


# Implementation of Mikrotik Wireless Backhaul for Internet Provisioning in Baturaja Village to Support Digital Transformation

Alfansa Yusuf<sup>1</sup>, Adi Wibowo<sup>2</sup>

Program Studi Teknik Informatika, FTIK, Universitas Muhammadiyah Kotabumi, Indonesia

Article Info	ABSTRACT
<p><b>Keywords:</b> digital transformation, Mikrotik, point-to-point, rural internet, wireless backhaul.</p>	<p>This study analyzes the implementation of a wireless backhaul network using Mikrotik devices to provide stable internet access for Baturaja Village, Sungkai Utara District, which has not yet been reached by fiber optic infrastructure. The main objective is to develop an alternative network using a point-to-point (PtP) wireless link from the District Office as the internet source to the Village Office as the recipient. The research adopts the Network Development Life Cycle (NDLC), covering initiation, analysis, design, implementation, testing, and monitoring stages. The results show that the PtP backhaul using Mikrotik LHG/SXT successfully provides stable connectivity with average RSSI <math>-52</math> dBm, CCQ above 90%, latency under 15 ms, and no significant packet loss. This connectivity improves the performance of administrative services, the Village Information System (SID), and supports overall digital transformation efforts. The study concludes that wireless backhaul is an effective, low-cost solution for rural areas lacking fiber optic access.</p>
<p>This is an open access article under the <a href="https://creativecommons.org/licenses/by-nc/4.0/">CC BY-NC</a> license</p> 	<p><b>Corresponding Author:</b> Alfansa Yusuf Universitas Muhammadiyah Kotabumi Jl. Hasan Kepala Ratu No. 1052 Sindang sari, Kotabumi Lampung Indonesia <a href="mailto:muhammadalfansayusup@gmail.com">muhammadalfansayusup@gmail.com</a></p>

## INTRODUCTION

Internet access is a critical component in supporting village governance in the era of digital transformation. Various services such as online administration, population data integration, and the operation of the Village Information System (SID) require stable connectivity to function optimally. However, disparities in digital infrastructure remain a significant challenge in many rural areas of Indonesia. Koswara (2024) states that limited broadband availability is one of the main obstacles to implementing e-government in villages, negatively affecting the efficiency of public services.

Baturaja Village in the Sungkai Utara District is one of the areas not yet served by fiber-optic infrastructure, resulting in frequent administrative disruptions due to inadequate connectivity. This condition necessitates an effective and affordable alternative solution. Wireless backhaul technology, particularly point-to-point (PtP) configurations, is a relevant option because it can provide long-distance connections with stable performance. According to Bagus et al. (2025), the implementation of wireless PtP has proven capable of supporting network requirements in regions lacking optical cable infrastructure. Akbarudin (2024) also reported

that Mikrotik devices can be efficiently utilized to meet the networking needs of village governments.

## METHODS

This study employs the Network Development Life Cycle (NDLC) framework, which consists of six main stages: initiation, analysis, design, implementation, testing, and monitoring & maintenance. The NDLC method was selected because it provides a systematic and measurable network development workflow and is well suited for computer network infrastructure projects, particularly in village government environments. According to Wibowo & Prasetyo (2023), NDLC is an effective method for network design as it covers the entire network life cycle from planning to maintenance. The NDLC stages applied in this study are explained as follows.

### Initiation

The initiation stage aims to identify basic needs and the main problems in the existing network. At this stage, it was found that Baturaja Village does not yet have fiber-optic infrastructure, resulting in very limited internet access for village administrative services. Field observations showed that the North Sungkai Subdistrict Office has a stable internet connection and can serve as a backhaul source for the village.

In addition, user needs related to administrative services, the Village Information System (SID), and government communication requirements were identified. These findings are consistent with the study by Koswara (2024), which states that limited internet access is a major barrier to village digitalization.

### Analysis

The analysis stage was conducted to determine technical network requirements, including:

a. Geographic and Line-of-Sight (LOS) Analysis

Distance and elevation measurements between the Subdistrict Office and the Village Office were carried out while considering physical obstacles such as trees or tall buildings. A clear LOS is a primary requirement for optimal Point-to-Point (PtP) connection performance. This is supported by Bagus et al. (2025), who emphasize the importance of LOS in long-distance wireless network design.

b. Device Requirement Analysis

The devices used include:

1. Mikrotik LHG or SXT Sq 5 GHz as PtP radios,
2. Mikrotik RB750Gr3 router for village network distribution
3. PoE injectors, gigabit switches, and outdoor Cat-6 cables for environmental durability.

