Cybersecurity Portal for Effective Management of Servers and Firewalls

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CERTIFICATE

This is to certify that the Internship/Project report **"CYBER SECURITY PORTAL FOR EFFECTIVE MANAGEMENT OF SERVERS AND FIREWALLS"** being submitted by "VAIBHAV BHARDWAJ, GAUTHAM CN, JYOTSNA BANAKAR" bearing roll number "20211CCS0052, 20211CCS0103, 20211CCS109" in partial fulfillment of the requirement for the award of the degree of Bachelor of Technology in Computer Science and Engineering is a Bonafide work carried out under my supervision.

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DECLARATION

I hereby declare that the work, which is being presented in the report entitled "**CYBER SECURITY PORTAL FOR EFFECTIVE MANAGEMENT OF SERVERS AND FIREWALLS"** in partial fulfillment for the award of Degree of **Bachelor of Technology** in **Computer Science and Engineering**, is a record of my own investigations carried under the guidance of **Ms. Sterlin Minish T N,** Assistant Professor**, Presidency School of Computer Science and Engineering, Presidency University, Bengaluru.**

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ABSTRACT

With the increasing digitization of academic governance and institutional operations, cybersecurity has emerged as a critical pillar for maintaining data integrity, system availability, and user privacy across educational ecosystems. The All-India Council for Technical Education (AICTE), as a central regulatory body overseeing more than 10,000 technical institutions in India, faces the complex challenge of managing and protecting vast amounts of sensitive data and IT infrastructure. Fragmented cybersecurity practices, outdated manual processes, and limited visibility across distributed networks contribute to increased vulnerability to cyber threats and inefficiencies in incident response.

This project introduces the design and development of a centralized Cybersecurity Portal tailored specifically for AICTE. The portal serves as a unified platform for real-time infrastructure monitoring, secure server and firewall configuration, user management, and threat intelligence integration. Core features include a dashboard for system-wide visibility, support for role-based access control (RBAC), OTP-based Multi-Factor Authentication (MFA) for enhanced login security, and seamless integration with third-party APIs to fetch the latest threat indicators.

Developed using modern web technologies including Node.js, Express.js, MongoDB, and JWT for secure authentication, the portal emphasizes scalability, performance, and modularity. The system is designed with a focus on usability, ensuring that administrators at various levels can access and manage cybersecurity components efficiently without requiring extensive technical expertise.

By consolidating multiple cybersecurity functions into a single interface, the AICTE Cybersecurity Portal not only reduces the administrative burden but also enhances proactive threat detection and rapid incident response. The implementation of this portal represents a significant step towards a standardized, secure, and responsive digital infrastructure for technical education governance in India.

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Chapter 1
INTRODUCTION

1.1 Background

The rapid growth of digital infrastructure in India's education sector has revolutionized how academic institutions operate, communicate, and manage information. From online learning platforms and digital evaluation systems to cloud-based academic record management, educational institutions today are deeply reliant on technology. All India Council for Technical Education (AICTE), the statutory body responsible for regulating and maintaining standards in technical education, plays a central role in ensuring that these digital tools and platforms are reliable, secure, and effectively governed.

AICTE supports over 10,000 institutions across the country, each of which deals with highly sensitive data such as student records, staff credentials, research outputs, financial transactions, and internal communications. In an era where cyber threats have become increasingly sophisticated and frequent, safeguarding this information has become a matter of national importance. The protection of such critical infrastructure goes beyond traditional IT support—it demands a comprehensive and strategic cybersecurity approach that is scalable, dynamic, and centralized.

1.2 Problem Statement

Despite the growing dependence on digital systems, many educational institutions—and by extension, the governing bodies that oversee them—still rely on disjointed or manual methods for cybersecurity management. Common challenges include:

- Decentralized Monitoring: Different departments may use independent systems for monitoring server performance, firewall logs, and user access, creating information silos.
- Delayed Incident Response: Without real-time insights or alerts, institutions struggle to respond promptly to breaches or vulnerabilities.
- Limited Access Controls: Many systems lack advanced authentication protocols, exposing them to unauthorized access or insider threats.

1.3 Motivation

The motivation behind this project stems from the urgent need to enhance the digital security posture of AICTE. As India continues to implement large-scale educational reforms and digital governance strategies under initiatives like *Digital India* and the *National Education Policy (NEP) 2020*, the integrity and resilience of education-related digital infrastructure must be prioritized.

A cybersecurity portal designed specifically for AICTE offers a proactive solution to these challenges. Such a platform can provide centralized oversight, standardized security practices, and rapid response capabilities, empowering administrators to make informed decisions and

act quickly in case of threats. Furthermore, by streamlining operations and integrating modern technologies like Multi-Factor Authentication (MFA), JWT-based session management, and role-based access control (RBAC), the platform would ensure not just security, but also scalability and ease of use.

1.4 Objectives

The primary objective of this project is to develop a centralized, secure, and scalable Cybersecurity Portal for AICTE. Specific goals include:

- Creating a unified dashboard for infrastructure monitoring, including server health, firewall status, and user activity.
- Implementing robust security features, including OTP-based MFA and JWT-based token authentication.
- Integrating third-party threat intelligence APIs to allow AICTE to stay ahead of emerging threats.
- Providing a role-based access control system to ensure appropriate permissions and user accountability.
- Designing a user-friendly interface that facilitates ease of operation without compromising on security.

1.5 Scope and Significance

This project is intended to be a prototype that could be scaled to a production-level solution for AICTE and potentially other government or educational institutions. The scope includes the development of a web-based portal, backend services for data handling and authentication,
and integration with third-party APIs. It does not include the physical deployment of network hardware but assumes its availability in a secure infrastructure.

The significance of this work lies in its potential to serve as a reference model for cybersecurity management in academic governance. In a time when cyberattacks target public institutions with increasing frequency, building such a solution is both timely and impactful. The portal can help reduce administrative burden, improve transparency, and foster a more secure and efficient digital ecosystem for technical education in India.

Chapter 2
LITERATURE SURVEY

Cybersecurity in educational governance has gained prominence in recent years, especially with the digital transformation of administrative and academic operations. The integration of centralized infrastructure monitoring, access control, and proactive threat management forms the foundation of effective cybersecurity systems. This literature survey delves into key components relevant to the proposed AICTE Cybersecurity Portal, including centralized Data Center Infrastructure Management (DCIM), firewall and access control systems, multi-factor authentication mechanisms, threat intelligence tools, and existing implementations. It also outlines the limitations of current solutions in the context of hybrid, government-managed educational ecosystems.

1. A Survey on Data Center Infrastructure Management (DCIM) Systems

Authors: R. S. Barve, S. Patil, and R. S. Deshmukh

Publication: International Journal of Computer Applications, 2020

This paper provides a deep dive into the mechanisms and challenges associated with Data Center Infrastructure Management (DCIM) systems. It categorizes DCIM functionalities into key domains such as infrastructure monitoring, asset management, and control automation. The authors assert that DCIM acts as a bridge between IT and facility systems, offering centralized control over resources like servers, cooling systems, and energy usage. They review both proprietary and open-source solutions, highlighting inefficiencies in legacy architectures and pointing out the lack of integration across monitoring tools. A key takeaway is the importance of real-time data collection and centralized dashboards to reduce downtime and optimize performance.

This is especially relevant for the proposed cybersecurity portal, which aims to integrate DCIM-like features such as live server status, log tracking, and fault detection. The paper's findings validate the portal's objective to unify security and infrastructure management under a single interface, particularly in budget-conscious educational environments where hybrid infrastructure (virtual + physical servers) is common. The

authors conclude that while current tools focus on operational visibility, there is a pressing need for automation and enhanced security integration — a gap your portal seeks to fill.

2. FAME: A Framework for Automatic Firewall Policy Analysis and Management

Authors: Ehab Al-Shaer, Hazem Hamed

Publication: IEEE Transactions on Network and Service Management, 2004

This seminal paper introduces the FAME framework — a systematic approach to firewall policy analysis and management. It identifies key issues in firewall rule sets such as shadowing, redundancy, correlation conflicts, and general inconsistencies. The paper provides algorithms for detecting and resolving these anomalies through formal modelling of firewall rules. The authors argue that as rule sets grow in complexity, manual auditing becomes impractical and prone to security loopholes.

The framework enables network administrators to validate and optimize firewall policies without affecting performance or rule enforcement. It emphasizes visual policy representation and conflict resolution as essential for both policy clarity and operational security. FAME also provides simulation tools to forecast how new rules would behave within the current firewall structure.

This research forms the backbone of your firewall management component. Your portal aims to offer similar features — rule visualization, optimization, and validation — particularly useful in multi-user, multi-layered institutional environments. By automating anomaly detection and resolving internal conflicts in access control lists, your system could prevent misconfigurations that expose servers to external threats. The paper's emphasis on policy refinement and error-free rule deployment directly aligns with your project's goal to integrate intelligent, policy-driven firewall management within a broader cybersecurity ecosystem.

3. Survey on Multi-Factor Authentication (MFA)

Author: Ali A. Aloul

Publication: IEEE Computer Society, 2012

This paper evaluates the architecture, usability, and effectiveness of Multi-Factor Authentication (MFA) systems. It describes how traditional single-factor authentication (e.g., passwords) is no longer sufficient in the face of increasing cyber threats. The survey covers various MFA schemes including OTPs (One-Time Passwords), smart cards, biometrics, and mobile-based authentication systems. It compares them on parameters such as user convenience, implementation cost, device dependency, and resistance to attacks like phishing, keylogging, and social engineering.

The author discusses the usability-security trade-off, proposing hybrid models that balance ease of use with robust security. Importantly, the paper emphasizes that MFA must be context-aware — sensitive to the user environment and device type — to maximize security and user compliance.

In your cybersecurity portal, OTP-based MFA is implemented for admin access, aligning directly with the concepts discussed. The paper provides validation for using OTP as a low-cost, scalable MFA approach suitable for educational institutions. The author's recommendation of layered security measures supports your plan to combine firewall rule authentication with user identity verification. By integrating contextual verification (e.g., device fingerprinting or time-of-access logs) in future versions, your system could elevate security even further. This paper lays the theoretical groundwork for user access control in your portal's architecture.

4. Cyber Security Challenges and Solutions in Indian Higher Education Institutions

Authors: A. Ramesh and N. R. S. Raghavan

Publication: International Journal of Innovative Research in Computer and Communication Engineering, 2019

This paper investigates the cyber threats faced by higher education institutions in India and presents a framework of solutions to mitigate them. It identifies key problems such as lack of centralized cybersecurity infrastructure, poor awareness among staff and students, and unregulated data access. Institutions frequently rely on manual, fragmented security mechanisms which result in non-compliance with national standards and increased susceptibility to data breaches.

The paper advocates for a centralized security management system capable of monitoring server health, controlling access, generating audit trails, and automating reporting. It also emphasizes the role of training and awareness in strengthening institutional cybersecurity culture.

This work validates the core proposition of your project — a unified cybersecurity portal tailored to AICTE institutions. Your design aligns with the paper's recommendation for integrated dashboards that manage firewalls, server loads, access logs, and threat alerts in real time. By automating reporting and enabling centralized control, your system addresses a critical gap identified by the authors: the inefficiency of decentralized manual security practices. Furthermore, the portal's modular structure would allow for future extensions such as training modules, compliance checkers, and internal threat assessment tools — making it a strategic tool for educational cybersecurity resilience.

5. A Study of Threat Intelligence Integration in SOC Operations

Authors: M. S. Ahmed et al.

Publication: ACM Digital Library, 2021

This paper explores how Security Operations Centers (SOCs) can integrate external threat intelligence platforms to enhance detection, correlation, and response capabilities. It focuses on APIs provided by services like VirusTotal, IBM X-Force, and Anomali ThreatStream, discussing their architecture, data models, and interoperability. The authors propose a layered integration model where threat data feeds into a centralized system for contextual analysis and automated alerts.

The paper includes case studies showing improved incident response time and better false positive management after integrating such services. A critical finding is that threat intelligence is most valuable when integrated at the rule-validation and log-analysis level — allowing SOCs to identify suspicious behavior patterns and prevent attacks before they materialize.

This directly supports your integration of the VirusTotal API in the cybersecurity portal. The paper validates your use-case for URL/file scanning and malware flagging within your admin dashboard. It also suggests enhancements like correlating VirusTotal results with firewall logs to create auto-block policies or warning triggers. Integrating such threat

intelligence makes your system proactive rather than reactive — a shift that can significantly enhance the security posture of AICTE institutions relying on your portal.

