

Analysis The Impact of Enclosing Various Materials on The Strength of Wifi Signal Reception

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ABSTRACT

Installation Wi-Fi is sometimes hindered by obstacles such as wood, concrete, and glass. The presence of these materials may affect the signal strength received by the user. Therefore, research was carried out by enclosing router using PVC, acrylic and glass materials with a thickness of 2mm, 3mm and 5mm and a distance of 2m, 4m, 6m, 8m, 10m, 12m, 10.2m and 11.4m for RSSI measurements and Quality of Service at a distance of 12m and 11.4m in the morning, afternoon and evening. The measurement results show a decrease in RSSI depending on the obstacle and distance. This is because the signal experiences diffraction and reflection which causes the signal strength to weaken and the farther the distance the weaker the signal. Measurements at the moment non-line of sight has quite poor results, especially when the glass barrier with a thickness of 5mm is at a distance of 11.4 with an average RSSI value of 74.6 dBm. QoS parameter results show Throughput When video streaming all have a bad category due to low number of packets. Parameter Packet Loss all of them are in a very good category, showing the least missing packets. Parameter Latency all of them have a very good category though Throughput low, influenced by the number of incoming packets. Parameter Jitter good with 2mm and 3mm barriers, while 5mm in the afternoon is moderate, influenced by Latency.

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1. INTRODUCTION

The use of the internet has now become a thing fundamental for all of us. In our daily activities, we use the internet at least for work, study or just for entertainment. The need for large, fast internet and users to be able to move freely without cables has made this Wireless Fidelity (Wi-Fi) is a solution to this problem.

Installation Wi-Fi which is placed according to the wishes of the installer sometimes the signal is strong Wi-Fi less than the maximum caused by one of them obstacles or materials around the installation Wi-Fi which could weaken the network or signal Wi-Fi. In general, obstacles are a fundamental problem in the world of internet networks, where obstacles are very disturbing in the transfer of signal frequencies with various constituent materials. Obstacles which are often encountered are wood, concrete walls, ceramic walls, glass and magnetic fields around Wi-Fi that are installed.

Differences in ingredients around Wi-Fi may affect the quality of the received signal. This inhibiting the process of exchanging data which can result in disruption of user activity. Based on this, a signal quality measurement is carried out which includes the signal strength of the signal Wi-Fi transmitted by the device Wi-Fi to determine the quality of the signal received by user.

Several similar related studies that have been used as constituents or supporting materials in this study. In research conducted by Nova Argita Damayanti in 2022 with the title "Analysis of Quality of Service on the Iconnet Network Using the Wireshark Application" this discusses comparing the quality of data transfer speeds in Iconnet packages when making Video Calls and playing Online Games using the Wireshark application. [1].

Research conducted by Apriadi Robianto in 2021 with the title "Analysis of IndiHome Network Quality with the Wireshark Application for Video Calls and Online Games" discusses this research discussing the

analysis of IndiHome network quality with Quality of Service parameters. From all the recapitulation of the quality of the data transfer speed on the 10 Mbps, 20 Mbps and 50 Mbps packages [2].

Research conducted by M. Hanafi in 2019 with the title "Simulation Analysis of the Effect of Wifi Signal Strength Test from Obstacle Materials" aims to determine the effect of the wifi signal strength test on obstacle materials. The results obtained are that there is a reduction in the strengthening of the Wifi signal if there is a barrier, and each barrier has a different effect on the strength of the Wifi signal [3].

Research conducted by Aishah Garnis in 2017 with the title "Assessment of Signal Quality and Position Wifi Access Point with the RSSI Method in the Sriwijaya State Polytechnic KPA Building" The purpose of the research is to provide a solution in determining the distance position of the access point in a room or building. The final result of this study is that the RSSI value is obtained from the calculation results and to obtain a signal quality value from a distance of 1 meter [4].

Research conducted by Sasa Ani Arnomo in 2014 with the title "Analysis Quality of Signal Wifi(QWS) On Network Hotspot RT/RW Based on Obstacle Type and Location" This study aims to determine the QWS on the RT/RW network based on the type of obstruction and location. As a result, it was found that the effect of distance and obstacles on the quality of the hotspot signal received by the user [5].

