MATICS : Jurnal Ilmu Komputer dan Teknologi Informasi ISSN : 1978-161X(p); 2477-2550(e)
Volume 18, No. 2(2026), pp 88-94 DOI : 10.18860/mat.v18i2.35292
Received : May 7th 2026; **Accepted** : August 5th 2026 ; **Avalaible Online** : September 29th 2026

Wireless Network Service Quality Using Network Performance Monitoring at PPSDM Regional Yogyakarta

Agung Prayogo, Landung Sudarmana, Selvi Dwi Hartiyani, Jidan Dewa Saksana

***Abstract*—Wireless networks have become a critical infrastructure supporting various sectors, including education, business, and public services. However, the increasing dependence on wireless connectivity introduces significant challenges in maintaining Quality of Service (QoS), particularly in ensuring stable bandwidth, low latency, minimal jitter, and low packet loss. This study aims to evaluate and analyze the QoS performance of the wireless network at the Human Resources Development Center (PPSDM) Regional Yogyakarta. The research adopts a quantitative approach using the Network Performance Monitoring (NPM) method to systematically collect, analyze, and visualize network performance data. Network monitoring tools such as PRTG Network Monitor and Zabbix were utilized to measure key QoS parameters, including throughput, delay, jitter, and packet loss. The collected data were then evaluated based on the TIPHON standardization framework to determine the overall service quality index. The results indicate that the throughput parameter achieved an index value of 2, while packet loss and delay parameters each reached an index value of 4, and the jitter parameter obtained a value of 3. Based on the aggregation of these parameters, the overall QoS performance of the wireless network at PPSDM Regional Yogyakarta falls into the "Good" category, with a QoS percentage value of 81.25%. In conclusion, the implementation of the NPM method effectively provides comprehensive insights into network performance, enabling proactive monitoring and optimization. The findings suggest that although the network performance is generally good, improvements in throughput optimization are still required to enhance overall service quality.**

Index Terms—Wireless Network, Quality of Service (QoS), Network Performance Monitoring (NPM), TIPHON Standard, Throughput, Packet Loss, Delay, Jitter

I. INTRODUCTION

The rapid development of information technology in the digital era has positioned the internet as a fundamental component in almost all organizational activities[1],[2]. Wireless Fidelity (Wi-Fi), as one of the most widely adopted technologies, enables flexible and cable-free internet access across various environments such as homes, campuses, workplaces, and public spaces[3],[4]. Despite its advantages, the increasing dependency on wireless networks introduces significant challenges, particularly in maintaining consistent Quality of Service (QoS)[5]. Common issues such as high delay, packet loss, and jitter frequently occur and can degrade network performance, ultimately affecting user experience and operational efficiency[6].

The Human Resources Development Center (PPSDM) Regional Yogyakarta is an institution that relies heavily on wireless network infrastructure to support training, administrative processes, and communication activities. In this context, stable and high-performance network services are essential to ensure the effectiveness of learning processes, research activities, and institutional operations[7]. However, the dynamic nature of network usage, especially during peak training periods, often leads to performance degradation, indicating the need for systematic evaluation and optimization[8],[9].

To address these challenges, this study proposes the use of the Network Performance Monitoring (NPM) method as a proactive approach to analyzing network performance[10],[11]. Unlike conventional methods that rely on offline packet analysis, NPM enables continuous and real-time monitoring of network conditions[12]. This approach provides comprehensive visibility into network performance, allowing early detection of anomalies, faster troubleshooting, and more informed decision-making for network optimization.

The objective of this research is to analyze the QoS of the wireless network at PPSDM Regional Yogyakarta using the NPM method, focusing on key parameters such as throughput, delay, jitter, and packet loss. The study also aims to identify performance bottlenecks and provide recommendations for improving overall network quality[13],[14].

From a theoretical perspective, QoS represents the network's ability to deliver services based on measurable performance indicators, including bandwidth, latency, jitter, and packet loss[15]. The application of standardized frameworks such as TIPHON provides a structured basis for evaluating and categorizing network performance[16]. Furthermore, the integration of real-time monitoring systems aligns with modern network management paradigms that emphasize proactive and data-driven approaches[17].

It is expected that the results of this study will provide practical contributions in improving wireless network

Manuscript received May 07, 2026. This work was supported in part by Information Technology Study Program of Faculty of Engineering at Proklamasi 45 University.

