CHAPTER 1
INTRODUCTION

1.1 Background

Based on data and information from cellular operators, the current condition of mobile data usage has caused cellular network density or called congestion so the throughput on the customer side has been decreased. The government conducted an evaluation regarding the problem of network density in several cities in Indonesia such as Medan, Semarang, Yogyakarta, Surabaya, Denpasar, Pontianak, Makassar, and JABODETABEK [1]. The government is also targeting an even distribution of LTE networks in tens of thousands of villages by 2022 because more than fifty percent of the territory in Indonesia has not been covered by LTE networks which were explained in the event "The Role of the Telecommunications Sector in National Economic Recovery" held in September 2020 [2].

One way to solve this problem is to expand the LTE network. However, to expand the network, additional frequencies are needed, there are several options regarding the frequencies that will be available in Indonesia that can be used for the implementation of LTE networks, including analog TV (700 MHz), 3G (2100 MHz), and WiMax (2300 MHz). 2300 MHz frequency is indeed available but currently commercialized 5G networks in Indonesia use a frequency of 2300 MHz. Although information and communication technology is starting to enter a new stage with the presence of 5G in Indonesia. 5G services are starting to be available in Indonesia but do not cover all regions. Currently, it is only available in several parts of Indonesia, one of which is in Jakarta. The Ministry of communication and informatics divides three telecommunication layers for the 5G network, namely Low Band, Middle Band, and High Band[3]. The 5G network is said to have high data transfer rates and low latency. The presence of 5G does not directly replace previous networks such as 4G because basically 5G development still requires an operational base from 4G. Most likely after the 5G network is adequate and access has been evenly distributed, the 5G network will be more reliable than 4G and 5G users will also increase but at this time the 4G network is still needed in Indonesia[4].

In previous studies, the techno-economic calculations with study case India, have been carried out using a frequency of 700 MHz for LTE networks and compared with the existing frequencies there are 1800 MHz and 2100 MHz, the results showed the potential for good financial recovery in the use of the 700 MHz frequency [5]. In addition, LTE feasibility tests were carried out using the frequencies of 900 MHz, 1800 MHz, 2100 MHz, and 2300 MHz with the techno-economic calculations and the results showed that the use of the 2300 MHz frequency had a faster payback period than others [6]. In Banyumas area use 1800 MHz and 700 MHz frequencies with bandwidth 15 MHz and obtained decent results for frequency 700 MHz [7]. Another study conducted LTE network planning in Semarang by using capacity planning and coverage planning. From these calculations, the number of eNodeB needed for the coverage planning was 161 sites while the capacity planning was 46 sites [8]. The calculation of the design of LTE technology deployment based on the coverage area of Banyumas Regency in 2016 requires 124 sites, while the calculation based on capacity requires 71 sites. The simulation results using Atoll software show an average RSRP value of -80.9 dBm and SINR value of 0.64 dB [9]. The weakness of the research is that the design is only carried out using a capacity and coverage approach from the technical side. Therefore, the LTE design research is proposed by conducting a feasibility analysis from the technical and economic side using techno-economic calculations, then there will be an additional study using cost and benefit analysis. The use of cost and benefit analysis will include feasibility parameters in terms of frequency availability.

In this study, we will examine the availability of the 700 MHz, 1800 MHz, 2100 MHz, and 2300 MHz frequencies using two scenarios for LTE networks in urban, suburban, and rural areas with a feasibility test from the economic side using techno-economic calculations and the technical side using capacity planning and coverage planning. Furthermore, the feasibility of each frequency will be analyzed based on the technical side and the economic side regarding the availability of frequency candidates using a cost and benefit analysis with the Simple Multi-Attribute Rating Technique (SMART) weighting method.

1.2 Research Problem

The problem focus in this study is to provide recommendations for the best frequency band options for LTE network implementation by conducting cost and benefit analysis. The research problem in this study are:

1. How to calculate capacity planning and coverage planning for candidate frequencies, namely 700 MHz, 1800 MHz, 2100 MHz, and 2300 MHz?
2. How to do the techno-economic calculation of each candidate frequency?
3. How to do a comparison of each candidate frequency using cost and benefit analysis?

1.3 Research Objectives

The purpose of this study is to give recommendations for the best frequency band using cost and benefit analysis methods. The cost and benefit analysis is obtained in the following ways:

1. Analyze and calculate capacity planning and coverage planning of each candidate frequency with the aim of ensuring technical feasibility.
2. Analyze and perform techno-economic calculations of each candidate frequency with the aim of ensuring economic feasibility.
3. Comparing the cost and benefit analysis of each candidate frequency.

