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Research Article

NETWORK AUTOMATION FOR ZERO-BASED PROVISIONING, SIMULATION, TESTING, AND POLICY-COMPLIANT OPTIMIZATION

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Abstract

Aims: To evaluate the effectiveness of an Automated Provisioning System in financial data centers, focusing on time efficiency, error reduction, and user satisfaction compared to manual provisioning. The study also aims to align automation benefits with UN Sustainable Development Goals (SDGs), particularly in promoting resilient infrastructure and sustainable IT practices. **Methodology:** Using a mixed-methods approach, the research combines quantitative metrics (time/error rates) with qualitative feedback from IT engineers via Likert-scale surveys. A Django-Python-based automation system was tested in a financial data center in a third-world country, featuring Zero-Touch Provisioning (ZTP), configuration templating, simulation, testing, and policy-compliance checks. **Results:** Results demonstrate a 91.67% reduction in provisioning time (5 vs. 60 minutes per device manually) and complete elimination of configuration errors. User surveys revealed high satisfaction (mean scores: 4.2–4.8/5), particularly for simplified device configuration (4.8 ± 0.45) and productivity gains (4.6 ± 0.55). The system's scalability allowed simultaneous configuration of 12 devices unachievable manually. While the findings underscore automation's potential to align with UN Sustainable Development Goals (e.g., resilient infrastructure), minor reliability concerns (SD: 1.3 for stability metrics) indicate areas for refinement. **Conclusion:** The study concludes that automated provisioning significantly enhances operational efficiency in financial institutions but recommends further improvements in system robustness, training, and security frameworks for broader adoption.

Keywords: Network automation, Zero-Touch Provisioning, Django-Python, Data Center.

INTRODUCTION

In today's rapidly evolving digital landscape, the efficiency and reliability of IT infrastructure play a critical role in the success of financial institutions. Network provisioning the process of configuring and deploying network devices has traditionally been a manual and time-consuming task, prone to human errors and inefficiencies. As enterprises scale, the need for automation in network provisioning becomes essential to ensure operational efficiency, reduce errors, and enhance cybersecurity. This study explores the implementation of an Automated Provisioning System at financial data center strategically positioned in third world countries, designed to streamline device configuration, minimize errors, and significantly reduce provisioning time. By automating the configuration process, this research aims to provide empirical evidence of the advantages of automation over manual provisioning, focusing on key metrics such as time efficiency, error rate reduction, and system scalability. Even in today's modern era and advancement of technologies, middle to large scale financial institutions is not an exception, even though their continuous momentum and with the global direction for automation process, it is still very evident that some departments within the business still use manual provisioning, especially on network infrastructure during weekend changes. There are still departments like the Data Center team that still uses the good old spreadsheets to monitor their daily operations and infrastructure. This is due tothe fact that automation itself has its pros and cons wherein network engineering still wasn't fully on boarded yet on this process. Though automation can fast track implementation and turnaround time for the business to introduce new services.

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The idea of automation process if not fully matured will have its negative consequences where exponentially can lead to network outages once the button to Mulyana and Fakih (2022), their experiment confirmed that using automation process with a single source of truth (SoT) will achieve an automation goal by reducing the required network device provisioning time by 70% to 92%. The results of their experiment also indicate a clear benefit compared to manually provisioned systems. Using manual configuration time and based on my actual experienced in the field of network engineering, it will take around approximately 30 to 60 minutes to completely configure one network device such as router or a switch. Take this time and multiply it exponentially as network devices will increase as new services, applications, and network connections are needed to scale up and to meet business needs and requirements. Operational efficiency improvements will be assessed through time saved in configuration, reduced errors, and automation workflow initiate the automation is started, hence financial impact might be inevitable. This will introduce monitoring and tracking difficulty overtime, maintenance challenges in ensuring the accuracy and data consistency, limited scalability and capacity, and limited collaboration especially when multiple people maintain the document file. Even in today's technology, numerous advancements has been made however Cisco System confirmed that up to 95% still of network changes are done manually. These manual changes lead to a lot of infrastructure issues, inconsistencies where network expansion will be impacted. Cisco's "Automating Network Operations" study found that automation reduced the time spent on repetitive network configuration tasks by up to 67% and decreased errors by 60%. According to Mulyana and Fakih (2022), their experiment confirmed that using automation process with a single source of truth (SoT) will achieve an automation goal by reducing the required network