Of the five studies above, the difference from previous research and this research lies in the variation of materials, thickness and distances measured for data collection. In this study it is expected to know the difference in signal strength received before and when it is closed using a barrier and with varying distances.

2. Theoretical Basis

2.1 Internet

The internet (interconnection-networking) is a network system that connects each computer globally in all corners of the world. The connection that connects each of these computers has a standard that is used which is called the Internet Protocol Suite, abbreviated as TCP/IP. Computers connected to the internet will have the ability to exchange data very quickly [6].

2.2 WiFi

WiFi (Wireless Fidelity) is a communication technology that works on devices and local networks without wires (wireless), only with the appropriate components can be connected to the network. Wi-Fi technology has standards set by an international institution that issues standards to regulate wireless data communications called the Institute of Electrical and Electronic Engineers (IEEE). An access point is a network device that contains a transceiver and antenna for transmitting and receiving signals to and from remote clients. With Access Point allows wireless devices to connect to the network [7].

2.3 Quality of Service

Quality of Service (QoS) is a service performance that can determine the level of user satisfaction in a service. The influence of service performance can determine user satisfaction. Quality of Service (QoS) is also the ability of a network to provide the best service by analyzing the value of throughput, packet loss and delay [8]. Telecommunications and Internet Protocol Harmonization Over Networks (TIPHON) will contribute to the overall QoS ranking of end-to-end quality to achieve the best rating for the system [10].

2.4 Throughput

Throughput is a measure of the effective speed of data transfer sent over the network in bits per second (bps). Throughput is also a data packet that has been successfully observed in a certain time interval [11].

2.5 Packet Loss

Packet Loss is a QoS parameter that shows a total number of packets lost or not reaching the destination, due to overload or congestion on the network. In a network, packet loss is required to have a small percentage according to standards [12].

2.6 Latency

Latency is the total delay time of a packet during the process of sending a packet from one point to another that is the destination [13].

2.7 Jitter

Jitter or Packet Arrival Variation this is caused by variations in queue length, in data processing time, and also in the time of reassembling packets at the end of the jitter trip. Jitter is commonly called delay variation,

closely related to latency, which indicates the amount of delay variation in data transmission on the network [14].

2.8 Signal Sstrength

Signal quality determines reliability whether or not a WiFi, meaning that the stronger the signal, the better and reliable connectivity. The signal strength emitted by the Wi-Fi device or an Access Point is strongly influenced by the infrastructure that builds the access point [15].

Table 1. Measurement RSSI

Strength Signal(dBm)	Category
>-60	Excellent
-60 s/d -70	Good
-71 s/d -80	Bad Enough
-81 s/d -90	Bad
<-90	Worst

Source: Firdaus (2012)

3. METHOD

This research begins with determining data variables, the process of making tools, testing tools, collecting and analyzing data, and ends with writing a thesis.

Tool design and research was carried out at the Telecommunications Laboratory, Faculty of Engineering, Tanjungpura University. The reason for the researcher to choose this place is to speed up the work process of the final project.

3.1 Location

This research will be conducted at the Untan Faculty of Engineering Telecommunications Laboratory which uses a Wi-Fi network in Pontianak City. Research will be with the provisions that have been planned.

3.2 Tools and Materials

3.2.1 Tools

In general, this research will use the following tools.

1. Hardware:

- Laptop
- Mobile
- Router TP-LINK TD-W8961N

2. Software:

- Network Signal Info application
- Wireshark application

3.2.2 Materials

3 materials are used which will be made into a box, as for the materials are glass, acrylic and PVC board.

3.3 Research methods

- Study Literature

A literature study was carried out by looking for supporting theories regarding Wi-Fi networks and calculations to find QoS parameter values when streaming video when the Wi-Fi router is closed (enclosing).

- Data collection

Data retrieval is carried out simply by connecting the Wi-Fi network to a mobile phone with the provision that the Wi-Fi router will be closed using a box made of glass, acrylic and PVC board with a diameter of 30x30x30cm so that the box can cover the entire router and the variable thickness is 2mm, 3mm, and 5mm. Data is taken once for each RSSI data sample, monitoring is carried out for 1 minute so that the recorded signal is stable, and measurements for each different material and thickness are carried out at a distance of 2m, 4m, 6m, 8m, 10m, 12m, 10.2m, and 11.4m. While the data sample taken from the QoS parameter is by doing video streaming use Youtube with video entitled "The Adams – Timur" 1024p quality using the application Wireshark with a monitoring time of 5 minutes for each material and thickness and with a distance of 12 meters and 11.4 meters.

