Analysis of Wi-Fi Network Performance at Gading Pluit Hospital to Increase User Productivity Using QoS Method

Sadrak Malau[1], Albinur Limbong[2],
[1,2]Fakultas Teknologi Informasi, Universitas Advent Indonesia
e-mail: [1]2182026@unai.edu, [2*]albinur.limbong@unai.edu

Abstract

Wi-Fi network performance is critical in a healthcare environment in a hospital, where efficient communication and access to information are essential. This study analyzes the performance of a Wi-Fi network in Gading Pluit Hospital using the Quality of Service (QoS) method. The main focus of this study is the evaluation of QoS parameters such as delay, jitter, throughput, and packet loss to identify areas that need improvement in the network infrastructure. The test results show that throughput has a stable network and packet loss is at a very good level which supports network stability. Delay is mostly in the good to very good category, although there are fluctuations. However, jitter shows significant variability in some locations, indicating the need for further optimization, especially for time-sensitive applications such as voice or video communication.

Keywords: *Wi-Fi Network, Quality of Service, Network Performance*

Analisis Kinerja Jaringan Wi-Fi di RS Gading Pluit untuk Meningkatkan Produktivitas Pengguna Menggunakan metode QoS

Abstrak

Kinerja jaringan *Wi-Fi* sangat penting dalam lingkungan layanan kesehatan di rumah sakit, di mana komunikasi yang efisien dan akses ke informasi sangat penting. Penelitian ini menganalisis kinerja jaringan *Wi-Fi* di Rumah Sakit Gading Pluit menggunakan metode *Quality of Service (QoS)*. Fokus utama penelitian ini adalah evaluasi parameter QoS seperti *delay, jitter, throughput*, dan *packet loss* untuk mengidentifikasi area yang perlu ditingkatkan dalam infrastruktur jaringan. Hasil pengujian menunjukkan bahwa *throughput* memiliki jaringan stabil dan *packet loss* berada pada tingkat sangat baik dimana mendukung kestabilan jaringan. *Delay* sebagian besar berada dalam kategori baik hingga sangat baik, meskipun terdapat fluktuasi. Namun, *jitter* menunjukkan variabilitas signifikan di beberapa lokasi, yang mengindikasikan perlunya optimasi lebih lanjut, terutama untuk aplikasi sensitif waktu seperti komunikasi suara atau video.

Kata Kunci: Jaringan Wi-Fi, Quality of Service, Kinerja Jaringan

1. Introduction

Gading Pluit Hospital is located in Kelapa Gading, Jakarta. This hospital was inaugurated in 2005 and has always strived to become a leading and advanced hospital with the aim of making it easier for the public to access existing health facilities without having to go abroad. The Wi-Fi network at Gading Pluit Hospital is installed in strategic areas to support smooth operations, especially in the emergency room, waiting room, and staff workroom. This hospital strives to provide a fast and stable connection by using Wi-Fi 5 standard Access Points and 14 switches spread across all floors. Gading Pluit Hospital, one of the leading hospitals in Jakarta, also faces a major challenge in providing optimal Wi-Fi services for all its users, be it medical staff, employees, patients and families. The Internet is a technology that is now very important

in everyday life and has become a human need throughout the world [1]. The internet network also needs to have high speed to attract many users, especially in public places such as hospitals, airports, or schools. The purpose of using Wi-Fi at Gading Pluit Hospital is to access patient data accurately and precisely for medical staff, provide internet services for visitors and enable important hospital applications, such as the hospital management information system (SIMRS) to function smoothly.

According to [2], the success of a health service can be measured by its ability to provide satisfaction to patients, including those who are not hospitalized. Patient satisfaction does not only depend on the availability of facilities and infrastructure but also on the performance of nurses with a great sense of responsibility. The network in the hospital is very much needed for optimization in working so that hospital staff can work well too. Currently, many hospitals do not know how important it is to manage very large amounts of data that are not well structured so that it hinders the operational efficiency of hospital services [3]. This study has greater benefits than just measuring the technical performance of the network but will also discuss the broader impact on user productivity at Gading Pluit Hospital. Medical staff can access patient information faster, make the decision-making process faster in the clinic, and increase the efficiency of assistance with a strong Wi-Fi network.