device provisioning time by 70% to 92%. The results of their experiment also indicate a clear benefit compared to manually provisioned systems. Using manual configuration time and based on my actual experienced in the field of network engineering, it will take around approximately 30 to 60 minutes to completely configure one network device such as router or a switch. Take this time and multiply it exponentially as network devices will increase as new services, applications, and network connections is needed to scale up and to meet business needs and requirements. Operational efficiency improvements will be assessed through time saved in configuration, reduced errors, and automation workflow streamlining.

Problem statement

With the rapid paced of technology adoption in all facet of infrastructure domain, most institutions specially the financial businesses are being impacted not because of lack of resources and access to these next generation technologies but the lack of understanding of different factors such as the risk, impact, and the overall comprehension to the technology itself that hinders automation adoption. Global financial institutions have their edge on this race however there is still a push back that becomes a challenge to the management and managing a large-scale network infrastructures are not easy. Manual provisioning in enterprise network environments presents several critical challenges: 1. Time Inefficiency – Configuring a single device manually can take up to 60 minutes, limiting the ability to scale network deployment efficiently. 2. High Error Rate – Manual provisioning is prone to syntax errors, leading to network misconfigurations, downtime, and security vulnerabilities. 3. Scalability Issues – The traditional approach does not support mass deployment, resulting in a slow and resource-intensive provisioning process. 4. Operational Overhead – Network engineers spend excessive time on repetitive tasks instead of focusing on higher-value network optimization and security strategies. Thus, this study seeks to address these issues by implementing an Network Automation System and measures the effectiveness of the platform through quantitative performance metrics and user feedback, providing a data-driven approach to network management improvements. This system will enable: 1. Faster deployment by reducing provisioning time from 60 minutes to 1 minute per device. 2. Error-free configurations by automating the command execution process. 3. Scalability improvements, allowing for the provisioning of multiple devices simultaneously. 4. Increased productivity by enabling network engineers to focus on critical infrastructure security and enhancements.

LITERATURE REVIEW

Foreign literature

The shift towards network automation in recent years has been substantial, with studies highlighting its role in reducing manual configuration, lowering error rates, and enhancing system reliability. According to Miller and Taylor (2021), automation frameworks like automation tools are widely adopted in network engineering to streamline configuration management and increase efficiency in dynamic environments. A Source of Truth (SoT) framework centralizes and verifies network data for consistent device configurations, making it easier to audit and update information in real-time. According to the report by Network Computing advisers (Smith & Green, 2022), companies adopting SoT solutions have seen up to a 40% reduction in configuration errors. APIs facilitate seamless integration between systems, enhancing operational flexibility. A Gartner (2022) report emphasizes that organizations employing APIs in their network infrastructure gain increased agility and responsiveness to changing demands.

According to Mihăilă *et al.* (2017), Network programmability is a next gen trend that inspired by various network automation platforms specially programming scripting methods and standard programming languages used for controlling and monitoring of network elements. Currently, 95% of network operations are provisioned and implemented manually, in which a parallel costs are expected hence it results in a more money on operational cost, effort, and time consuming, A.A. Mazin *et al.* (2023).

Local literature

The Philippines has shown growing interest in automation within IT operations, specifically in network management. In a report by Department of Information and Communications Technology (2021), automation in network management was shown to improve operational efficiency and reduce dependence on The DICT's Annual Report (2022) highlights the growing importance of centralized management systems for IP address and device management, suggesting that a Source of Truth approach can streamline IP allocation and enhance data accuracy annual processes.

