and viewing audit logs, as shown in Figure 1. Conversely, Staff members possess limited access and can only view data and generate reports.

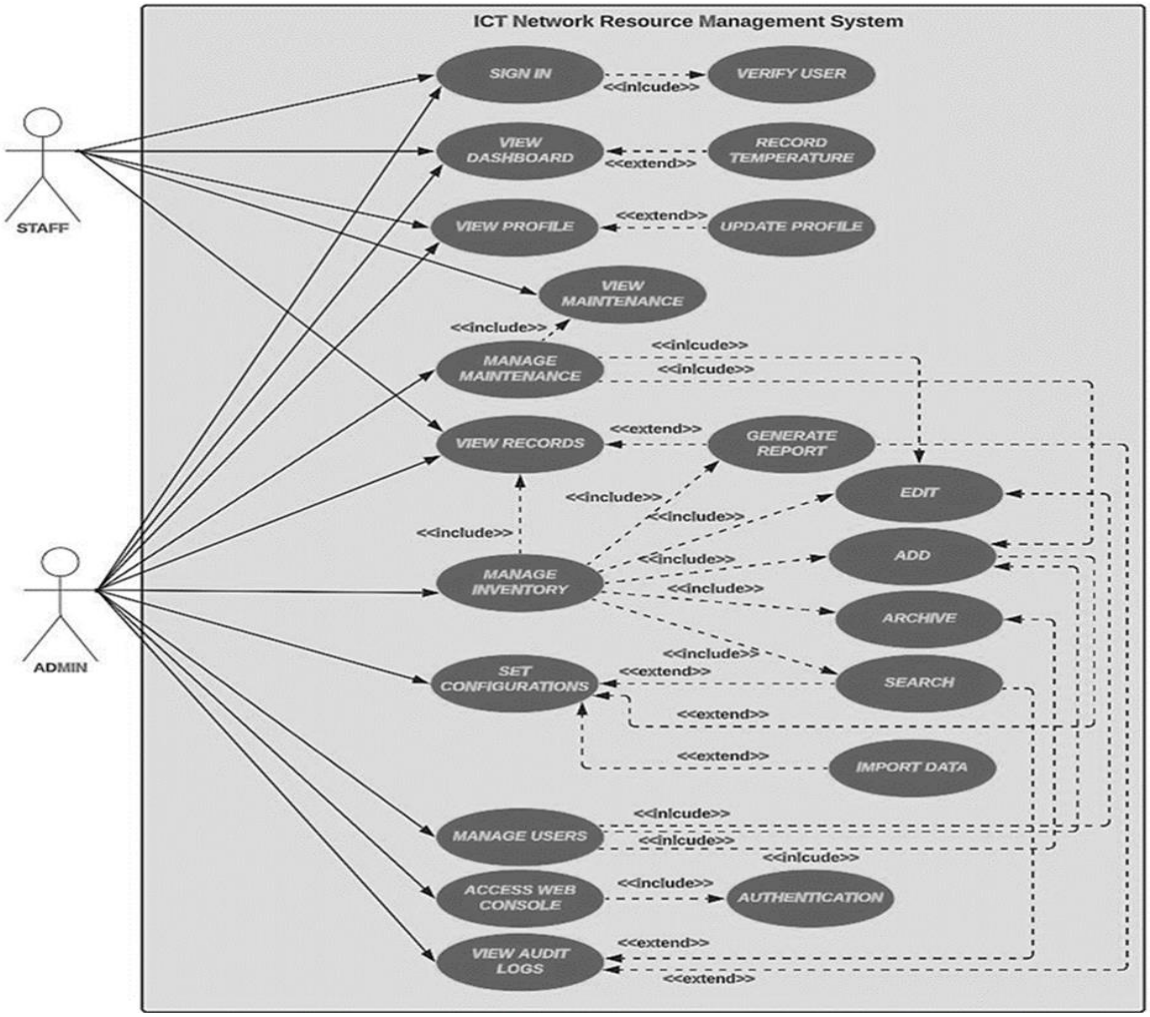

Figure 1. System Use Case Diagram of ICT Network Resource Management for Lyceum of The Philippines University Cavite

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System Development Process

The ICT Network Resource Management design for Lyceum of University Philippines Cavite. The Agile Model is used to modify the system to acquire continuous feedback. System modifications can be resolved at any iteration since this method quickly identifies projects, as illustrated in Figure 2. It is characterized by the development of products using short cycles that give an output and constant revision. The agile model contributed to creating and evaluating the system, allowing for ongoing improvement, and providing highly qualified systems that satisfied the client's needs.

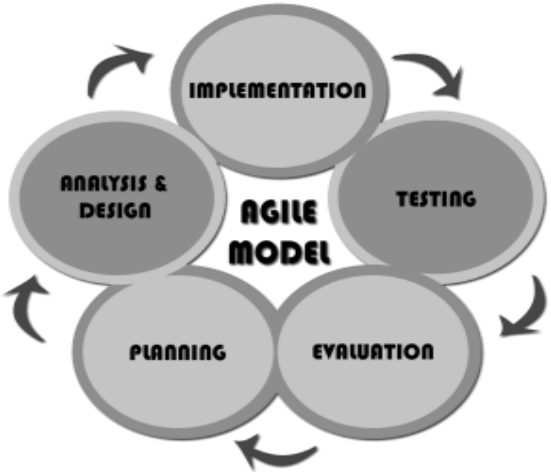

Figure 2. Agile Model for ICT Network Resource Management of the Lyceum of The Philippines University Cavite

The first phase of development is called the Planning Phase. The project was conceptualized and recognized during this phase, and the researchers paid close attention to the suggested features and preferences of the clients. The Analysis and Design phase is the second stage for carrying out the project. The project's structure and design, including its diagrams, framework, and prototype, were constructed at this stage. The next stage is the implementation phase, where the project's features, functionalities, and actual implementation are developed. The project then underwent a Testing phase to identify system problems, functionalities, and errors. The Evaluation phase is the final phase. This was where clients and researchers concluded on any changes and suggestions they would like to make to the project. After the discussion with the client, the objectives were altered using the Agile model. The researchers used the working model to meet the client’s needs and ensure that the product they acquire satisfies their demands.