- Observation

Analysis The Impact of Enclosing Various Materials on The Strength of Wifi Signal Reception
(Adil Nurhaqqi Rizki Akbar Rabbani)

Observing the difference in signal strength received by the user and observing the packets recorded by the Wireshark application with the appropriate standards according to TIPHON.

- Measurement and data processing
Analyze the data that has been observed in full according to the theory used with the results obtained. Then take measurements with the Wireshark application through monitoring network speed changes in the form of data read by the Wireshark application, after that look for values according to the formula in the Quality of Service (QoS) standard. Then evaluate the data for each data obtained.
- The calculation data is obtained based on the measurement data obtained.
Perform complete data calculations on RSSI and QoS parameters. Then an analysis is carried out to evaluate the data obtained whether the QoS data obtained is in accordance with TIPHON standards or not.
- Determine the conclusion of the calculations that have been done.

3.4 Research Steps

The research flow chart used can be seen in the following figure. The following are the steps in conducting research.

- First, what is done is to measure the RSSI at the timer outer Wi-Fi not closed (enclosing) using the app Network Signal Info with monitoring time for 1 minute with a predetermined distance.
- Then, repeat measurements with the conditions router Wi-Fi which has been closed (enclosing) using various materials and thicknesses alternately with a predetermined distance.
- After the RSSI measurement, continue to look for parameters throughput, packet loss, latency and jitter by doing video streaming, monitoring time for 5 minutes, measurements using the application Wireshark. Measurements were taken in the morning, afternoon and evening with a distance of 12 meters and 11.4 meters.
- After completing monitoring with materials with different thicknesses, distances and times, the author will carry out calculations to compare with the data that has been recorded.
- An analysis of the results of measurements that have been carried out is carried out.
- Then write conclusions and suggestions for each increase and decrease signals that occurred during the close router Wi-Fi with different materials.

The following is a flow chart of the research steps to be carried out:

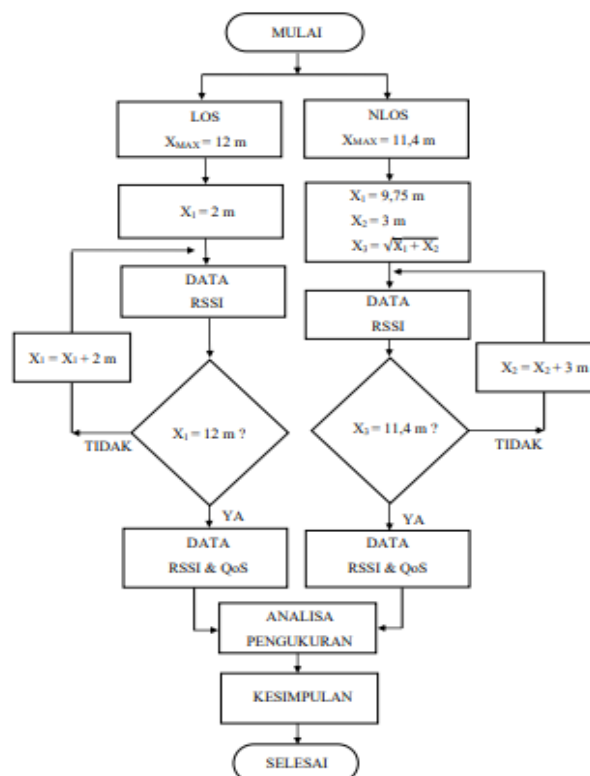


Figure 1. Specifically Research Flowchart

4. RESULT AND DISCUSSION

In this final project research, data measurements were carried out at the Telecommunications Laboratory of the Untan Faculty of Engineering to look for the influence of Wi-Fi reception signal strength and Quality of Service when the router is covered with PVC, acrylic and glass with a thickness of 2mm, 3mm and 5mm.