Foreign studies

A study by Cisco Networking experts Brown and Alexander (2020) tested network automation effectiveness as a network automation tool, demonstrating a 60% reduction in configuration time compared to manual processes. This study illustrates how automation frameworks can standardize configuration procedures and reduce human error. Research by the Chen and Lee (2021) explored the implementation of SoT models in enterprise environments, finding improved network consistency and data accuracy. The study suggested that using a SoT for IP and device management allows for better data synchronization across platforms. According to Mulyana and Fakih (2022), using a single source of truth for configuration data will lessen the deployment period and reducing the required provisioning time. A recent study by Khan and Lopez (2023) explored energy savings achieved through network automation, noting that reduced manual intervention leads to shorter device idle times and decreased energy consumption.

Local studies

A study by Cruz and Santos (2022) of Ateneo de Manila University investigated automation in local network management, showing that automation increases uptime and accuracy. The study recommended further integration of SoT models for better resource management. Both Villanueva and Reyes (2021) of University of the Philippines also conducted a study on API adoption, finding that API integrations enable real-time data access. A separate study by Dela Cruz and Fernandez (2020) of De La Salle University examined the impact of IT automation on employment, finding that while certain roles may be reduced, there is an increase in demand for IT professionals skilled in automation technologies.

METHODOLOGY

This study presents the research methodology employed in assessing the implementation of an automated network provisioning system focusing on financial institutions strategically positioned on a third world country. The methodology is designed to ensure that the study yields empirical, objective, and replicable network provisioning tasks. The following metrics werefindings, contributing to the body of knowledge in network automation, IT infrastructure management, and operational efficiency. The methodology encompasses the research design, data collection methods, survey instrument development, performance evaluation metrics, and statistical analysis techniques. Furthermore, ethical considerations and study limitations are discussed to provide a holistic view of the study's scope.

Research Design

The research follows a mixed-methods approach, integrating both quantitative and qualitative methodologies to comprehensively evaluate the impact of automation in network provisioning. The quantitative component measures the efficiency of the automated provisioning system in terms of time consumption, error rates, and user satisfaction scores. The qualitative component explores perceptions, usability challenges, and feedback from IT professionals interacting with the automated system. This study employs a comparative research design to analyze the differences between manual and automated provisioning methods. A pre-test/post-test evaluation framework is used to empirically validate the improvements introduced by automation.

Survey-based data collection

A structured Likert-scale survey was designed to capture user perspectives on the efficiency, reliability, and usability of the automated provisioning system. Participants rated statements on a five-point scale:

Table 1. Five-point Likert scale

Scale	Numerical Value
Strongly Agree	5
Agree	4
Neutral	3
Disagree	2
Strongly Disagree	1

The survey instrument included key questions such as: 1. The new system simplifies network device configuration. 2. The automated provisioning system reduces network deployment time. 3. The system enhances reliability in device provisioning. 4. The system improves overall productivity. 5. The system's user interface is intuitive and easy to use.

Performance data collection

To measure the effectiveness of automation, time-based and error-based data were collected during real-world analysis.

Table 2 Metrics for Data Collection

Implementation Items	Automation Provisioning	Mannual Provisioning
Time consume in device configuration(per device)	approx. 5 mins	60 minutes
Total number of configured devices	12 devices	1 device
Issues Encountered	None	Syntax errors
Total configuration errors	NA	Few Configuration lines

Data analysis techniques

The data collected were analyzed using descriptive statistics, inferential statistics, and comparative performance analysis.

Mean score analysis for survey data

This will highlight into average user satisfaction levels for each system feature.

$$\overline{X} = \frac{\sum X_i}{N}$$

Where:
$\overline{X}$ = Mean score
Xi = Numerical value of each response
N = Number of responses

Standard Deviation Calculation

To determine the consistency of responses, standard deviation was computed using:

$$S = \sqrt{\frac{1}{N-1}\sum(Xi - \overline{X})^2}$$

Where:
S = Standard Deviation
Xi = Numerical value of each response
$\overline{X}$ = Mean score
N = Number of responses

The higher standard deviation values indicated greater variability in user opinions, while lower values suggested consensus among respondents.