Software Requirements

The software requirements in the developed system, ICT Network Resource Management System, are composed of Integrated Development Environment (IDE) platforms used to facilitate programming, the programming languages used in developing the system, and the web browser used to view or display the system. The IDEs include Visual Studio Code as an HTML, CSS, JavaScript, and PHP text editor. In addition, the proponents also use SQL Yog Ultimate to facilitate database management, which can be substituted for phpMyAdmin. The programming languages include HTML and CSS for the front-end and user interface of the web-based system and JavaScript and PHP for the back-end processes. For the web browser the project can run on any web browser. However, the proponents used Chrome during the project development.

Hardware Requirements

The hardware requirements in the developed system are the computer systems, such as laptops and desktop computers used by the proponents in making the system. Thus, it is expected to be compatible with similar computer systems with the exact specifications. For the minimum specifications, the system can run on any desktop or laptop computer with Windows or Mac Operating System no earlier than 2016 to ensure maximum compatibility, at least 4GB of RAM, and 500GB of storage for computer systems.

Test Plan

This phase was primarily focused on evaluating the system to ensure that all functions were working correctly and to identify any issues that needed to be addressed. The goal was to identify and fix any problems or errors in the system before it was released for use. This phase ensured the system performed as intended and met the necessary quality standards. The screen size compatibility was tested on devices with various operating systems (Windows 10 and 11). The system was also accessed using various web browsers (Google Chrome, Opera Mini, and Microsoft Edge) to ensure it functioned correctly on different platforms.

Test Procedure

During development, the developers used unit testing and the Agile method to test new functionality and track any defects. After testing, the cycle for development restarted until units needed to be tested again. After the system's completion, unit functionality testing and browser compatibility testing were done with the cooperation of eight (8) respondents, consisting of (1) technical adviser, two (2) admin, and five (5) IT Experts. The test was conducted using the following steps.

1. The proponents prepared the necessary documents for the testing procedure.
2. The proponents provided a video explaining the web-based system's purpose and function. They also distributed the test instruments via email.
3. To access the system, the respondents must have internet connectivity and a web browser, such as Google Chrome, Microsoft Edge, and Opera Mini.
4. The test respondents tested the functionality and compatibility of the web-based system.
5. The test plan results were collected after the respondents checked the system thoroughly.
6. All the suggestions and comments from the respondents were considered.

Test Instrument

The system was examined using functionality and compatibility tests. The functionality test ensured that every feature worked properly. Furthermore, a compatibility test identified whether the system could function on different web browsers.

Evaluation Plan

The evaluation phase ensures the software serves its purpose and benefits its users. ISO 25010 was employed as the system evaluation tool. Twenty-three (23) evaluators were employed, composed of the technical adviser, two (2) admins, ten (10) I.T. experts, and ten (10) end users.

Evaluation Procedure

The evaluation phase was done successfully with the following steps:

1. The evaluators were scheduled for a meeting based on their availability. The evaluators were contacted through email.
2. The evaluation proceeded after the confirmation of evaluators.
3. The development team discussed the system's importance and functions through a recorded video.
4. The evaluation tool, sub-criteria, and criteria were all discussed.
5. The evaluators were given ample time to test and check the system's functionality.
6. The form used to answer the evaluation test is Google Forms. https://forms.gle/8xnK1myriRfbEgzd9
7. The evaluation results were collected and examined by the researchers.
8. The evaluation results were interpreted using the mean and standard deviation formula.

Evaluation Tool

The evaluation instrument used in this project was IS0 25010. This instrument evaluated the system's Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability.

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RESULTS AND DISCUSSION

The project's interface explicitly shows the user interface design, project capabilities and limitations, test results, and evaluation to address the objective of this research project. The User Interface is where the user can interact and communicate with the system.

Figure 3 shows the Sign-In Page. This is where the user can input their credentials to access the system. There is only a login button since the admin will create accounts in the system. The name of the system can be found on the upper left-hand side. It is called the ICT Network Resource since they are the ones who will utilize the platform. The primary color of the platform is University Red because it is the color the university uses.