This analysis aims to evaluate how well the Wi-Fi network at Gading Pluit Hospital can meet the needs of its users, especially in terms of speed, stability, and reliability. One of the most effective methods for this analysis is to use the QoS method. Quality of Service [4] is a method of measuring a network with several parameters to determine the quality of service from an internet connection so that it can run as expected. By using the QoS method, various parameters such as bandwidth, jitter, throughput, and packet loss can be measured and analyzed to provide a comprehensive picture of the current performance of the Gading Pluit Hospital Wi-Fi network.

2. Research Methods

Research Design

This study will use quantitative research methods with the aim of collecting data to be tested using Iperf, ping, and Command Prompt software to measure the quality of internet connection services at Gading Pluit Hospital. Quantitative research [5] is a research method that collects and analyzes data based on numbers and numerical measurements. The testing location will be at Gading Pluit Hospital. The research will be conducted in 2 days and in 3 places, namely in the administration room, IT staff office and waiting room at 09.00 to 14.00. This time is a busy period for the internet network at Gading Pluit Hospital.

Research Stages

To achieve the objectives of this research, the following are the steps that will be taken at this stage:

Figure 1 Research Stages

In this research stage, there is the following explanation:

A. Data Collection

At this stage, data will be collected by conducting direct observations in the field and collecting information related to the Wi-Fi network used at Gading Pluit Hospital. Data collection is important because it will guide readers to understand the research process properly [6]. This data is in the form of Wi-Fi network point locations, number of users and devices used. Gading Pluit Hospital has network data in three main areas, namely the ER, waiting room, and staff workroom. This

data will be obtained by measuring network performance in each area using test equipment, which includes QoS (Quality of Service) parameters such as throughput, delay, jitter, and packet loss. Gading Pluit Hospital also uses the Ruckus brand for access points, Switch uses the H3C brand, and Nutanix as a cloud data server. It has 83 bedrooms and 220 staff and doctors and the building consists of 7 floors where the ER and ICU rooms are on the 1st floor.

B. Determining QoS Parameters

Once the data has been collected, relevant QoS parameters will be determined as a basis for measuring the performance of the Wi-Fi network.

C. Performing QoS Testing

QoS testing will be done by measuring the performance of the Wi-Fi network in the administration room, IT staff room and waiting room. Each QoS parameter will be measured using special tools such as Iperf, ping and command prompt.

D. Classification of Test Results

The QoS test results will be classified based on applicable performance standards. Data from various areas will be grouped and analyzed to determine whether there are differences in performance between locations or times. This test is expected to obtain differences in values for delay, jitter, throughput, and packet loss analysis [7].

E. Conclusion

After everything is done, a conclusion will be drawn regarding the condition of the Wi-Fi network performance at Gading Pluit Hospital. This conclusion will include recommendations for improvement if any problems are found in network performance, as well as an evaluation of everything.

Quality of Service Parameters

Some Quality of Service (QoS) parameters are as follows:

A. Throughput

Throughput can be defined by the data transfer rate [8]. In addition, throughput can be defined as the total number of successful packet arrivals observed at a destination within a given time span.

B. Delay

Delay is the time required for data to move from sender to receiver [1]. This delay can be influenced by factors such as distance, type of transmission media, or relatively long processing duration [9].

Table 1 Delay Parameters [10]

Delay Category	Delay Size (ms)	Index
Very Good	<150	4
Good	150 ms s/d 300 ms	3
Medium	300 ms s/d 450 ms	2
Poor	>450 ms	1

C. Jitter

Jitter is a variation of delay between packets that occurs on an IP network. Queuing delays on routers and switches can cause jitter [8]. The jitter value depends on the variation of traffic load

and collisions between packets on the IP network, so that a larger jitter value is negatively correlated with QoS. The jitter categories are as follows:

Table 2 Jitter Parameters [10]

Jitter Category	Jitter Magnitude(ms)	Index
Very Good	<150	4
Good	150 ms s/d 300 ms	3
Medium	300 ms s/d 450 ms	2
Poor	>450 ms	1

D. Packet Loss

Packet Loss is [11] a parameter that describes the condition that shows the total number of lost packets. The failure of the packet to reach its destination. The Packet Loss value is very small when using an IP network [1]. The Packet Loss categories are as follows:

Table 3 Packet Loss Parameters [10]

Packet Loss Category	Packet Loss	Index
Very Good	0-2%	4
Good	3-14%	3
Medium	12-24%	2
Poor	>25%	1

Network Topology

The following is the network topology of Gading Pluit Hospital:

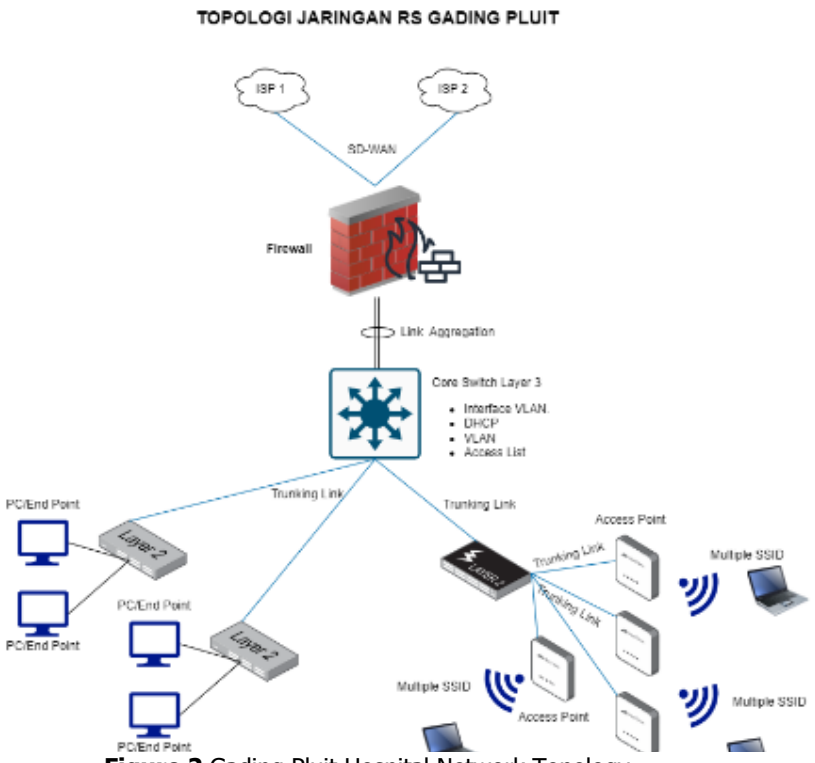

Figure 2 Gading Pluit Hospital Network Topology

In Figure 2, the Gading Pluit Hospital network topology combines two ISPs managed through SD-WAN to ensure network redundancy and efficiency. Network topology is [12] a way to connect multiple computers to create a computer network. A firewall is used to secure the network from external threats. This network uses a Layer 3 Core Switch that functions to manage VLAN, DHCP, and Access List, and uses Link Aggregation to increase network capacity. This core switch connects devices such as PC End Points through Layer 2 switches and Access Points that provide Wi-Fi networks with multiple SSIDs for users. Access points are connected via trunking links to ensure a wide and stable Wi-Fi network throughout the hospital. Gading Pluit Hospital has 30 rooms that get Access Points. With the support of Wi-Fi 5 standard Access Points and the distribution of 14 switches throughout the building floors, this hospital strives to meet the need for fast and stable connections to support users.

Software Used

Iperf

Iperf is an open-source software used to measure bandwidth in a network performance [13]. Bandwidth is a measure of the amount of information that can flow from one place to another in a certain time [14]. With Iperf, users will be able to send data over the network and measure the performance parameters of the network. Iperf will later be used in Command Prompt and later Iperf will be tested to find out the bandwidth and throughput at Gading Pluit Hospital.

The following are the commands that iperf uses to calculate throughput:

```
iperf -s
iperf -c [IP_SERVER] -t [TIME_TEST] -i [INTERVAL_REPORT]
```

This command will show the network throughput. Adjust the test time (-t) and report interval (-i) as needed. The -c command is a command to specify the client and destination ip address, -i is a result report interval in seconds.

The following are the commands that iperf uses to identify jitter, packet loss, and delay:

```
iperf -s
iperf -c [IP_SERVER] -u -b [BANDWIDTH] -t [TIME_TEST] -i [INTERVAL_REPORT]
```

To fulfill these three commands, you must use the -u command where -u is for UDP (User Datagram Protocol) mode, the -b command is the target bandwidth and -t is the test duration in seconds.

