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Development of a Mikrotik API-Based Leaderboard System for Monitoring ISP User Activity

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Abstract
The digital transformation has significantly increased the demand for fast, stable, and transparent internet access. The surge in internet users, particularly in the post-COVID-19 era, has made internet services a primary necessity (Dahiya et al., 2021). PT Olean Telematika as an Internet Service Provider (ISP) utilizing Fiber To The Home (FTTH) technology, needs to implement a monitoring system capable of displaying customer activity in real time as a form of service transparency. This study aims to develop and evaluate a leaderboard system based on Mikrotik API that presents bandwidth usage rankings of ISP customers. The system was developed using the Waterfall model and integrated with PHP and MySQL to manage customer upload and download activity data (Yutanto et al., 2023). Rankings are visually displayed through a web-based interface. We evaluated the system using the System Usability Scale (SUS) instrument with 30 active users, resulting in an average score of 75.63, which falls into the "good" category. These results indicate that the system is not only functional but also positively received by users. The leaderboard system is effective in enhancing service transparency and supporting data-driven decision-making by ISPs to improve customer satisfaction (Lumbantoruan, 2020)

Keywords: Leaderboard; Mikrotik API; ISP; SUS Evaluation; Internet Activity

1. Introduction

In today's digital era, the demand for fast, stable, and reliable internet access has become essential for both individuals and organizations. To effectively manage and optimize such services, data-driven approaches are increasingly required by Internet Service Providers (ISPs). One emerging innovation is the implementation of a leaderboard system, which enables real-time monitoring of customer activity and promotes more efficient bandwidth utilization (Gunantara et al., 2022)

Several studies have demonstrated that the quality of internet services including access speed, network stability, and monitoring systems plays a substantial role in shaping customer satisfaction levels (Hendric et al., 2023). The adoption of bandwidth management techniques, such as the Hierarchical Token Bucket (HTB), has been empirically proven to enhance overall network performance and significantly improve the Customer Satisfaction Index (CSI) compared to other conventional methods (Gunantara et al., 2022). Meanwhile, the utilization of Mikrotik routers configured with the Per Connection Queue (PCQ) method has shown effectiveness in distributing bandwidth more efficiently across users, leading to a more comfortable and balanced user experience.

Previous research, such as the study conducted by Yutanto et al. (2023), has primarily focused on the implementation of leaderboard systems within academic settings, with limited exploration in real-world ISP operations. In response to this gap, the present study introduces a novel contribution by developing a Mikrotik API-based leaderboard system designed for direct application in the operational environment of Internet Service Providers as a real-time monitoring tool.

This study also represents an extension of previous research that focused on the development of a leaderboard application within a university setting, utilizing a functional testing approach (black-box). In its current iteration, the study shifts its emphasis toward an operational ISP environment and adopts a usability evaluation framework employing the System Usability Scale (SUS) instrument. This approach enables a more comprehensive assessment of user acceptance and comfort in interacting with the system, while simultaneously expanding the scope of technological implementation from academic contexts to industrial applications.

As one of the leading Internet Service Providers (ISPs) in Indonesia, PT Olean Telematika faces increasingly complex challenges in meeting the rising demands of its customers. With the growing number of internet users both for personal and business purposes ISPs are expected to deliver connectivity that is not only fast but also stable and highly reliable. High-quality internet services play a critical role in enhancing customer productivity and operational efficiency, which in turn significantly influences

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customer satisfaction and long-term loyalty.(Mukhsin, 2020).

One of the key technologies widely adopted by ISPs to meet these demands is the Point-to-Point Protocol over Ethernet (PPPoE). This technology enables customers to connect to the network efficiently through fiber-optic-based modems, providing the speed and stability necessary to support a wide range of online activities, including web browsing, streaming, and business communication (Darusalam, 2024). In response to the steadily increasing demand, it is essential for PT Olean Telematika not only to focus on delivering high-quality services, but also to actively monitor and analyze customer internet usage patterns to ensure optimal network performance and user satisfaction.