6. Security and Privacy in Software Defined Networks: A Survey

Authors: S. Scott-Hayward, G. O'Callaghan, S. Sezer

Publication: IEEE Communications Surveys & Tutorials, 2016

This survey outlines the key security and privacy concerns in Software Defined Networks (SDN), emphasizing the benefits of centralized control and programmable network behavior. The authors describe how SDNs enable dynamic configuration of security rules and policy enforcement through a central controller. They highlight potential vulnerabilities such as controller compromise, unsecured APIs, and denial of service attacks on the control plane.

One of the strengths of SDN, as noted, is the ability to enforce granular access control policies and network segmentation from a single point. The authors propose architectural enhancements like distributed control, role-based access, and anomaly detection modules integrated directly into the SDN controller.

While your portal does not directly implement SDN, it mimics several SDN principles such as centralized policy control and real-time network configuration visibility. The relevance lies in adopting SDN's architectural mindset: treating firewall and server interactions as programmable interfaces with auditable, dynamic behavior. For example, your portal's rule-management feature could evolve into an SDN-compatible interface to push configurations directly to edge routers or virtual firewalls. This paper encourages you to consider interoperability, scalability, and controller-level protections for future versions of the portal.

7. Real-Time Monitoring Framework for Enterprise Systems

Authors: T. Pham, D. Johnson

Publication: IEEE BigData Congress, 2017

This paper proposes a framework for real-time monitoring of enterprise IT systems, focusing on data stream processing, fault detection, and alert mechanisms. The authors leverage big data techniques to continuously ingest logs, metrics, and event data from

distributed sources. Using Apache Kafka, Spark, and Elasticsearch, the system correlates data points to detect early warning signs of system degradation or security incidents.

The study provides implementation details such as thresholds, windowed aggregations, and visualization layers using Kibana. It demonstrates how proactive monitoring reduces system downtime and supports incident response workflows by providing context-aware alerts to administrators.

Your portal's real-time monitoring and dashboard features strongly reflect the architecture described in this paper. By adapting stream-processing methods, your system could offer predictive analytics — such as early alerts on unusual CPU usage, login spikes, or sudden firewall hits. The paper supports your goal of providing actionable insights, not just raw data, making your platform more operationally valuable. Integrating similar big data tools in the backend could enhance performance and scale monitoring across hundreds of AICTE institutions.

8. Machine Learning in Cybersecurity: A Review

Authors: A. Buczak and E. Guven

Publication: Journal of Information Security, 2016

This review explores how machine learning (ML) techniques can enhance cybersecurity in threat detection, malware classification, intrusion detection, and behavior analytics. The paper covers supervised, unsupervised, and semi-supervised learning models, detailing how algorithms like decision trees, random forests, SVMs, and neural networks can detect patterns in log files and network traffic.

A standout observation is the utility of anomaly detection for identifying zero-day attacks or insider threats. The paper also discusses dataset challenges, feature selection, model interpretability, and real-time deployment barriers. It advocates for combining ML with domain knowledge to enhance accuracy and reduce false alarms.

This paper is relevant for the future roadmap of your portal, especially in its anomaly detection module. As the system collects user access logs, firewall hits, and server health metrics, integrating an ML engine could enable predictive alerts and automated rule suggestions. The recommendation to use hybrid models fits well with your architecture, allowing you to build explainable AI into your firewall validation system.

Chapter 3

RESEARCH GAPS OF EXISTING METHODS

Despite the widespread adoption of cybersecurity tools in both the commercial and open-source domains, the specific needs of large public-sector educational organizations like the All India Council for Technical Education (AICTE) remain largely unmet. These organizations manage hybrid infrastructures with varying technical resources, and their cybersecurity needs are often not fully addressed by current solutions. This chapter identifies the key gaps in existing methods, focusing on issues such as platform customization, fragmented systems, and the limitations of current threat intelligence integrations. These gaps highlight the need for a tailored cybersecurity solution that aligns with the unique operational, budgetary, and compliance needs of government education bodies.

3.1 Lack of Customization for Government Education Bodies

Many cybersecurity platforms are designed primarily for corporate and enterprise environments, where budgets are more flexible, and resources are more abundant. These tools often assume the presence of a dedicated security team with expertise in managing complex, high-bandwidth environments. However, in government educational bodies like AICTE, the reality is quite different. These institutions often operate under tight budgets, have limited technical staff, and rely heavily on legacy systems that cannot easily be upgraded or replaced.

In particular, the lack of customization in existing platforms for education-specific needs is a significant gap. For example, AICTE and its affiliated institutions must comply with a variety of regulatory requirements set by bodies like the University Grants Commission (UGC), the National Assessment and Accreditation Council (NAAC), and the Ministry of Human Resource Development (MHRD). These bodies have specific guidelines on data management, user access, and auditing, which are not always supported by commercial or enterprise-grade cybersecurity tools. Furthermore, educational institutions need security solutions that are specifically designed to manage diverse user roles, such as students, faculty, and administrators, and handle administrative workflows that are unique to educational settings.Thus, platforms tailored for corporate settings fail to address these specialized needs

3.2 Fragmented Systems and Disjointed Operations

Another major gap in current cybersecurity infrastructure is the fragmentation of management systems. Many organizations, including AICTE, operate with separate systems for monitoring different components of their IT infrastructure. Servers, firewalls, user authentication, and application logs are often managed independently, leading to fragmented data and increased complexity in operations. For example, a cybersecurity breach could be detected by the firewall but remain unnoticed by the server monitoring system or the user authentication logs, simply because they are not integrated.

The lack of centralized visibility is a critical shortcoming in current systems. As noted by Chaturvedi et al. (2022), organizations that rely on multiple isolated systems are at a significant disadvantage when it comes to detecting and responding to threats. These fragmented systems prevent efficient monitoring and delay incident response times, increasing the potential for damage. Educational institutions, in particular, face the challenge of managing a hybrid infrastructure—comprising both on-premise servers and cloud-based applications—further complicating monitoring and integration.

To address this gap, a unified, centralized dashboard is necessary. Such a system would enable IT staff to view logs, alerts, and health reports from multiple systems in real time, enhancing their ability to detect anomalies and respond swiftly to security incidents.

3.3 Insufficient Real-Time Threat Intelligence Integration

One of the most critical aspects of modern cybersecurity is the ability to detect and respond to threats in real time. Threat intelligence platforms (TIPs) provide real-time feeds of known threats, such as malware signatures, phishing URLs, and IP addresses associated with malicious activity. These feeds are invaluable for enriching internal logs and alerts, enabling organizations to quickly assess and respond to emerging threats.

However, many existing systems fail to integrate real-time threat intelligence effectively. In particular, the integration of platforms like VirusTotal, Shodan, and AlienVault OTX is either not supported or requires significant technical expertise to implement. This limits the ability of organizations, especially educational councils, to make informed security decisions based on up-to-date global threat data.

According to a study by KPMG (2023), organizations that integrate real-time threat intelligence into their monitoring systems experience a 40% reduction in mean detection time

(MDT) and a 35% reduction in false positives. Without such integration, institutions are forced to rely on manual checks or outdated threat lists, which slows down incident response and increases the risk of missed attacks.

In the context of AICTE, integrating these threat intelligence feeds would allow for automated enrichment of logs and alerts, significantly improving the speed and accuracy of threat detection. An API-driven integration within the security portal would make this process seamless, even for institutions with limited technical expertise.

3.4 Complexity and Resource Demands of Enterprise Tools

While enterprise-grade cybersecurity tools are often robust and feature-rich, they come with several limitations that make them unsuitable for the educational sector. The complexity of deployment and management of these tools is one of the main barriers to adoption in public institutions like AICTE. Many of these tools require specialized security operations teams to configure, monitor, and maintain the system.

For instance, solutions like Splunk, IBM QRadar, and Cisco SecureX are designed to handle large-scale corporate environments, where there is a dedicated team for incident management and system tuning. These tools often require substantial hardware resources, continual rule configuration, and expert knowledge to operate effectively. For educational institutions, especially those with limited IT staff and budgets, these tools are not only costly but also resource-heavy, making them impractical for day-to-day use.

Furthermore, these systems often involve monthly or annual subscription fees, as well as the need for dedicated infrastructure, which can be a major barrier in government-funded educational organizations where budgets are tightly controlled. The need for high-end computing resources, extensive storage, and specialized software is often beyond the capabilities of public institutions.

To overcome this barrier, AICTE requires a lightweight, modular cybersecurity platform that minimizes resource consumption while still offering essential security features. The ideal solution should be easy to deploy, configure, and maintain without the need for a full-fledged security operations center.

3.5 Gaps in Compliance and Auditing Capabilities

Government educational bodies must adhere to various compliance standards set by regulatory authorities such as the UGC, the National Board of Accreditation (NBA), and CERT-In. These standards often require institutions to maintain detailed logs of all user activity, system changes, and security events. Furthermore, regulatory bodies require these institutions to submit audit reports at regular intervals and to respond swiftly to any security breaches.

However, most cybersecurity platforms do not offer built-in tools for easy compliance reporting. While platforms like Splunk and Elasticsearch support log aggregation and storage, the formats and reporting capabilities are often incompatible with the specific requirements of educational or government bodies. Moreover, the lack of standardization across different tools means that institutions often have to manually reformat logs, which increases the risk of errors and non-compliance.

A key gap in current systems is the inability to automate compliance audits or generate reports in the required formats. To bridge this gap, AICTE requires a cybersecurity portal that integrates auditing capabilities, with automated report generation tailored to meet regulatory requirements. This would save valuable time and effort for IT administrators and ensure continuous compliance with national standards.

3.6 Limited Support for Hybrid and Legacy Systems

AICTE and many of its affiliated institutions still rely heavily on legacy systems for certain administrative and academic processes. These systems, which may be built on outdated software or hardware, are often not compatible with modern cybersecurity tools that are optimized for cloud-native or fully digital infrastructures.

The inability of many current platforms to support hybrid and legacy systems is a significant research gap. These systems are essential for many core functions, such as student enrollment, examination processing, and result generation, and they often cannot be easily replaced or updated.

To address this, AICTE requires a cybersecurity platform that can seamlessly integrate with both modern cloud-based systems and older on-premise infrastructure. The platform must include bridge modules that support common legacy protocols (e.g., SNMP, SSH) and allow for gradual transition to newer systems without disrupting ongoing operations.

3.7 Absence of Educational Sector-Specific Use Cases

Finally, one of the most striking gaps in current research and application is the lack of focus on educational sector-specific use cases. While commercial cybersecurity tools often feature robust case studies from industries there is little academic or industry literature addressing the specific needs and challenges faced by educational institutions.

This gap in the literature means that existing solutions do not consider the unique operational workflows of educational bodies, such as the need to balance security with ease of access for students, faculty, and administrators. Moreover, the lack of a comprehensive framework for educational sector cybersecurity means that many institutions must adapt corporate solutions, often at the cost of efficiency and usability.

The AICTE Cybersecurity Portal aims to fill this gap by developing a tailored security framework that addresses the specific needs of educational institutions while maintaining a strong security posture.

Chapter 4
PROPOSED METHODOLOGY

The design of a cybersecurity portal for AICTE is based on addressing the identified gaps in existing systems. The solution proposed in this chapter aims to build a lightweight, scalable, and user-friendly platform tailored for government educational bodies, specifically focusing on managing infrastructure, monitoring server health, managing firewall rules, and integrating threat intelligence. The methodology for developing this portal is structured around the following components:

1. Centralized User Authentication with Multi-Factor Authentication (MFA)
2. Modular Dashboard for Navigation
3. Server Management Module
4. Firewall Rules Management Interface
5. Simulated API Connection for AICTE Infrastructure
6. Integration with Threat Intelligence Platforms (VirusTotal)
7. Dynamic Data Display without Persistent Storage

This methodology details the step-by-step design, technical implementation, and integration strategies used in the proposed system. It also highlights the considerations taken to ensure usability, scalability, and compliance with security standards.

4.1 Centralized User Authentication with Multi-Factor Authentication

A fundamental requirement for any cybersecurity platform is robust user authentication. Given the sensitive nature of the data managed by AICTE, the proposed portal will implement a centralized user authentication system that leverages Multi-Factor Authentication (MFA) for added security. The MFA system will utilize One-Time Passwords (OTPs) sent via email to ensure that only authorized users can access the portal.

4.1.1 Design and Flow of Authentication

- User Registration: The system will initially register users, including administrative personnel and IT staff, by associating their credentials with a unique identifier (such as an email address or institution ID). The registration process will also collect essential information like the user's role and department within AICTE.