3. Results

This test is useful for determining the performance of an internet network service at Gading Pluit Hospital which will be carried out in 3 places, namely the administration room, IT staff room and waiting room of Gading Pluit Hospital and the server room is on the 4th floor next to the IT staff room. The devices used in this study were two laptops, each of which had a function as a client and server to run the process of measuring the network capabilities at Gading Pluit Hospital. The laptop acts as a client connected to the Wi-Fi network in the administration room, IT staff room, and waiting room at Gading Pluit Hospital so that it obtains an IP address as a client. While one laptop functions as a server which is connected to the network at the main test location to obtain the server IP address. The client IP address in the administration room is 10.34.0.16. The client IP address in the IT staff room is 10.34.0.8. While the client IP address in the waiting room is 10.34.0.24

QoS measurement results in the Administration Room

Iperf, Ping, and Command Prompt software were used to measure network QoS parameters. The study was conducted for 2 days and measurements were taken from 09:00 to 14:00 in the morning.

Jitter

The Jitter measurement results for everyone in the administration room are in accordance with the Jitter values obtained from the measurements above, which are used as the standard for the Jitter index when the clock is working.

Table 4 Jitter Of Administration Room

O'clock	Average Jitter (ms)	Category
09 : 00	0.511 ms	Poor
10 : 00	5.079 ms	Poor
11 : 00	0.338 ms	Medium
12 : 00	1.508 ms	Poor
13 : 00	0.967 ms	Poor
14 : 00	0.954 ms	Poor
O'clock	**Average Jitter (ms)**	**Category**
09 : 00	5.699 ms	Poor
10 : 00	3.295 ms	Poor
11 : 00	3.720 ms	Poor
12 : 00	6.016 ms	Poor
13 : 00	1.313 ms	Poor
14 : 00	4.677 ms	Poor

The results of the two-day jitter test show that the overall network quality is in the poor category, with the average jitter at most times exceeding the ideal tolerance limit for a stable network. On the first day, only one period (11:00) was in the moderate category with an average jitter of 0.338 ms, while the other times were in the poor category, including the highest value of 5,079 ms at 10:00. On the second day, all test times were in the poor category, with the highest value of 6,016 ms at 12:00.

Packet Loss Rate

Based on the results of measuring packet loss values on the network in the administration room, the average packet loss value was obtained as follows:

Table 5 Packet Loss Rate of Administration Room

O'clock	Average Packet Loss (%)	Category
09 : 00	0%	Very Good
10 : 00	0%	Very Good
11 : 00	0%	Very Good
12 : 00	0.2%	Very Good
13 : 00	0%	Very Good
14 : 00	0%	Very Good
O'clock	**Average Packet Loss (%)**	**Kategori**
09 : 00	0%	Very Good
10 : 00	0%	Very Good
11 : 00	0%	Very Good
12 : 00	0%	Very Good
13 : 00	0%	Very Good
14 : 00	0%	Very Good

The results of the two-day packet loss test showed very good network performance, with the average packet loss over the entire time period being in the Very Good category.

Throughput

Throughput testing is conducted to analyze the performance of Wi-Fi networks at a specific location using UDP and TCP protocols. Testing is conducted on two different days with an hourly interval starting from 09:00 to 14:00. The UDP protocol is used to measure data transfer speeds without error control, while the TCP protocol is used to measure transfer speeds with error control.

Table 6 Throughput of administration Room

O'clock	Throughput	
	UDP	TCP
09 : 00	993 Kbits/sec	72.2 Mbits/sec
10 : 00	36.9 Mbits/sec	22.9 Mbits/sec
11 : 00	9.91 Mbits/sec	35.4 Mbits/sec
12 : 00	9.90 Mbits/sec	35.7 Mbits/sec
13 : 00	9.92 Mbits/sec	73.1 Mbits/sec
14 : 00	9.91 Mbits/sec	73.1 Mbits/sec
O'clock	Throughput	
	UDP	TCP
09 : 00	9.90 Mbits/sec	17.7 Mbits/sec
10 : 00	9.91 Mbits/sec	11.4 Mbits/sec
11 : 00	1.05 Mbits/sec	14.6 Mbits/sec
12 : 00	9.91 Mbits/sec	10.1 Mbits/sec
13 : 00	9.92 Mbits/sec	14.9 Mbits/sec
14 : 00	9.91 Mbits/sec	17.4 Mbits/sec

Throughput test results show a difference in performance between the use of UDP and TCP protocols. On the first day, the average UDP throughput ranged from 9.90 to 993 Kbits/sec, while TCP throughput was higher, ranging from 22.9 to 73.1 Mbits/sec. On the second day, UDP throughput tended to be stable at around 9.90 Mbits/sec, while TCP throughput showed more significant variation, with the lowest value being 10.1 Mbits/sec and the highest being 17.7 Mbits/sec. This reflects the differences in effectiveness of the two protocols under different network conditions and the need for optimization to maintain consistent performance.