Comparative Efficiency Analysis (Automation vs Manual)

To assess the efficiency improvement due to automation, the following formulas were applied:

Time Savings Calculation

$$Time\ Savings(\%) = \left(1 - \frac{T_{automated}}{T_{manual}}\right) x\ 100$$

Where:
$T_{automated}$ = Time per device using automation
T_{manual} = Time per device using manual provisioning

Error Rate Reduction Calculation

$$Error\ Reduction(\%) = \left(1 - \frac{E_{automated}}{E_{manual}}\right) x\ 100$$

Where:
$E_{automated}$ = Errors encountered in automation
E_{manual} = Errors encountered in manual provisioning

Software Design

This study uses a developmental research design aimed at creating a Django-based network inventory configuration

management system integrated with python programming for network automation, network as a service platform that will uses python programming as the automation engine, offers a robust framework for managing network device configurations generation, inventory system, a built-in emulator to simulate and test device configuration accuracy and consistency, and a device configuration analyzer that design to have a single pane of glass potentially useful for network operations in troubleshooting network issues, device configuration standardization. The network automation solution proposed in this study aims to create a centralized, reliable foundation for network automation workflow processes. The conceptual design includes: 1. Centralized Data Management - Device inventory and automation services provide a single, authoritative source of network device and IP address information, ensuring accuracy and reliability in the data accesses. 2. Enhanced Configuration Accuracy - automates configuration by pulling real-time device and IP data from inventory database, ensuring the latest data informs network configurations. 3. Improved Consistency - The integration of consistent data models between inventory and reduces the risk of configuration errors and inconsistencies, leading to more stable network operations. 4. Streamlined Workflows - automates key tasks, such as device provisioning, configuration updates, and troubleshooting, based on the latest data from inventory. 5. Scalability - Designed to handle small and medium networks and complex configurations, provides scalability for organizations of any size and complexity. The researcher conceptualizes the development of the proposed capstone project and focuses on the development of a cost-effective solution based on a user perspective. A user-friendly web-based application for network automation services with additional features such as device inventory, testing and simulation, and device configuration analyzer for policy-compliance. Thisbroader aim goal is to share and have this application tailored for any type of businesses in the country.

The conceptual model presents python programming as the backbone of network device configuration management automation system, where Django serves as the web-based user interface to facilitate interaction with device inventory. The system enables seamless, automated configuration and efficient workflow for managing networks.

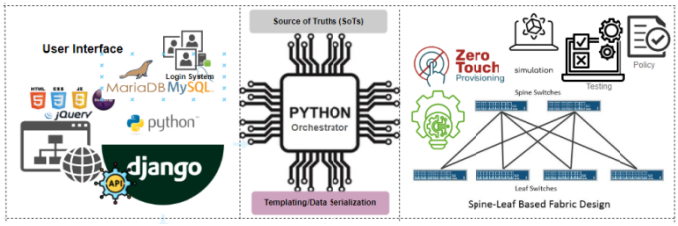

Figure 1. Conceptual framework design for network automation system

User Interface Design

The UI or User Interface will be designed with a user perspective and adaptation in mind, meaning the focus will be on the simplicity, usability and to zero out if not avoid user resistance to the new system by giving them easy to understand interface with summary dashboard upon login to provide overview of the total devices added, history of user login's, and a navigation menus and adaptive search functionality to allow users easily filter specific devices they are looking for or perform the CRUD actions devices as needed within the standard process from the inventory.

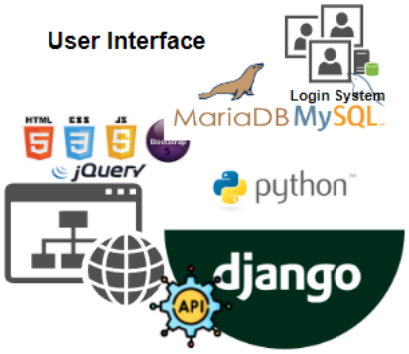

Figure 2. Django Framework

Database Design

Unified Modeling Language or UML was created for an entity-relationship (ER) model to define the database schema, including entities such as policy-compliance, emulator and simulation, network as a server (NaaS), devices, users, and session activity logs, along with their relationships and attributes. The UML diagram presentations will help as a visual tool that represents the structure of a system by showing its classes, attributes, methods and the relationships between to understand how the system is organized and how its components interact.