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performance at PPSDM Regional Yogyakarta[18]. Additionally, this research can serve as a reference for other institutions facing similar challenges in managing wireless network QoS, as well as contribute to the development of more adaptive and efficient network performance monitoring strategies[19],[20].

II. RESEARCH METHOD

This study employs the Network Performance Monitoring (NPM) method as a proactive and systematic approach to evaluate the Quality of Service (QoS) of wireless networks[21]. NPM is widely used in modern network management to enable continuous, real-time monitoring and analysis of network performance, allowing early detection of anomalies and faster corrective actions. The selection of this method is supported by prior studies in network performance evaluation that emphasize the importance of real-time monitoring systems compared to traditional offline packet analysis tools such as Wireshark, which tend to be reactive in nature[22].

2.1. Data Acquisition

The data in this study were obtained through direct measurement of network performance using monitoring tools installed within the PPSDM Regional Yogyakarta network infrastructure. The monitoring process focused on four main QoS parameters: throughput, delay, jitter, and packet loss. Data were collected from multiple locations, including Training areas, Administration offices, and Dormitory facilities, to represent different network usage characteristics[23].

Data collection was conducted automatically using Network Performance Monitoring tools such as PRTG Network Monitor or Zabbix. These tools utilized SNMP (Simple Network Management Protocol) and ICMP (ping-based monitoring) sensors to capture real-time network performance metrics. The observation period was carried out over three consecutive days, from 27 to 29 June 2023, during normal operational hours, with controlled background traffic (e.g., video streaming) to simulate realistic network conditions.

2.2. Research Procedure

The research procedure was conducted in a chronological sequence as follows:

1. Planning and System Configuration

The initial stage involved identifying monitoring requirements based on QoS parameters and determining observation locations. Monitoring tools were selected and configured, including the setup of sensors on network devices such as routers, switches, and access points. A baseline performance measurement was also established to serve as a reference for further analysis.

2. Data Collection

The configured NPM system continuously recorded QoS data in real time across the selected locations. The automated system ensured consistent and accurate data logging without manual intervention.

3. Data Analysis and Visualization

The collected data were processed and visualized using dashboards and trend analysis features provided by the monitoring tools. Performance metrics were analyzed to identify patterns, fluctuations, and anomalies in network behavior.

4. Evaluation and Interpretation

The QoS parameters were evaluated using the TIPHON standard, which classifies performance into four index categories (1–4). Each parameter was assessed to determine the level of service quality, and an overall QoS score was calculated. Further analysis was conducted to identify the root causes of performance degradation, such as bandwidth limitations or suboptimal access point placement[24].

5. Reporting and Recommendation Development

The final stage involved compiling the results into a comprehensive report, including performance summaries for each area and actionable recommendations for network optimization.

2.3. Measurement and Evaluation

The results of this study were measured based on quantitative QoS indicators, namely throughput, delay, jitter, and packet loss. Each parameter was tested against TIPHON standard thresholds to determine its performance index. The overall QoS level was calculated by aggregating these indices into a percentage score, which was then categorized into performance levels (Poor, Moderate, Good, or Excellent). This evaluation approach ensures objective assessment and provides a clear basis for recommending improvements in network performance[25].

III. RESULT AND DISCUSSION

3.1. Network Infrastructure Overview

The wireless network infrastructure at PPSDM Regional Yogyakarta is distributed across multiple functional zones, including Training Areas, Administration Offices, and Dormitory Facilities, as illustrated in Fig. 1. This spatial distribution significantly influences network performance due to varying user density, activity patterns, and physical obstructions.

The Training Area is characterized by high user intensity during learning sessions, the Dormitory Area shows moderate but continuous usage, while the Administration Area tends to have more stable and controlled traffic. This zoning is essential for interpreting QoS variations across different locations.

