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Factors Distance and Number of Users on WiFi Network Signal Quality

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Abstract: The influence of distance and number of users on the quality of WiFi network signals is a scientific article with the aim of analyzing whether signal quality is affected by distance and the number of WiFi network users. Qualitative method with a phenomenological approach, The phenomenological approach emphasizes the description of the subject's life experience from the participant's own perspective (phenomenology as a social research method). The results of this article are: 1) Distance affects the quality of WiFi network signals, 2) The number of users affects the quality of WiFi network signals. Apart from these 2 exogenous variables that affect the endogenous variable of signal quality, there are many other factors including network performance, communication barriers, connection stability.

Keywords: Distance, Number of Users, Signal Quality, WiFi Network.

INTRODUCTION

The development of wireless communication technology has brought significant changes to human activities, particularly in the use of Wireless Fidelity (WiFi) networks to support internet connectivity in various environments such as offices, educational institutions, and public spaces. WiFi has become a primary choice due to its ease of installation and flexibility in device usage. However, the increasing number of simultaneously connected users and the varying distance between user devices and access points (APs) often lead to a decline in signal quality and network performance. These factors impact connection stability, data transfer speed, and the overall user experience (Satwika & Sukafona, 2022).

Technically, WiFi signal quality is significantly affected by the distance between the user and the AP. The greater the distance between the user, the greater the attenuation (path loss) experienced by the signal, especially at the 2.4 GHz frequency, which is commonly used in indoor environments. Research conducted by Prasetyo and Tan (2021) shows that physical obstacles such as glass walls and increasing distance significantly reduce Received Signal Strength Indicator (RSSI) values and network throughput. Similar results were also found by Ardiansyah et al. (2023) in a Wireless Site Survey study at Telkom University, which showed that signal strength gradually decreases with increasing distance from the transmitter point, thus directly impacting user performance and service quality.

In addition to distance, the number of simultaneously connected users also affects WiFi network performance. The more devices actively using the network, the higher the channel contention rate and the potential for data collisions during transmission. This results in a decrease in average throughput per user and increased latency. Research by Nova Selvia et al. (2022) at Mitra Jambi Hospital showed that increasing the number of devices connected to a single AP leads to a decrease in Quality of Service (QoS) parameters, such as throughput, delay, and jitter. This finding aligns with research published in Litek Journal (2023), which explains that WiFi network performance is highly dependent on user load and operational distance.

Based on previous studies, it can be concluded that distance and number of users significantly influence WiFi network signal quality, both in terms of signal strength and network performance. However, most research in Indonesia still examines these two variables separately. Therefore, this study aims to simultaneously analyze the effect of user distance and number of users on WiFi network signal quality in indoor environments. The results are expected to serve as a reference in WiFi network planning and optimization, particularly in determining access point placement and user capacity to maintain optimal service quality despite an increase in the number of connected devices.

This study aims to explain the experiences and meanings given to the influence of user distance and number of users on signal quality in WiFi networks. Based on the previously explained problems, the research questions are as follows:

1. Does signal quality affect WiFi user distance?
2. Does signal quality affect the number of users?

METHOD

This study uses a qualitative method with a phenomenological approach, which aims to understand and describe in depth the phenomena that occur among WiFi network users related to changes in signal quality based on distance and the number of connected users. The phenomenological approach was chosen because it allows researchers to explore the lived experiences of users in using WiFi networks in various environmental conditions and user density levels. Through this approach, data is obtained not only from technical measurements, but also from perceptions, experiences, and direct observations regarding signal quality as perceived by users.

RESULT AND DISCUSSION

Results

The results of this article based on the background of the problem, objectives, and methods are as follows:

Signal Quality

Signal quality is an overall measure of how well a wireless signal is received. This includes signal strength (RSSI), signal clarity against interference (SNR), and the ability to maintain data transmission performance (such as throughput, latency, and packet loss). This quality value is influenced by the distance between the transmitter and receiver, physical obstacles, interference, user density, and other environmental conditions.

Signal quality in a WiFi network refers to the strength and clarity of the signal received by a user's device from an access point (AP). Good signal quality ensures a stable and fast connection, while poor signal quality can cause disruptions such as decreased speed, high latency, or even connection loss. Additionally, environmental factors such as the distance between the device and the AP, physical obstacles (such as walls or furniture), interference from other devices, and user density also affect signal quality. Decreased signal

quality can occur due to signal attenuation (path loss), multipath fading, and interference from other devices operating on the same frequency. (Maulana & Sulistyo, 2024).

There are signal quality indicators in research journals (Puspitasari, 2017), namely: 1) RSSI (Received Signal Strength Indicator). Measures the signal strength received by the device from the access point; the higher the number, the better the signal quality; 2) SNR (Signal-to-Noise Ratio). The ratio between the received signal and the level of interference (noise); a high value indicates a clear and stable signal.