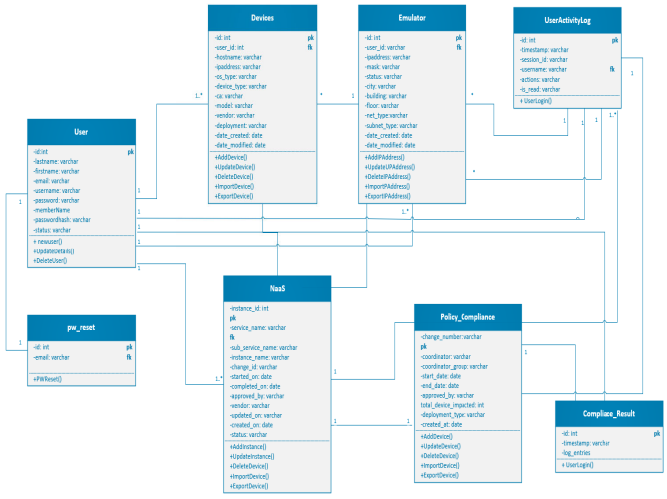

Figure 3 UML class diagram for network device automation system

Security Design

Authentication and Authorization will be implemented to have a secure login system for security authentication mechanisms, such as predefined username and password with password-hash to verify user identity. By default, Django frameworks prevents most common security mistakes such as XSS(cross-site scripting) protection wherein Django escapes variables, CSRF(cross site request forgery) protection in which Django framework guarantees that forms (POST requests) are sent from your own site, and SQL injection protection wherein Django uses built-in ORM (Object-Relational Mapper) thus there is no risk of SQL Injection. In addition, on Django's built-in security features. Role Based Access Control (RBAC) will be implemented defined onto the Django admin framework to identify user based on their role.Set flags for the access control and create a function to grant access based on the user department.

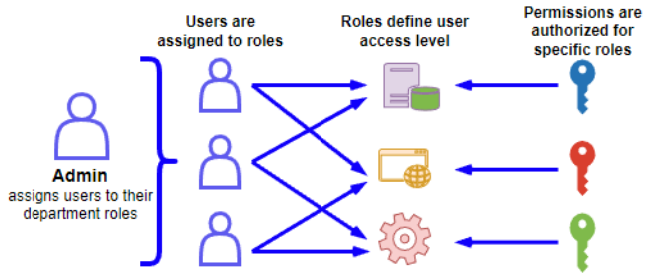

Figure 4. Role-access based control

Frontend Development

Develop a responsive UI or user interface using Django Framework Solution, HTML, CSS, and JavaScript. Incorporate Bootstrap 5 frameworks to ensure compatibility across different platforms. Interactive elements were also added such as dropdown menus and modals to add improvements and facilitate easy navigation for users to interact with the system. AJAX integration was also included to enable asynchronous data retrieval and updates, hence adding enhancements to user experience by potential reducing page reloads through real-timefeedback. Lastly, develop a form validation technique to validate user inputs and provide informative feedback/error messages to the users.