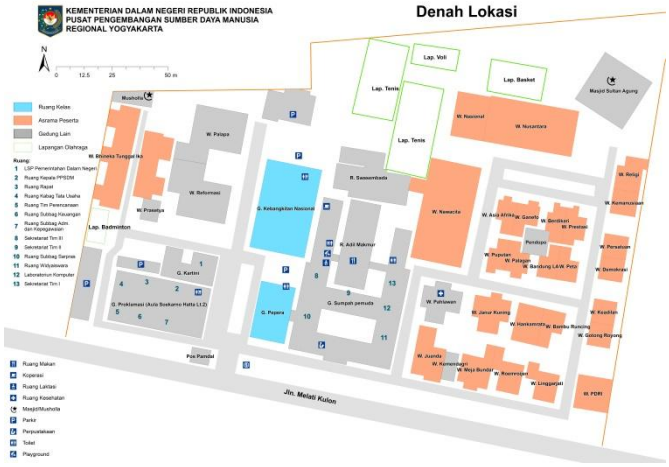

Fig. 1. Site map of PPSDM Regional Yogyakarta with building labels and layout of office, dormitory, and sport areas.

Table 1 presents the distribution of access points (APs) across buildings. A higher concentration of APs is observed in training-related buildings such as Soekarno-Hatta Hall and Sumpah Pemuda Building, indicating prioritization of coverage in high-demand areas. However, uneven AP

distribution in dormitory zones may contribute to performance degradation.

Table 1: Buildings and Number of Access Points – PPSDM Yogyakarta

No.	Building/Area Name	Number of Access Points
1	Bhinneka Tunggal Ika Building	4
2	Palapa Building	1
3	Reformasi Building	2
4	Prasetya Building	1
5	Kartini Building	1
6	Soekarno Hatta Hall – 1st Floor	7
7	Soekarno Hatta Hall – 2nd Floor	4
8	Security Room	1
9	Pepera Building	1
10	Kebangkitan Building – Floor 1 to 4	3 per floor (total 12)
11	Kebangkitan Building – Floor 5	1
12	Sumpah Pemuda Building	14
13	Cooperative Room	1
14	Adil Makmur Room – 2nd Floor	1
15	Wisma Nawacita	6
16	Tennis Court Area	1
17	Wisma Pahlawan	1
18	Wisma Juanda	1
19	Wisma Kemendagri	1
20	Wisma Meja Bundar	1
21	Wisma PDRI	1
22	Wisma Janur Kuning	1
23	Wisma Puputan	1
24	Wisma Palagan	1
25	Wisma Bandung Lautan Api	1
26	Wisma Peta	1
27	Wisma Asia Afrika	1
28	Wisma Ganefo	1
29	Wisma Berdikari	1
30	Wisma Prestasi	1
31	Wisma Nusantara	6
32	Wisma Gotong Royong	1
33	Wisma Keadilan	1
34	Wisma Demokrasi	1
35	Wisma Persatuan	1
36	Wisma Kemanusiaan	1
37	Wisma Religi	1
38	Mosque Area	1
39	Central Router & Mikrotik (Lab Room 12)	- (Control Center)

Figures 2–10 illustrate the physical infrastructure, including server racks, switches, antennas, and cabling systems. These components form a centralized topology where all APs are connected to a core switch and router located in the server room. While this topology simplifies management, it introduces potential bottlenecks at the central node, especially under high traffic conditions.

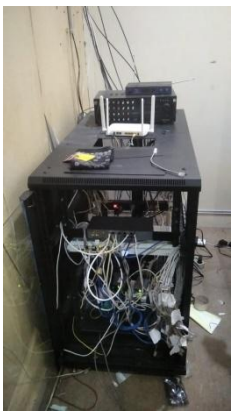

Figure. 2. Network server rack with structured cabling and network switches.

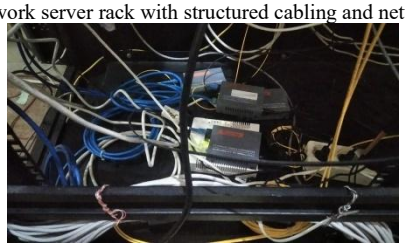

Figure. 3. Rear view of the network cabinet showing cable distribution and switch configuration.

Figure. 4. Wireless access point device with multi-antenna configuration.

Figure. 5. Outdoor antenna tower used for wide area wireless signal distribution.

Figure. 6. Ceiling-mounted switch for signal extension to isolated areas.

Figure. 7. Server room with air conditioning and external cable entry points.

Figure. 8. Front view of the server cabinet with powered access point on top.

Figure. 9. The Main Author beside antenna tower for network infrastructure inspection.