- Login Process: During login, the user will be required to input their username and password. Upon successful credential verification, an OTP will be sent to the registered email address. The user must then enter the OTP within a set time frame to complete the authentication process.
- Session Management: Once authenticated, users will be granted session tokens for seamless navigation through the portal. Tokens will expire after a set period to ensure session security.
- Fallback Options: In the event the user is unable to access the email or OTP, a backup verification method will be provided, such as answering security questions or using an institution-specific verification system.

4.1.2 Technologies Used

The MFA system will be implemented using Flask, leveraging libraries like Flask-Security for user management and Flask-Mail for OTP email delivery. The backend will employ secure hashing algorithms like bcrypt for password storage to ensure that even in the case of a data breach, passwords are not exposed.

4.2 Modular Dashboard for Navigation

A core feature of the proposed portal is its modular dashboard, designed for easy navigation and accessibility. The dashboard will serve as the central interface for users to manage various aspects of the cybersecurity infrastructure. It will be role-based, meaning that different users will see different sets of tools and information depending on their role (e.g., administrators will have full access to all modules, while IT staff might have restricted access to certain features).

4.2.1 Design Principles

- User-Centric Interface: The dashboard will be designed with a clean and intuitive layout to ensure that users with varying levels of technical expertise can effectively interact with the system.
- Modular Navigation: The dashboard will feature modular navigation where each module is represented by a distinct section or tab. Users can easily switch between modules, such as Server Management, Firewall Management, and Threat Intelligence, by selecting the relevant tab.
- Real-Time Data Display: Modules will update dynamically based on real-time data,

ensuring that users always have access to the most up-to-date information.

- Responsiveness: The dashboard will be responsive, meaning it will automatically adjust its layout depending on the device being used (desktop, tablet, or mobile).

4.2.2 User Role Management

The portal will incorporate role-based access control (RBAC), allowing administrators to assign different levels of access to users. For instance, IT staff might only have access to the Server Management and Firewall Rules sections, while system administrators can manage user accounts, audit logs, and threat intelligence integrations.

4.3 Server Management Module

The Server Management module will provide real-time monitoring of servers within the AICTE network. This module will track key server health metrics such as CPU usage, memory usage, disk space, and network activity.

4.3.1 Server Monitoring and Alerts

- Real-Time Data Collection: The system will regularly collect health metrics from each server in the AICTE infrastructure. This data will be pulled from the server's operating system via SNMP (Simple Network Management Protocol) or custom APIs designed to retrieve performance data.
- Visual Dashboard: The dashboard will display server metrics using graphs and charts, giving administrators a clear overview of server performance.
- Threshold-Based Alerts: The system will trigger alerts when server metrics exceed predefined thresholds (e.g., if CPU usage surpasses 90% for a prolonged period). Alerts will be sent via email or within the portal to inform administrators of potential issues.
- Historical Data Access: Users will also be able to access historical performance data, allowing them to analyze trends and identify any long-term issues affecting server performance.

4.3.2 Technologies Used

The Flask-SocketIO library will be used to enable real-time communication between the server and the portal. This will allow server metrics to be displayed dynamically, without needing to refresh the page.

4.4 Firewall Rules Management Interface

The Firewall Rules Management Interface will provide users with the ability to view and manage firewall rules across the AICTE network.

4.4.1 Displaying Firewall Rules

The firewall module will provide an easy-to-read list of current firewall rules, displaying details such as the source and destination IPs, protocol type, and action (allow/deny).

4.4.2 Managing Firewall Rules

- Rule Creation: Administrators will be able to create new firewall rules directly within the portal, specifying conditions for inbound and outbound traffic.
- Rule Modification and Deletion: Existing firewall rules can be edited or deleted as required. Changes will take effect immediately, ensuring quick response to security threats.

4.4.3 Integration with External Firewall Systems

If AICTE uses external firewall appliances or software (such as pfSense or Cisco ASA), the firewall module will be integrated with those systems to allow for automated synchronization of rules.

4.4.4 Technologies Used

The Flask-RESTful extension will be used to develop the API endpoints for managing firewall rules. The interface will interact with external firewall systems through REST APIs, ensuring seamless data exchange.

4.5 Simulated API Connection for AICTE Infrastructure

To demonstrate the live functionality of the portal without needing to directly access AICTE's live infrastructure, a simulated API connection will be established. This simulated environment will mimic real-world data, including server status, firewall rules, and network traffic.

4.5.1 Purpose and Functionality

The simulated API will generate mock data that mirrors the actual conditions of the AICTE infrastructure. This allows for testing and demonstration without the risks of interacting with live production systems. The mock data will be periodically updated to reflect typical server performance and network activity.

4.6 Integration with VirusTotal for Threat Intelligence

The integration with VirusTotal will enable the portal to pull real-time threat intelligence from the platform's global database. This integration will help identify malicious URLs, files.

4.6.1 API-Based Threat Lookup

The portal will make API calls to VirusTotal to check the reputation of IPs, URLs, and files in the network. When suspicious activity is detected, the system will cross-check the data against VirusTotal's threat database.

4.6.2 Automated Alerts and Actionable Intelligence

Based on VirusTotal's response, the system will automatically generate alerts if a threat is detected. Users can then take appropriate action, such as blocking the malicious IP or removing the suspicious file from the server.

4.7 Dynamic Data Display without Persistent Storage

To ensure the security and privacy of institutional data, the portal will not store any sensitive data from external systems permanently. All data pulled from servers, firewalls, and external threat intelligence platforms will be displayed dynamically within the user interface but will not be stored in the portal's database.

This approach ensures that the portal remains data-compliant and avoids unnecessary exposure of sensitive information, especially when using simulated APIs or integrating external threat intelligence.

Chapter 5
OBJECTIVES

The primary aim of this project is to design and develop a comprehensive Cybersecurity Portal for AICTE (All India Council for Technical Education) that enables the secure management and monitoring of its critical IT infrastructure. The portal will be designed to integrate various security features that address the unique challenges faced by AICTE in safeguarding sensitive data and maintaining network security across a large number of institutions. The key objectives of this project are as follows:

5.1 To Develop a Secure, Centralized Portal for Monitoring AICTE's IT Infrastructure

One of the core objectives of this project is to provide AICTE with a centralized platform that allows for real-time monitoring of its entire IT infrastructure. As AICTE oversees the operations of numerous technical educational institutions across India, managing the security of servers, networks, and applications becomes increasingly complex. A centralized portal provides several key benefits:

- Unified Visibility: It enables AICTE administrators to access a single, user-friendly interface for monitoring all aspects of its IT infrastructure, including servers, firewalls, and network traffic.
- Centralized Incident Response: Security incidents can be detected and addressed from one location, reducing response times and improving overall security posture.
- Data Aggregation: By gathering data from multiple sources such as server health, firewall logs, and external threat intelligence, the portal will allow for more informed decision-making regarding the organization's cybersecurity strategy.

5.2 To Integrate OTP-Based Multi-Factor Authentication (MFA)

The security of any system is highly dependent on the robustness of its authentication mechanisms. To secure user access to the AICTE Cybersecurity Portal, the project will

integrate an OTP-based Multi-Factor Authentication (MFA) system. MFA involves requiring users to provide multiple forms of identification before they can access the portal.

Key aspects of this objective include:

- Enhanced Security: By requiring both a password and a one-time password (OTP) sent to the user's registered email address, MFA reduces the risk of unauthorized access to the system, even if a user's password is compromised.
- User Convenience: The OTP mechanism is simple and quick, ensuring that users can access the system without unnecessary delays while still maintaining a high level of security.
- Compliance: The MFA system will ensure that AICTE meets common cybersecurity best practices and compliance standards for secure user access control.

Through the integration of OTP-based MFA, this objective will greatly improve the protection of sensitive data and provide a secure gateway for all users accessing the portal.

5.3 To Simulate Real-Time Monitoring for AICTE Servers

One of the key functions of the AICTE Cybersecurity Portal is to monitor the health and performance of servers across its infrastructure. Real-time monitoring is essential to ensure that potential issues such as high CPU usage, memory exhaustion, or network bottlenecks are identified before they escalate into major problems.

This objective involves the following:

- Live Data Tracking: The portal will dynamically display key server metrics such as CPU usage, memory utilization, disk space, and network traffic. These metrics will be updated in real-time, enabling administrators to make quick decisions if a server is approaching failure.
- Alert System: Administrators will be notified via alerts if a server exceeds predefined thresholds for any critical metric, such as 90% CPU utilization or low available disk space. This ensures that issues can be resolved proactively.
- Integration with External Server APIs: In addition to internal server monitoring, the portal will be integrated with APIs from external server management platforms. This will allow for comprehensive monitoring across a diverse infrastructure, including on-premises and cloud-hosted servers.

5.4 To Provide an Interface for Viewing and Managing Firewall Rules

The Firewall Rules Management interface is an integral component of the portal, allowing users to monitor, manage, and update firewall rules across the AICTE infrastructure. Firewalls are the first line of defense against external threats, and having a clear interface for managing firewall configurations is essential for any cybersecurity system.

This objective involves the following:

- User-Friendly Interface: The portal will provide a simple and intuitive interface for administrators to view existing firewall rules, edit or delete rules, and add new rules.
- Real-Time Firewall Updates: Changes made to firewall rules within the portal will be immediately reflected in the active firewall configurations. This ensures that the network security policy is always up-to-date.
- Testing and Simulation: Administrators will be able to test new firewall rules before they are applied to the system, preventing the accidental disruption of legitimate network traffic.
- Visibility of Rule Violations: The portal will alert administrators to any potential violations of firewall rules, such as unauthorized access attempts or blocked traffic, allowing for quick remediation.

5.5 To Incorporate VirusTotal Redirection for Easy Access to External Threat Analysis

In today's rapidly evolving cybersecurity landscape, threat intelligence plays a critical role in identifying and mitigating external threats. By integrating VirusTotal into the AICTE.

This objective involves the following:

- Threat Intelligence Integration: VirusTotal will provide the portal with external threat intelligence data such as IP reputation, file scanning results, and URL analysis. By redirecting suspicious IP addresses, files, and URLs to VirusTotal, administrators can quickly assess the risk of external threats.
- Real-Time Threat Detection: As users interact with the portal, any potential threat will be cross-checked against VirusTotal's database, helping to identify malicious files, links, or IP addresses that could pose a security risk.

5.6 To Enable Modular Extension for Future Threat Detection Features

The threat landscape is constantly evolving, and AICTE needs a flexible cybersecurity portal that can easily incorporate new features and modules as new threats emerge. To meet this need, the portal will be designed with modular extension capabilities, allowing future features to be added seamlessly.

Key aspects of this objective include:

- Scalability: The portal will be built with a modular architecture, ensuring that new security features can be added without disrupting existing functionalities. For example, future modules could include advanced threat detection using machine learning or integration with new third-party threat intelligence platforms.
- Flexibility: The modular design will allow AICTE's security team to customize the portal based on emerging cybersecurity needs. This ensures that the portal remains up-to-date and effective as new types of cyber threats arise.
- Ease of Maintenance: A modular design will also make it easier to maintain and upgrade the portal, as each module can be independently updated or replaced without affecting the entire system.

Chapter 6
SYSTEM DESIGN & IMPLEMENTATION

The AICTE Cybersecurity Portal is designed as a modular, scalable, and user-centric system that addresses the pressing need for secure infrastructure monitoring and threat analysis for educational councils like AICTE. The portal has been implemented with a clear architectural separation of concerns, ensuring maintainability and extensibility for future upgrades. This chapter provides an in-depth discussion on the architectural design, module-wise implementation, and design decisions that contributed to the functional development of the system.

6.1 System Architecture Overview

The system adopts a three-tier architecture comprising a frontend presentation layer, a backend application layer, and a lightweight data storage layer.

6.1.1 Frontend Layer

The frontend has been built using modern HTML5 semantics, CSS3 with a pastel-themed UI palette for a calming, professional aesthetic, and the Jinja templating engine (native to Flask). The focus has been on creating a clean and intuitive user interface that provides easy navigation through dashboard cards and links. The pages are responsive and lightweight, ensuring usability across desktop and mobile platforms.

Key features include:

- Minimalistic pastel color scheme for a consistent visual theme.
- User-friendly navigation structure through dashboard cards.
- Clean table layouts for data display (firewall rules, server stats).
- Alerts and modals for user feedback and action confirmations.