Delay

The ping command is used to calculate the delay value in the administrative room internet network scheme. This is done during peak hours and is affected by data transfer process time, distance, and network device media.

Table 7 Administration room delay performance

O'clock	Average Delay (ms)	Category
09 : 00	86ms	Very Good
10 : 00	97ms	Very Good
11 : 00	226ms	Medium
12 : 00	114ms	Very Good
13 : 00	77ms	Very Good
14 : 00	125ms	Very Good
O'clock	Average Delay (ms)	Kategori
09 : 00	9ms	Very Good
10 : 00	84ms	Very Good
11 : 00	70ms	Very Good
12 : 00	59ms	Very Good
13 : 00	60ms	Very Good
14 : 00	105ms	Very Good

The results of the two-day delay test showed very good network performance, with most of the time being in the Very Good category. On the first day, the average delay varied from 77 ms to 226 ms, with one period (11:00) falling in the moderate category (226 ms), while the other times remained in the very good category. On the second day, performance was more stable with all time periods being in the very good category, recording the lowest delay value of 9 ms at 09:00 and the highest of 105 ms at 14:00.

QoS measurement results in IT Staff Room

Iperf, Ping, and Command Prompt software were used to measure network QoS parameters. The study was conducted for 2 days and measurements were taken from 09:00 to 14:00 noon.

Jitter

The Jitter measurement results for everyone in the IT staff room are in accordance with the Jitter values obtained from the measurements above, which are used as the standard for the Jitter index during peak hours.

Table 8 IT Staff Room Jitter

O'clock	Average Jitter (ms)	Kategori
09 : 00	4.598 ms	Poor
10 : 00	64.279 ms	Poor
11 : 00	2.514 ms	Poor
12 : 00	3.115 ms	Poor
13 : 00	2.480 ms	Poor
14 : 00	5.825 ms	Poor
O'clock	**Average Jitter (ms)**	**Category**
09 : 00	7.124 ms	Poor
10 : 00	1.966 ms	Poor
11 : 00	1.664 ms	Poor
12 : 00	2.736 ms	Poor
13 : 00	2.228 ms	Poor
14 : 00	12.789 ms	Poor

The results of the jitter test over two days showed consistent network performance in the poor category, with the average jitter at all test times exceeding the ideal limit for a stable network. On the first day, the highest jitter was recorded at 64,279 ms at 10:00, while the lowest was 2,480 ms at 13:00. The second day showed similar results, with the highest jitter at 12,789 ms at 14:00 and the lowest 1,664 ms at 11:00.

Packet Loss Rate

From the results of measuring the packet loss value against the network in the IT Staff room, the average packet loss value is obtained as below.

Table 9 Packet Loss Rate of IT Staff Room

O'clock	Average Packet Loss (%)	Category
09 : 00	0%	Very Good
10 : 00	0%	Very Good
11 : 00	0%	Very Good
12 : 00	0%	Very Good
13 : 00	0%	Very Good
14 : 00	0%	Very Good
O'clock	**Average Packet Loss (%)**	**Kategori**
09 : 00	0%	Very Good
10 : 00	0%	Very Good
11 : 00	0%	Very Good
12 : 00	0%	Very Good
13 : 00	0%	Very Good
14 : 00	0%	Very Good

The results of the two-day packet loss test showed excellent network performance, with the entire test period recording a packet loss value of 0%, which is in the Very Good category.

Throughput

Throughput testing using UDP and TCP protocols was conducted to measure the performance of Wi-Fi networks at a specific location. UDP protocol is used to measure data transfer speed without error control, while TCP is used to measure transfer speed with error control. Testing was conducted for two consecutive days, at a time span of 09:00 to 14:00 with an interval of one hour