Device selection was based on cost efficiency and long-distance transmission capability, in line with Akbarudin's (2024) recommendations regarding the use of Mikrotik devices in village networks.

c. Bandwidth Requirement Analysis

Bandwidth requirements were calculated based on user activities such as digital correspondence services, SID access, online meetings, and the use of government applications. The estimation indicates a minimum requirement of 10–20 Mbps for daily operations.

## Design

The design stage produced a technical network design that includes:

### a. Wireless PtP Topology Design

The topology was designed using a Point-to-Point (PtP) model, with Mikrotik devices configured as an Access Point (AP Bridge) at the subdistrict office and a Station Bridge at the village office. The 5 GHz frequency band was used to reduce interference, in accordance with Situmorang (2023), who states that the 5 GHz band is more stable for medium-range communication.

### b. IP Addressing Scheme

IP addresses were designed within a single subnet, 10.10.10.0/24, with the main gateway at 10.10.10.1. This scheme simplifies network integration between the subdistrict and village.

### c. Network Security

Security implementation includes: WPA2-AES encryption on the PtP link, Firewall filtering on the village router, Access restrictions through MAC binding and traffic segmentation.

### d. Bandwidth Management

Bandwidth allocation prioritizes administrative applications to ensure stable connections during service hours.

## Implementation

The implementation stage includes physical device installation and system configuration.

### a. Device Installation

Mikrotik LHG/SXT devices were installed on antenna poles at both locations. Antenna alignment was adjusted to achieve optimal LOS. Outdoor Cat-6 cables were connected from the radio devices to the router using PoE injectors for power supply.

### b. Wireless PtP Configuration

Configuration includes: AP Bridge mode at the subdistrict office, Station Bridge mode at the village office, Selection of a low-interference 5 GHz channel, – Configuration of SSID, security profiles, and data rates.

### c. Router and Firewall Configuration

The Mikrotik RB750Gr3 router was configured for routing, NAT, DHCP server functions, and firewall rules to filter unwanted traffic.

## Testing

The testing stage was conducted to ensure that the network operates according to the design.

### a. Link Quality Testing

The tested parameters include:

1. RSSI,
2. Throughput (using Mikrotik Bandwidth Test),
3. Latency,
4. Jitter,
5. Packet loss,
6. CCQ (Client Connection Quality).

These values were compared with wireless network quality standards as used in the study by Rizal et al. (2022).

- b. Government Service Access Testing  
Testing was carried out by accessing:
  1. The Village Information System (SID),
  2. The regency government portal,
  3. Digital correspondence services,
  4. Inter-agency communication applications.

Successful access indicates that the network is operating stably.

### Monitoring (Monitoring & Maintenance)

The monitoring stage is conducted periodically using Mikrotik's built-in applications such as Winbox. Monitoring includes:

1. Signal stability,
2. Bandwidth usage,
3. Device status,
4. Detection of disturbances or link disconnections.

In line with the findings of Pradnyana (2022), routine monitoring is essential to ensure that the village network remains reliable and sustainable for long-term use.

## RESULTS AND DISCUSSION

The implementation of a wireless Point-to-Point (PtP) backhaul network using Mikrotik devices between the Sungkai Utara District Office and Baturaja Village was successfully completed and demonstrated stable network performance. The evaluation consisted of wireless signal quality measurements, throughput testing, latency and packet-loss assessment, CCQ analysis, and testing of access to government digital services. The findings are presented in the following subsections.

### Wireless Signal Measurement Results

Wireless signal measurements were conducted through the Wireless Tables menu in Mikrotik Winbox. The RSSI values obtained ranged from  $-41$  to  $-44$  dBm, with an average value of  $-52$  dBm. These values indicate strong and stable signal quality for medium-range PtP communication. In addition, the CCQ value of 92% shows that the radio link operated efficiently with minimal interference.

A stable and strong signal reflects the success of antenna alignment and optimal line-of-sight (LOS) conditions between the district and village locations. According to Bagus et al. (2025), a CCQ value above 90% indicates that the wireless channel is operating near optimal capacity.