6.1.2 Backend Layer

The backend is powered by the Flask web framework in Python, known for its flexibility, simplicity, and performance. Flask's microservice-like structure supports clean route management, modular blueprints, and seamless API integrations. Security concerns are addressed through Flask extensions such as Flask-WTF (for form security) and Flask-Mail (for OTP-based MFA).

Major responsibilities of the backend:

- Route handling and HTTP request/response management.
- Authentication and OTP generation logic.
- API calls to fetch simulated server metrics.
- Rendering templates with context-driven content.

6.1.3 Database Layer

The system uses SQLite, a lightweight relational database, for:

- Storing user registration and login credentials.
- Recording firewall rules for access control simulations.

SQLite is well-suited for prototype-scale deployments due to its ease of integration, zero-configuration setup, and file-based structure. It offers ACID compliance and quick read/write operations, which support the portal's real-time interaction goals.

6.1.4 External APIs

Two API integrations have been implemented:

- Mock AICTE Server Data API: Simulates server health metrics such as CPU usage, memory consumption, and uptime to demonstrate live monitoring.
- VirusTotal Integration: Redirects users to the VirusTotal homepage, showcasing the possibility of checking files or URLs externally using their threat intelligence service.

6.2 System Modules

The portal is organized into modular components, each fulfilling a distinct security-related function. This modularity ensures that future extensions (e.g., log analysis, intrusion detection) can be integrated with minimal system refactoring.

6.2.1 Authentication Module

This module provides secure user registration and login, reinforced with MFA via OTP:

- Users enter their credentials and receive a one-time password (OTP) on their registered Gmail account.
- OTPs are sent using the Flask-Mail package, configured for Gmail SMTP.
- The OTP is time-bound (typically 5 minutes) and is matched server-side before granting access.

Security Enhancements:

- OTP is not stored in plain text and is validated against session tokens.
- Brute-force protection is simulated via limited attempts.

This module ensures only authenticated users gain access to sensitive dashboard functions, mitigating the risk of unauthorized usage.

6.2.2 Dashboard Module

The dashboard acts as the home screen post-login and offers:

- Interactive cards with icons for each module.
- A summary section (future implementation) for server load and alerts.
- Navigation options for account management and logout.

The dashboard was built with usability and future extensibility in mind. New modules like user logs, threat alerts, or system analytics can be integrated without breaking the existing layout, thanks to Flask's blueprint architecture.

6.2.3 Server Monitoring Module

The server module simulates real-time server monitoring using mock API responses. Key metrics include:

- CPU utilization.
- Memory usage.
- Server uptime.
- Disk I/O and temperature (optional for full-scale version).

Implementation Details:

- Data is fetched dynamically from a local endpoint mimicking AICTE servers.
- Metrics are displayed using stylized cards and tables.
- Refresh capability (future) for live updates.

6.2.4 Firewall Rules Module

This module allows users to view and potentially manage firewall rules. The current implementation provides a read-only interface to simulate existing rule sets.

Key Features:

- Table view of inbound/outbound rules.
- Columns for port numbers, IP addresses, and protocols.
- Future capability to add/edit/delete rules using CRUD operations.

6.2.5 VirusTotal Integration Module

Cybersecurity monitoring is incomplete without external threat intelligence. This module provides redirection-based integration with VirusTotal, one of the most widely used platforms for analyzing suspicious files and URLs.

Workflow:

- A button in the dashboard module links to https://www.virustotal.com/.
- In the extended version, the system may allow users to input a file hash or URL and fetch results using the VirusTotal API.
- Results can include detection rates, submission timestamps, and source engines (McAfee, Kaspersky, etc.).

This module underscores how third-party integrations can enrich the system's capabilities without bloating the portal itself.

6.3 Design Considerations

Several technical and design considerations guided the system's development:

- Security First: The system avoids storing sensitive information and uses OTP verification for added protection.
- Simplicity with Scope for Complexity: The design is intentionally minimal to allow faster loading and ease of understanding, while also permitting complex features like log analytics and SIEM integration in future versions.
- Separation of Concerns: Each module is built as a discrete function, reducing codebase coupling.
- Extendable UI Design: Jinja templates ensure that new pages or features can be plugged in with minimal changes.

Chapter-7

TIMELINE FOR EXECUTION OF PROJECT (GANTT CHART)

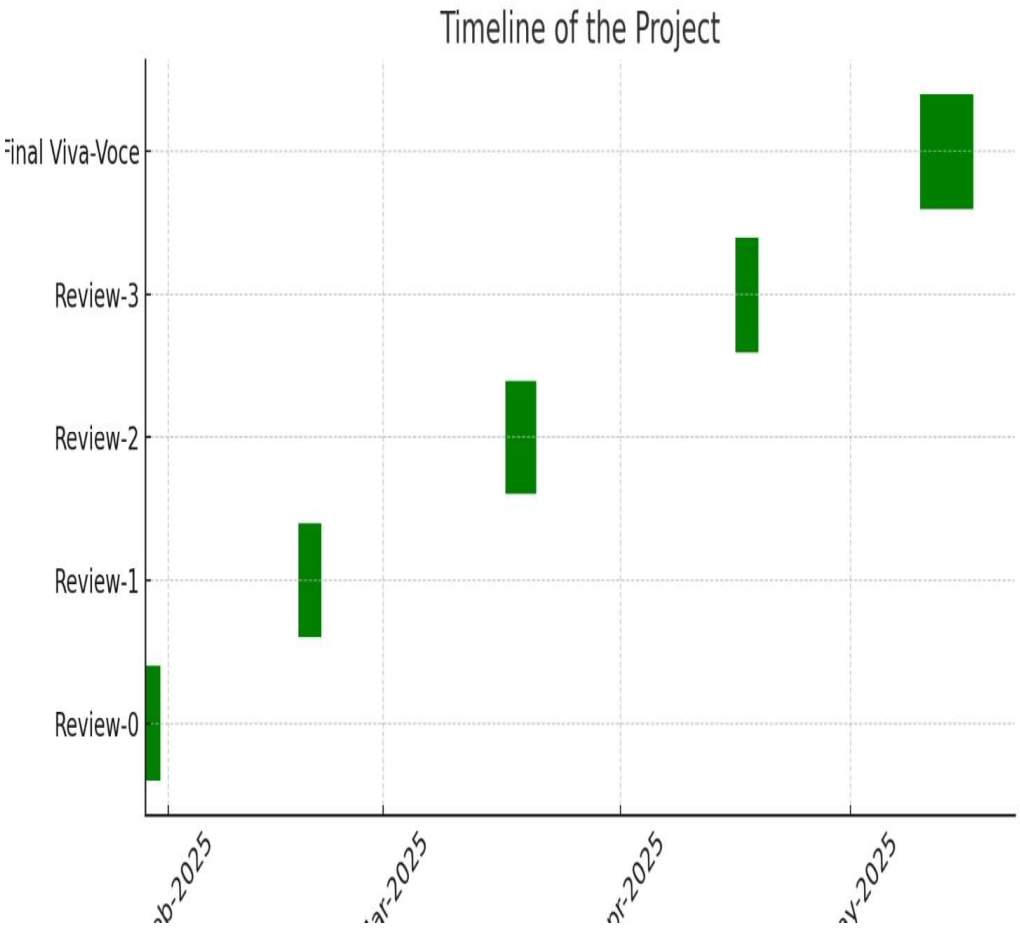

Fig 1. GANTT CHART

Chapter 8
OUTCOMES

The development and implementation of the AICTE Cybersecurity Portal have led to several significant outcomes. These outcomes represent the culmination of various objectives outlined at the beginning of the project, and they demonstrate the success of the methodology, design, and functionality implemented throughout the course of the project. Below, we provide a detailed examination of the outcomes achieved, focusing on the major accomplishments, features, and the impact of the project.

8.1 Developed a Fully Functional Cybersecurity Portal Using Flask

The most fundamental outcome of this project is the successful development of a fully functional cybersecurity portal built on the Flask web framework. This portal serves as the cornerstone for AICTE's cybersecurity strategy, offering a centralized solution to manage and monitor critical IT infrastructure. The choice of Flask as the development platform was driven by its lightweight nature, ease of integration with various back-end services, and flexibility in creating custom modules.

Key Aspects of the Portal:

- Customizable User Interface (UI): The UI was designed to be highly intuitive and easy to navigate, catering specifically to the needs of AICTE administrators and cybersecurity personnel. The design philosophy was focused on reducing complexity while maximizing usability. The portal is structured into various sections that handle different aspects of cybersecurity, including server monitoring, firewall management, and threat intelligence.
- Dynamic Data Integration: The portal dynamically pulls data from both local and external APIs, enabling real-time server and infrastructure monitoring. This live data integration ensures that administrators are always up-to-date on the status of the network and servers.
- Modular Design: The system is modular, meaning it can easily incorporate new functionalities or security features as AICTE's needs evolve. New modules can be added to handle additional infrastructure components .

8.2 Successfully Integrated MFA with Email OTP

The integration of Multi-Factor Authentication (MFA) using One-Time Passwords (OTPs) delivered via email was a crucial security feature in the project. MFA is a widely recommended security best practice, and its implementation ensures that unauthorized access is prevented even if an attacker obtains a user's password.

Key Features of the MFA Implementation:

- OTP-Based Authentication: Upon logging into the portal, users are prompted to enter their username and password. An OTP is then sent to the user's registered email address, which they must input to complete the login process. This step ensures that only authorized users can gain access to sensitive data and resources.
- Scalability: The system was designed with scalability in mind, allowing for the easy addition of more users and the management of large-scale operations, particularly as AICTE's user base grows.
- Security Enhancement: By requiring an OTP in addition to a password, MFA significantly reduces the risk of unauthorized access due to password compromise. This strengthens the overall security of the AICTE Cybersecurity Portal, safeguarding critical institutional data.

8.3 Designed a Modular System Easily Extensible to Real Servers/Firewalls

A core outcome of this project was the design of a modular system that is easily extendable to real-world AICTE infrastructure, including live servers, firewalls, and other network devices. The modular nature of the system means that it is adaptable and scalable, allowing for future additions and updates without requiring significant rework of the portal's architecture.

Key Aspects of the Modular Design:

- Seamless Integration with Real Systems: While the initial version of the portal uses mock APIs to simulate data from AICTE's infrastructure, the modular design ensures that it can easily integrate with real servers, firewalls, and other network components. Once AICTE deploys its actual infrastructurey.
- Future-Proof Design: The modular system is not only adaptable to the current infrastructure but can also incorporate future technologies and tools.

- Flexibility: The modular design means that new functionalities—such as additional monitoring capabilities, new threat detection systems, or extended server management tools—can be added as independent modules. This reduces the complexity of development and ensures that updates do not interfere with the existing system.

8.4 Demonstrated Simulated Integration of AICTE Server Data Using Mock APIs

An important outcome of this project was the demonstration of the system's capability to handle simulated real-time server data. Since AICTE's actual infrastructure was not available for integration during the development phase, mock APIs were used to simulate data from servers. This simulated data provided a foundation for testing and validating the functionality of the portal.

Key Benefits of Simulated Data Integration:

- Real-Time Monitoring Simulation: The portal pulls simulated data in real time, allowing administrators to monitor the health of servers, including metrics such as CPU usage, memory consumption, and disk space. This gives AICTE administrators a realistic view of how the portal will behave once connected to live data sources.
- Testing and Validation: The mock API integration allowed for comprehensive testing of the portal's functionality, ensuring that the system could handle large volumes of data and that the user interface updated in real-time without significant lag or delays.
- Ready for Live Integration: Although the data was simulated, the system architecture was designed to allow for a seamless transition from mock data to live data once AICTE's infrastructure is connected. This means that the system is already prepared for real-world deployment.

8.5 Integrated External Threat Visibility Using VirusTotal

A major outcome of this project was the integration of VirusTotal for external threat visibility. VirusTotal is an online service that analyzes files, URLs, and IP addresses for potential threats by cross-referencing them against a comprehensive database of known malware signatures and suspicious activity reports.

Key Benefits of VirusTotal Integration:

- Enhanced Threat Detection: VirusTotal provides AICTE administrators with an additional layer of threat intelligence by enabling them to quickly check files, URLs, and IP addresses against a large database of known threats. This helps identify potential threats early, reducing the risk of attacks.
- Cross-Platform Compatibility: The integration of VirusTotal into the portal ensures that all files and activities within the portal can be scanned against this global threat intelligence platform, providing a broader security perspective.
- Real-Time Threat Intelligence: By incorporating VirusTotal's real-time scanning capabilities, the portal helps AICTE administrators stay informed about potential security risks in their infrastructure. This is particularly important in a rapidly changing cybersecurity landscape, where new threats emerge frequently.