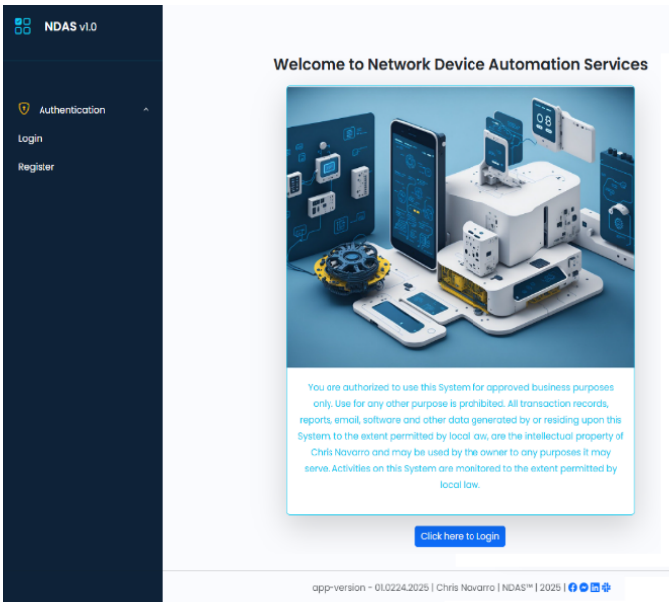

Figure 5. Network Device Automation Services

Backend Development

Server-side programming language was utilized, used Python native to the Django Framework for server-side scripting to handle WEB requests, process data and interaction with MySQL database. Design APIs for integrating external systems as the Source of Truth (SoTs) and to define endpoints for CRUD (Create, Read, Update, Delete) operations on network device details, allowing seamless communication between the Frontend and Backend. Used Django's built-in modules to establish secure connections to the MySQL database and execute DB queries for data manipulation. A sequential python scripts will be the core andused to automate the configuration and provisioning of network devices.The said platform will be an open source IT automation tool used for IT tasks such as configuration management, application deployment, and provisioning (Reh Hat, 2024).This will also introduce the "The Plug 'n Play" deployment or what is being called a Zero-Based Touch Provisioning process or ZTP.

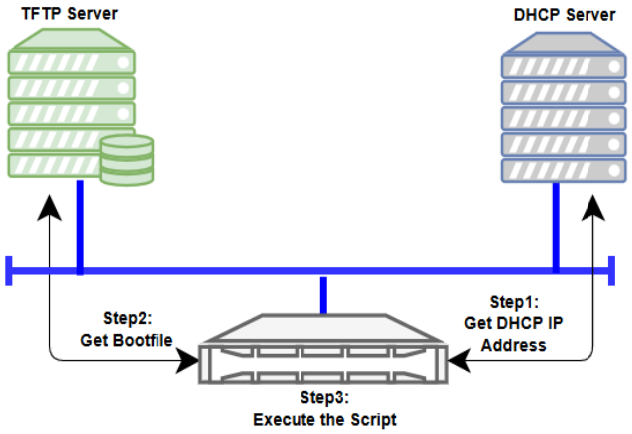

Figure 6. Zero-Based Provisioning Processes

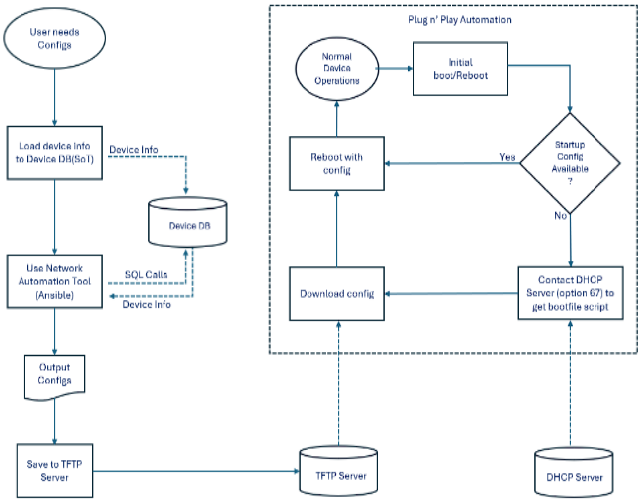

Figure 7. Zero-Based Provisioning (ZTP) Workflow

This zero-based or zero touch provisioning starts with user instantiating the workflow by using the Network as a Service (NaaS) feature of the platform. When user needs to generate a device configuration, by just clicking the automation button in the page, it will start a full sequential process from loading device variables from the database and feed the data into the templating engine that will produce the well formatted device configuration, once generated, it will be copied to a remote TFTP server and will be saved as device bootfile ready for the ZTP deployment.

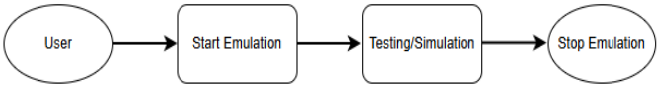

Figure 8. Testing and Simulation feature

This critical feature of the application will provide a more complete overall testing and simulation of the use to validate the consistency and accuracy of the device generated configuration from the network device automation service or NaaS. The user will enable the emulation service by starting the device container a backend python program will run to instantiate the containerize operating system of the virtual device such as cEOS.