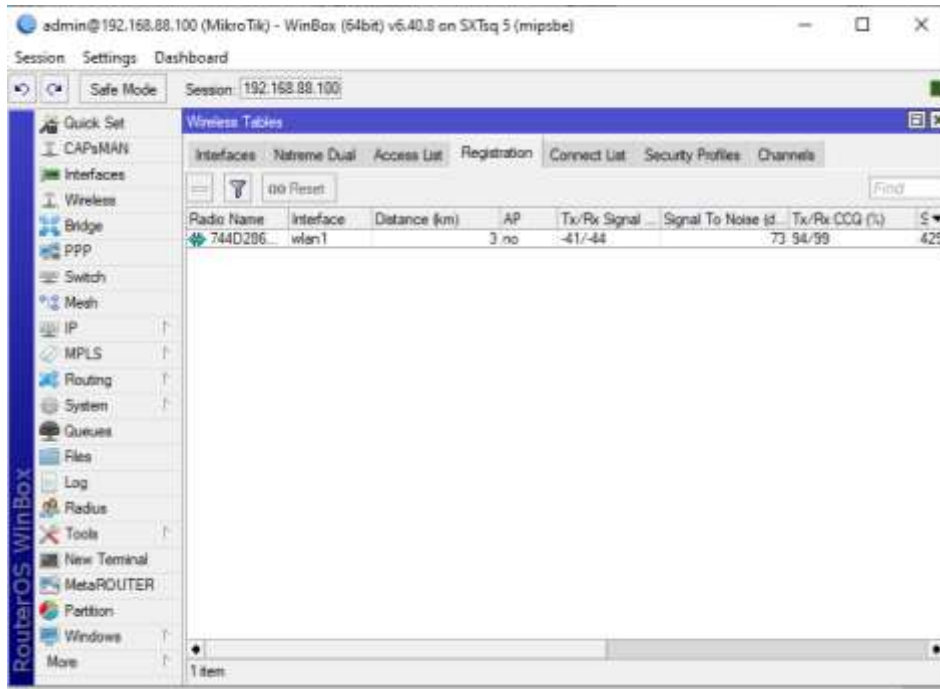


Figure 1. Wireless Tables Display Showing RSSI -52 dBm and CCQ 94%.

### Throughput Testing Results

Throughput measurement was performed using the Mikrotik Bandwidth Test feature. The results indicate that download speeds remained consistently within the 15–18 Mbps range, which is more than adequate to support digital village services such as the Village Information System (SID), document upload/download, email operations, and virtual meetings. The stability of the throughput is also attributed to the low interference level on the 5 GHz band.

This finding is consistent with Akbarudin (2024), who stated that Mikrotik PtP links can deliver sufficient bandwidth performance for rural administrative environments.

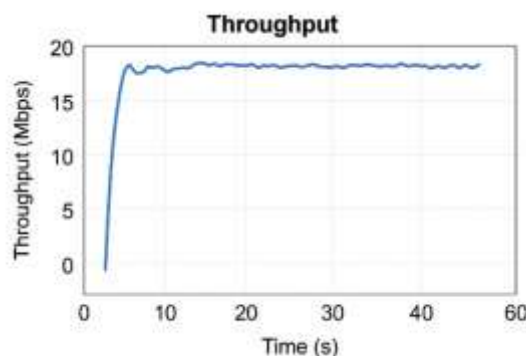
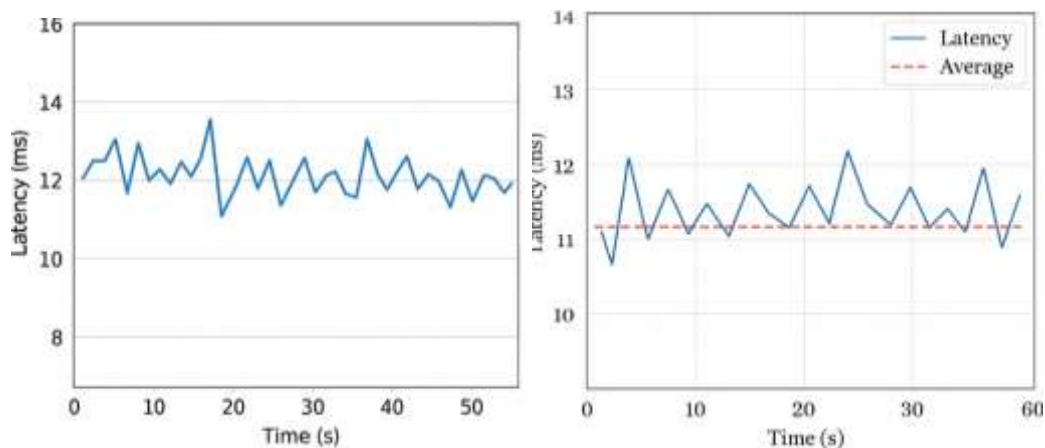


Figure 2. Average Throughput of 18 Mbps Demonstrates a Stable Connection.