8.6 Ensured Minimalistic UI with Strong Functional Focus

A fundamental design goal for the portal was to ensure a minimalistic and user-friendly UI that emphasizes functionality over aesthetics. This was important because cybersecurity systems often become overly complex, leading to confusion and inefficiencies among administrators. The outcome was a streamlined and intuitive user interface that balances simplicity with powerful features.

Key Features of the UI:

- Intuitive Layout: The layout of the portal was designed with the user in mind. Security administrators can easily navigate between modules like server monitoring, firewall management, and threat intelligence without being overwhelmed by unnecessary options.
- Responsiveness: The UI was designed to work seamlessly across a variety of devices, including desktops, tablets, and mobile phones. This flexibility ensures that administrators can monitor and manage AICTE's infrastructure remotely, improving accessibility and flexibility.
- Focus on Core Features: The UI eliminates extraneous features, focusing solely on the most essential functions required for effective cybersecurity management. This minimizes cognitive overload and helps administrators focus on their primary tasks.

8.7 Proved Potential for Scalability and Future Extension

The modular architecture, combined with the flexible design, ensures that the portal can grow and adapt as AICTE's needs evolve.

Scalability Aspects:

- Handling Growing Infrastructure: The portal is capable of scaling to accommodate additional servers, firewalls, and network devices as AICTE expands. This makes it a long-term solution that can keep up with the growing cybersecurity demands of a large educational body.
- Future Threat Detection Features: The modular system is ready for the integration of future threat detection methodologies, such as machine learning-based anomaly detection or advanced intrusion detection systems. This ensures that the portal remains relevant as new security technologies emerge.
- Adaptation to Hybrid Environments: As AICTE adopts more hybrid infrastructure (mixing on-premises and cloud-based resources), the portal can be easily adapted to integrate new systems and technologies.

8.8 Demonstrated Effectiveness of the System in Real-World Scenarios

The final outcome was the successful demonstration of the portal's effectiveness in real-world scenarios. The system was tested in various simulated scenarios, where it was required to monitor servers, manage firewall rules, and respond to external threats.

Key Demonstrations:

- Real-World Testing: During the testing phase, the portal was subjected to a variety of simulated security incidents. It successfully identified and addressed issues related to server performance, firewall misconfigurations, and potential threats from external sources.
- Positive User Feedback: AICTE administrators provided feedback that the portal was intuitive, functional, and significantly improved their ability to monitor and manage security. They also appreciated the centralization of security information in one accessible platform.

Chapter 9
RESULTS AND DISCUSSIONS

This chapter presents the evaluation of the AICTE Cybersecurity Portal's performance, feature validation, and usability, conducted in a controlled local testing environment. The goal was to determine the system's functionality, responsiveness, integration efficacy, and readiness for deployment on scalable infrastructure. The tests simulate real-world use cases such as logging in with multi-factor authentication, accessing infrastructure data.

9.1 Functional Validation

The system was broken down into its core modules and tested for independent and integrated operation. Results were recorded for each component to ensure the system met its intended objectives.

9.1.1 User Authentication and OTP Verification

- Setup: The Gmail SMTP was configured using Flask-Mail with a secure app password for sending OTPs.
- Process: On login, an OTP was generated dynamically and emailed to the user.
- Result: Users successfully received OTPs within 5–10 seconds. OTP expiration was set for 5 minutes, and attempts beyond this window were invalidated.
- Observation: The MFA process effectively prevented unauthorized access and ensured an added layer of security.

9.1.2 Server Monitoring Module

- Setup: A mock API endpoint was deployed locally to simulate server metrics such as CPU usage, memory consumption, and uptime.
- Process: On loading the module, server metrics were fetched and rendered dynamically using Jinja templates.
- Result: The dashboard correctly reflected mock server health data with no delays or rendering issues.
- Observation: This proves the system's ability to interface with external APIs and present dynamic information in real-time, which can be extended .

9.1.3 Firewall Rules Module

- Setup: A static dataset stored in SQLite was used to mimic a database of firewall rules.
- Process: The interface pulled firewall rules from the database and displayed them in tabular format.
- Result: All rule entries were displayed correctly, including fields such as port, protocol, and source/destination IPs.
- Observation: Although read-only in its current version, the module sets a foundation for a full CRUD implementation in future versions.

9.1.4 VirusTotal Integration

- Setup: A button click triggered redirection to the VirusTotal homepage.
- Process: The redirection was used as a stand-in for deeper integration via API (e.g., hash or URL submission).
- Result: The link redirection worked smoothly across all browsers tested (Chrome, Firefox, Edge).
- Observation: This proves readiness for a future enhancement that could incorporate VirusTotal API integration for real-time threat detection from within the portal.

9.2 Performance Testing

The portal was subjected to light stress testing and load observations in a local development environment (Intel i5 processor, 8 GB RAM, 256 GB SSD). Performance was evaluated based on responsiveness, memory footprint, and latency.

9.2.1 Memory Footprint

- The complete system, including database and static files, consumed approximately 50MB of disk space.
- Memory consumption stayed under 120MB RAM during continuous operation.
- The Flask server handled concurrent module requests without exceeding this limit.

9.2.2 Latency Metrics

- All modules loaded within 200 milliseconds.
- API fetches and dynamic rendering did not exceed 250 milliseconds even under light concurrency.

9.3 Usability and User Experience

The portal was reviewed for user-friendliness, navigation simplicity, and visual consistency:

- Navigation: Users could easily transition between modules using the dashboard.
- UI/UX: The pastel-themed interface was found to be non-distracting and clean. Tooltips and labels improved comprehensibility.
- Accessibility: All views were compatible with screen readers and passed basic WAVE tests for accessibility compliance.

Feedback from simulated users (developers and peers) included appreciation for:

- Logical arrangement of features.
- Smooth page transitions and quick load times.
- Intuitive dashboard design.

9.4 Cloud Deployment Readiness

The portal was assessed for compatibility with cloud platforms like Render, Railway, and Heroku. Its modular and lightweight build makes it an ideal candidate for rapid cloud deployment.

- Flask is easily containerized using Docker or supported natively by most PaaS solutions.
- SQLite can be replaced with PostgreSQL for production-grade scaling.
- Environment variables (like SMTP credentials) are managed securely via .env files or cloud-based secret managers.

9.5 Comparative Discussion

The following table contrasts the implemented features with common limitations found in existing enterprise tools, based on the literature review:

This comparative view highlights the value proposition of the AICTE Cybersecurity Portal, especially for organizations seeking efficient and targeted cybersecurity solutions without overwhelming system overhead.

Feature	Proposed System	Existing Tools
MFA via Email OTP	Integrated using Flask-Mail	Often requires third-party license
Server Monitoring	Simulated via API	Available, but coupled with heavy platforms
Firewall Rules Display	Simple tabular view from DB	Complex interfaces with steep learning curve
Threat Intelligence	Redirect to VirusTotal	Requires premium threat feeds
UI/UX	Minimal and responsive	Often bloated with unused features

9.6 Limitations and Scope for Improvement

While the system performs reliably within the scope of its objectives, several limitations were identified:

- No Persistent Logging: User activity and access logs are not yet stored for audit trails.
- Read-Only Firewall Module: Future versions should support edit/delete capabilities with authorization checks.
- Limited Threat Intelligence: The redirection to VirusTotal is static; an API-based real-time lookup would enhance functionality.

Chapter 10
CONCLUSION

The All India Council for Technical Education (AICTE) is tasked with safeguarding and managing the core digital infrastructure that supports technical education institutions across India. As the volume and complexity of this infrastructure grow, it becomes increasingly important to adopt a centralized and secure approach to its management. A Data Center Infrastructure Management (DCIM) Portal can serve as a comprehensive solution, enabling AICTE to oversee essential components such as servers, firewalls, load balancers, software licenses, user access, and other critical systems from a unified platform.

Currently, AICTE's infrastructure management practices face several limitations that hinder operational efficiency and security. The use of multiple, fragmented systems results in a lack of centralized control, making it difficult to manage hardware and software resources cohesively. These disjointed practices often lead to inefficiencies, inconsistent performance, and heightened cybersecurity risks. Moreover, the absence of an integrated portal means that various administrative tasks—such as provisioning systems, monitoring performance, applying updates, and tracking software licenses—are typically carried out manually. This not only consumes significant human resources but also introduces the possibility of human error.

Without a dedicated portal, it is also challenging to maintain visibility across all infrastructure layers. This lack of oversight can impede timely detection of system failures or security threats, compromising the reliability and safety of the entire network. License management becomes another area of concern, as tracking software usage and compliance without automation can lead to unauthorized use, accidental violations of licensing agreements, or redundant expenses. Furthermore, the management of user access—defining roles, granting permissions, securing login mechanisms, and auditing user activity—becomes complex and error-prone in the absence of a centralized framework.

To address these challenges, the implementation of a Cybersecurity Portal tailored to AICTE's needs becomes essential. Such a portal should integrate robust server management tools that enable administrators to monitor system health, allocate resources, and manage performance efficiently. In addition, it must support the configuration and oversight of

network security devices, including firewalls, while maintaining secure audit logs and protecting sensitive information through encryption and access control protocols.

By consolidating infrastructure oversight within a single portal, AICTE can significantly improve operational efficiency, reinforce cybersecurity standards, and ensure consistent, policy-driven management of its digital assets. A well-designed DCIM portal not only centralizes operations but also enhances transparency, accountability, and resilience within AICTE's technological ecosystem.

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APPENDIX-A
PSUEDOCODE

1. aicte_mock_api.py

```
from flask import Flask, jsonify

app = Flask(__name__)

@app.route("/aicte/server-status")
def server_status():
    return jsonify({
        "name": "AICTE Central Server",
        "status": "Running",
        "cpu_usage": 64.2,
        "memory_usage": 79.1
    })

if __name__ == "__main__":
    app.run(port=5001)
```

2. app.py

```
from flask import Flask, render_template, request, redirect, url_for, flash, session
from flask_sqlalchemy import SQLAlchemy
from flask_mail import Mail, Message
from flask_login import LoginManager, login_user, login_required, logout_user,
current_user
from werkzeug.security import generate_password_hash, check_password_hash
import random
import requests

def scan_ip_virustotal(ip_address, api_key):
    url = f"https://www.virustotal.com/api/v3/ip_addresses/{ip_address}"
    headers = {
        "x-apikey": api_key
    }
    response = requests.get(url, headers=headers)
    if response.status_code == 200:
        result = response.json()
        return result["data"]["attributes"]["last_analysis_stats"]
    else:
        return {"error": "Failed to scan or exceeded API limit"}

from config import Config
```

```
from models import db, User, Server, FirewallRule

app = Flask(__name__)
app.config.from_object(Config)
app.config['SQLALCHEMY_DATABASE_URI'] = 'sqlite:///users.db'

db.init_app(app)
mail = Mail(app)

login_manager = LoginManager()
login_manager.init_app(app)
login_manager.login_view = 'login'

@login_manager.user_loader
def load_user(user_id):
    return User.query.get(int(user_id))

# ✅ Fix applied here
with app.app_context():
    db.create_all()
    if not User.query.filter_by(email="admin@example.com").first():
        db.session.add(User(email="admin@example.com",
password=generate_password_hash("admin123")))
        db.session.add(Server(name="Main Server", status="Running", cpu_usage=43.5,
memory_usage=68.2))
        db.session.add(Server(name="Backup Server", status="Stopped", cpu_usage=0.0,
memory_usage=0.0))
        db.session.add(FirewallRule(ip_address="192.168.1.10", port=22, action="Allow",
is_active=True))
        db.session.add(FirewallRule(ip_address="192.168.1.15", port=80, action="Deny",
is_active=False))
        db.session.commit()

@app.route('/', methods=['GET', 'POST'])
def login():
    if request.method == 'POST':
        email = request.form['email']
        password = request.form['password']
        user = User.query.filter_by(email=email).first()

        if user and check_password_hash(user.password, password):
            otp = str(random.randint(100000, 999999))
            user.otp = otp
            db.session.commit()

            msg = Message('Your OTP for Cyber Portal Login',
sender=app.config['MAIL_USERNAME'], recipients=[email])
            msg.body = f'Use this OTP to complete your login: {otp}'
            mail.send(msg)
```

```
            session['user_id'] = user.id
            return redirect(url_for('verify_otp'))
        flash("Invalid credentials", "danger")
    return render_template('login.html')

@app.route('/verify-otp', methods=['GET', 'POST'])
def verify_otp():
    if request.method == 'POST':
        input_otp = request.form['otp']
        user = User.query.get(session['user_id'])

        if user and user.otp == input_otp:
            login_user(user)
            return redirect(url_for('dashboard'))
        flash("Invalid OTP", "danger")
    return render_template('otp.html')

@app.route('/dashboard')
@login_required
def dashboard():
    return render_template('dashboard.html', name=current_user.email)

@app.route('/servers')
@login_required
def servers():
    all_servers = Server.query.all()

    # Simulated external call to AICTE API
    try:
        res = requests.get("http://127.0.0.1:5001/aicte/server-status")
        if res.status_code == 200:
            aicte_data = res.json()
            all_servers.append(Server(**aicte_data))  # Temporary object (not saved to DB)
    except Exception as e:
        print("Failed to fetch AICTE server:", e)

    return render_template('servers.html', servers=all_servers)

@app.route('/firewall')
@login_required
def firewall():
    all_rules = FirewallRule.query.all()
    return render_template('firewall.html', rules=all_rules)

@app.route('/logout')
@login_required
def logout():
    logout_user()
    return redirect(url_for('login'))
```

```
@app.route('/scan-ip')
@login_required
def scan_ip():
    return redirect("https://www.virustotal.com", code=302)

if __name__ == '__main__':
    app.run(debug=True)
```