Analyzing online activity through a leaderboard system can also provide valuable insights for management. By understanding usage trends, PT Olean Telematika can identify peak usage periods and potential network congestion points that may impact service delivery. This data-driven approach enables the organization to take proactive measures, such as upgrading infrastructure or optimizing network configurations, to more effectively meet user demands (Adiati et al., 2022). Moreover, the implementation of such a system can assist in identifying users who may require additional support or resources, thereby enhancing customer service quality and overall satisfaction (Rintyarna et al., 2022).

Given the identified research gap and the operational demands faced by Internet Service Providers, this study aims to design and evaluate a leaderboard system that enables real-time monitoring of customer bandwidth usage and generates user ranking data to support data-driven decision-making in internet service management.

2. Literature Review

Mikrotik routers constitute a critical component in managing Point-to-Point Protocol over Ethernet (PPPoE) connections, widely implemented by Internet Service Providers (ISPs). Their support for advanced traffic control mechanisms such as Equal Cost Multi Path (ECMP) and Per Connection Queue (PCQ) enables systematic optimization of bandwidth allocation (Nugroho, 2023). Furthermore, the availability of the Mikrotik Application Programming Interface (API) facilitates seamless integration with monitoring applications, particularly those developed using PHP. This interface allows for real-time extraction, storage, and analysis of bandwidth usage data within a MySQL environment, ultimately supporting dynamic leaderboard generation (Mohammedali et al., 2021).

Leaderboards are utilized to rank users based on specific performance metrics or activity levels, and in this context, they serve to transparently display customer bandwidth usage. The implementation of such systems has been shown to increase user awareness of bandwidth consumption and to encourage more efficient use of internet services (Balci et al., 2022). To assess the effectiveness of the system, the System Usability Scale (SUS) is employed a simple yet validated evaluation tool that has been widely used to measure user satisfaction and perceived ease of use in web-based systems(Thu & Hue, 2022).

2.1. Mikrotik Router

Mikrotik routers have received considerable attention in the field of networking, particularly for their capabilities in managing Point-to-Point Protocol over Ethernet (PPPoE) connections. PPPoE is a network protocol primarily used to establish direct connections between two network nodes, and it is widely adopted by Internet Service Providers (ISPs) to manage user access. The versatility of Mikrotik routers allows them to handle numerous PPPoE connections efficiently, while offering essential features such as load balancing, bandwidth management, and enhanced security

One of the key functions of Mikrotik routers is their ability to implement load balancing across multiple PPPoE connections. This capability is particularly critical in environments where both reliability and speed are essential. Studies have shown that techniques such as Equal Cost Multi Path (ECMP) and Per Connection Queue (PCQ) can significantly enhance internet connection performance by evenly distributing traffic across available links (Nugroho, 2023). Metode ECMP For instance, the ECMP method allows simultaneous utilization of multiple ISP connections, thereby reducing downtime and improving overall network performance(Khaerudin et al., 2023). Additionally, PCQ has proven effective in bandwidth management by ensuring that no single user monopolizes the available resources, thus improving service quality for all users (Sari et al., 2022).

2.2. API Mikrotik

An Application Programming Interface (API) is a collection of protocols, routines, and tools used to build software and applications. APIs enable communication between different applications and systems, thereby simplifying the integration and utilization of existing system features by developers(Balci et al., 2022). Mikrotik RouterOS provides an API feature that allows developers to programmatically interact with Mikrotik routers, access data, and perform configurations through applications built using specific programming languages (Mohammedali et al., 2021).

The Mikrotik API comprises a wide range of functions and methods that support various operations, including authentication, user

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management, network monitoring, and configuration management. Its object-oriented structure allows developers to access and manipulate data more effectively and flexibly.

