

CHAPTER I

INTRODUCTION

1.1 Background

The increasing demand for network coverage at PT. Putra Perkasa Abadi, Jobsite Adaro Indonesia, has driven the adoption of digital transformation as a key strategy to support the implementation of Good Mining Practice (GMP). Digital transformation is defined as the comprehensive integration of digital technologies into business models, operational processes, and organizational culture, with the objective of enhancing efficiency, productivity, and value creation for the company[1].

In the mining industry context, digital transformation encompasses the adoption of various technologies, including the Internet of Things (IoT), big data analytics, cloud computing, artificial intelligence (AI), and advanced communication technologies such as Long-Term Evolution (LTE). The integration of these technologies enables real-time operational monitoring, improvements in workplace safety standards, and the strengthening of environmental sustainability initiatives[2][3][4].

The implementation of digital transformation aligns with GMP principles as it facilitates integrated management of operational and environmental data, accelerates data-driven decision-making processes, and minimizes the risks of occupational accidents and environmental degradation[5][6]. ICMM studies [7] demonstrate that digitalization can improve resource efficiency by up to 30% and reduce environmental impact by 25%, while supporting key GMP aspects such as real-time safety monitoring (in compliance with ESDM Regulation No. 26/2018 [8], environmental data management, and data-driven supply chain optimization. This transformation is not only crucial for corporate operations but is also expected to significantly contribute to national economic growth through production optimization and technology-based job creation[9][10][11].

However, this implementation faces network infrastructure challenges, with 60% of mining areas in Indonesia still experiencing connectivity constraints [12].

Network enhancement becomes critical to ensure optimal digital transformation while supporting comprehensive GMP achievement - from productivity improvement and environmental management to workplace safety assurance. Therefore, the company needs to provide optimal network coverage and quality to ensure unimpeded digital transformation, including overcoming infrastructure challenges and data traffic congestion.

Prior research on network planning for Wireless Access Points utilizing microwave technology through Point-to-Point and Point-to-Multipoint configurations has proven effective in providing alternative solutions for network implementation across remote mining areas [13][14][15][16]. However, this approach has yet to fully optimize network coverage and quality, primarily due to hardware limitations and the challenging geographical conditions of the region.

In order to address these limitations, PT Putra Perkasa Abadi partnered with Telkomsel to deploy private LTE technology as a smart mining solution within the mining industry [17]. According to the business model analysis, private LTE enables the optimization of mining activity monitoring and strengthens information security, with coverage reaching up to 95% and a bandwidth capacity of 40 MB/s [18][19]. Previous studies on cost and feasibility comparisons of LTE technology at different frequencies (900 MHz, 1800 MHz, 2100 MHz, and 2300 MHz), utilizing cost-benefit analysis, have highlighted the potential for cost optimization in the deployment of LTE networks in Indonesia [20]. However, there is a lack of research that specifically compares two alternative network mapping solutions to address the needs of the coal mining industry.

This study aims to identify a methodological solution capable of effectively meeting network requirements to support and optimize digital transformation. In addition, this research compares two alternative network mapping solutions Wireless Access Point and LTE in addressing coverage and network quality needs within the coal mining industry. The study includes a technical analysis through capacity and coverage planning, as well as an economic analysis to evaluate the cost differences associated with the use of different network systems in mining companies.

The results of this study are expected to provide in-depth insights into the cost and feasibility differences between Wireless Access Point and LTE network infrastructures, thereby assisting the company in making strategic decisions regarding network implementation to support digital transformation. This research is conducted in accordance with the regulations stipulated by the Ministry of Communication and Information Technology (*Peraturan Menteri Komunikasi dan Informatika*) [21], as well as the Decrees of the Ministry of Energy and Mineral Resources of the Republic of Indonesia (*Keputusan Menteri Energi dan Sumber Daya Mineral Republik Indonesia*) [22].

1.2 Research Objectives

The objective of this study is to provide a recommended network solution for use in the mining operations of PT Putra Perkasa Abadi, Jobsite Adaro Indonesia, to ensure the feasibility of implementing digital transformation. An economic analysis method is applied to evaluate the differences in the use of network systems by conducting the following steps:

1. Analyzing the existing network conditions.
2. Designing network models for both Wireless Access Point (WAP) and LTE technologies.
3. Simulating the Wireless Access Point and LTE networks using software tools.
4. Conducting a technical analysis of the network design results for Wireless Access Point and LTE generated by the software.
5. Performing an economic analysis to assess the differences between Wireless Access Point and LTE network systems.
6. Developing a new methodological solution to optimize technologies that rely on networks as a medium for data transmission.

