ASSESSMENT OF WI-FI NETWORK PERFORMANCE FOR PRACTICAL-BASED LEARNING ACTIVITIES IN EDUCATIONAL INSTITUTIONS: A CASE STUDY OF POLITEKNIK MERLIMAU MELAKA

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Abstract

The adoption of wireless technology into teaching and learning environments has become essential, particularly in technical and vocational education institutions where practical-based courses require stable and robust Wi-Fi connectivity. However, many institutions face challenges related to limited coverage, weak signal strength, and inconsistent network performance, which can hinder effective teaching delivery. This study aims to evaluate the Wi-Fi coverage and connectivity performance within Politeknik Merlimau Melaka (PMM) by analyzing Received Signal Strength Indicator (RSSI) values across six strategic campus locations. Data collection was conducted using the Network Cell Info application, with five student groups performing systematic measurements at designated points within the Administration Block, Library, Dewan Platinum, Jabatan Kejuruteraan Awam (JKA), Jabatan Kejuruteraan Elektrik (JKE), and Jabatan Pelancongan dan Hospitaliti (JPH). Each student recorded RSSI readings, which were first averaged at the group level and subsequently aggregated across all groups to derive final location averages. The analysis revealed significant variations in Wi-Fi coverage, with the Administration Block exhibiting a very poor average RSSI of -104.67 dBm, while Dewan Platinum and JKA recorded fair signal strength levels. Areas such as the Library and JPH also displayed poor coverage, indicating potential disruptions in connectivity during high-demand usage. The study emphasizes the need for targeted network infrastructure enhancements, including additional access points and optimization of existing configurations, to address coverage gaps and ensure reliable connectivity. Future work will focus on evaluating network throughput and latency to provide a comprehensive assessment of overall Wi-Fi performance in support of practical wireless courses.

Keywords: *Wi-Fi Coverage, Network Cell Info application, Signal Strength, RSSI Analysis, Wireless Connectivity*

Introduction

The advancement of wireless technology has emerged as a fundamental enabler of modern teaching and learning, particularly within higher education institutions offering engineering programs, especially Electrical Engineering (Electronic Communication) courses. Consequently, a reliable and high-performance Wi-Fi infrastructure is no longer perceived as a convenience but rather as a critical necessity, particularly in technical institutions such as Politeknik Merlimau Melaka (PMM). As Wireless Communication courses are integrated into the curriculum for electrical students, ensuring comprehensive Wi-Fi coverage and stable connectivity becomes imperative to facilitate hands-on learning activities, seamless access to online resources, and real-time network analysis (Easha et al., 2020). Moreover, as the dependency on wireless tools and digital platforms continues to increase, it is essential to assess the coverage and performance of campus-wide Wi-Fi networks to ensure they adequately meet the demands of educational delivery.

Recent studies have examined Wi-Fi performance in educational institutions, focusing on coverage, signal strength, and impact on learning. Research has shown that proper access point placement and network optimization are crucial for improving Wi-Fi service in university campuses (Easha et al., 2020). Wi-Fi reliability has been linked to student academic performance, with inconsistent speeds disrupting coursework (Fernandez et al., 2025). Studies have employed various tools for analysis, including heat mapping and RSSI measurements (Satwika & Sukafona, 2018). Investigations have revealed disparities in signal strength across campus locations and identified interference as a major issue (Ajeigbe et al., 2025). Research has also highlighted the importance of upgrading to modern access points and optimizing channel allocation (Adiba Abd Ghafar et al., 2020). Wi-Fi availability has been found to benefit students' academic work and communication (Moate et al., 2017), while hands-on Wi-Fi networking activities enhance student learning (Sarkar, 2006).

Nevertheless, numerous institutions continue to face persistent challenges associated with signal strength fluctuations, radio frequency interference, and uneven network coverage, all of which have the potential to hinder the overall effectiveness of wireless connectivity. Wi-Fi signal strength and network performance are influenced by a multitude of factors, including access point (AP) placement, physical obstructions within buildings, architectural layouts, RF interference, and user density (Ghafar et al., 2020). Consequently, inadequate signal coverage or inconsistent connectivity not only hampers instructional delivery but also undermines students' learning experiences, particularly during bandwidth-intensive tasks.