Figure. 10. The Main Author beside the server rack showing the scale of cabling setup.

Table 2 summarizes the functions and locations of the key devices deployed in the wireless network system.

Table 2: List of Network Devices and Locations in PPSDM Regional Yogyakarta

No	Device Type	Location/ Building	Function
1	Wireless Router (AP)	Server Room	Distribute wireless internet signal
2	Core Switch	Server Room Rack	Backbone switching between segments
3	Distribution Switch	Building corridors & ceilings	Signal distribution to access points
4	Antenna Tower	Courtyard near classrooms	Signal propagation support
5	Patch Panel + Cabling	Server Rack	Cable management and labeling

3.2. QoS Measurement Results

3.2.1. Packet Loss Analysis

Table 3 shows that packet loss values across all areas range from 0.1% to 0.4%, resulting in a TIPHON index of 4 (Excellent).

This indicates that the network is highly reliable in delivering data packets with minimal transmission failure. Such performance suggests that the physical infrastructure (cabling, switching, and routing) is functioning optimally. Additionally, low packet loss reflects stable link quality and minimal interference at the transmission layer.

Table 3: Packet Loss

Area	Loss (%)	TIPHON Index	Category
Training Area 1	0.1	4	Excellent
Administration	0.1	4	Excellent
Dormitory	0.4	4	Excellent

Average Index: 4 (Excellent). The wireless infrastructure is highly reliable in data delivery across all areas.

3.2.2. Throughput Analysis

Table 4 reveals significant variation in throughput across different areas. The Administration Area achieved 2,215 Kb/s (Index 4 – Excellent), while the Training Area and Dormitory recorded only 110 Kb/s and 220 Kb/s respectively (Index 1 – Poor).

This discrepancy is logically consistent with network usage patterns. The Training and Dormitory areas experience higher user density and concurrent connections, leading to bandwidth contention and reduced effective throughput. In contrast, the Administration Area has fewer simultaneous users and more controlled traffic, resulting in higher throughput.

These findings indicate that throughput degradation is primarily influenced by network congestion rather than infrastructure failure.

Table 4: Throughput

Area	Throughput (Kb/s)	TIPHON Index	Category
Training Area 1	110	1	Poor
Administration	2,215	4	Excellent
Dormitory	220	1	Poor

Average Index: 2 (Moderate). Throughput issues were observed in the Training and Dormitory areas, likely due to user congestion or interference.

3.2.3. Delay Analysis

Based on Table 5, delay values range between 2.4 ms and 10.6 ms, all categorized as Index 4 (Excellent).

This demonstrates that the network is capable of delivering low-latency communication, which is critical for real-time applications such as video conferencing and online training. The consistently low delay across all areas suggests efficient routing and minimal queuing delay within the network.

Table 5: Delay

Area	Delay (ms)	TIPHON Index	Category
Training Area 1	10.6	4	Excellent
Administration	2.4	4	Excellent
Dormitory	8.3	4	Excellent

Average Index: 4 (Excellent). The network shows minimal delay, supporting real-time applications efficiently.

3.2.4. Jitter Analysis

Table 6 shows jitter values between 2.4 ms and 10.7 ms, corresponding to Index 3 (Good).

Although jitter performance is acceptable, fluctuations are observed in high-usage areas such as the Training Area. This is likely caused by variable packet arrival times due to network congestion and shared bandwidth usage.

While not critical, this condition may affect real-time services such as VoIP or video streaming if not properly managed.

Table 6: Jitter

Area	Jitter (ms)	TIPHON Index	Category
Training Area 1	10.7	3	Good
Administration	2.4	3	Good
Dormitory	8.3	3	Good

Average Index: 3 (Good). Jitter is acceptable but could be further improved in high-usage zones.

3.3. Overall Quality of Service (QoS) Evaluation

The aggregated QoS index is calculated as follows:

Throughput: 2

Packet Loss: 4

Delay: 4

Jitter: 3

Overall QoS Score**:** *(13 / 16) × 100% = 81.25%* → Good Category

This places the network performance in the "Good" category according to TIPHON standards.

The result is consistent and valid, considering:

1. Strong infrastructure reliability (packet loss & delay excellent)
2. Moderate transmission stability (jitter good)
3. Bottleneck at bandwidth distribution (throughput moderate)

3.4. Discussion and Interpretation

The results indicate that the wireless network at PPSDM Regional Yogyakarta is structurally reliable but experiences performance imbalance across different zones.