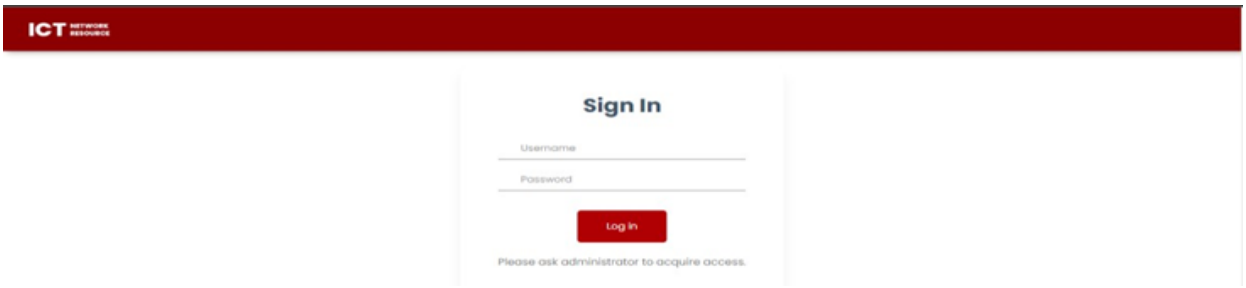

Figure 3. User Interface Sign-In Screen of "ICT Network Resource Management System

In Figure 4, the user is directed to the home screen, which displays the site dashboard upon logging in. The system dashboard provides an overview of all the system's functions and includes the ICT logo and logout button on the left side of the screen. The dashboard also shows the number of registered users, active users, and active equipment, and each panel includes a "more info" link that will take the user to additional pages. The data center monitoring feature displays the temperature and humidity readings of the data center. It sends an email alert to the logged-in user if the temperature exceeds normal levels. It includes a plus icon where the user can add a record of the server room's temperature.

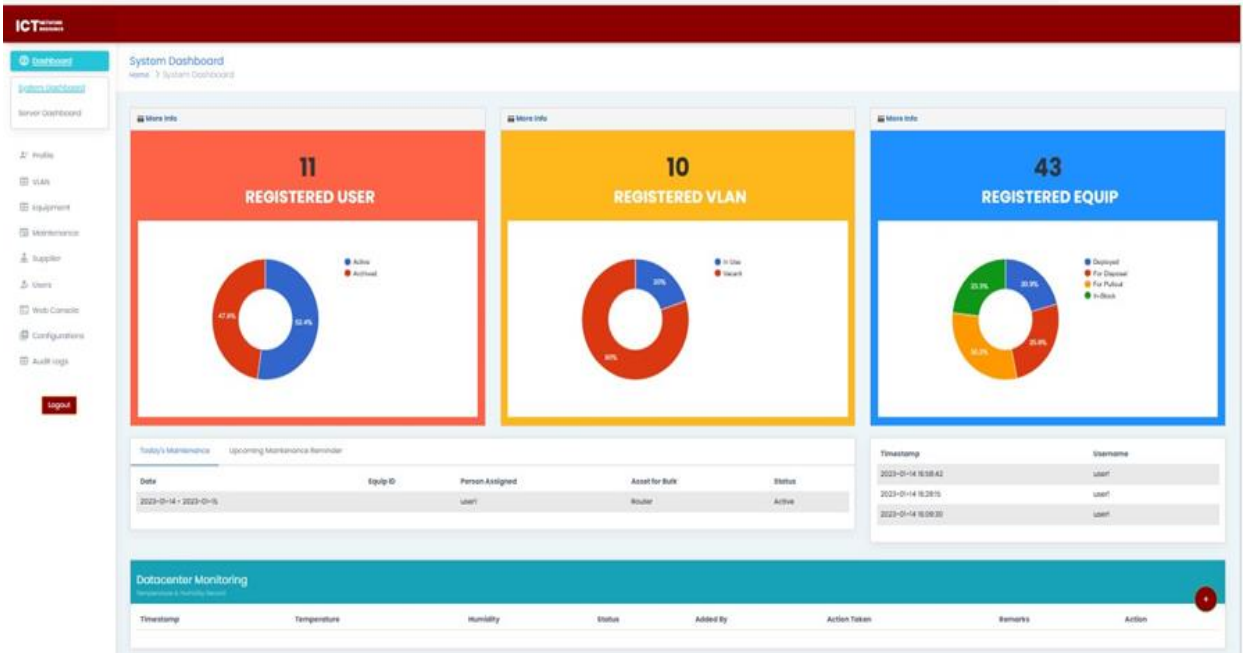

Figure 4. System Dashboard of "ICT Network Resource Management System

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The Server Dashboard page displays the operating system, number of logged-on users, system load, CPU, RAM, available disk space, bandwidth usage, and port monitoring services such as FTP, SMTP, and Web. Figure 5 shows information about the VLAN Inventory, where users can add, edit, archive, view, search, and export VLAN data. The VLAN information can be filled in by clicking the add button, including the ID, description, IP address, subclass, type, remarks, and unique tags. When clicked, the edit button displays the data the user wants to edit, and a small window appears where the user can update data. At the bottom, there are two buttons, Save and Cancel.