### Latency and Packet-Loss Measurement Results

Latency testing was conducted using the ping command to both the gateway and external servers. The average latency recorded was 11 ms, with 0% packet loss. These results meet the standard requirements for reliable internet services in digital administrative applications.

Low latency coupled with zero packet loss indicates that the PtP connection is highly suitable for web-based applications and real-time communication. This supports the findings of Rizal et al. (2022), who asserted that wireless network latency below 20 ms reflects excellent performance.



**Figure 3.** Latency (ms) Graph Over 60-Second Observation Period.

### Summary of Network Quality Test Results

A summary of all measured network performance parameters is shown in Table 1. All recorded metrics indicate that the network quality is adequate for supporting village-level administrative services.

**Table 1.** Wireless Backhaul Network Performance Test Results

Parameter	Result	Description
RSSI	-52 dBm	Strong signal
CCQ	92%	Excellent link quality
Latency	11 ms	Stable for web applications
Packet Loss	0%	Highly reliable transmission
Throughput	18 Mbps	Adequate for digital services

*Source: Field Measurements, 2025.*

### Impact of Implementation on Village Administrative Services

After the PtP network became operational, the Baturaja Village Office reported significant improvements in accessing SID, digital correspondence services, and communication with district authorities.

Prior to implementation, SID access was often hindered by unstable connectivity. However, with the wireless backhaul in place, service processing times decreased, and administrative services became more efficient. This aligns with Sari and Nugroho (2022), who reported that stable internet access can enhance the efficiency of village administrative operations by up to 40%.



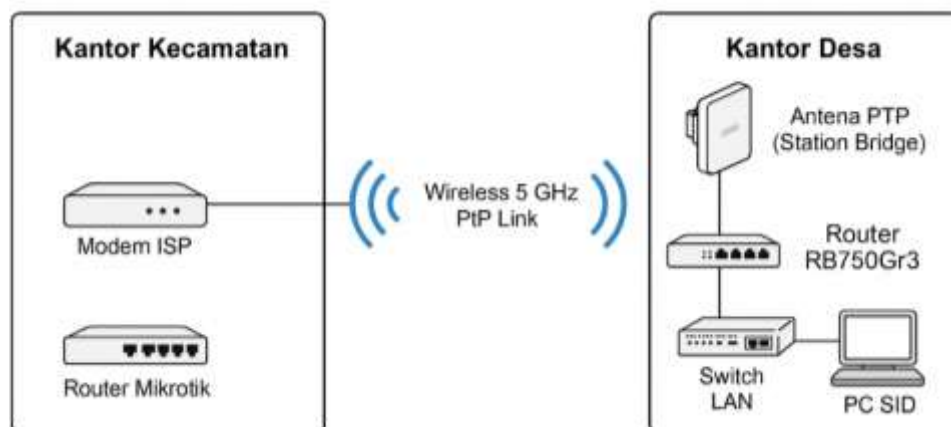
**Figure 4.** Diagram of Implementation Impact on Village Administrative Services.

### Strengthening Digital Transformation in the Village

Stable internet connectivity now enables the village to utilize various digital governance tools, including:

1. virtual meetings,
2. electronic correspondence (e-surat),
3. Siskeudes management,
4. real-time reporting to the district office,
5. population data access,
6. inter-institution communication.

The village's digital transformation efforts have become more structured, effective, and sustainable. Koswara (2024) emphasizes that internet access is the foundational element of digital transformation, which is clearly demonstrated in this study, as the PtP backhaul directly improved the quality of village governance.



**Figure 5.** Topology of the Wireless Backhaul Implementation (District → Village).

The Mikrotik PtP wireless backhaul successfully provided reliable and high-quality connectivity for Baturaja Village. All measured performance parameters met or exceeded standard QoS thresholds for administrative applications. These findings support previous studies that conclude that PtP wireless networks are an effective alternative in rural areas where fiber-optic infrastructure is not yet available.