Data measurement for signal strength is carried out by Line of Sight with distances of 2 m, 4 m, 6 m, 8 m, 10 m, 12 m and Non Line of Sight with distances of 10.2 m and 11.4 m, while QoS measurements only carried out at 12 meters for the Line of Sight and 11.4 meters for the Non Line of Sight. Measurements start from the router without being given a barrier followed by being given a barrier by PVC boxes, acrylic boxes and glass boxes. Data measurements for RSSI were carried out 5 times for each material thickness and distance, for QoS measurements were carried out 1 time each in the morning, afternoon and evening for each material thickness and distance.

4.1. RSSI Analysis

From the results of measurements that have been carried out using the Network Signal Info application, the results are obtained and can be analyzed with the provision that if the measurement result is less than -60 dBm it means the signal strength is very good, the measurement result -61 dBm to -70 dBm it means the signal strength is good, the measurement result -71 dBm to -80 dBm means the signal strength is quite bad, a measurement result of -81 dBm to -90 dBm means the signal strength is bad, a measurement result of more than -91 means the signal strength is very bad.

4.1.1 Measurement Line of Sight

A. Comparison Between Materials

Figure 2 is a graph of the measurements taken before and while the router was covered by various barrier materials.

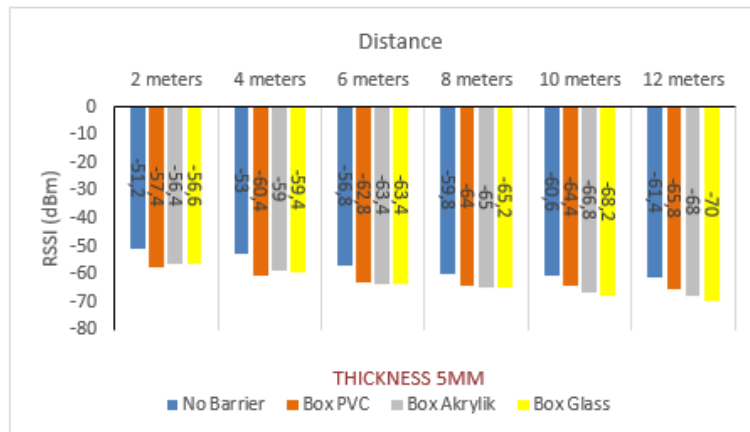
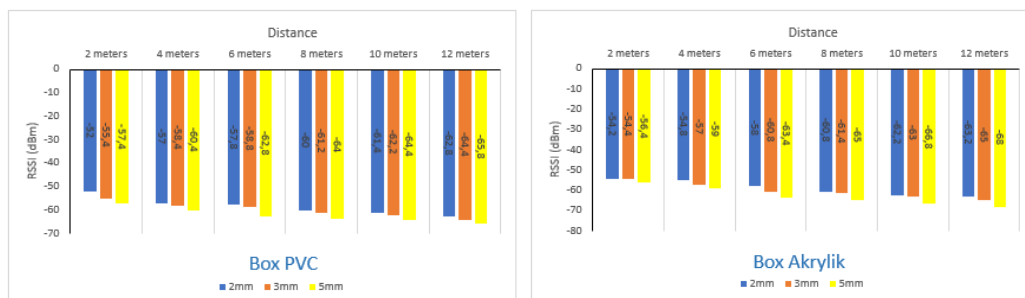


Figure 2. Material Comparison 5mm Thickness

Each obstacle causes a different decrease in Wi-Fi signal strength. PVC box barrier caused -6.2 to -7.4 dBm of drop, acrylic box barrier -5.2 to -6.6 dBm, and glass case barrier -5.4 to -9.4 drop dBm. The phenomena of diffraction and reflection from obstacles cause the signal to experience deflection and reflection, so that the signal strength decreases. In addition, interference from signals around the router also contributes to weakening the Wi-Fi signal strength. The measurement distance also affects the signal strength, the farther the distance from the router, the weaker the received signal strength.

B. Comparison Between Thickness

Furthermore, the results of the comparison between thicknesses with the same material are poured into a graph as shown in Figure 3.