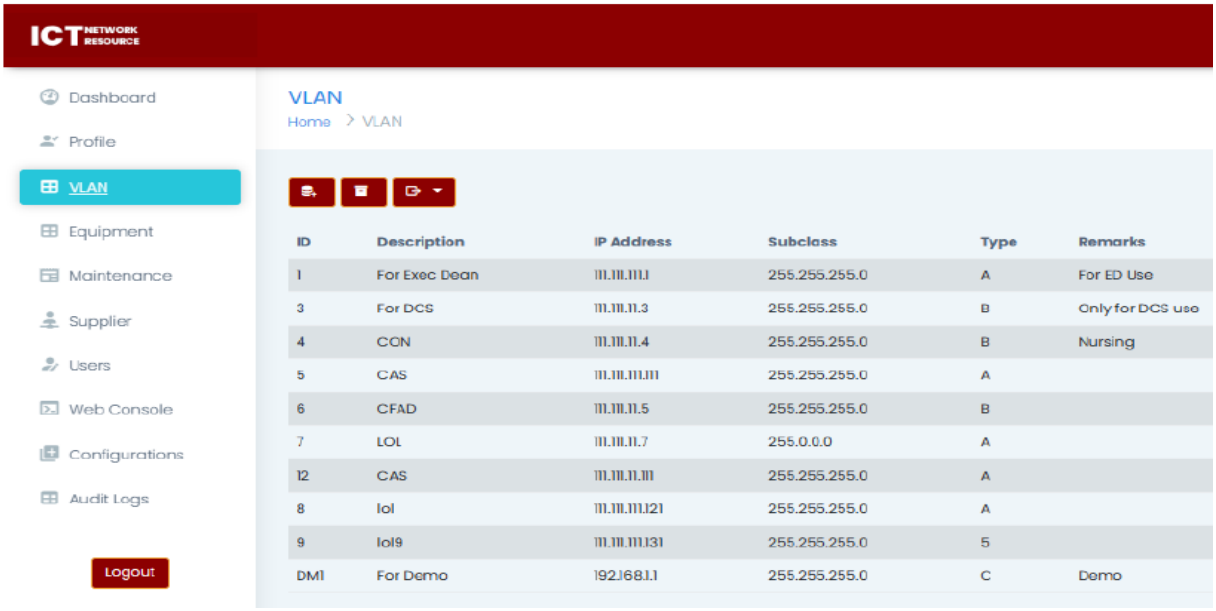

Figure 5. VLAN Section of ICT Network Resource Management System

The View Archive Button displays the archived VLANs, as shown in Figure 6. The user can see a button that leads back to the VLAN tab. When the Export button is clicked, VLAN information can be exported. It displays the VLAN that can be exported, and the button has a file type selection.

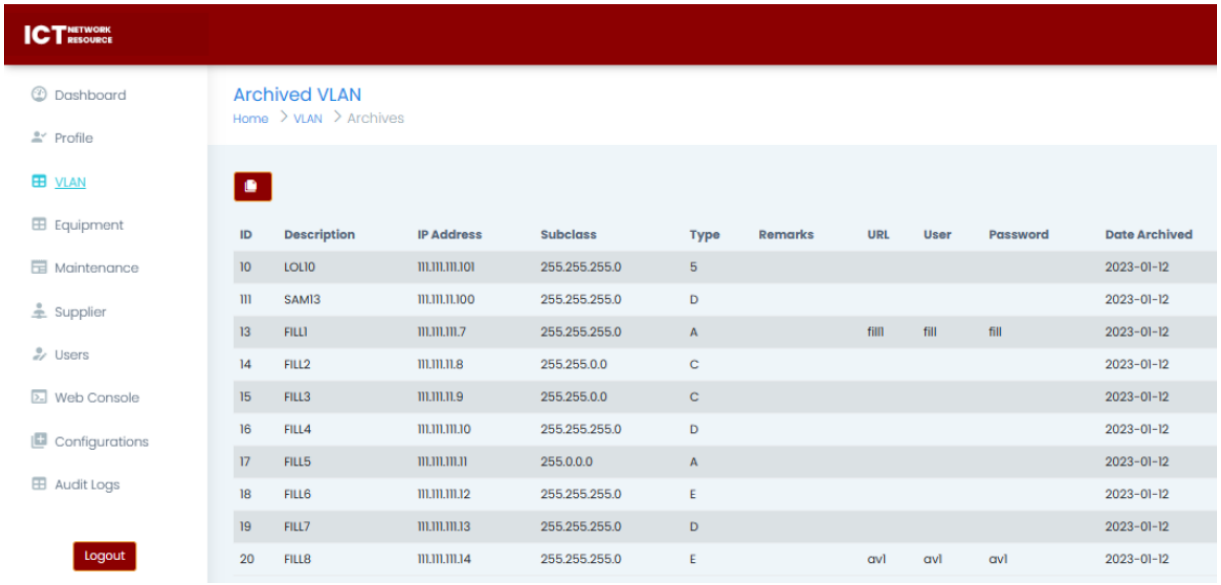

Figure 6. VLAN Archives Section of ICT Network Resource Management System

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As shown in Figure 7, clicking the Equipment tab reveals a drop-down menu that displays the Active, Archives, Deployed, and For Retrieval Equipment tabs.