2.3. PHP & MYSQL

According to B. Raharjo in his book *Mudah Belajar PHP* (2015), PHP is a general-purpose programming language that can be used similarly to other languages such as C, C++, Pascal, Python, Perl, and Ruby. However, PHP is most commonly used for developing web applications. PHP code can be embedded within HTML, allowing developers to create websites without writing lengthy scripts, as is often required in languages like Perl or Python. As a server-side scripting language, PHP is open-source software that can be freely distributed, licensed, and downloaded from its official website.

To connect to the Mikrotik API, developers need to create an instance of the RouterosAPI class and use the connect() method. The following is an example of the connection script:

```
require('routeros_api.class.php');
$API = new RouterosAPI();
if ($API->connect('192.168.88.1','admin',
'password')) {
   echo "Connection successful!";
} else {
   echo "Connection failed!";
}
```

The integration of Mikrotik API with PHP and MySQL for processing internet usage data to generate a leaderboard is a complex task that involves various technical and theoretical components. In this context, the Mikrotik API functions as a powerful tool for managing network devices and monitoring internet usage. By leveraging this API, developers can build applications that interact directly with Mikrotik routers to retrieve internet usage data such as upload and download statistics, as well as session durations. This data can then be stored in a MySQL database, enabling efficient processing and manipulation. The implementation of such systems has been demonstrated in various studies, where PHP is employed as the server-side programming language to facilitate communication between web applications and the Mikrotik API (Muhammad Firdaus Ilhamy & Slameto, 2024).

PHP, as a server-side programming language, provides the necessary tools to interact with the Mikrotik API and manage data within a MySQL database. This combination of technologies enables the development of dynamic web applications capable of real-time data processing and user interaction (Dalimunthe & Saputra, 2022)

2.4. Leaderboard

A leaderboard is an effective tool for displaying user rankings based on various aspects of system interaction. It organizes all users according to their scores or performance, from the highest to the lowest. The implementation of a leaderboard serves not only as a ranking mechanism but also as a means to help users understand their level of achievement relative to others, thereby fostering a sense of healthy competition(Mukhsin, 2020).

In terms of development, leaderboards can be implemented using various programming languages, one of which is PHP. PHP enables developers to customize the leaderboard to meet specific requirements, including display settings, user data management, and integration with other relevant systems (Darusalam, 2024). The user interface (UI) design of a leaderboard must consider user experience and accessibility. A well-designed interface that clearly presents rankings and provides insights into user performance can significantly enhance the system's overall effectiveness. The integration of visual elements such as charts and diagrams can aid in understanding usage patterns, making the data more accessible to end users. A study by Yutanto et al., (2023) emphasized the importance of user-friendly design in the development of leaderboard applications that effectively monitor internet usage.

2.5. System Usability Scale

The System Usability Scale (SUS) is a widely used tool for assessing the usability of a system in a simple yet effective manner. SUS consists of ten items designed to measure users' perceptions of the system's usability and satisfaction. The SUS score ranges from 0 to 100, with scores above 68 considered above average (Hartono et al., 2021). SUS includes two main components:

- Odd-numbered items: These evaluate the positive aspects of the system, such as ease of use and intuitiveness. Examples include, "I think that I would like to use this system frequently" and "I found the system very intuitive."
- Even-numbered items: These reflect negative perceptions, such as complexity and confusion in using the system. Examples include, "I found the system unnecessarily complex" and "I needed to learn a lot of things before I could get going with this system."

Utilizing a leaderboard-based system to analyze customer online activity offers strategic insights into behavioral usage patterns, which are essential for informed network management and service optimization. The collected data allows Internet Service Providers (ISPs) to identify users with both high and low bandwidth consumption, facilitating more equitable and efficient allocation of network resources. Moreover, by providing users with

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personalized feedback regarding their internet usage, the system empowers them to make better decisions about how they consume services. This approach also enhances service transparency and accountability by delivering clear, data-driven information about usage trends and system performance.