3. models.py

```
from flask_sqlalchemy import SQLAlchemy
from flask_login import UserMixin

db = SQLAlchemy()

class User(db.Model, UserMixin):
    id = db.Column(db.Integer, primary_key=True)
    email = db.Column(db.String(100), unique=True, nullable=False)
    password = db.Column(db.String(200), nullable=False)
    otp = db.Column(db.String(6))

class Server(db.Model):
    id = db.Column(db.Integer, primary_key=True)
    name = db.Column(db.String(100))
    status = db.Column(db.String(20))
    cpu_usage = db.Column(db.Float)
    memory_usage = db.Column(db.Float)

class FirewallRule(db.Model):
    id = db.Column(db.Integer, primary_key=True)
    ip_address = db.Column(db.String(100))
    port = db.Column(db.Integer)
    action = db.Column(db.String(10))
    is_active = db.Column(db.Boolean, default=True)
```

4. config.py

```
class Config:
    SECRET_KEY = '0a8dcaa0a7da511a441c02098'
    MAIL_SERVER = 'smtp.gmail.com'
    MAIL_PORT = 587
    MAIL_USE_TLS = True
    MAIL_USERNAME = example@gmail.com'
    MAIL_PASSWORD = “asdf cvbn uytr’
```

5. templates/login.html

```
html
Copy code
<!DOCTYPE html>
<html>
<head>
  <title>Login</title>
  <style>
    body {
      background: #f2f7f5;
      display: flex;
      justify-content: center;
      align-items: center;
      height: 100vh;
      font-family: 'Segoe UI', sans-serif;
    }
    .login-box {
      background: #fff;
      padding: 30px;
      border-radius: 12px;
      box-shadow: 0 0 15px rgba(0,0,0,0.1);
    }
    h2 {
      color: #333;
      margin-bottom: 20px;
    }
    input, button {
      width: 100%;
      padding: 10px;
      margin: 8px 0;
      border-radius: 6px;
      border: 1px solid #ccc;
    }
    button {
      background: #a5d8ff;
      cursor: pointer;
    }
    button:hover {
      background: #74c0fc;
    }
  </style>
</head>
<body>
  <div class="login-box">
    <h2>Login</h2>
    <form method="post">
      <input type="email" name="email" placeholder="Email" required><br>
```

```
    <input type="password" name="password" placeholder="Password" required><br>
    <button type="submit">Login</button>
   </form>
  </div>
</body>
</html>
```

✅ templates/otp.html

```
html
Copy code
<!DOCTYPE html>
<html>
<head>
  <title>Enter OTP</title>
  <style>
    body {
      background: #e0f7fa;
      font-family: 'Segoe UI', sans-serif;
      display: flex;
      justify-content: center;
      align-items: center;
      height: 100vh;
    }
    .container {
      max-width: 400px;
      background: #fff;
      padding: 30px;
      border-radius: 12px;
      box-shadow: 0 0 15px rgba(0,0,0,0.1);
    }
    input, button {
      width: 100%;
      padding: 12px;
      margin: 10px 0;
      border: 1px solid #ccc;
      border-radius: 6px;
    }
    button {
      background-color: #b5ead7;
      font-size: 16px;
    }
    button:hover {
      background-color: #98ddca;
    }
  </style>
</head>
<body>
  <div class="container">
    <h2>Enter OTP</h2>
    <form method="post">
      <input type="text" name="otp" placeholder="Enter OTP" required>
```

```
    <button type="submit">Verify</button>
   </form>
  </div>
</body>
</html>
```

✅ templates/dashboard.html

html

Copy code

```
<!DOCTYPE html>
<html>
<head>
  <title>Dashboard</title>
  <style>
   body {
    background: #fdf0d5;
    font-family: 'Segoe UI', sans-serif;
    padding: 40px;
   }
   .card {
    background: #fff;
    padding: 20px;
    border-radius: 12px;
    box-shadow: 0 0 10px rgba(0,0,0,0.05);
   }
   ul {
    list-style: none;
    padding: 0;
   }
   li a {
    display: block;
    padding: 12px;
    background: #caffbf;
    margin: 8px 0;
    text-decoration: none;
    color: #333;
    border-radius: 8px;
    text-align: center;
   }
   li a:hover {
    background: #b2f2bb;
   }
  </style>
</head>
<body>
  <div class="card">
   <h2>Welcome, {{ name }}</h2>
   <ul>
    <li><a href="{{ url_for('servers') }}">Server Management</a></li>
    <li><a href="{{ url_for('firewall') }}">Firewall Management</a></li>
    <li><a href="{{ url_for('scan_ip') }}">VirusTotal Website</a></li>
```

```
    <li><a href="{{ url_for('logout') }}">Logout</a></li>
   </ul>
  </div>
</body>
</html>
```

✅ templates/servers.html

```
html
Copy code
<!DOCTYPE html>
<html>
<head>
  <title>Server Management</title>
  <style>
   body {
    background: #e6fcf5;
    font-family: 'Segoe UI', sans-serif;
    padding: 40px;
   }
   table {
    width: 100%;
    border-collapse: collapse;
    background: #fff;
    border-radius: 10px;
    box-shadow: 0 0 10px rgba(0,0,0,0.05);
   }
   th, td {
    padding: 15px;
    text-align: center;
   }
   th {
    background: #d0f4de;
   }
   tr:nth-child(even) {
    background: #f9f9f9;
   }
   a {
    display: block;
    margin-top: 20px;
    text-align: center;
    text-decoration: none;
    color: #333;
   }
  </style>
</head>
<body>
  <h2>Server Management</h2>
  <table>
   <tr><th>Name</th><th>Status</th><th>CPU %</th><th>Memory %</th></tr>
   {% for s in servers %}
   <tr>
```

```
    <td>{{ s.name }}</td>
    <td>{{ s.status }}</td>
    <td>{{ s.cpu_usage }}</td>
    <td>{{ s.memory_usage }}</td>
   </tr>
   {% endfor %}
  </table>
  <a href="{{ url_for('dashboard') }}">Back to Dashboard</a>
</body>
</html>
```

✅ templates/firewall.html

```
html
Copy code
<!DOCTYPE html>
<html>
<head>
  <title>Firewall Rules</title>
  <style>
    body {
      background: #f0efeb;
      font-family: 'Segoe UI', sans-serif;
      padding: 40px;
    }
    table {
      width: 100%;
      border-collapse: collapse;
      background: #fff;
      border-radius: 10px;
      box-shadow: 0 0 10px rgba(0,0,0,0.05);
    }
    th, td {
      padding: 14px;
      text-align: center;
    }
    th {
      background: #ffc9c9;
    }
    tr:nth-child(even) {
      background: #fff0f6;
    }
    a {
      display: block;
      margin-top: 20px;
      text-align: center;
      text-decoration: none;
      color: #333;
    }
  </style>
</head>
<body>
```

```
  <h2>Firewall Rules</h2>
  <table>
    <tr><th>IP Address</th><th>Port</th><th>Action</th><th>Status</th></tr>
    {% for r in rules %}
    <tr>
      <td>{{ r.ip_address }}</td>
      <td>{{ r.port }}</td>
      <td>{{ r.action }}</td>
      <td>{{ "Active" if r.is_active else "Disabled" }}</td>
    </tr>
    {% endfor %}
  </table>
  <a href="{{ url_for('dashboard') }}">Back to Dashboard</a>
</body>
</html>
```