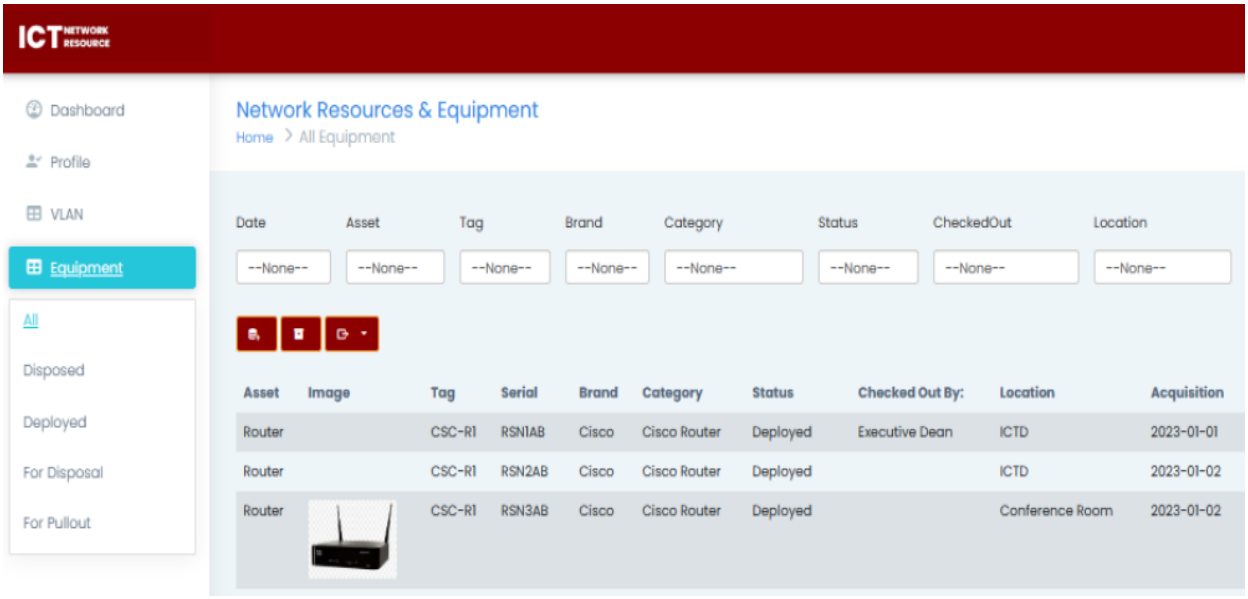

Figure 7. Equipment Section of ICT Network Resource Management System

All Equipment tab redirects users to the Network Resources & Equipment tab. Here, all the active equipment is listed. The Disposed tab under the Equipment dropdown menu redirects the user to the Disposed Equipment page, which displays information about the equipment removed from the active equipment. The Deployed tab redirects users to the Deployed Equipment page, which displays all equipment that has been deployed. It includes an action tab where the user can dispose of, edit, or set the maintenance of the equipment. Users are redirected to the For Disposed Equipment Page when they click the For Disposal tab, which shows all the equipment marked for disposal. Users are redirected to the For Retrieval Equipment Page when they click the For Retrieval tab, which shows all the equipment marked for retrieval.

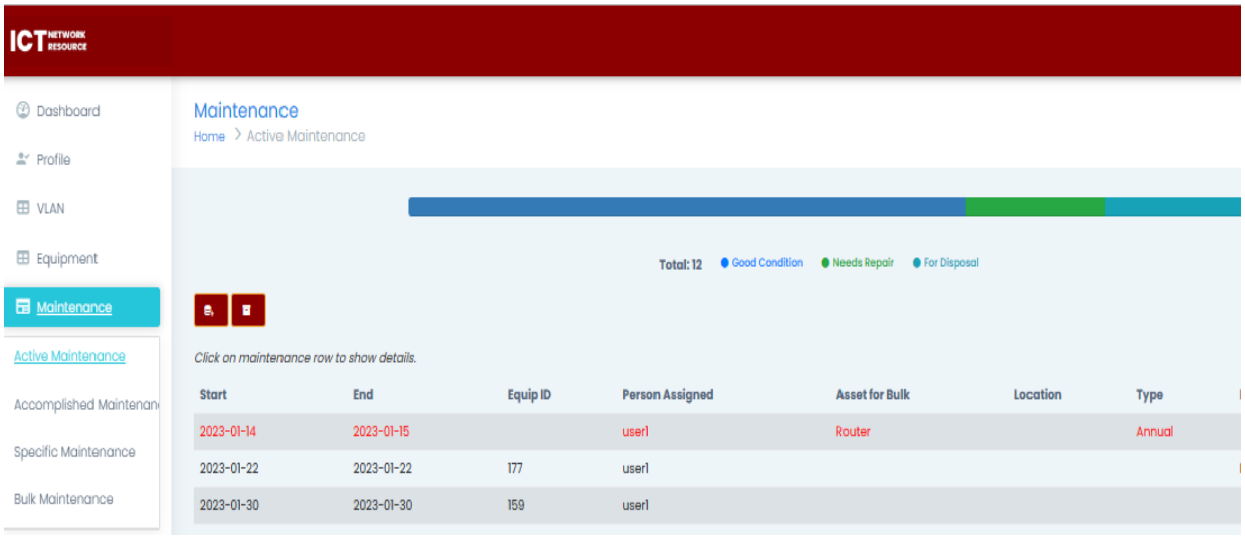

Figure 8. Maintenance Section of ICT Network Resource Management System

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As shown in Figure 8, all maintenance sets in the Maintenance Scheduled tab are listed. There are two buttons on the upper left side of the table: Add Bulk Maintenance and View Accomplished Maintenance. At the bottom, the number of pages is displayed. There is an action column on the table that contains the Update button. When the Add Bulk Maintenance button is clicked, a pop-up window appears. The window contains the data that needs to be filled in to set a maintenance schedule. When the Add button is clicked, the assigned user is notified that the maintenance schedule is added. The accomplished maintenance is the maintenance that the users have completed. A button at the top of the table will redirect the users to the Active Maintenance tab. A pop-up window appears when the Update button is clicked from the Scheduled Maintenance tab. The user can move the updated date, personnel assigned, and remarks in this window. Specific Maintenance displays maintenance for specific equipment only. The information displayed in the Bulk Maintenance Section is about the maintenance set for bulk equipment.