3. Research Method

3.1 *Research Time and Location*

This research was conducted starting in August 2024, with the study object focused on the network infrastructure of PT. Olean Telematika, which operates as an Internet Service Provider (ISP). The primary objective of this study is to analyze and develop a leaderboard system that monitors internet usage by customers connected via Point-to-Point Protocol over Ethernet (PPPoE).

3.2 *Research Methodology*

The research adopted the Waterfall methodology, a conventional linear and sequential approach widely used in software development. This method consists of five main phases: system analysis, system design, system development, implementation, and system evaluation. Each phase is executed systematically and in order, as illustrated in Figure 1.

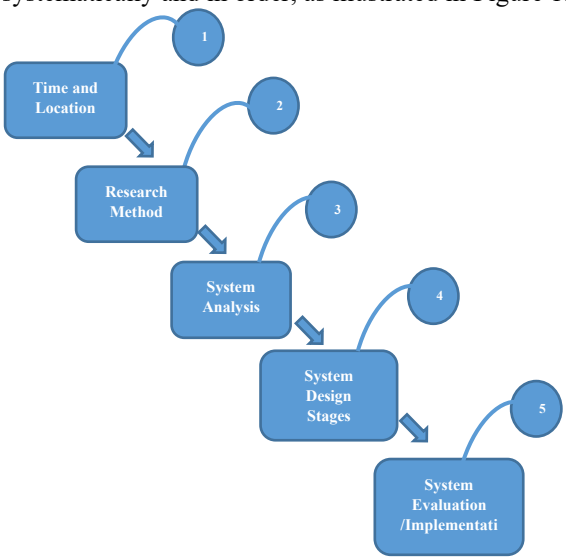

Figure 1. Research Methodology

3.2.1. *System Analysis*

In the context of managing ISP network infrastructure, traffic monitoring and analysis play a critical role. Based on observations, discussions/interviews, and literature review, the implementation of a leaderboard system at PT Olean Telematika serves as an effective tool to monitor and analyze customers' internet usage. By adopting a leaderboard system, PT Olean can not only rank customers based on their bandwidth consumption but also identify usage patterns that support strategic decision-making (Mukhsin, 2020).

The leaderboard system enables real-time visualization of internet usage data, facilitating management to detect potential issues before they impact users. For instance, if a user excessively consumes bandwidth or exhibits abnormal usage behavior, the system can trigger alerts for the management to take appropriate actions, such as bandwidth adjustments or offering service packages tailored to the user's needs (Silalahi, 2023).

The integration of technologies such as Mikrotik with the leaderboard system offers deeper insight into network traffic. By leveraging Mikrotik's built-in monitoring features, PT Olean can collect essential data to optimize network performance and enhance customer experience. This approach not only improves operational efficiency but also strengthens the relationship between the ISP and its customers through greater transparency and proactive communication (Suryani et al., 2018).

As shown in Figure 2, the existing infrastructure consists of a Mikrotik router acting as the core router, and a RADIUS server for managing PPPoE accounts. These components are connected to an Optical Line Terminal (OLT), which further connects to customer modems through a fiber-to-the-home (FTTH) network. Each customer modem dials in using a username and password to connect to the Mikrotik router. All active user activities including upload and download bandwidth usage are monitored through the Mikrotik system.

