

ABSTRACT

The demand for internet access in remote areas, especially in highland regions with challenging topography, continues to grow amid the limitations of fiber optic infrastructure. This study aims to evaluate the techno-economic feasibility of a hybrid Free Space Optics (FSO) and Microwave transmission system as an alternative connectivity solution in Dalisodo Village, Malang Regency. The assessment was conducted through Bit Error Rate (BER) performance simulations using local weather data and a system configuration adjusted to comply with national regulation Kepmenkominfo No. 43/2025 regarding Class 1M laser power limitations.

Simulation results indicate that the FSO system, operating at -34 dBm, suffers from severely limited performance, particularly under foggy and even clear atmospheric conditions, making it unreliable for maintaining a stable link. The Microwave system, on the other hand, demonstrates more consistent performance but is still impacted by moderate to heavy rainfall. The proposed hybrid FSO-Microwave architecture fails to provide optimal service availability due to switching constraints and the differing propagation characteristics of each technology.

From an economic perspective, Net Present Value (NPV) and Internal Rate of Return (IRR) analyses suggest that the project is theoretically feasible, with an IRR of 8.8% and a payback period in the seventh year. However, this level of profitability is relatively low considering the equipment's operational lifespan is only around 10 years, making the investment less attractive without external support. The analytical model successfully integrates weather, topographical, and regulatory constraints into both technical simulations and economic calculations, offering a practical reference for rural network planning.

Keywords: hybrid FSO-microwave, rural back-haul, techno-economic analysis, Indonesia