

ABSTRACT

As the telecommunications industry progresses toward the deployment of sixth-generation (6G) networks, the necessity for advanced security solutions becomes paramount. This thesis explores the potential of Quantum Key Distribution (QKD) as a pivotal enhancement for security in 6G Radio Access Networks (RAN). This thesis aims to analyze QKD protocols within the 6G RAN framework in several international documents and standards, providing a practical recommendations for Indonesia case study.

This thesis investigates and evaluates practical quantum-based security solutions for 6G RAN by adopting a comprehensive methodology that addresses four main objectives: (i) Review of International Telecommunication Union (ITU) documents; (ii) proposed possible fronthaul system models for implementing quantum-based security in 6G RAN; (iii) assessment of different QKD protocols to identify their strengths and limitations; (iv) a qualitative analysis incorporating SWOT (Strengths, Weaknesses, Opportunities, Threats) and financial evaluations to determine the practicality and implications of deployment, including detailed financial planning, analysis of CAPEX (Capital Expenditures), OPEX (Operational Expenditures), revenue projections, and ROI (Return on Investment) calculations.

This thesis found that financial commitment required for integrating Quantum Key Distribution (QKD) into Indonesia's 6G networks, with an estimated investment of about USD 590.1 million while operational expenses (OPEX) are carefully calculated to ensure sustainability. Financial projections are promising, with a Return on Investment (ROI) showing profitability from the first year and increasing substantially over a 15-year period. The Net Present Value (NPV) is highly positive at IDR 1,917,472,851, indicating that the future cash inflows greatly outweigh the costs. An impressive Internal Rate of Return (IRR) at 125.27% and a Benefit-Cost Ratio (BCR) of 4.249 underscore the project's financial effectiveness. These results conclusively support the thesis that integrating QKD into 6G RAN is not only technically feasible but also financially advantageous, providing a secure and profitable investment for the future of Indonesia's telecommunications.

Keywords: Quantum Key Distributions, Security, RAN Fronthaul 6G.