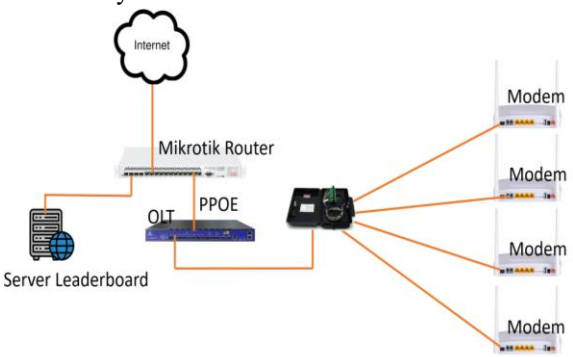

Figure 2. Network Infrastructure of PT Olean Telematika

3.2.2 *System Design Stages*

Figure 3 illustrates the system design stages, which include a MikroTik network infrastructure with PPPoE authentication and user modems for PPPoE dial-in using a username and password. The designed leaderboard system functions to monitor the activity of each customer connected via PPPoE and to capture bandwidth usage data using the MikroTik API through PHP. This enables accurate tracking of both download

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and upload bandwidth usage. The collected data is then processed and presented as user rankings in the developed leaderboard system.

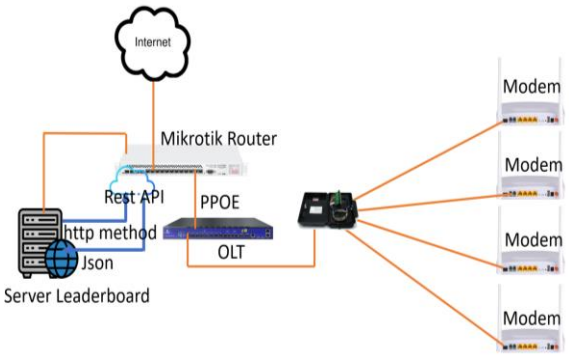

Figure 3. Leaderboard System Design Infrastructure

3.2.3 *Implementation Stage*

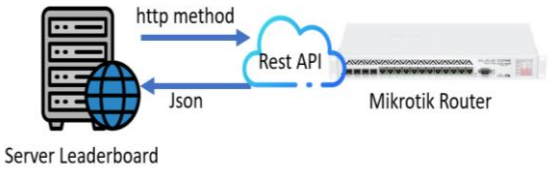

Figure 4. Leaderboard Integration with MikroTik

Figure 4 shows the connection between the leaderboard server and the MikroTik router. The initial implementation stage involves configuring the MikroTik Router by enabling the API feature and creating an API user group to allow communication with the Leaderboard System. The next step is to set up the leaderboard server, which is equipped with a Core i7 processor, 16GB RAM, and a 500GB hard drive, running on Ubuntu Server 22.04. This server is configured with a LAMP stack using PHP version 7.0. Figure 5 presents the PHP script used to establish a connection between MikroTik and PHP via the API, retrieving data to be stored in the database.

3.2.4 *System Evaluation*

In the context of the leaderboard system implemented for ISP customers at PT Olean Telematika, the System Usability Scale (SUS) offers a simple yet comprehensive framework to collect user feedback (Sembodo et al., 2021). By presenting a set of questions that address usability, convenience, and the perceived effectiveness of the system in monitoring and analyzing bandwidth usage, the evaluation aims to yield valuable insights into user satisfaction and system performance.

SUS is a reliable and widely adopted tool for measuring system usability. It uses a ten-item questionnaire rated on a 5-point Likert scale, where scores range from 1 (Strongly Disagree) to 5 (Strongly Agree). The statements are structured to assess both positive and negative user experiences. Table 1 presents the full set of SUS questionnaire items used to assess the system's usability.

Table 1. SUS Questionnaire Items

No	Statement	Scale
1	I found the leaderboard system easy to use.	1–5
2	Respondents expressed a high level of comfort when interacting with the leaderboard system.	1–5
3	The leaderboard helped me effectively monitor upload and download bandwidth usage.	1–5
4	The leaderboard helped me accurately analyze upload and download bandwidth usage.	1–5
5	I would recommend this leaderboard system to others.	1–5
6	The leaderboard supported effective monitoring of my internet activity.	1–5
7	The leaderboard enabled accurate bandwidth usage analysis.	1–5
8	The system helped identify areas for improvement in bandwidth usage.	1–5
9	I believe this system helped improve the efficiency of my bandwidth usage.	1–5
10	I believe this system helped reduce my internet usage costs.	1–5

To calculate the SUS score:

- For odd-numbered items (1, 3, 5, 7, 9), subtract 1 from the user's rating.
- For even-numbered items (2, 4, 6, 8, 10), subtract the rating from 5.
- The adjusted scores are summed, and the result is multiplied by 2.5 to obtain a SUS score ranging from 0 to 100.