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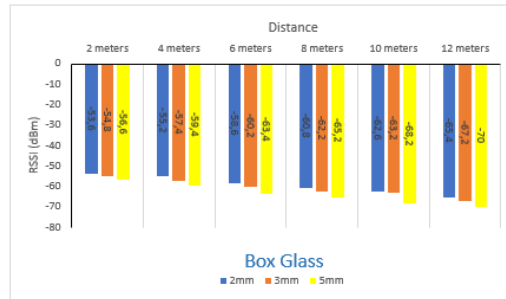


Figure 3. Comparison of the Thickness of Each Material

At a distance of 2 meters, a PVC barrier with a thickness of 2mm causes a signal drop of -1.8 dBm, a thickness of 3mm causes a signal drop of -3.4 dBm, and a thickness of 5mm causes a signal drop of -5.4 dBm. The phenomena of diffraction and reflection from obstructions also play a role in weakening the Wi-Fi signal strength. Interference from signals around the router also contributes to a decrease in signal strength.

At a distance of 2 meters with an obstacle of 2mm thick acrylic box, the Wi-Fi signal strength is -54.2 dBm which means very good. The use of a 3mm thickness acrylic box barrier resulted in a decrease in signal strength to -54.4 dBm (very good). The 5mm thick acrylic box barrier causes a drop in signal strength to -56.4 dBm (very good). Measurements at a distance of 4 meters to 12 meters also show a pattern of decreasing Wi-Fi signal strength with the use of acrylic box barriers with different thicknesses. The thicker the thickness of the barrier, the greater the signal attenuation and causes a decrease in the strength of the Wi-Fi signal.

At a distance of 2 meters with a 2mm thick glass box obstacle, the Wi-Fi signal strength is -53.6 dBm which means very good. The use of a 3mm thickness glass case barrier resulted in a decrease in signal strength to -54.8 dBm (very good). The 5mm thick glass case barrier causes a drop in signal strength to -56.6 dBm (very good). Measurements at a distance of 4 meters to 12 meters also show a pattern of decreasing Wi-Fi signal strength with the use of glass blocks with different thicknesses.

4.1.2 Measurement Non Line of Sight

A. Comparison Between Materials

The measurement results were found under NLOS conditions, Figure 4 shows the results of measuring the Wi-Fi signal strength at a distance of 10.2 meters and 11.4 meters with a router without obstructions and with PVC boxes, acrylic boxes, and glass boxes as barriers.

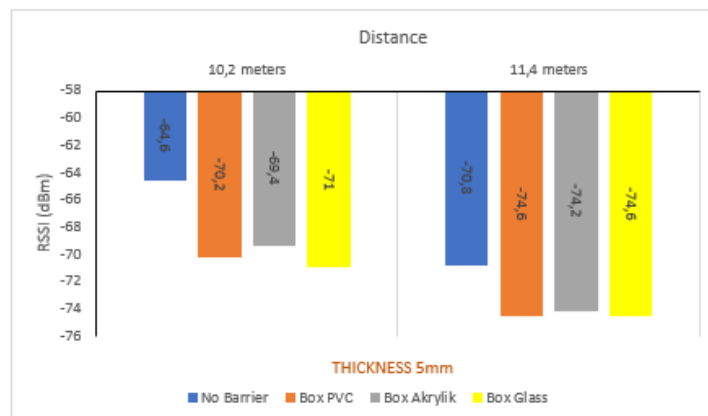


Figure 4. Material Comparison 5mm Thickness

Each obstacle causes a different decrease in Wi-Fi signal strength. The PVC box barrier caused a -4.4 dBm drop, the acrylic box barrier caused -4.8 dBm drop, and the glass box barrier caused -4.4 dBm drop. The phenomena of diffraction and reflection from obstacles cause the signal to experience deflection and reflection, so that the signal strength decreases. In addition, interference from signals around the router also contributes

to weakening the Wi-Fi signal strength. The measurement distance also affects the signal strength, the farther the distance from the router, the weaker the received signal strength.

B. Comparison Between Different Thicknesses

Figure 5 shows the results of measuring the Wi-Fi signal strength at a distance of 10.2 meters and 11.4 meters with 2mm, 3mm and 5mm thick PVC barriers.

