CHAPTER I INTRODUCTION

1.1 Background

Satellite technologies are one of the most strategic communication infrastructures in Indonesia as an archipelagic country. With the growing satellite technology, satellite could increase the affordability of internet in Indonesia high capacity [1]. Indonesia ICT Development Index is among the lowest in the ASEAN regions with one of the challenges on affordability. Based on ICT Development Index 2023 by International Telecommunication Union (ITU), Indonesia ranked 80th worldwide and 6th in Southeast Asia with score 80.1 [2]. Meanwhile, its neighbours, Malaysia and Singapore, scores 94.5 and 97.1 respectively, with Singapore highest in Southeast Asian region [3]. Indonesia has been using satellite since 1976 and currently operates more than six active satellites [4], however the ICT Development Index 2023 found that only 65.4% of the individuals from the population of Indonesia that uses the internet [3]. In the ITU Global Connectivity Report 2022, there are techno-economic barriers to deploy internet in rural and undeserved areas, which relevant to Indonesia areas. The cost to deploy internet access in these areas are significantly higher than the urban areas. These barriers are due to high deployment costs, low demand, and inadequate regulatory measures [5].

Indonesian government through BAKTI Kominfo launched Satria-1 Satellite Network (Satria-1) in 2023 for government communication in Indonesia [6]. On the other hand, the 150 Gbps capacity [7] of Satria-1 may not enough to meet minimum capacity needed. For instance, online meeting requires about 3 Mbps bandwidth of internet [8], while Satria-1 serves about 150,000 spots for government communications [9]. In only less than a year later, Indonesia issued a license to foreign satellite operator using non-geostationary satellite constellation, namely Starlink [10]. Starlink Gen 1.5 Satellite Systems (Starlink), a Low Earth Orbit (LEO) satellite owned by SpaceX [11], could be an alternative solution to increase the total capacity for government communications throughout Indonesia.

To face those challenges, this research will utilize a techno-economic analysis of the implementation of Satria-1 and Starlink, comparing these two systems on their technological capabilities and business implications under the lens of Indonesian and international regulations. The comparison will be conducted on two scenarios; the first scenario will be conducted only for the Satria-1 satellite, the second scenario will be conducted for both Satria-1 and Starlink satellite, with Starlink as a complementary for Satria-1. This study will evaluate the technical performance, economic value, and regulatory ramification of the deployment of these satellites in the country. The analysis will involve a comprehensive review of the technical specifications, cost structure, and the total cost of the two systems.

1.2 Previous Researches

On [12], the research assesses the techno-economic model for three Low Earth Orbit (LEO) satellite constellations which includes Starlink, OneWeb, Kuiper. The assessment simulating the satellite impact on the coverage, capacity, and the cost as number of the satellite increases as well as the quantity of users. However, those research were conducted globally and not specific into one country or region. Research on satellite's technical and economic viability to a particular country or region is an important decision element for that country or region (a group of countries). United States, Canada, Indonesia, Australia, Brazil, to name a few, are countries that both adopted GSO and non-GSO VHTS, and yet techno economic analysis for both countries are not found. Therefore, research for a specific country or region must be carried out, as each country or region may have different or unique results. Although, [13] assesses the techno-economic model between conventional GSO satellite and High-Throughput Satellite (HTS), the assessment did not explicitly simulate the satellite impact on the coverage, capacity, and the cost on Ku and Ka frequency band for a country like Indonesia. In addition, there have been analysis of comparation between GSO and non-GSO satellite system, but not particular to Indonesia [14]. It presents a comprehensive exploration of the challenges and opportunities in non-GSO satellite communication systems. However, the research gap is to understand the coexistence challenges, resource management, and overall performance efficiencies between non-GSO and GSO satellite systems, since BAKTI has invested GSO HTS satellite network, while at the same time there are other foreign non-GSO satellite systems that can potentially provide similar satellite services to Indonesia. Therefore, research that focuses studies between GSO and non-GSO satellite for a country such as Indonesia, in terms of technical and economic performances, is critical to be conducted.

1.3 Problem Identification

Despite of technology advancement in satellite communication technology, research on a country specific that focuses on technical and economic implementation of a GSO and non-GSO HTS that uses two different frequencies has never been conducted. Previous research ([12], [13], [14]) were not a country specific, covering technical and economic analysis, nor on different orbits. Research that are focused on technical and economic implementation of GSO and non-GSO satellite communication system that uses Ka-Band and Ku-Band and are focuses on techno economic analysis for a specific country like Indonesia, will be critical to address the following problems, which become the research questions that needs to be addressed.

1. What is the satellite capacity of Satria-1 and Starlink within Indonesia service area?
2. What are the technical and economic performances of Satria-1 and Starlink within Indonesia service area?
3. How the above analyses impact the satellite regulation in Indonesia?