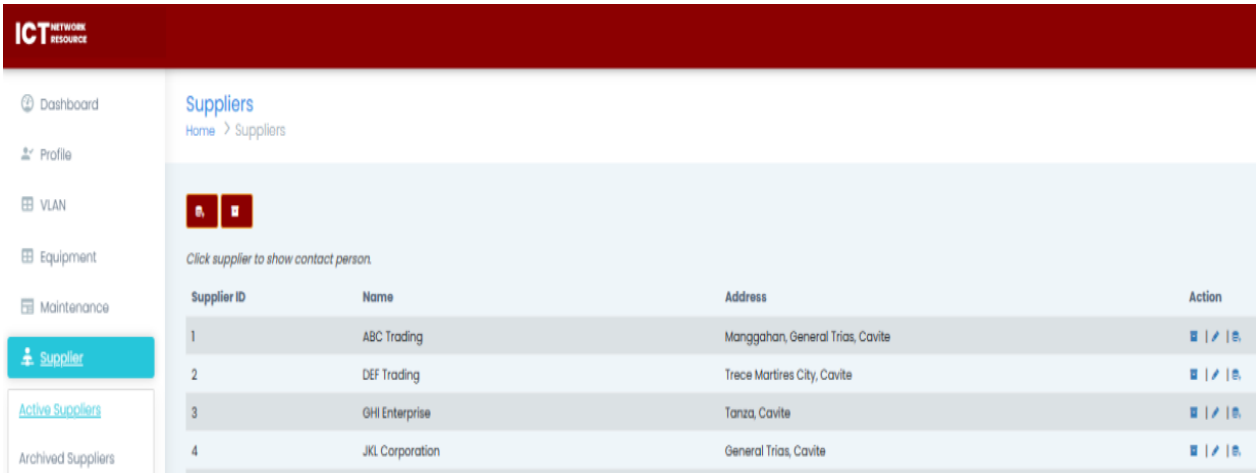

Figure 9. Suppliers Section of ICT Network Resource Management System

The Suppliers Section has two subsections: Active Suppliers and Archived Suppliers as shown in Figure 9. The Active Suppliers tab contains the supplier that the department is currently working with. In this tab, there are two buttons at the top of the table: Add Supplier and View Archive Suppliers. The table contains an action column containing the Archive, Update, and Add Contact Person buttons. The contact person under the Suppliers tab contains the supplier's contact information and can archive or edit the details. The Archive Suppliers tab contains the suppliers that are currently archived. In this tab, you can view the archived information about the suppliers. The archived contact person under the Suppliers tab contains the information of the archived contact form of supplier info.

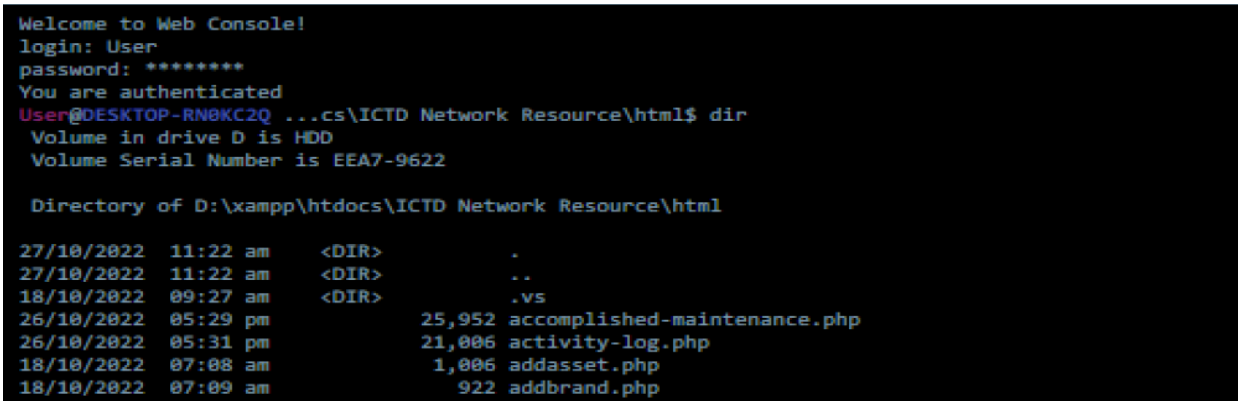

Figure 10. Web Console of ICT Network Resource Management System

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After clicking the link to the web console, the user can manage the server's data using the Web Console tab, as presented in Figure 10. The user can also use commands to configure the web server through the web console.