In response to these challenges, this study is undertaken with the primary objective of evaluating the current state of Wi-Fi signal coverage and connectivity performance across key academic and administrative zones within the PMM campus. Specifically, the research aims to systematically identify weak-signal areas and performance inconsistencies that may adversely affect the quality of teaching and learning activities. Additionally, the study seeks to propose data-driven recommendations for optimizing Wi-Fi infrastructure, particularly concerning access point placement and frequency band management strategies, thereby enhancing network reliability and coverage efficiency. Furthermore, by involving students enrolled in the Wireless Communication course in real-time data collection activities, this research aspires to promote research-based learning, providing students with practical exposure to wireless network assessment tasks, while simultaneously generating empirical data for institutional infrastructure enhancement.

Accordingly, this study employs the Network Cell Info application to perform an in-depth analysis of Wi-Fi coverage and connectivity across selected zones of the PMM campus. The application enables real-time monitoring of critical network parameters such as signal strength (RSSI), bandwidth, and frequency allocation. Through systematic data collection protocols and signal classification methods, this research endeavours to analyze PMM’s Wi-Fi signal distribution, identify areas of weak and strong coverage, and formulate strategic recommendations for network optimization. The findings of this study are anticipated to offer actionable insights for network administrators and academic planners at PMM, while also contributing to the broader academic discourse on wireless network optimization in higher education environments.

2.0 Methodology

This study adopted a structured practical approach involving student participation to ensure reliable and accurate Wi-Fi signal strength data collection. The data collection workflow is summarized in Figure 1, outlining the systematic procedures undertaken during the measurement phase. Each methodological step was carefully structured to minimize potential measurement bias and to promote internal validity and data reliability.

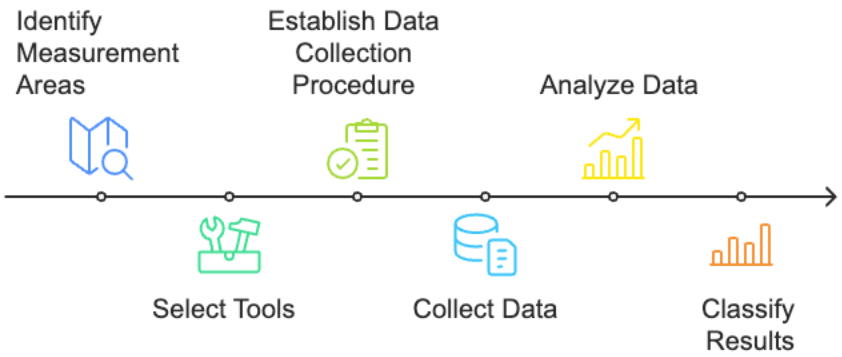


Figure 1: Data Collection Process

2.1. Measurement Area Selection

As presented in Figure 2**,** this study focused on six (6) strategic Wi-Fi coverage locations within Politeknik Merlimau, namely the Administration Block, Library, Dewan Platinum, Jabatan Kejuruteraan Awam (JKA), Jabatan Kejuruteraan Elektrik (JKE), and Jabatan Pelancongan dan Hospitaliti (JPH). The selected locations represent high-density academic zones where Wi-Fi reliability is critical to support frequent student engagement and practical learning activities.



Figure 2: Wi-Fi coverage locations within Politeknik Merlimau

2.2 Measurement Tools and Applications

The data collection was conducted using Network Cell Info, an Android-based diagnostic application capable of real-time monitoring of various wireless network parameters. The tool was chosen for its comprehensive features, including the ability to display Received Signal Strength Indicator (RSSI) in dBm, bandwidth usage, frequency band detection for both 2.4 GHz and 5 GHz spectrums, signal-to-noise ratio (SNR), and SSID/BSSID information as present in Figure 3. The application also allows data export in structured CSV format, enabling detailed analysis and visualization (Ting Ng et al., 2021). All measurement devices were dual-band mobile phones equipped to capture signals across multiple frequencies to ensure comprehensive data coverage.