A higher SUS score indicates better system usability. Generally, a score above 68 is considered above average, while a score below that indicates room for improvement (Palyama & Tomasila, 2022).

4. Results and Discussion

4.1 *Leaderboard Architecture*

The implementation of the leaderboard architecture involves a series of structured and systematic stages to ensure both the effectiveness and efficiency of the system. These stages include the determination of relevant metrics for measuring bandwidth usage both upload and download that will be displayed on the leaderboard. In this configuration, the Ubuntu server assigned for the leaderboard operates under the IP address 172.16.10.1, while the MikroTik router is assigned 172.16.11.1.

Software configuration follows, including the setup of the PHP development environment and

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MySQL database. At this stage, the MikroTik API is integrated with a PHP-based application, allowing for the automatic retrieval of network data. This process involves writing PHP scripts that interface with the MikroTik API to fetch bandwidth usage data and store it into appropriately structured tables in the MySQL database.

```
/ip service enable api
/user add name=api_user password=api_password group=full
```

Figure 5. API Configuration on MikroTik Router

During the implementation stage of the leaderboard system, Figure 6 illustrates the main workflow for retrieving data from the MikroTik device and storing it in a MySQL database. The initial phase of the PHP script involves establishing a connection to the MikroTik router via API by defining essential parameters such as IP address, username, and authentication password. Once the connection is successfully established, the system sends queries to extract data from the PPPoE-client interface, which contains user activity information such as upload (tx-byte) and download (rx-byte) statistics. The retrieved data is then processed using a foreach iteration, where each user entry is analyzed and prepared for storage in the MySQL database.

```
?php
require 'vendor/autoload.php;

use RouterOS\Client;
use RouterOS\Query;

// Konfigurasi Mikrotik
$mikrotikIp = '172.16.11.1';
$username   = 'api_user';
$password   = 'api_password';

// Koneksi ke Mikrotik
$client = new Client([
   'host' >= $mikrotikIp,
   'user' >= $username,
],'pass' >= $password,

// Ambil data PPPoE
$query = new Query(/innterface/ppooe
 Check if there are existing records:
 if ($ttmt->num_rows > 0) {
    // If data already exists, update
    $tmt.close(;
    $tmt = mysqlii-prepare("UPDATE
    bandwidth_usage SET download = ?
    WHERE username = *);
    $tmt->bind_param("iis,  $download,
    $upload,$username);
 }
 // If no records exist, insert new data
 $tmt->close(;
 $tmt = msysyqli-preepare("INSERT INTO
 bandwidth_usage (username, download,
 upload) VALUES (?,?
 );

 // Execute the prepared statement
 $tmt->execute;
 $tmt->close(;
 $mysqli.close(;
```

Figure 6. PHP–MySQL Integration Process

To prevent duplication, the system executes a SELECT command to verify whether the username already exists in the bandwidth_usage table. If the data exists, it is updated accordingly; if not, a new entry is inserted. All database operations are performed using prepared statements to enhance security and mitigate risks such as SQL injection. This implementation framework ensures that the leaderboard can continuously update internet usage data in real time with accuracy and security. As such, the integration of MikroTik's API with a PHP-based database serves as a foundational component in supporting the operational reliability and transparency of the leaderboard system for monitoring customer bandwidth usage.