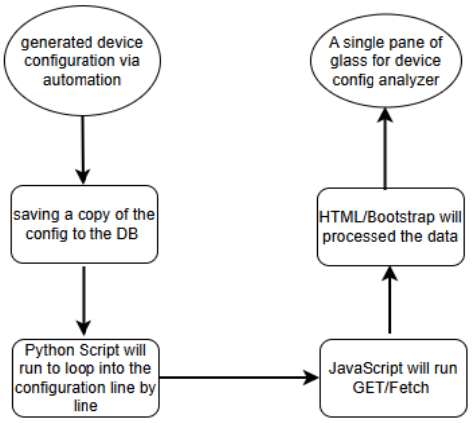

Figure 9. Policy-Compliance feature

One of the important feature of this application is the device configuration analyzer that will display device configuration data in a single pane of glass environment.

RESULTS AND DISCUSSION

This chapter presents the results of the study, analyzing the collected quantitative and qualitative data to evaluate the impact of an automated provisioning system. The findings are structured around key research objectives, specifically comparing automation vs. manual provisioning in terms of time efficiency, error rates, and user satisfaction. The discussion provides statistical interpretations, linking empirical evidence to relevant literature and industry best practices.

Comparative analysis of automation vs manual

A structured assessment was conducted to compare the two provisioning methods. Experts from a local financial institution tried and tested the said platform and put it into tests. The results reveal substantial efficiency gains and error reduction through automation.

Time consumption analysis

The table below presents the mean time required per device configuration for both methods.

Table 3, Time Comparison (Automation vs Manual)

Implementation Items	Automation Provisioning	Mannual Provisioning
Time consume in device configuration(per device)	approx. 5 mins	60 minutes
Total number of configured cevices	12 devices	1 device

Using the time savings formula:

$$Time\ Savings(\%) = \left(1 - \frac{T_{automated}}{T_{manual}}\right) x\ 100$$

$$= \left(1 - \frac{1}{12}\right) x\ 100 = 91.67\%$$

Thus, network automation reduces time consumption by 91.67%, demonstrating its effectiveness in high-volume deployments making it exponentially more efficient than manual provisioning.

Configuration error rate and system reliability

The study compared the error rates encountered in automated vs manual provisioning, due to the testing and simulation feature of the platform, experts concurred that before progressing the automation process they tend to simulate first the syntaxes hence giving them the opportunity to correct issues before initiating the automation and clearly provide a more error-free workflow. The table below illustrates the total error recorded during configuration.

Table 4. Configuration error-rate analysis

Provisioning Method	Issues Encountered	Total Configuration Errors
Automated Provisioning	None	0%
Manual Provisioning	Syntax Errors	Multiple Syntax Errors

The formula used to calculate error rate reduction percentage is:

$$Error\ Reduction(\%) = \left(1 - \frac{E_{automated}}{E_{manual}}\right) x\ 100$$

$$= \left(1 - \frac{0}{E_{manual}}\right) x\ 100 = 100\%$$

Based on the experts experienced and the results of the calculation indicates, automation totally eliminates configuration errors compared to a manual method.

User satisfaction on automated provisioning

To further strengthen the analysis, statistical computations were performed on the survey responses. Using this approach, the mean scores for each survey question were computed to quantify the general perception of the system. A Likert-scale survey was conducted among IT Engineers in a local financial institution to assess user satisfaction with the automated provisioning system. Table 5 presents the computed mean and standard deviation for each survey question. The high mean scores indicate strong user approval, while the low standard deviation values suggest consistent positive responses among participants.

Table 5. User feedback on the network automation system

Question	Mean Score	Standard Deviation
The new system simplifies network device configuration.	4.8	0.45
The automated provisioning system has reduced network deployment time.	4.4	0.89
I am satisfied with the reliability of the automated provisioning system.	4.2	1.3
The new system has improved my overall productivity.	4.6	0.55
The user interface of the automated provisioning system is intuitive and easy to use.	4.2	0.84

The mean scores and standard deviations provide a quantitative measure of user perceptions. The high mean scores across all categories indicate strong user satisfaction, while the standard deviations highlight the consistency of responses.