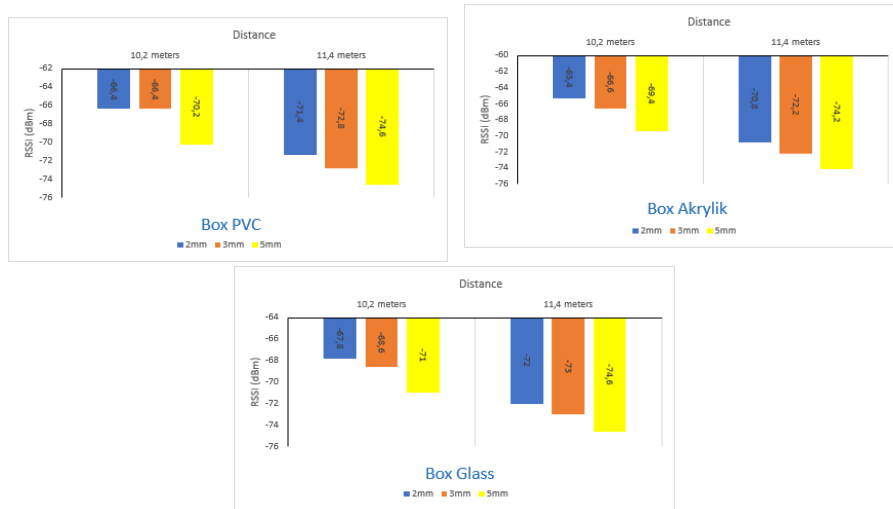


Figure 5. Comparison of the thickness of each material

At a distance of 10.2 meters the 2mm thickness PVC barrier produces a signal strength of -66.4 dBm (good). The 3mm thickness PVC barrier at the same distance did not change, remaining at -66.4 dBm (good). A 5mm thick PVC barrier at a distance of 10.2 meters resulted in a drop in signal strength to -70.2 dBm (good). At a distance of 11.4 meters, a 2mm thickness PVC barrier causes the signal strength to be -71.4 dBm (pretty bad). The 3mm thick PVC barrier at that distance resulted in a drop in signal strength to -72.8 dBm (bad enough). A 5mm thick PVC barrier at a distance of 11.4 meters causes a drop in signal strength to -74.6 dBm (quite bad).

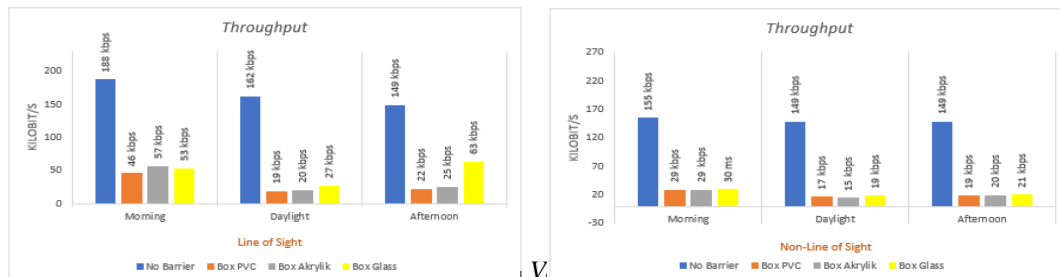
At a distance of 10.2 meters, the 2mm thickness acrylic barrier produces a signal strength of -65.4 dBm (good). The 3mm thickness acrylic barrier at that distance decreased the signal strength to -66.6 dBm (good). The 5mm thickness acrylic barrier at that distance decreased the signal strength to -69.4 dBm (good). At a distance of 11.4 meters, the 2mm thickness acrylic barrier produces a signal strength of -70.8 dBm (good). The 3mm thick acrylic barrier at that distance dropped the signal strength to -72.2 dBm (quite bad). The 5mm thick acrylic barrier at that distance dropped the signal strength to -74.2 dBm (quite bad).

At a distance of 10.2 meters, the 2mm thickness glass barrier produces a signal strength of -67.8 dBm (good). The 3mm thick glass barrier at that distance decreased the signal strength to -68.6 dBm (good). The 5mm thick glass barrier at that distance dropped the signal strength to -71 dBm (quite bad). At 11.4 meters, a 2mm thick glass barrier resulted in a signal strength of -72 dBm (pretty bad). The 3mm thick glass barrier at that distance dropped the signal strength to -73 dBm (quite bad). The 5mm thick glass barrier at that distance dropped the signal strength to -74.6 dBm (quite bad).