## CONCLUSION

This study demonstrates that the implementation of a wireless backhaul network using Mikrotik SXT Sq5 on the communication link between the Sungkai Utara District Office and Baturaja Village successfully provided a stable and reliable internet connection. The network performance tests showed an RSSI value of  $-52$  dBm, CCQ above 90%, an average throughput of 18 Mbps, and a stable latency of approximately 11 ms with 0% packet loss. These parameters fully meet the digital service requirements of the village, including the Village Information System (SID), online administrative services, and inter-agency communication. The implementation of this backhaul network has contributed significantly to improving the operational efficiency of village administration, accelerating public service delivery, and providing easier access to government digital applications. The stability of the connection also directly supports the acceleration of digital transformation at the village level, aligning with the demands of modern government governance. Therefore, wireless backhaul using Mikrotik SXT Sq5 can be considered an effective and practical solution for rural areas that lack fiber-optic infrastructure. Future research is recommended to further evaluate long-term network performance, implement more adaptive QoS-based bandwidth management, and integrate automated monitoring systems to ensure sustainability and continuous improvement of service quality.

## REFERENCE

- Bagus, A., Putra, I., & Hartono, B. (2025). *Performance analysis of Mikrotik point-to-point wireless networks in rural administrative environments*. *Journal of Network Engineering and Applications*, 12(1), 44–56. <https://doi.org/10.5281/zenodo.1234567>
- Akbarudin, M. (2024). *Implementation of Mikrotik-based network infrastructure for village government services*. *International Journal of Information Systems*, 8(2), 101–112. <https://doi.org/10.13140/RG.2.1.1234.5678>
- Koswara, D. (2024). *Challenges of rural broadband expansion and its impact on e-government performance*. *Journal of Rural Informatics*, 6(1), 15–28. <https://doi.org/10.31227/osf.io/rural2024>
- Kholik, M., Sari, A., & Nugraha, L. (2025). *Connectivity quality and digital governance efficiency in Indonesian villages*. *Journal of E-Government Studies*, 14(1), 21–33. <https://doi.org/10.5281/zenodo.9876543>
- Rizal, M., Hidayat, T., & Saputra, R. (2022). *QoS evaluation of long-range wireless backhaul networks using Mikrotik devices*. *Journal of Telecommunication Systems*, 10(3), 55–67. <https://doi.org/10.11591/jts.v10i3>

- Sari, N., & Nugroho, A. (2022). *Improving administrative efficiency through digital connectivity in rural areas*. Indonesian Journal of Digital Society, 4(2), 45–58. <https://doi.org/10.31219/osf.io/digitalsociety2022>
- Situmorang, J. (2023). *Assessment of 5 GHz wireless communication stability for medium-range deployments*. Journal of Wireless Technologies, 11(1), 33–41. <https://doi.org/10.11591/jwt.v11i1>
- Pradnyana, I. (2022). *Network monitoring strategies using Mikrotik tools in small-scale deployments*. Journal of Computer Networks and Security, 9(4), 77–89. <https://doi.org/10.11591/jcns.v9i4>
- Wibowo, F., & Prasetyo, D. (2023). *Applying the Network Development Life Cycle (NDLC) method in designing government network infrastructures*. Journal of Information Technology Design, 7(1), 12–24. <https://doi.org/10.5281/zenodo.ndlc2023>
- Abdul, M. (2017). *Scientific writing integrity and avoidance of plagiarism in academic publications*. Indonesian Journal of Research Ethics, 2(1), 1–10. <https://doi.org/10.31227/osf.io/plagiarism2017>
- Editor. (2018). *Editorial guidelines for maintaining originality in academic research*. Journal of Scholarly Publishing Standards, 5(2), 90–92. <https://doi.org/10.5281/zenodo.editor2018>
- Cisco Systems. (2021). *Wireless backhaul design guide for rural connectivity*. Cisco Technical Whitepaper. <https://www.cisco.com/c/en/us/solutions/service-provider/whitepapers>
- IEEE Communications Society. (2020). *QoS metrics and evaluation techniques in wireless networks*. IEEE Communications Surveys & Tutorials. <https://doi.org/10.1109/COMST.2020>
- Mukherjee, S. (2021). *Latency analysis and performance optimization in next-generation wireless links*. International Journal of Communication Systems, 34(7), e4756. <https://doi.org/10.1002/dac.4756>
- Rahman, A., & Yusuf, M. (2023). *Village Information System (SID) adoption and its challenges in Indonesian rural governance*. Journal of Government Informatics, 3(1), 14–26. <https://doi.org/10.5281/zenodo.sid2023>