Table 10 IT Staff Room Throughput

O'clock	Throughput (bps)	
	UDP	TCP
09 : 00	9.92 Mbits/sec	9.12 Mbits/sec
10 : 00	6.89 Mbits/sec	2.20 Mbits/sec
11 : 00	9.94 Mbits/sec	16.3 Mbits/sec
12 : 00	9.91 Mbits/sec	22.6 Mbits/sec
13 : 00	1.05 Mbits/sec	6.28 Mbits/sec
14 : 00	9.91 Mbits/sec	9.43 Mbits/sec
O'clock	Throughput (bps)	
	UDP	TCP
09 : 00	9.92 Mbits/sec	25.3 Mbits/sec
10 : 00	9.92 Mbits/sec	24.6 Mbits/sec
11 : 00	1.05 Mbits/sec	25.6 Mbits/sec
12 : 00	9.90 Mbits/sec	18.7 Mbits/sec
13 : 00	9.90 Mbits/sec	24.1 Mbits/sec
14 : 00	9.91 Mbits/sec	21.3 Mbits/sec

The throughput test results show the performance differences between UDP and TCP protocols. On the first day, UDP throughput varied between 1.05 and 9.94 Mbits/sec, while TCP throughput showed a larger variation, from 2.20 to 22.6 Mbits/sec. On the second day, UDP throughput tended to be stable, ranging from 1.05 to 9.92 Mbits/sec, while TCP throughput was more consistently high, ranging from 18.7 to 25.6 Mbits/sec.

Delay

The ping command is used to calculate the delay value in the internet network scheme of the IT staff room. This is done during peak hours and is influenced by data transfer process time, distance, and network device media.

Table 11 Performance of IT Staff Room Delay

O'clock	Average Delay (ms)	Category
09 : 00	84ms	Very Good
10 : 00	378ms	Medium
11 : 00	280ms	Good
12 : 00	172ms	Good
13 : 00	197ms	Good
14 : 00	102ms	Very Good
O'clock	Average Delay (ms)	Category
09 : 00	183ms	Good
10 : 00	123ms	Very Good
11 : 00	180ms	Good
12 : 00	205ms	Good
13 : 00	236ms	Good
14 : 00	81ms	Very Good

The results of the two-day delay test show that most of the test time is in the good and very good category. On the first day, there was a significant fluctuation, with the highest delay recorded at 10:00 (378 ms), which is in the medium category, while other times recorded delays between 84 ms and 280 ms. On the second day, the delay quality tended to be more stable, with most of the time being in the good category and two periods (09:00 and 14:00) recorded as very good.

QoS measurement results in the Waiting Room

Iperf, Ping, and Command Prompt software were used to measure network QoS parameters. The study was conducted for 2 days and measurements were taken from 09:00 to 14:00 in the morning.

Jitter

The Jitter measurement results for everyone in the waiting room are in accordance with the Jitter values obtained from the measurements above, which are used as the standard for the Jitter index during peak hours.

Table 12 Waiting room Jitter

O'clock	Average Jitter (ms)	Category
09 : 00	0.272 ms	Good
10 : 00	1.014 ms	Poor
11 : 00	1.327 ms	Poor
12 : 00	1.764 ms	Poor
13 : 00	1.090 ms	Poor
14 : 00	0.402 ms	Medium
O'clock	**Average Jitter (ms)**	**Category**
09 : 00	3.636 ms	Poor
10 : 00	1.885 ms	Poor
11 : 00	1.813 ms	Poor
12 : 00	1.751 ms	Poor
13 : 00	3.265 ms	Poor
14 : 00	1.091 ms	Poor

The results of the jitter test over two days showed less stable network performance, with most of the test time falling in the poor category. On the first day, although there were some periods with low jitter, most of the time recorded higher jitter, reaching 1,764 ms at 12:00 and 1,090 ms at 13:00, which fell into the poor category. The second day showed similar results, with the highest jitter recorded at 09:00 (3,636 ms) and 13:00 (3,265 ms), both in the poor category.

Packet Loss Rate

From the results of measuring the packet loss value against the network in the waiting room, the average packet loss value is obtained as below.

Table 13 Packet Loss Rate of Waiting Room

O'clock	Average Packet Loss (%)	Category
09 : 00	0%	Very Good
10 : 00	0%	Very Good
11 : 00	0%	Very Good
12 : 00	0%	Very Good
13 : 00	0%	Very Good
14 : 00	0%	Very Good
O'clock	**Average Packet Loss (%)**	**Category**
09 : 00	0%	Very Good
10 : 00	0%	Very Good
11 : 00	0%	Very Good
12 : 00	0%	Very Good
13 : 00	0%	Very Good
14 : 00	0%	Very Good

The results of the two-day packet loss test showed excellent network performance, with 0% packet loss recorded across all tested time periods. All measurements on the first and second days were in the very good category.