4.2 Analysis Quality of Service

1. Throughput

This study measured throughput in the morning, afternoon, and evening with no obstructions and using PVC, acrylic, and glass boxes as barriers. The measurement results show an increase and decrease in throughput values at various measurement times, both with and without obstructions.



Reception
(Adil Nurhaqqi Rizki Akbar Rabbani)

Figure 6. Parameter Throughput 5mm Thickness Barrier

The lowest value is found when measuring Non Line of Sight conditions with a PVC box barrier with a value of -15 kbps. The lowest value is found when measuring Non Line of Sight conditions with an acrylic box barrier with a value of -19 kbps.

2. Packet Loss

This study measured packet loss in the morning, afternoon and evening without any barriers and using PVC, acrylic and glass boxes as barriers. The measurement results show that the value of packet loss at all measurement times and with various obstructions is at a very low number, even reaching 0%.

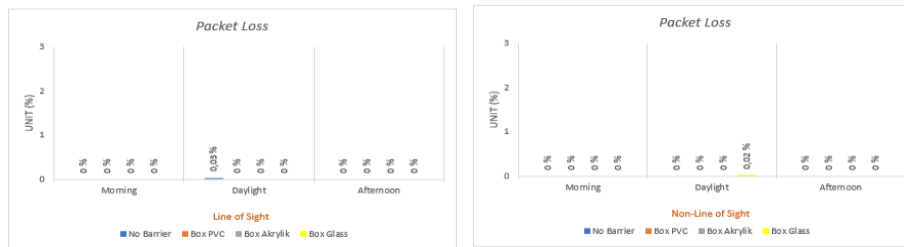


Figure 7. Parameter Packet Loss 5mm Thickness Barrier

All packet loss measurements in the morning, afternoon and evening as well as with various obstructions have an index value of 4 or fall into the very good category based on the TIPHON standard.

The quality of the Wi-Fi signal measured based on the packet loss parameter in this study was classified as very good at various measurement times and when there were barriers made of PVC, acrylic and glass boxes. This shows that data transmission is going very well and almost no data packets are lost during measurements.

3. Latency

This study measured latency in the morning, afternoon, and evening with no obstructions and using PVC, acrylic, and glass boxes as barriers. The measurement results show that the latency value at all measurement times and with various obstacles is at a very low number and is in a very good category based on the TIPHON standard.

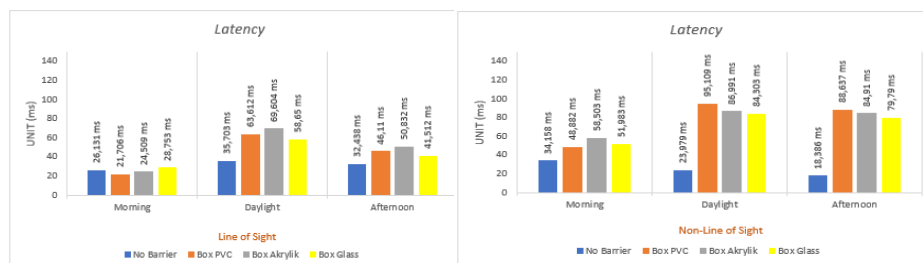


Figure 8. Parameter Latency 5mm Thickness Barrier

There is an increase and decrease in latency values for several measurements, which are affected by different throughput at each measurement time. The highest value of latency in the Line of Sight condition was during daylight with an acrylic box barrier with a value of 69.604 ms, while the highest value was in the Non Line of Sight condition during daylight with a PVC box barrier with a value of 95.109 ms.

4. Jitter

This study measured jitter in the morning, afternoon, and evening with no obstructions and using PVC, acrylic, and glass boxes as barriers. The measurement results show that the jitter value at all measurement times and with various obstructions is in a good category based on the TIPHON standard with a value index of 3