Signal quality has been widely studied by previous researchers, including: (Maulana, & Sulistyo., 2024), (Puspitasari, 2017), (Garnis et al., 2017), (Yusnita et al., 2019), (Alwi, E. I., 2019), (Tamtama et al., 2017), (Evalina, N., 2021), (Anggraeni et al., 2020), (Nisyah et al., 2020), (Imansyah, F., 2020).

Distance

(Naraswari et al., 2017), The distance between a WiFi user and the access point (AP) affects the received signal strength. The greater the distance between the user's device and the access point (AP), the weaker the received signal, which can reduce the quality of the internet connection. This demonstrates the importance of considering distance when designing a WiFi network to ensure optimal signal quality.

(Sulistyo et al., 2023), the distance between WiFi users is affected by the presence of physical obstructions such as walls and fences. Greater distances from the access point can result in poor WiFi signal coverage, resulting in dropped internet connections. Adding a signal booster, such as the Mi WiFi Range Extender Pro, can extend signal coverage and address this issue.

WiFi user distance indicators according to (Naraswari et al., 2017):

1) Physical Distance between User and Access Point (AP)
   a. Measures how far the user's device is from the AP.
   b. The closer the distance, the higher the received signal strength.
2) Maximum Effective Distance
   a. The maximum distance within which a device can still receive a signal with minimal usable quality.
   b. If the distance exceeds this limit, the connection will weaken or drop.

Distance has been widely studied by previous researchers, including: (Syaljumairi, R., 2021), (Sulistyo et al., 2023), (Naraswari et al., 2017), (TRIHADMOJO, A. I., 2019), (Subchan, M., & Goeritno, A., 2017).

Number of Users

(Ningsih, 2023), The number of users simultaneously connected to a WiFi network can impact network performance. If the number of users exceeds the network's capacity, service quality, such as internet access speed, will decrease, and the connection may become unstable.

(Permadi, 2018), fluctuations in the number of users connected to a WiFi service can affect service quality. If the number of users increases significantly, service quality, such as internet access speed, may decrease. Therefore, network optimization is necessary to adapt to the number of users.

(Minarsih, 2018), wireless network design must consider the number of connected users. A high number of users requires more bandwidth to ensure optimal service quality. If the number of users does not match the available bandwidth capacity, service quality will decrease.

Indicators for the Number of WiFi Users in (Ningsih, 2023), namely: 1) Number of Active Users. Measures the number of devices connected to the WiFi network

simultaneously; 2) User Density per Access Point (AP). If too many users on a single AP, the connection can become slow or unstable; 3) Fluctuation in the Number of Users. Changes in the number of users over time affect network performance.

Number of users has been widely studied by previous researchers, including: (Ningsih, 2023), (Permadi, 2018), (Minarsih, 2018), (Stefanny, V., & Tiara, B., 2021), (Simangunsong, Y. S., & Rozaini, N., 2023), (Tama, A. B., & Suartana, I. M., 2022).

Discussion

a) The effect of distance between WiFi users on signal quality

Based on previous research, a user's distance from an access point (AP) is one of the main factors affecting WiFi signal quality. (Naraswari et al., 2017) stated that the greater the distance between a user's device and an AP, the weaker the received signal. This is evident from the decrease in the Received Signal Strength Indicator (RSI) value as distance increases. This decrease in signal strength results in decreased internet access speed and potential connection drops at distances exceeding the AP's effective range.

In addition to physical distance, environmental factors also affect signal quality. Research by (Sulistyo et al., 2023) shows that physical obstacles such as walls or furniture can degrade signal quality, even when the user is relatively close to the AP. This suggests that distance does not act alone, but synergizes with physical environmental conditions to determine received signal quality.

Furthermore, research by (Syaljumairi et al., 2021) uses the K-Nearest Neighbor (K-NN) classification method to determine signal quality based on the user's distance from the WiFi hotspot. The results showed that users closer to the hotspot received a stronger signal, while users further away experienced decreased signal quality. This confirms that user distance is a direct indicator of the signal quality received by the device.

Overall, previous studies have shown a negative correlation between user distance and WiFi signal quality: the greater the distance, the lower the signal quality. Therefore, when designing a WiFi network, the optimal distance between users and the AP must be considered to maintain good connection quality.