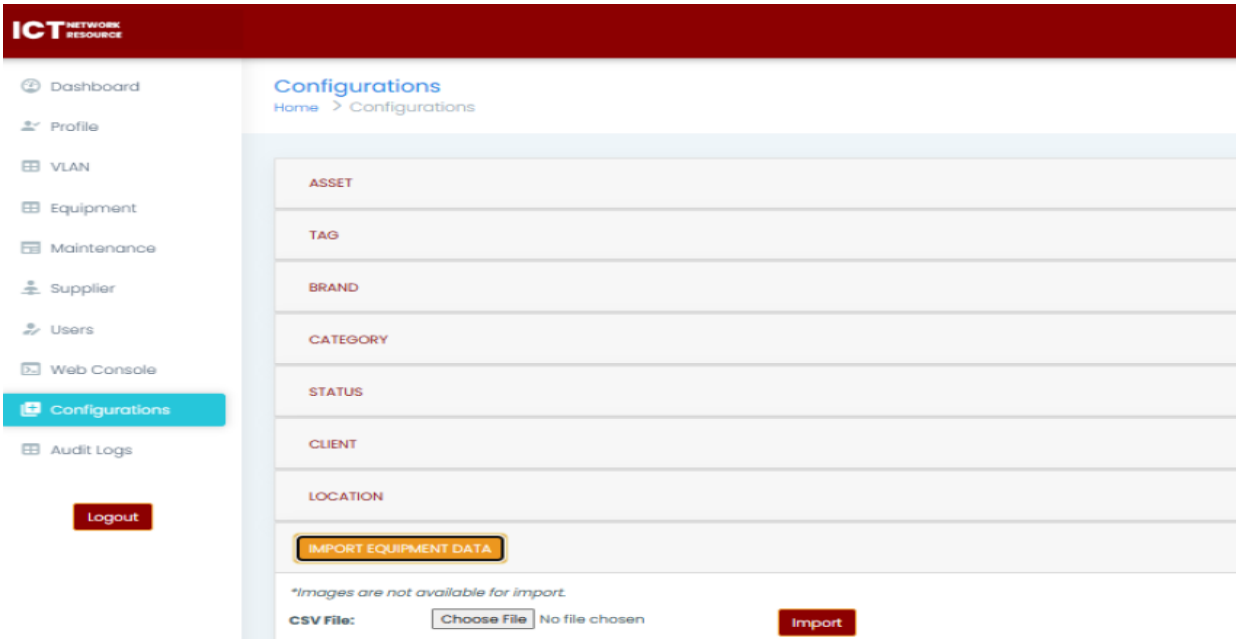

Figure 11. Web Console of ICT Network Resource Management System

Figure 11 shows the Configuration tab, where the user can manually enter the various types of configuration data and search. It also shows the Configuration tab for bulk file uploads. It allows the user to upload CSV files and import them into the equipment page.

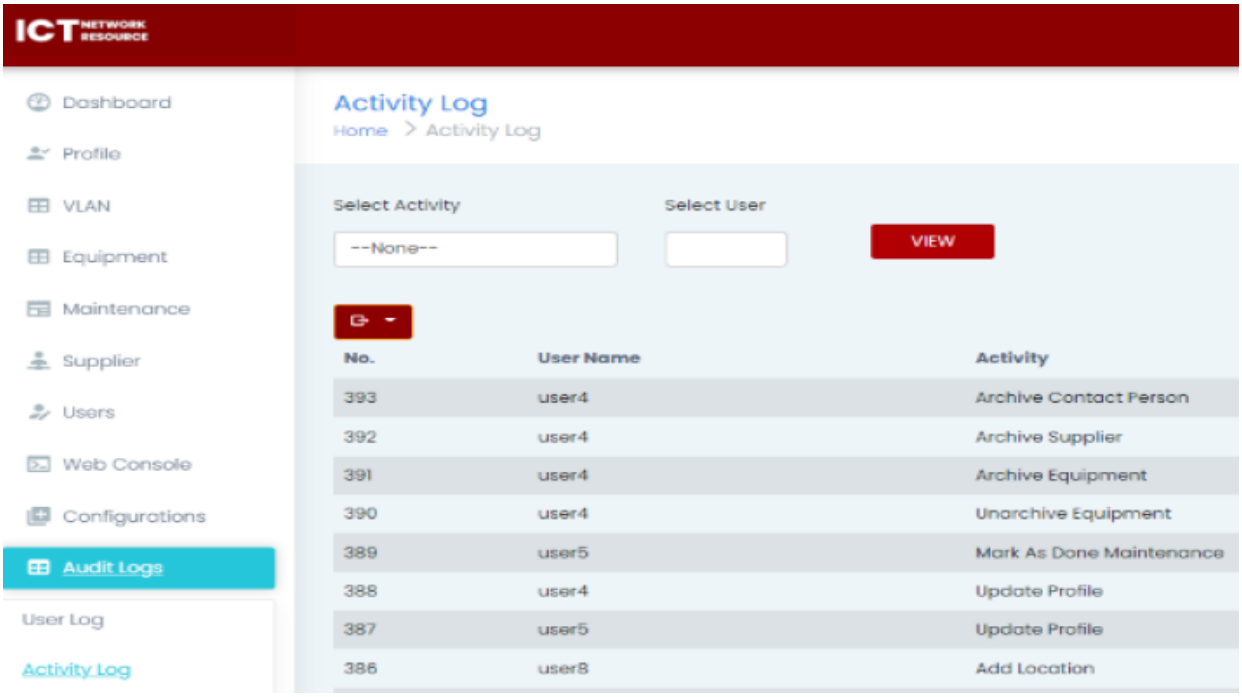

Figure 12. Web Console of ICT Network Resource Management System

As shown in Figure 12, the user's login time is displayed in the user log tab, and the user can generate reports. The user's whole activity history is recorded in the activity log. It comprises the user who made the changes and the time it happened.

There are two types of users in the system: admin and staff. The staff are not allowed to create and manage users, and the admin does not have restrictions. The overview of the system is displayed in the dashboard. The registered users, active VLAN, and active equipment in the dashboard will redirect users to their tabs when clicked. The system can record the activity and user logs. The activity log will show if the user changes or adds something to the system. The user logged-in time is recorded in the user logs. The system can store the temperature readings of the data center. It will send an email notification to all the admins if the temperature is at a critical level. The web console has a double authentication feature. It sends a code to the user's email, which expires after 60 seconds. The system can export files in CSV, PDF, and XLS format. The user can also choose which specific data they want to export. In case of failure, the system has a cron backup that automatically backs up the system daily at 1 AM.