After a successful connection is established, the next step as illustrated in Figure 7 involves calculating total bandwidth usage based on daily, weekly, monthly, and yearly periods.

```
function getBandwidthUsage($mysqli, $period) {
        $query = SELECT SUM(download, SUM(ulpoad AS total_upl(
            FROM bandwidth_usage
            WHERE timestamp = NOW() - INTERVAL $period';
        $result + mysqli->query($query);
        return sresult>fetch_assoc()
}

$mysqli = new mysqli('172.16.10.1','db_user', 'db_password');

header('Content-Type: application/json')
echo json_encode([
    'daily'  =  getBandwidthUsage($mysqli,'1 DAY'),
    'weekly' =  getBandwidthUsage($mysqli,'1 WEEK'),
    'monthly' = getBandwidthUsage($mysqli,'1 MONTH'),
    'yearly' =  getBandwidthUsage($mysqli,'1 YEAR')
];
$mysqli->close();
```

Figure 7. Bandwidth Calculation

4.2 *Leaderboard Implementation*

The results of the user interface (UI) and user experience (UX) design for the leaderboard system at PT Olean Telematika demonstrate a significant improvement in user interaction with the platform. The interface was developed with an emphasis on intuitive and responsive design principles, enabling users to easily navigate and interpret the information presented. Visual elements, such as charts and tables, have been optimized to clearly and effectively represent bandwidth usage both upload and download. As illustrated in Figure 8, the interface displays the top 20 customers with the highest bandwidth consumption.

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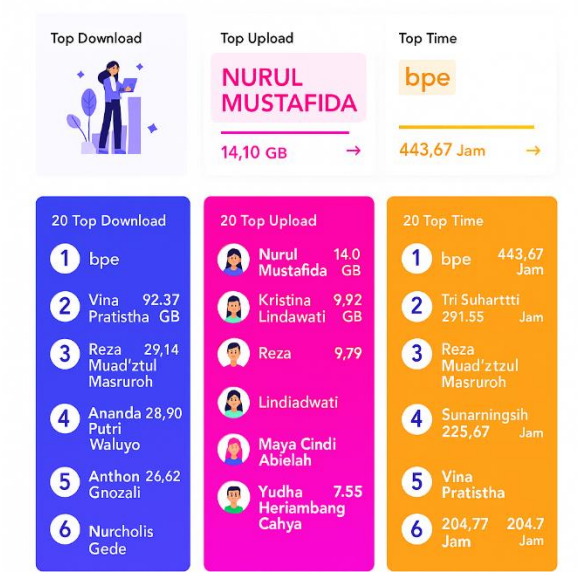

Figure 8. Top Upload and Top Download Leaderboard

Figure 9 illustrates the daily monitoring of the top 20 customers with the highest bandwidth usage, both in terms of upload and download activities.