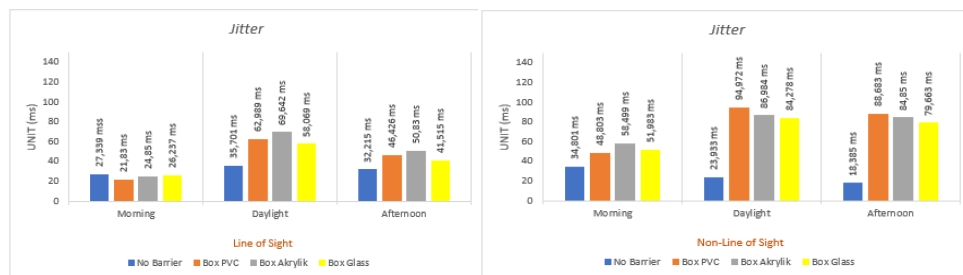


Figure 9. Parameter Jitter 5mm Thickness Barrier

There is an increase and decrease in latency values for several measurements, which are affected by different throughput at each measurement time. The highest value of latency in the Line of Sight condition was during daylight with an acrylic box barrier with a value of 69.642 ms, while the highest value was in the Non Line of Sight condition during daylight with a PVC box barrier with a value of 95.972 ms.

5. CONCLUSION

From the results of the research that has been done, it can be concluded 1) If viewed from the type of material, for conditions line of sight when measuring distances of 2 meters and 4 meters with a PVC box barrier the results are -57.4 dBm and -60.4 dBm, with an acrylic box barrier the results are -56.4 dBm and -59 dBm, and with a glass box barrier the results are -56.6 dBm and -59.4 dBm. While measuring a distance of 6 meters with a PVC box barrier it has a result of -62.8 dBm, an acrylic box barrier has a result of -63.4 dBm, and a glass box barrier has a result of -63.4 dBm. Furthermore, at subsequent distances, it experiences a steady decline, such as at a distance of 6 meters. So in general it can be concluded that the sequence of signal attenuation materials starting from strongest to weakest is as follows: 1. Glass Box 2. Acrylic Box 3. PVC Box. 2) For conditions non line of sight at a distance of 10.2 meters with a PVC box barrier has a result of -66.4 dBm, an acrylic box barrier has a result of -65.4 dBm, and a glass box barrier has a result of -67.8 dBm. Furthermore, at a distance of 11.4 meters, the PVC box barrier resulted in -71.4 dBm, the acrylic box barrier resulted -70.8 dBm, and the glass box barrier resulted in -72 dBm. So, in general it can be concluded that the material sequence of signal attenuation starts from the strongest to the weakest as follows: 1. Glass Box 2. PVC Box 3. Acrylic Box. 3) When viewed from the thickness of the material, the results of measuring a distance of 2 meters with a 2mm thick PVC box barrier resulted in -52 dBm, decreased -3.4 dBm to -55.4 dBm when replaced with 3mm thickness and again decreased -2 dBm to -57.4 dBm when switched 5mm thick and sustained like this at different distances. This also applies when using acrylic box barriers and glass boxes. From this, in general, the thickness is directly proportional to the attenuation ability. 4) When viewed from the distance, in general, it can be concluded that the distance is directly proportional to the decrease in signal strength. 5) Parameter results Throughput in the morning, afternoon and evening when doing Video Streaming good moment router without barriers or with barriers all have a bad category, this is because the total arrival of packets that are measured is not much so that the speed (rate) low measurable effective data transfer. 6) High and low scores Throughput caused by the number of packet arrivals measured during the observation process has an effect on speed (rate) measurable effective data transfer. Another thing that can affect the high and low scores Throughput is the existence of a barrier that blocks the signal to weaken the signal and the number user connected to router. 7) All parameter results Packet Loss in the morning, afternoon and evening by doing Video Streaming good moment router without a barrier or given a barrier has a very good category. This means that the percentage of lost packets is not too large. 8) All parameter results Latency in the morning, afternoon and evening by doing Video Streaming good moment router without a barrier or given a barrier has a very good category even though it has value Throughput low but offset by the number of packets that arrive during the measurement time interval. 9) Parameter results Jitter in the morning by doing Video Streaming good moment router without hindrance or barrier. While in the afternoon and evening it has a moderate category. This is due to high and low values Jitter influenced by value Latency. 10) Conditions surrounding the measurement (amount user, access point nearby) and weather conditions can cause a decrease in signal quality.

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*Analysis The Impact of Enclosing Various Materials on The Strength of Wifi Signal Reception
(Adil Nurhaqqi Rizki Akbar Rabbani)*

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