Evaluation Results

Table 1
Functionality Test Result

Test Respondents	Pass	Failed	Test Criteria	Percentage
Technical Adviser	293	0	293	100.00%
Admin 1	293	0	293	100.00%
Admin 2	293	0	293	100.00%
IT Expert 1	285	8	293	97.61%
IT Expert 2	293	0	293	100.00%
IT Expert 3	280	13	293	95.56%
IT Expert 4	293	0	293	100.00%
IT Expert 5	288	5	293	98.29%

According to Table 1, out of eight (8) respondents who participated in the functionality testing, three reported finding errors and bugs in the system. The first (1) IT expert identified bugs related to viewing users and VLANs in the dashboard, adding temperature, and the refresh button in the server dashboard. The third (3) IT expert also reported discovering minor bugs related to viewing disposed of equipment, active maintenance, graphs, issues with a particular tag when adding equipment, and a problem with the XLS button when generating reports. The fifth (5) IT expert also found minor issues and bugs in the system similar to those reported by the other IT experts. The system's developers were able to verify the bugs quickly and subsequently resolved them using debugging and log analysis techniques, which ensured that the system remained operational and that the users were able to access and utilize the system effectively. Table 2 shows that the eight (8) respondents to the compatibility testing did not find any significant faults, bugs, or issues with the different screen sizes and web browser tests. The screen size test consists of tiny (640px), medium (768px), large (1024px), and extra-large (1280px) screen sizes. Web browser compatibility is also tested using Google Chrome, Microsoft Edge, and Opera Mini.

Table 2
Compatibility Test Result

Test Respondents	**Pass**	**Failed**	**Test Criteria**	**Percentage**
Technical Adviser	7	0	7	100.00%
Admin 1	7	0	7	100.00%
Admin 2	7	0	7	100.00%
IT Expert 1	7	0	7	100.00%
IT Expert 2	7	0	7	100.00%
IT Expert 3	7	0	7	100.00%
IT Expert 4	7	0	7	100.00%
IT Expert 5	7	0	7	100.00%

Table 3 shows the overall evaluation results of the 1 technical adviser, 2 admins, 10 IT experts, and 10 end-users. It shows that Security comes first, followed by Compatibility, Usability, Reliability, Functional Suitability, Portability, Maintainability, and Performance Efficiency. All aspects of the system have been deemed "Highly Acceptable," with an average mean of 3.65 and an average standard deviation of 0.15.

Table 3
Evaluation Result

Criteria	Mean	S.D	Interpretation	Rank
Functional Suitability	3.50	0.00	Highly Acceptable	7
Performance Efficiency	4.00	0.00	Highly Acceptable	1
Compatibility	3.75	0.70	Highly Acceptable	3
Usability	3.58	0.40	Highly Acceptable	6
Reliability	3.63	0.50	Highly Acceptable	4
Security	3.90	0.44	Highly Acceptable	2
Maintainability	3.60	0.44	Highly Acceptable	5
Portability	3.50	0.00	Highly Acceptable	8

CONCLUSION

This research project aims to create a web-based system for ICT-D that would enhance the administration of various network resources at the Lyceum of the Philippines' Cavite Campus, making it more convenient and practical. This would improve their inventory and user management monitoring by having a system dedicated to network resources instead of documenting the inventory using Excel, which they currently use. The developed system also boasts web server monitoring, wherein users can see the real-time status of the web server through a server dashboard. In addition, the system provides remote access to the system's administrators to manipulate the web server using its command-line terminal. Essentially, any improvement to the system used by a unit of the ICT-D would also benefit the university and its stakeholders by giving access to better services.

ICT Network Resource Management System was a management system with VLAN and network equipment inventory features. It was created to enhance the management of network resources inside the NTSU in the ICT department. The system used tables to display its records, such as VLAN, network equipment, maintenance, supplier, data center monitoring, and audit logs. The dashboard included charts that better show an overview of some features in the system.

The system was tested with an average of 98.93% using the Unit type of Functionality Test to ensure that every button, text field, and other feature worked as intended. The compatibility test had an average of 100% and was conducted using browser testing to show that the system could be used and was functional in different screen sizes. The test proved that evaluators deemed the helpful system functional, efficient, portable, reliable, maintainable, and secure.

The system was also evaluated using the ISO 25010 to ensure its acceptability. The system was evaluated by twenty-three (23) respondents, one (1) technical adviser, two (2) admin, ten (10) IT Experts, and (10) end users. The evaluation had a 3.65 Mean and a standard deviation of 0.15, which translated to "Highly Acceptable." Based on this result, the system was highly acceptable to end-users. Thus, the system was up to the standard set by ISO 25010 regarding Compatibility, Usability, Reliability, Functional Suitability, Security, Portability, Maintainability, and Performance Efficiency. Overall, the ICT Network Resource Management system could greatly benefit the management and operation of network resources in the NTSU department.

The following recommendations can help guide other developers who may develop a similar project and make potential project improvements. It is suggested that extra security measures like MFA (Multi-Factor authentication) and session logoff be provided when in hibernate mode. The network topology would help the department locate the actual location of equipment in different buildings and departments. It is suggested that having an automated temperature recording would lessen the department's work. An analysis of temperature data is also highly recommended. It is also recommended that sensors, like other monitoring tools, be added to monitor the activity of the nodes with the router, etc. The audit logs can be improved by adding a reporting interface where the users can

generate a report based on the dashboard. Maintenance email notifications should be sent days prior to the scheduled maintenance date. Server monitoring should include other servers aside from the web server.

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