Discussion

The results of the survey indicate a highly positive reception of the automated provisioning system, reinforcing its significance in enhancing network operations. The following sections elaborate on each surveyed aspect, integrating relevant literature and theoretical frameworks to contextualize the findings. By incorporating statistical analysis, this study provides empirical evidence supporting the effectiveness of the automated provisioning system. These findings serve as a

foundation for further enhancements and optimization usability is a critical success factor in automation in network automation practices.

Simplification of network device configuration

The system received the highest mean score (4.8) with a low standard deviation (0.45), indicating that nearly all users strongly agreed that it simplifies network device configuration. This high approval rate underscores the system's ability to reduce manual interventions in network setups, minimizing configuration errors and ensuring standardized deployments.

Reduction in network deployment time

The system's efficiency in reducing network deployment time was positively rated, with a mean score of 4.4. However, the standard deviation (0.89) indicates slight variability in responses, suggesting that while most users experienced improvements, some may not have observed significant time reductions due to factors such as learning curves or specific network environments. Research suggests that automation significantly reduces deployment time by eliminating redundant manual processes and expediting the provisioning workflow.

System reliability

User feedback on system reliability yielded a mean score of 4.2, with a standard deviation of 1.3, indicating a more diverse range of experiences. While most users found the system reliable, one respondent disagreed, highlighting potential areas for improvement. Reliability is crucial in automated environments, as failures in provisioning can lead to operational disruptions. Enhancements in stability, error handling, and proactive monitoring could further improve user confidence in the system's dependability.

Improvement in productivity

The system's impact on productivity was highly rated, with a mean score of 4.6 and a standard deviation of 0.55, indicating strong consensus among users. The automated provisioning system's ability to streamline operations and reduce workload burdens directly contributes to organizational efficiency. Industry research correlates automation with increased operational agility, reduced time-to-service, and improved resource utilization, reinforcing the benefits observed in this study.

User interface intuitiveness

User perceptions of the system's interface were generally positive, with a mean score of 4.2 and a standard deviation of 0.84. While most users found the interface intuitive and easy to use, some variation in responses suggests room for usability enhancements. Human-computer interaction (HCI) principles emphasize that adoption, and these findings validate the system's effectiveness while identifying potential areas for improvement.

CONCLUSION AND RECOMMENDATION

The findings of this study demonstrate that the automated provisioning system has successfully enhanced network operations by improving efficiency, reliability, and user experience. The overwhelmingly positive responses affirm the system's effectiveness in simplifying configurations, reducing deployment time, and increasing productivity. However, concerns regarding reliability suggest that further refinements are necessary to ensure consistent system performance. Overall, the implementation of network automation aligns with global industry trends advocating for reduced operational overhead and increased agility in IT infrastructure management. Based on the empirical findings and discussion and by implementing these recommendations, the automated provisioning system can continue to evolve as a highly reliable, efficient, and user-friendly solution, ensuring long-term value for any organization and position the organization at the forefront of modern network automation process. The following recommendations are proposed to further optimize the system's performance and maximize its benefits: 1. Enhancing System Reliability: Conduct in-depth failure analysis and integrate robust redundancy measures to mitigate potential disruptions. This can be achieved through improved logging mechanisms, predictive analytics, and fault-tolerant architecture. 2. User Training and Continuous Learning: Implement ongoing training programs to familiarize users with advanced functionalities and best practices in network automation. Regular workshops and certifications can enhance user competence and confidence.3. Iterative System Improvements: Establish a structured feedback loop to collect real-time user experiences, enabling continuous refinement of features based on operational requirements and evolving network demands. 4. Scalability and Future Expansion: Expand the system's capabilities to support a wider range of network configurations and devices. This ensures adaptability to future technological advancements and evolving business needs. 5. Security and Compliance Considerations: Strengthen the security framework by integrating compliance monitoring and automated threat detection to safeguard against vulnerabilities associated with automated provisioning.

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Competing interests

I affirm there are no conflicts of interest that could influence the outcomes or objectives of this study. I have no personal or financial connections with any individuals, entities, or institutions that might compromise the impartiality of this research. This commitment ensures the research remains unbiased and credible.

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