1.3 Problem Statement

The problem addressed in this study is the need for an evaluation to determine the feasibility of two alternative network solutions for deployment in coal mining areas, with the aim of improving network coverage and quality. From the company's perspective, this research is expected to provide a comprehensive analysis of the

cost differences between Wi-Fi and LTE network implementation. The evaluation process is carried out through the following stages:

1. How to design network models for Wireless Access Point (Wi-Fi) and LTE in coal mining areas?
2. How to perform network simulations for Wireless Access Point and LTE to support feasibility testing ?
3. What are the results of the network design and technical analysis of the network models ?
4. How to conduct an economic analysis of Wireless Access Point and LTE networks to support future network expansion ?

1.4 Scope and Limitations

This study is constrained by the following scope and limitations :

1. The design of the Wireless Access Point (WAP) network is limited to candidate frequencies of 2.4 GHz and 5 GHz.
2. The design of the LTE network is limited to the 1800 MHz frequency band.
3. The technical analysis is conducted through capacity planning and coverage planning methods.
4. The economic analysis applies a techno-economic approach to evaluate the feasibility and cost-effectiveness of the network solutions.
5. The simulation area is specifically focused on the coal mining area at PT Putra Perkasa Abadi (PT PPA), Jobsite Adaro Indonesia.
6. The techno-economic analysis is limited to evaluating the performance and cost aspects of the network systems implemented within the mining operations.

1.5 Research Methodology

This research is carried out through a series of stages, as follows:

1. Literature Review

The literature review is conducted by identifying the research problems, collecting, and reviewing information from similar studies by gathering various journals, papers, articles, and other relevant literature related to network mapping planning in mining areas, capacity and coverage planning, technology economics, and frequency regulations.

2. Data Collection

The data collected for this study includes information such as the number of employees and existing technological devices at PT PPA, Adaro Indonesia Jobsite, planning area data, current working frequency criteria used for Wireless Access Point technology, LTE network data along with proposed frequency criteria, planning cost data, and applicable regulatory data relevant to this research.

3. Simulation and Planning Analysis

The network coverage expansion for Wi-Fi in this study is simulated using Ekahau Site Survey, while Forsk Atoll is used for LTE technology planning. Three types of analyses are conducted in this research: technical analysis, economic analysis, and regulatory analysis. The operational area data of PT Putra Perkasa Abadi, Jobsite Adaro Indonesia serves as the primary reference to support digital transformation efforts.

4. Conclusion and Reporting

In this stage, the thesis proposal report is prepared, including discussions and analysis of the designed system. This phase concludes with findings and recommendations, providing suggestions for future research.

1.6 Research Method

The research method used to improve network coverage and quality as a provider for digital transformation is by designing a hybrid network as a solution through the implementation of a new approach. The methodological approach applied in this study is the overlay method, which is used to identify network requirements for each digital transformation application.

The technologies used for network planning in this study are as follows:

1. The technology used for Wi-Fi devices is Wi-Fi 5, based on the IEEE 802.11ac standard.
2. 4G LTE technology is implemented as a wireless communication standard based on GSM/EDGE and UMTS/HSDPA networks, providing high speed data access for mobile phones and other mobile devices.

1.7 Hypothesis

The findings of this study demonstrate significant potential as an innovative solution for network infrastructure development aimed at optimizing technological utilization and operational efficiency within the mining industry. Through the strategic deployment of Wireless Access Point (WAP) networks and appropriately configured LTE systems, this approach can play a pivotal role in advancing digital transformation initiatives in industrial mining environments.

1.8 Research Roadmap

This research follows a structured roadmap consisting of four main phases. The first phase involves the preparation of the research proposal, including the determination of the title, selection of the appropriate methodology, and outlining the overall research process. The second phase focuses on identifying and collecting design data, as well as performing technical calculations and establishing economic assumptions. In the third phase, network design simulations are carried out using Atoll and Ekahau Site Survey, followed by detailed techno-economic calculations. Finally, the fourth phase includes comparing the analyzed results and applying sensitivity analysis to evaluate the robustness of the findings. The overall research roadmap is illustrated in Figure 1.1.

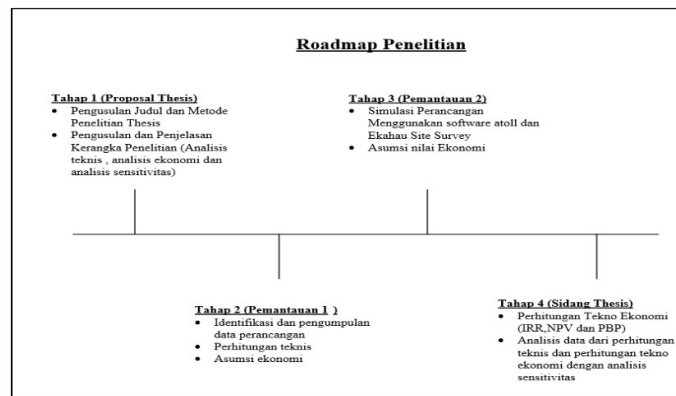


Figure 1. 1 Research Roadmap