Figure 3: Network Cell Info Apps interface

2.3 Data Collection Procedure

Data collection was conducted through a structured approach involving six (6) student groups, each consisting of 2 to 3 members, were assigned to collect data from all six (6) locations. The following protocol was followed:

- Time Variations: For consistency and reliability, data were collected during a single time window in the morning between 9:00 AM and 10:00 AM**,** which reflects typical high-usage periods for campus teaching and learning activities.
- Spatial Sampling Points: Each location had five fixed measurement points: four at the room's corners and one at the center within a 10-meter radius to capture spatial signal distribution.
- Measurement Duration: At each point, continuous RSSI readings and SNR values were recorded for a duration of 5 minutes.
- Device Orientation: To minimize measurement discrepancies, all measurement devices were consistently positioned at an approximate height of 1.2 meters above ground level and maintained in a fixed orientation to control for positional variation.
- Repetitions: Each group independently repeated the measurements, ensuring data

2. 4. Data Analysis

The data analysis process in this study involved a structured two-level averaging approach to ensure accuracy and minimize measurement inconsistencies. Each student within a group independently collected RSSI readings at designated measurement points across the six selected locations. These individual readings were first averaged within their respective groups to obtain a group average for each location. This step was essential to balance out minor variations caused by factors such as device handling, measurement angles, and momentary environmental interference.

After completing the intra-group averaging, the group averages from all six groups were compiled. The final average RSSI values for each location were then calculated by taking the average of these six group averages. This two-tier averaging method provided a robust dataset that accurately reflected the signal strength conditions by minimizing the influence of outliers and ensuring consistency across all measurements.

Additionally, the data were analyzed to observe any temporal variations in signal performance that might occur due to fluctuating network load or environmental factors. This comprehensive averaging and comparison process ensured that the final results presented a reliable and representative evaluation of Wi-Fi coverage at Politeknik Merlimau Melaka.

2.5 Signal Strength Classification

The final averaged RSSI values were categorized into signal strength levels based on standardized industry thresholds as illustrated in Table 1. This classification provided a clear and objective assessment of the Wi-Fi coverage quality across the surveyed locations, allowing for the identification of areas that require further network

optimization and infrastructure upgrades to support effective wireless learning environments.

Table 1: Signal strength readings

Colour	Signal Strength	RSSI (dBm)
Light Green	Excellent	- 30 to – 50 dBm
Green	Good	- 51 to – 60 dBm
Yellow	Fair	- 61 to – 70 dBm
Red	Poor	-71 to - 80 dBm
Grey	Very poor	<-80 dBm

(Adapted from Wi-Fi industry standard references: (CISCO, 2017))

3.0 Results and Discussion

3.1 Overview of RSSI and Signal Strength Results

Table 2 presents the averaged RSSI values and corresponding signal strength classifications for the six selected locations within Politeknik Merlimau Melaka. The RSSI measurements were obtained through a structured data collection and analysis process, ensuring reliable representation of Wi-Fi coverage performance.

Table 2: RSSI and Signal Strength Results for Selected Areas

Location	Average (dBm)	Range (dBm)	Signal Strength
Administration	-104.67	-140 to -66	Very Poor
Library	-71.17	-87 to -61	Poor
Dewan Platinum	-64.8	-67 to -60	Fair
JKA	-63.5	-80 to -50	Fair
JKE	-69.83	-71 to -69	Fair
JPH	-75.5	-86 to -66	Poor

3.2 Analysis of Coverage Performance

The results reveal a significant disparity in Wi-Fi signal strength across different campus locations. According to Cisco's Wi-Fi signal guidelines as in Table 1, the Administration Block recorded the weakest signal, with an average RSSI of -104.67 dBm, which falls under the Very Poor category. This indicates a severe lack of coverage in that area, possibly due to its distance from access points (APs) or interference from structural materials and electronic equipment.