Throughput

Throughput testing using UDP and TCP protocols is done to measure the performance of Wi-Fi networks at a specific location. UDP protocol is used to measure data transfer speed without error control, while TCP is used to measure transfer speed with error control. Testing is done for two consecutive days, at a time span of 09:00 to 14:00 with an interval of one hour.

Table 14 Waiting Room Throughput

O'clock	Throughput	
	UDP	TCP
09 : 00	9.92 Mbits/sec	2.83 Mbits/sec
10 : 00	95.3 Mbits/sec	37.1 Mbits/sec
11 : 00	9.92 Mbits/sec	30.0 Mbits/sec
12 : 00	9.92 Mbits/sec	33.6 Mbits/sec

13 : 00	9.91 Mbits/sec	84.4 Mbits/sec
14 : 00	9.92 Mbits/sec	82.5 Mbits/sec
O'clock	**Throughput (bps)**	
	UDP	**TCP**
09 : 00	1.05 Mbits/sec	112 Mbits/sec
10 : 00	9.92 Mbits/sec	17.1 Mbits/sec
11 : 00	1.05 Mbits/sec	39.6 Mbits/sec
12 : 00	9.90 Mbits/sec	16.2 Mbits/sec
13 : 00	9.92 Mbits/sec	122 Mbits/sec
14 : 00	9.90 Mbits/sec	65.5 Mbits/sec

Throughput test results show differences in performance between UDP and TCP protocols. On the first day, UDP throughput varied between 1.05 and 9.94 Mbits/sec, while TCP throughput showed greater variation, from 2.20 to 22.6 Mbits/sec. On the second day, UDP throughput tended to be stable, ranging from 1.05 to 9.92 Mbits/sec, while TCP throughput was more consistently high, ranging from 18.7 to 25.6 Mbits/sec. These results indicate the need for further evaluation to improve throughput stability, especially in the use of the UDP protocol in hospital networks.

Delay

The results of measuring the delay value of the internet network scheme in the waiting room are measured using the ping command. This is done during peak hours and is influenced by distance, network device media, and data transfer process time.

Table 15 Waiting Room Delay Performance

O'clock	Average Delay (ms)	Category
09 : 00	46ms	Very Good
10 : 00	149ms	Very Good
11 : 00	59ms	Very Good
12 : 00	45ms	Very Good
13 : 00	67ms	Very Good
14 : 00	141ms	Very Good
O'clock	**Average Delay (ms)**	**Category**
09 : 00	76ms	Very Good
10 : 00	49ms	Very Good
11 : 00	62ms	Very Good
12 : 00	53ms	Very Good
13 : 00	98ms	Very Good
14 : 00	63ms	Very Good

The results of the two-day delay test showed very good network performance with an index of 4 throughout the test period. On the first day, the average delay varied between 45ms to 149ms, with most of the time being in the very good category. The second day also showed consistent results with an average delay between 49ms to 98ms, still in the very good category.

4. Discussion/Conclusion

Based on the information collected from the Quality of Service analysis in the administration room, IT staff room, and waiting room of Gading Pluit Hospital, the following conclusions can be drawn. The results of this study analyze the performance of the Wi-Fi network at Gading Pluit Hospital using the main parameters of throughput, delay, jitter, and packet loss to evaluate network quality. The test results show that the performance of the Wi-Fi network varies by time and location, with quite significant fluctuations at certain hours. The measured delay and jitter tend to be in the good category, although at some times there is a decrease, which has the potential to affect the user experience. On the other hand, packet loss is recorded as low, indicating the stability of data delivery even though there is a decrease in throughput at certain hours. Through throughput testing using the UDP and TCP protocols, differences in performance were found between the two protocols, with TCP showing higher values but tending to be more volatile than UDP. Overall, although the Wi-Fi network at Gading Pluit Hospital can be categorized as a network

that has quite good performance, there are several areas that need to be improved, especially related to throughput and delay consistency, to improve the quality of service at the hospital.

Based on the results of the two-day research analysis, the addition of access points at strategic points, such as the waiting room and certain areas in the emergency room, needs to be done to improve network quality in areas that show less than optimal performance. In addition, reconfiguring the network is needed to ensure more even signal distribution and reduce interference between devices. Further research can include real-time bandwidth usage analysis and device testing with the latest Wi-Fi standards, such as Wi-Fi 6, to evaluate improvements in network performance in supporting increasingly complex hospital service needs. Studies on network security aspects can also be a concern for future research.

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