1.4 Scope of Problem

This research has scope of problem as follows:

1. This study designs an LTE network using three frequencies, there are 700 MHz, 1800 MHz, 2100 MHz, and 2300 MHz.
2. The research case study uses urban, suburban, and rural areas in Semarang City.
3. The technical studies in this research use the calculation of capacity planning and coverage planning.
4. The economic studies in this research use techno-economic calculations.

1.5 Research Methodology

The workflow of this research is divided into several stages, there are:

1. Literature Study

In the first stage of this research, the search for related information is carried out. Literature studies are taken from books, previous research results such as journals or papers, and other official sources.

2. Data Retrieval

   At this stage, related data is collected, such as population data in Semarang with urban, suburban, and rural areas from Badan Pusat Statistik (BPS) data and market share providers data to forecast users for the next few years.

3. Technical Side Calculation

   At this stage, calculations are carried out from the technical side using capacity planning and coverage planning.

4. Economic Side Calculation

   The calculation on the economic side is using a techno-economic model to determine the estimated cost or income for operators who will provide LTE networks at each frequency. Calculations that can be known include, Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period.

5. Cost and Benefit Analysis

   In this section, the cost and benefit analysis is used to calculate the potential value that can be obtained and analyze the feasibility at 700 MHz, 2100 MHz, and 2300 MHz frequencies.

6. Drawing Conclusions

   Conclusions are drawn based on the results of the data obtained in the research.

1.6 Research Roadmap

This research is divided into four stages, stage 1 regarding the proposal of the title and method to be used in this research as well as an explanation of the research flow or process, stage 2 is identifying and collecting design data and performing calculations from the technical side and economic assumptions, stage 3 did a design simulation using Atoll and performs techno-economic calculations, and stage 4 compares and analyze the obtained results using the cost and benefit analysis method. The research roadmap can be seen in Figure 1.1.

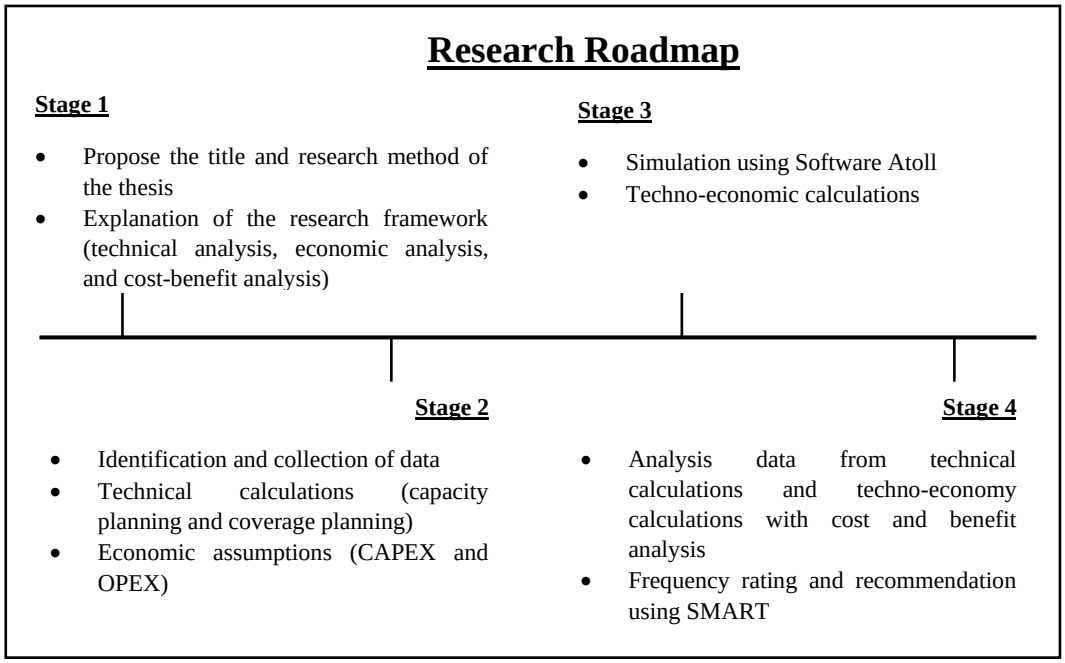

Figure 1. 1 Research roadmap.