The Library and Jabatan Pelancongan dan Hospitaliti (JPH) also demonstrated Poor signal strength, with average RSSI values of -71.17 dBm and -75.5 dBm, respectively. Although slightly better than the Administration Block, these areas are still inadequate for supporting bandwidth-intensive activities such as online streaming, video conferencing, or live wireless lab sessions. The lower range limits in these areas, extending to -87 dBm and -86 dBm, suggest frequent signal drops and unstable connectivity.

On the other hand, Dewan Platinum, JKA, and JKE recorded Fair signal strength, with average RSSI values between -63.5 dBm and -69.83 dBm. These values are within acceptable thresholds for basic internet access and moderate usage. However, they may not provide consistent performance under high network demand or during simultaneous usage by multiple users. Dewan Platinum showed a relatively narrow range (-67 to -60 dBm), indicating stable but moderate signal strength, while JKA and JKE exhibited wider ranges, hinting at occasional signal variability.

3.3 Implications for Wireless Courses

The inconsistent Wi-Fi coverage poses challenges for the effective delivery of practical wireless courses. Areas such as the Administration Block, Library, and JPH require immediate attention, including the deployment of additional access points (APs) or signal repeaters to enhance coverage. Without improvements, students and staff may face connectivity issues that hinder interactive learning experiences, particularly in activities that depend on stable and high-speed internet connections.

Meanwhile, although Dewan Platinum, JKA, and JKE currently provide Fair coverage, network performance could degrade during peak usage times or when handling high-bandwidth applications. Proactive measures such as AP optimization, signal amplification, or bandwidth management should be considered to ensure these locations consistently meet academic demands.

3.4. Summary of Findings

The overall analysis indicates that Wi-Fi coverage within Politeknik Merlimau Melaka is uneven, with certain academic zones falling below acceptable performance standards. The findings underline the necessity of strategic infrastructure enhancements to support the increasing reliance on wireless technology for teaching and learning. A comprehensive network audit and subsequent optimization plan are recommended to address the identified coverage gaps and ensure reliable connectivity campus-wide.

For future work, it is recommended that a detailed site survey using professional Wi-Fi audit tools (e.g., Ekahau, NetSpot Pro) be conducted to map signal propagation and interference patterns in greater detail (Faradina et al., 2021). Furthermore, additional performance metrics such as network throughput, latency, and packet loss should be measured to provide a comprehensive assessment of overall network quality. Infrastructure upgrades, including the addition of strategically placed access points (APs), deployment of signal boosters, and optimization of network configurations, should be prioritized based on the survey findings (Kassim et al., 2022)

In addition, incorporating student feedback on Wi-Fi performance in learning spaces could provide valuable insights into user experiences, ensuring that any enhancements made align with actual usage patterns and academic requirements. Continuous monitoring and periodic evaluations should also be implemented to maintain optimal wireless coverage as user demands evolve.

4.0 Conclusion

This study has successfully evaluated the current state of Wi-Fi coverage and connectivity within six critical academic and administrative locations at Politeknik Merlimau Melaka. The findings revealed significant variations in signal strength across different areas, with the Administration Block exhibiting a Very Poor average RSSI of -104.67 dBm, while other essential areas such as the Library and Jabatan Pelancongan dan Hospitaliti (JPH) recorded poor signal strength. Dewan Platinum, Jabatan Kejuruteraan Awam (JKA), and Jabatan Kejuruteraan Elektrik (JKE) demonstrated fair signal strength, sufficient for basic tasks but potentially inadequate for high-bandwidth applications during peak usage.

These inconsistencies in wireless coverage pose challenges to the effective delivery of practical wireless courses, which are increasingly reliant on stable and robust internet connectivity for activities such as real-time simulations, cloud-based learning platforms, and online assessments. The study highlights the urgent need for infrastructural enhancements, particularly in areas with poor connectivity, to ensure a conducive learning environment for both students and staff.

Acknowledgement

The authors would like to thank the students of DEP50063 Wireless Communication course from DEP5A, Session 2 2024/2025, Jabatan Kejuruteraan Elektrik, Politeknik Merlimau Merlimau, for their participation in the data collection activities that contributed to this research.

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