This research is in line with research conducted by: (Naraswari et al., 2017), (Syaljumairi et al., 2021), (Sulistyo et al., 2023), (Syaljumairi, R., 2021), (Sulistyo et al., 2023), (Naraswari et al., 2017), (Maulana, & Sulistyo., 2024), (Puspitasari, 2017), (Garnis et al., 2017), (Yusnita et al., 2019), (Alwi, E. I., 2019), (Tamtama et al., 2017), (Evalina, N., 2021), (Anggraeni et al., 2020), (Nisyah et al., 2020), (Imansyah, F., 2020).

b) The effect of the number of WiFi users on signal quality

The number of users connected to a WiFi network significantly impacts the quality of the received signal. Ningsih (2023) states that the more devices simultaneously connected to a single access point (AP), the more likely each user is to experience a decrease in signal quality. This decrease can be seen in indicators such as the Received Signal Strength Indicator (RSSI), throughput, and latency. The higher the number of users, the more bandwidth must be shared across all connected devices, resulting in each user receiving less network capacity. This results in decreased access speeds, slower connections, and an increased risk of network outages. Therefore, the number of users is a crucial factor to consider when designing and managing a WiFi network.

In addition to the total number of users, the density of users per AP also significantly impacts signal quality. Minarsih (2018) explains that when too many users connect to a single AP, the network can become overloaded. This condition leads to a decrease in overall performance, including a weakened received signal, reduced throughput, and increased latency. This study emphasizes the importance of adjusting the number of users to the

maximum capacity of the AP to maintain stable signal quality and a smooth connection. Strategies such as distributing users across multiple APs and managing the distance between APs are crucial for mitigating excessive user congestion.

Fluctuations in the number of users over time are also a factor affecting WiFi network stability. Permadi (2018) found that when the number of users increases suddenly, signal quality can drastically decrease. This fluctuation causes connection interruptions, decreased throughput, and network instability. Therefore, dynamically managing the number of users is crucial, for example, through the use of a user management system and bandwidth allocation settings. With proper settings, the network can adjust its capacity based on the number of users, maintaining optimal signal quality despite changes in the number of users.

Overall, previous research indicates that the number of users is a major factor affecting WiFi signal quality. As more users connect, signal quality tends to decline without proper management. Therefore, user management strategies, AP distribution, and bandwidth optimization are key to maintaining good signal quality. Implementing these strategies enables WiFi networks to provide stable, fast, and reliable service even when used by many users simultaneously. Thus, managing the number of users becomes an important part of designing and operating a WiFi network.

This research is in line with research conducted by: (Ningsih, 2023), (Permadi, 2018), (Minarsih, 2018), (Maulana, & Sulistyo., 2024), (Puspitasari, 2017), (Garnis et al., 2017), (Yusnita et al., 2019), (Alwi, E. I., 2019), (Tamtama et al., 2017), (Evalina, N., 2021), (Anggraeni et al., 2020), (Nisyah et al., 2020), (Imansyah, F., 2020), (Stefanny, V., & Tiara, B., 2021), (Simangunsong, Y. S., & Rozaini, N., 2023), (Tama, A. B., & Suartana, I. M., 2022).

Conceptual Framework

Based on the formulation of the problem, theoretical studies, relevant previous research and discussion of the influence between variables, the framework for thinking in this article is obtained as below.

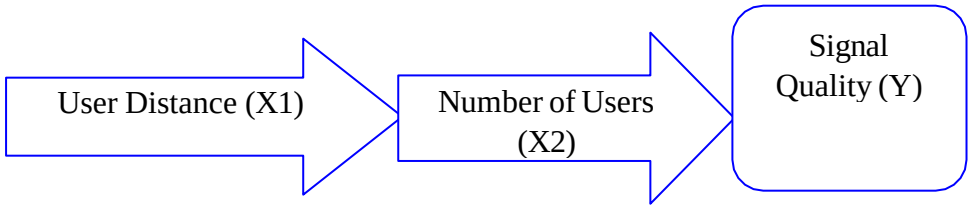


Figure 1. Conceptual Framework

And there are many other factors that influence Signal Quality (Y), including:

a) Network Perfomance : (Rahayu et al., 2017), (Sukendar, T., & Saputro, 2019), (Saputra et al., 2023), (Sugiharto, A., & Alfi, I., 2018), (Wibawa, M. S., 2017), (Sugiharto, A., & Alfi, I., 2019).
b) Communication Barriers : (Alfi, I., & Saputro, 2018), (Nurdianti, S., 2014), (Yudhistira & Trihastuti, 2023), (Aisyah, S., 2021).
c) Connection Stability : (Saputra et al., 2024), (Praditya, M. F., & Arifin, 2025), (Muryanto et al., 2025).

CONCLUSION

This study aims to determine whether user distance and the number of users affect the quality of a WiFi network signal. Based on the article's questions, the following conclusions can be drawn from this study: 1) User distance affects the quality of a WiFi network signal, 2) The number of users affects the quality of a WiFi network signal.

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