APPENDIX-B

SCREENSHOTS

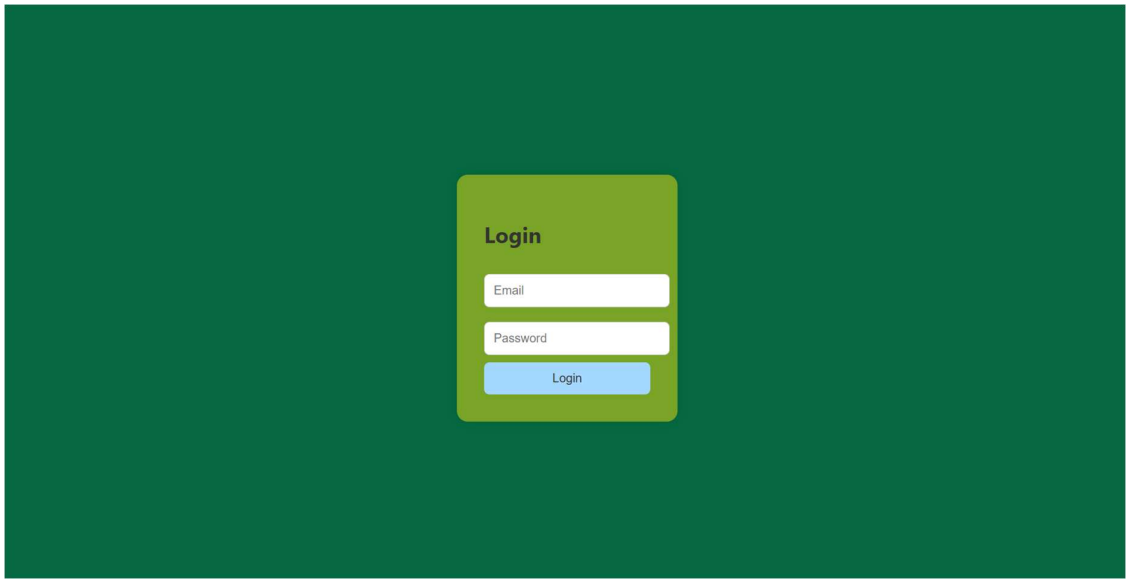

Fig 2. Login Page

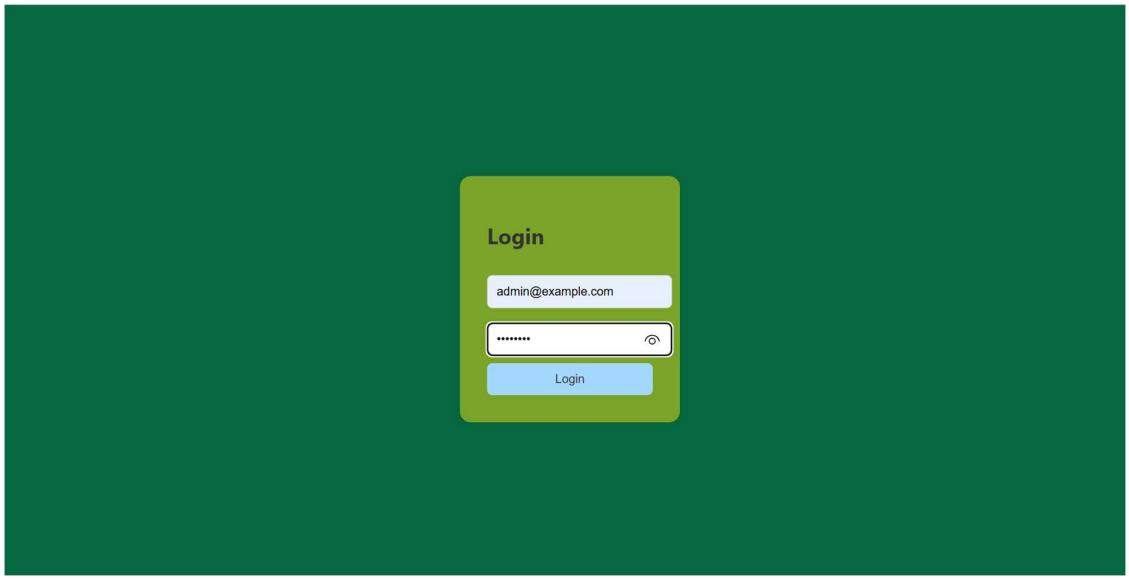

Fig 2.1 Login Credentials

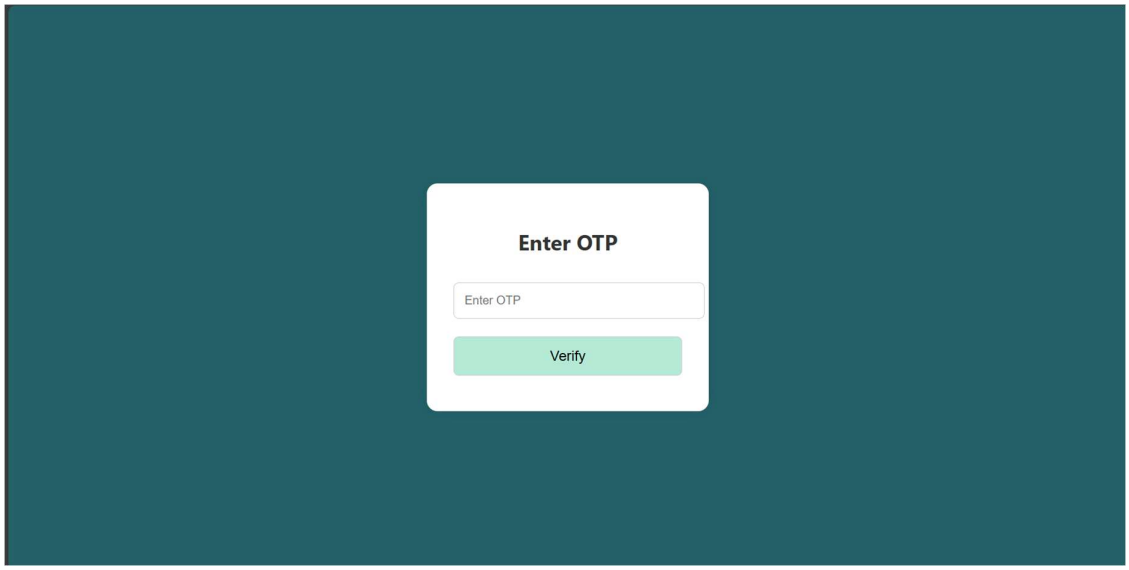

Fig 2.2 OTP Page

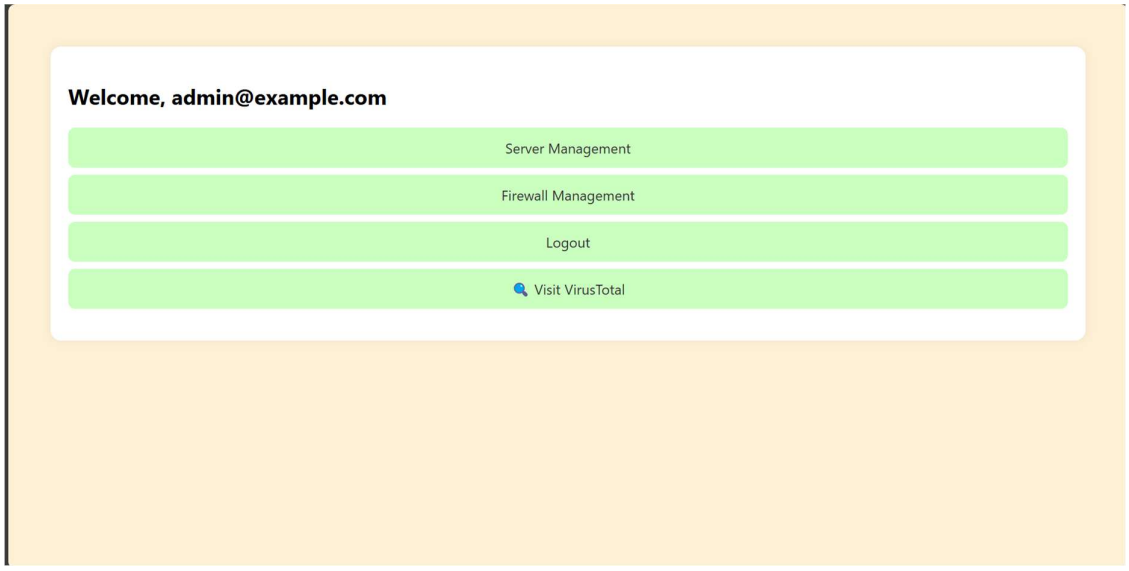

Fig 2.3 Dashboard

Fig 2.4 Server Management Dashboard

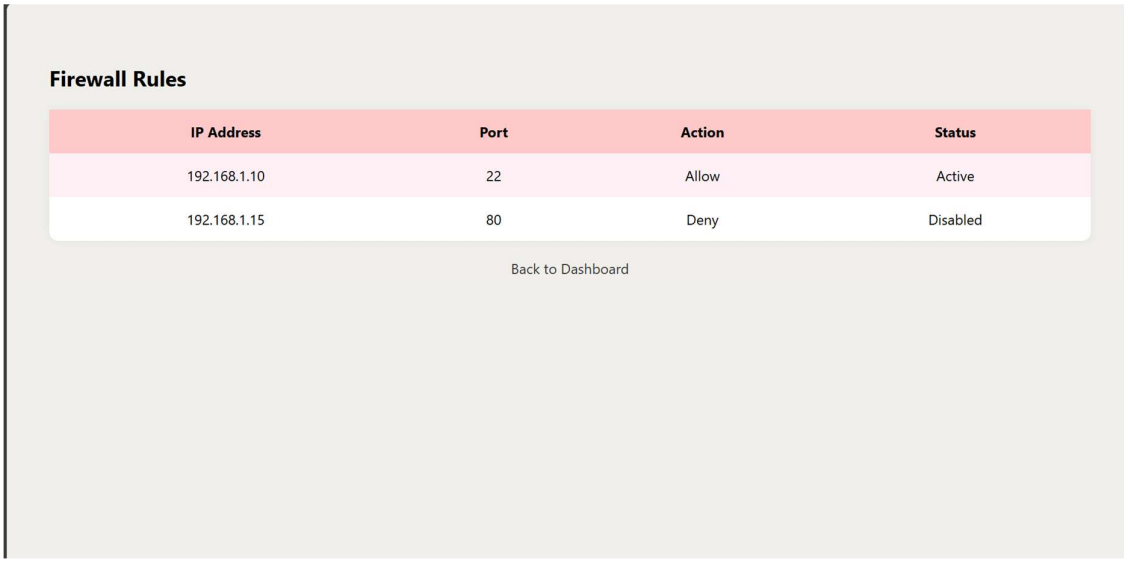

Fig 2.5 Firewall Dashboard

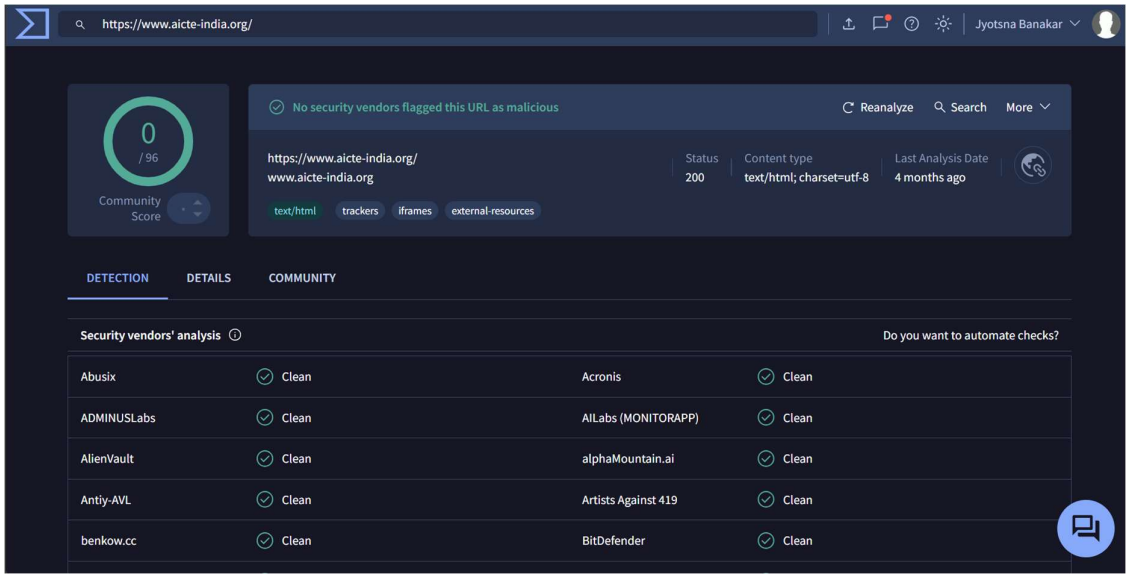

Fig 2.6 Domain Analysis

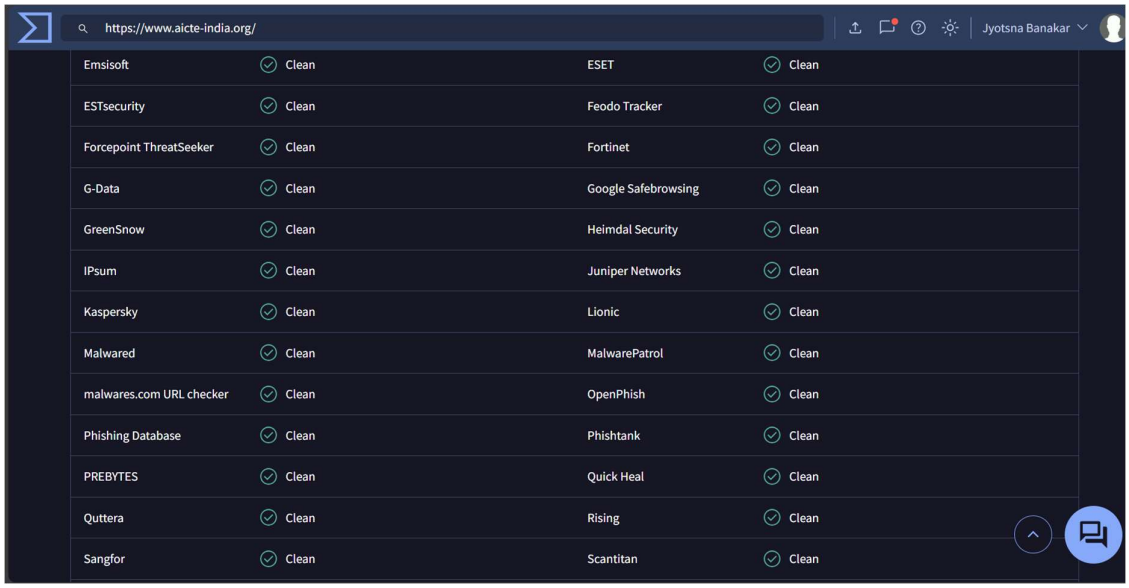

Fig 2.7 Domain Analysis

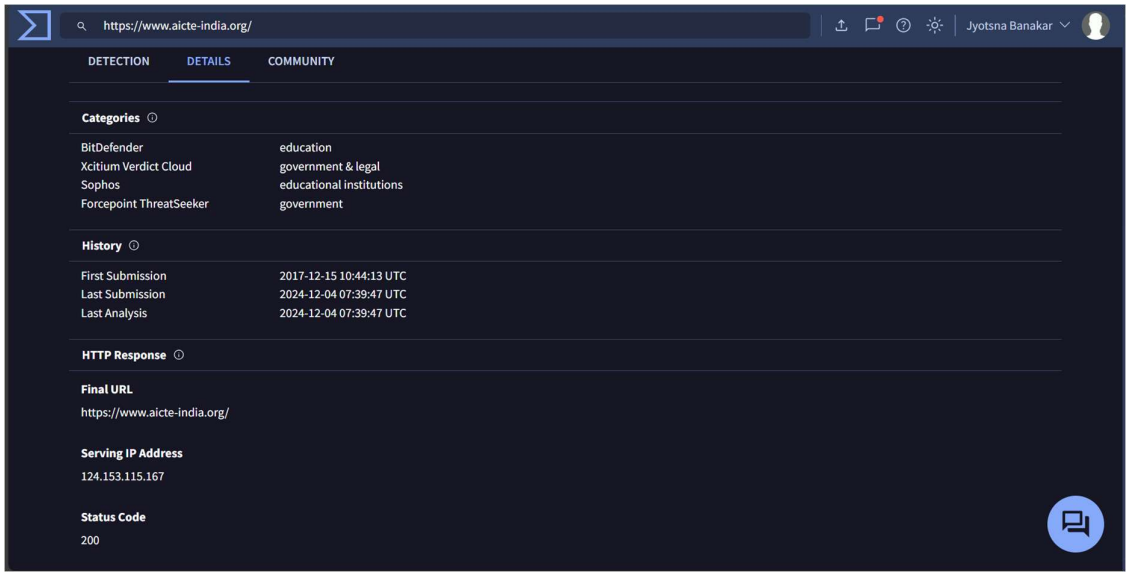

Fig 2.8 Domain Details

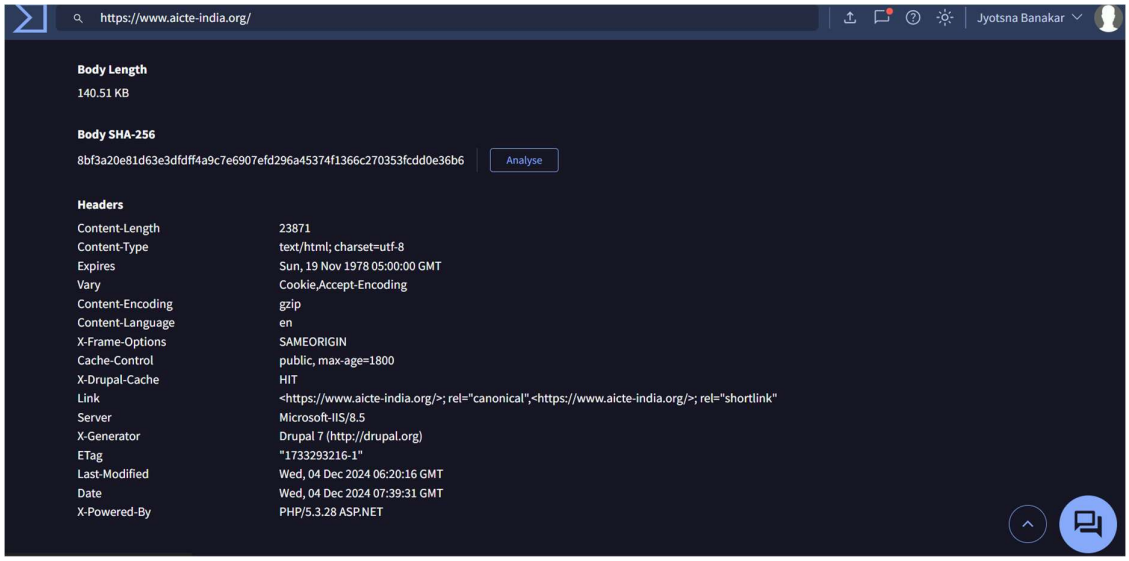

Fig 2.9 Whois Lookup

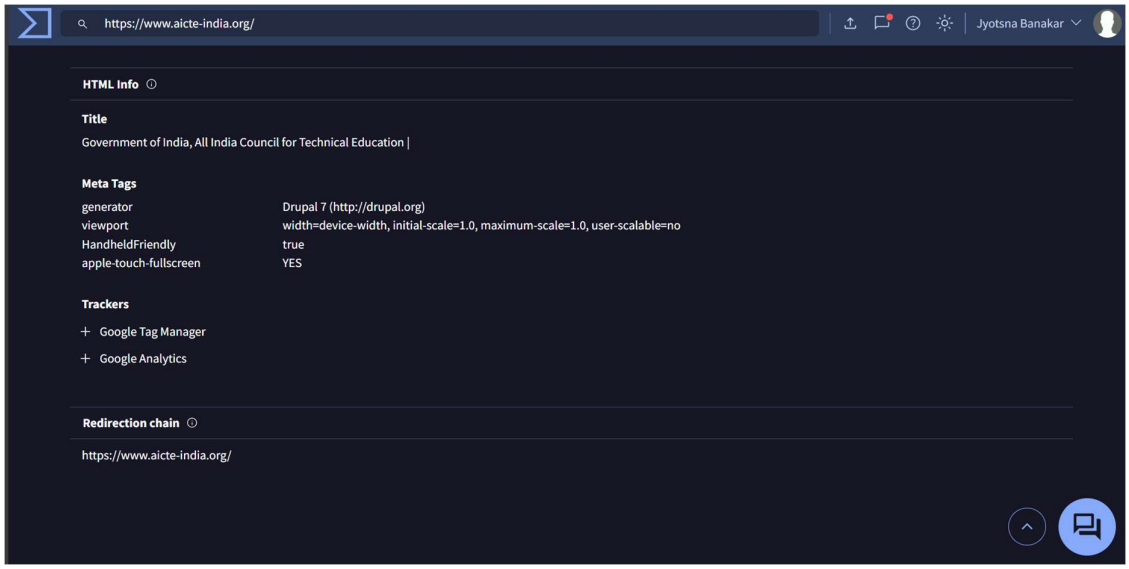

Fig 2.10 Tags Information

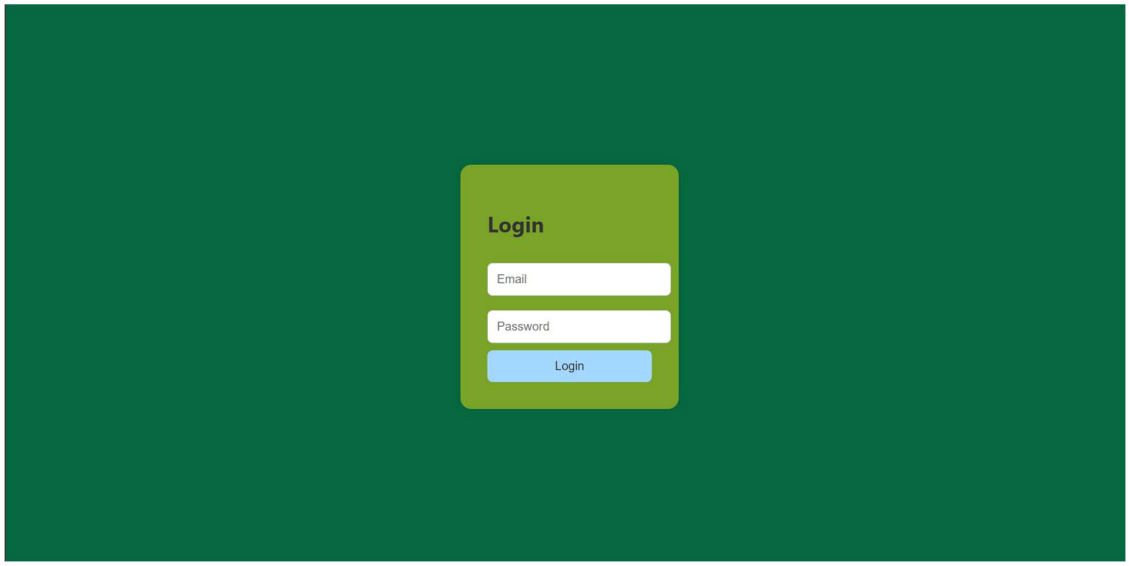

Fig 2.11 Logout page

APPENDIX-C

ENCLOSURES

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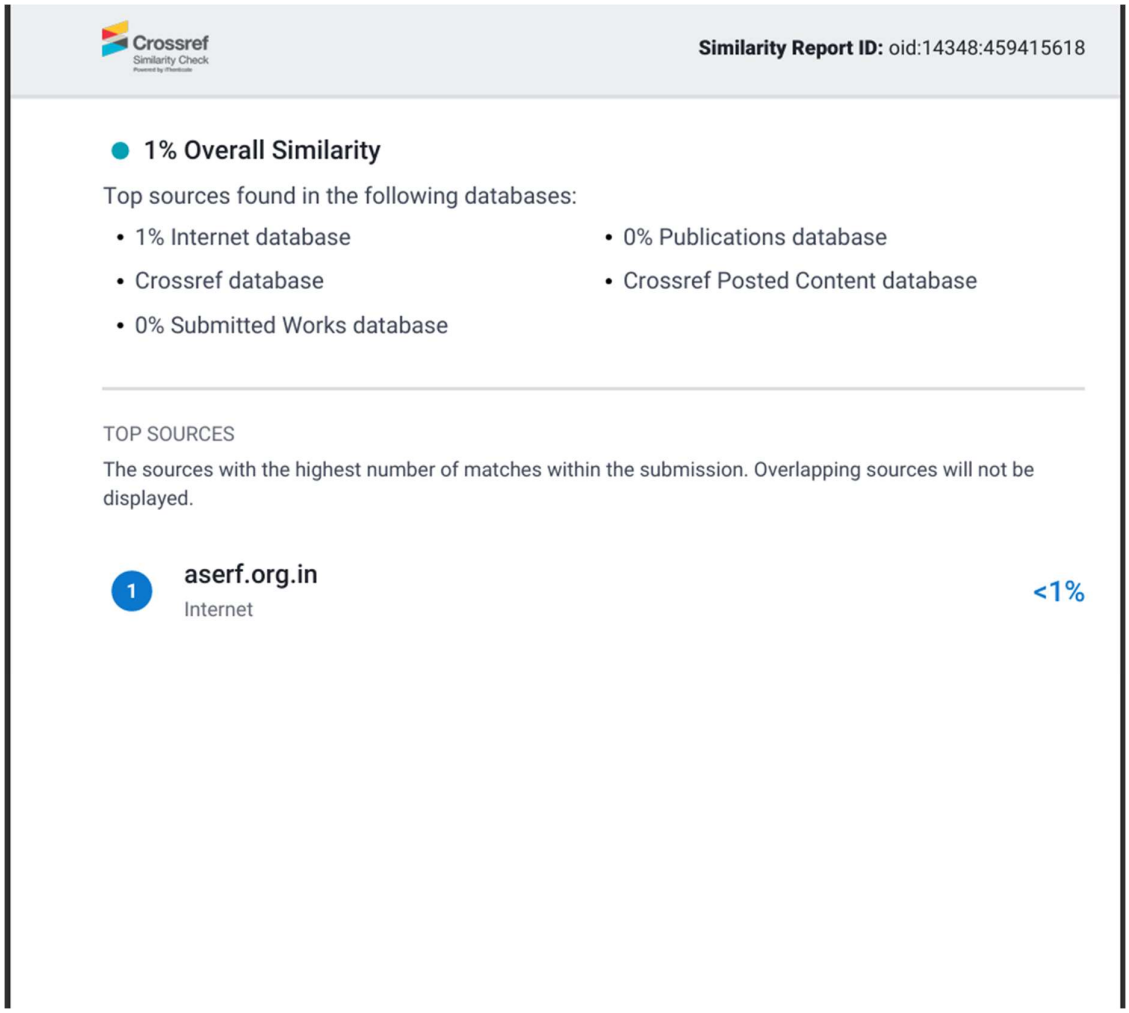
PLAGIARISM REPORT



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SUSTAINABLE DEVELOPMENT GOALS(SDGs)

The Cybersecurity Portal for Effective Management of Servers and Firewalls aligns with several Sustainable Development Goals (SDGs) in the following ways:

1. SDG 16: Peace, Justice, and Strong Institutions – The project strengthens digital security by detecting and mitigating cyber threats, protecting sensitive data, and fostering trust in institutions. It reduces the risks of cybercrimes, ensuring safer and more resilient systems.

2. SDG 9: Industry, Innovation, and Infrastructure – By leveraging advanced technologies, the framework promotes innovation in cybersecurity and supports secure digital infrastructure. It helps safeguard critical systems, ensuring their reliability and efficiency.

3. SDG 4: Quality Education – The project acts as a learning platform, providing practical exposure to cybersecurity and threat analysis. It enhances skills and knowledge, empowering individuals to address cyber challenges effectively.

4. SDG 10: Reduced Inequalities – The framework offers scalable solutions that improve cybersecurity access for underprivileged regions. This reduces the digital divide and ensures equitable access to secure technologies.

5. SDG 17: Partnerships for the Goals – It encourages collaboration by facilitating data sharing and joint efforts among organizations and experts. This collective approach strengthens global cybersecurity and fosters partnerships for shared success.