The main issue lies in throughput**,** particularly in high-density areas. This suggests that:

1. Access point capacity is insufficient relative to user load
2. Channel interference may occur due to overlapping frequencies
3. Bandwidth allocation is not evenly distributed

From a network engineering perspective, this condition is typical in centralized WLAN architectures without adaptive load balancing.

The excellent delay and packet loss performance confirm that:

1. Core network devices (router, switch) operate efficiently
2. No significant transmission errors or routing inefficiencies exist

Meanwhile, jitter fluctuations reinforce the presence of traffic variability rather than hardware limitations.

Thus, the findings are coherent and aligned with real-world wireless network behavior, where congestion—not infrastructure failure—is the dominant factor affecting QoS.

3.5. Practical Implications

Based on the analysis, several technically grounded implications can be derived:

1. The network is ready for real-time applications, but optimization is needed for scalability
2. Throughput optimization should be prioritized, particularly in training and dormitory zones
3. The centralized topology should be enhanced with load balancing or segmentation mechanisms
4. Continuous NPM implementation proves effective for data-driven network management

3.6. Summary of Key Findings

1. Packet loss and delay indicate high network reliability
2. Jitter shows moderate variability under load conditions
3. Throughput is the main limiting factor, especially in high-density areas
4. Overall QoS (81.25%) is good but not optimal
5. Performance issues are usage-driven, not infrastructure-driven

IV. CONCLUSION AND RECOMMENDATION

4.1. Conclusion

This study has evaluated the Quality of Service (QoS) of the wireless network at PPSDM Regional Yogyakarta using the Network Performance Monitoring (NPM) method based on TIPHON standardization. The main findings indicate that packet loss and delay achieved excellent performance with index values of 4, demonstrating reliable data transmission and low latency suitable for real-time applications. Jitter was categorized as good with an index value of 3, indicating relatively stable transmission performance. However, throughput showed variability across different areas, with an overall index value of 2 (moderate), highlighting inconsistencies in network capacity distribution. Overall, the QoS level reached 81.25%, which falls into the "Good" category.

This research contributes by providing an empirical evaluation of wireless network performance using a systematic NPM-based approach integrated with TIPHON standards, offering a practical framework for QoS assessment in institutional environments. The findings also enrich the body of knowledge in network performance evaluation, particularly in the context of public service institutions.

The implications of this study suggest that while the network infrastructure is generally reliable, optimization is required in specific areas to ensure uniform service quality. The results can serve as a reference for network administrators in improving performance through targeted interventions such as throughput optimization and load balancing.

This study is limited by its focus on a single institutional environment and a specific set of QoS parameters. Additionally, the analysis is based on periodic monitoring data, which may not fully capture dynamic network behavior under all usage conditions.

Future research is recommended to include broader network environments, integrate additional performance indicators such as user experience (QoE), and apply advanced analytical techniques, including machine learning, to predict and optimize network performance more effectively.

4.2. Recommendations

Based on the research findings, several recommendations are proposed to enhance the wireless network performance at PPSDM Regional Yogyakarta:

1. Reconfigure and optimize Access Point (AP) placement and channel allocation, particularly in high-density areas such as training and dormitory zones.
2. Implement Quality of Service (QoS) policies on network devices to prioritize critical applications during peak usage.
3. Increase network capacity by upgrading bandwidth and adding additional APs in congested areas.
4. Conduct periodic audits of wireless infrastructure to detect signal interference, coverage gaps, and hardware degradation.
5. Maintain continuous monitoring using the NPM system to support proactive network management and data-driven decision-making.
6. Provide technical training for IT personnel to enhance their capability in managing and optimizing network performance using NPM tools.

By implementing these recommendations, PPSDM Regional Yogyakarta is expected to improve the reliability, scalability, and overall performance of its wireless network infrastructure.

V. Acknowledgement

The authors thank the staff of PPSDM Regional Yogyakarta for their support and assistance during the network performance monitoring research. The authors thanks the Study Program of Information Technology and LPPM at Universitas Proklamasi 45 for its valuable input and resources. The authors also express their gratitude to the technical team involved in the setup and documentation of the WLAN infrastructure.

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