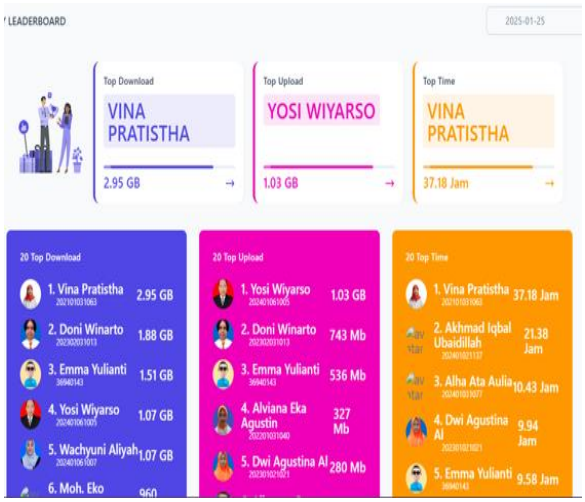

Figure 9. Daily Bandwidth Monitoring

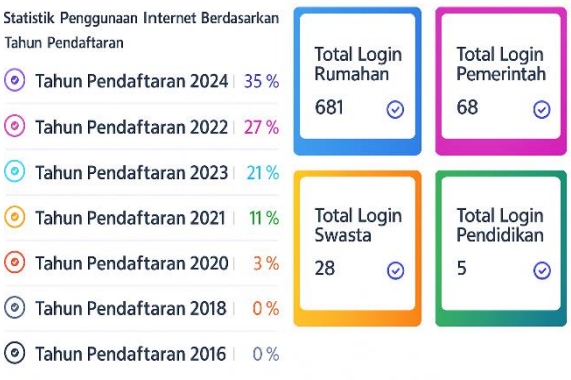

Figure 10. Bandwidth Statistics in the Leaderboard

4.3 *Leaderboard Testing*

The leaderboard system was evaluated through usability testing involving management personnel and 30 selected customers. The assessment utilized the **System Usability Scale (SUS)** as the evaluation instrument. The questionnaire was distributed during the official launch of the Leaderboard application. Table 2 below presents the summarized results of the usability assessment.

Table 2. System Usability Score (SUS) Evaluation Results for the Leaderboard System

Respondent	Score	Respondent	Score
R1	77	R16	79
R2	75	R17	74
R3	80	R18	80
R4	72	R19	73
R5	75	R20	75
R6	80	R21	80
R7	73	R22	72
R8	78	R23	75
R9	75	R24	80
R10	72	R25	74
R11	76	R26	76
R12	74	R27	72
R13	75	R28	77
R14	81	R29	75
R15	72	R30	72
Average Score			**75.63**

The results of the System Usability Scale (SUS) analysis, which yielded an average score of 75.63 with a range between 72 and 81, indicate that the ISP leaderboard system developed by PT Olean demonstrates a high level of usability, despite variations among individual respondents. This finding aligns with previous studies that have applied SUS across diverse contexts, suggesting that scores above the threshold of 68 generally reflect satisfactory usability and user acceptance (Boyd et al., 2019). The SUS framework itself offers a practical means of obtaining quantitative insights into system effectiveness, efficiency, and user satisfaction, as also evidenced in digital library evaluations (Jamal et al., 2021).

The variation in individual scores ranging from the lower 70s to over 80 reveals differences in user perception that may be attributed to varying levels of technical background, familiarity, and user expectations. As suggested by Núñez et al. (2024), combining quantitative scoring with qualitative interpretation is crucial to uncovering deeper patterns in user experience, particularly when user groups are heterogeneous. The observed score range underscores the importance of iterative interface refinement, aimed

at narrowing experience gaps and fostering a more intuitive and accessible design across the board.

Overall, the average score of 75.63 indicates that the system is well-accepted and functional by industry usability standards. Nevertheless, the score variability highlights areas where UI/UX improvements could be made to better accommodate diverse user needs. A more participatory and comprehensive evaluation approach supported by the literature can serve as a robust foundation for future design iterations that are more responsive to user feedback (Núñez et al., 2024). Accordingly, this study not only assesses general usability but also identifies critical areas for enhancement, in line with prior research employing SUS in various digital system evaluations.

5. Conclusion

The development and implementation of the Mikrotik API-based leaderboard system at PT Olean successfully achieved its objective of enabling real-time monitoring and ranking of customer internet bandwidth usage. The system has proven effective in enhancing transparency and providing structured insights into user activity patterns. Usability testing using the System Usability Scale (SUS) resulted in an average score of 75.63, indicating a good level of user acceptance. These results confirm that the system fulfills its functional goals and has the potential to be further optimized as a strategic tool for intelligent and user-oriented internet service management.

Acknowledgements

The author wishes to express sincere gratitude to the entire network administration staff at PT Olean Telematika, as well as the participating customers, for their invaluable support throughout this research. Their contributions ranging from insightful discussions and planning, to the implementation, testing, and evaluation of the leaderboard system were instrumental in enabling this study. This collaborative effort has significantly enriched the development and assessment of the user ranking system within the customer base of PT Olean Telematika's internet services.

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