1.4 Research Hypothesis

Based on the above problem identification and previous research, the hypothesis of this research are as follows.

1. The combined use of GSO (Satria-1) and non-GSO (Starlink) satellites will significantly increase the capacity of government satellite communication services in Indonesia, compared to the use of GSO or non-GSO satellites independently.
2. Starlink will offers more capacity and coverage compared to Satria-1 services in Indonesia.

3. GSO and non-GSO satellite combined implementation will more economically cost-effective than using GSO or non-GSO satellites independently, considering the CAPEX-OPEX and the total costs.
4. Current Indonesian regulation does not fully support the efficient implementation of non-GSO satellites, particularly Starlink, and certain changes or adaptations in regulations are needed to maximize the potential of this technology.

1.5 Research Objectives

The objective of this research is to establish an understanding of the technical and economic performances of Satria-1 and Starlink satellites for Indonesian territory, while also formulating strategic recommendations and potential regulatory guidelines.

1.6 Research Limitation

This research limits its focus to technical and economical parameters of both satellite systems and its impact to satellite regulatory in Indonesia. By limiting the scope to these specific parameters, it helps to ensure the accuracy of the data and analysis also not widen the research fields. In addition, below are the approach this research.

1. Link budget analysis will be used to determine the satellite capacity.
2. Service area for both satellites are Indonesia territory.
3. Data is based on the value obtained by data from PT. Telkom Satelit Indonesia (Telkomsat) for Starlink, Indonesia Communication and Informatics Accessibility Board (BAKTI) Kominfo for Satria-1.
4. Data will be used for determining the total cost of both projects within satellite lifetime.
5. International regulations will be based on the regulations by International Telecommunication Union (ITU), and the Indonesia regulations will be based on the existing regulations by Kominfo.

The stage of this research is as follows.

1. Conducts technical analysis of Satria-1 and Starlink by coverage and capacity.
2. Conducts economic analysis for Satria-1 and Starlink including CAPEX-OPEX analysis and total costs of the projects.
3. Carry out analysis for different scenarios; Satria-1 operating independently, and Satria-1 combined with Starlink for Government communications.

1.7 Research Method

Below are the research methods for techno-economic analysis of Satria-1 and Starlink. These methods ensure a structural approach to provide a reliable analysis of Satria-1 and Starlink techno-economic analysis in Indonesia.

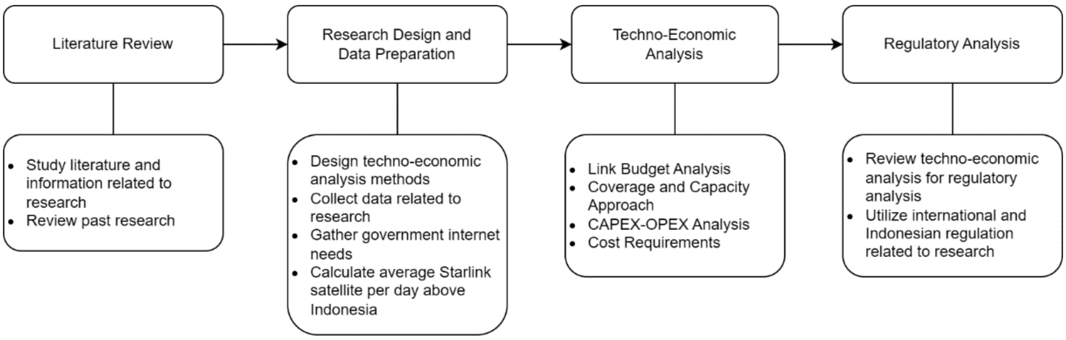

Figure 1.1 Research Method

Below are the explanations for the research method.

1. Literature Review
   - Studies related literature and reliable information from books, journal articles, thesis, and relevant literature for the basis of the theory.
   - Reviews past research on GSO and non-GSO satellites, particularly on techno-economic analysis and Starlink.
2. Research Design and Data Preparation
   - Designs the techno-economic analysis method for the research.
   - Collect data related to the research.
   - Calculate Starlink satellite average per day on Indonesian territory on [15].
   - Gather government internet needs from BAKTI Kominfo [9].

3. Data Processing and Analysis
   - Calculate the link budget for Satria-1 and Starlink.
   - Determine the coverage and capacity for both satellites.
   - Analyse the CAPEX-OPEX for both satellites
   - Calculate the total cost required
4. Data Post-Processing
   - Review techno-economic analysis for regulatory analysis.
   - Utilize both international and Indonesian regulation related to the research.

1.8 Thesis Structure

Below is the structure of this research.

- CHAPTER I INTRODUCTION: Contains research background that refers to the problem of analysing techno-economic of Satria-1 and Starlink in Indonesia.
- CHAPTER II LITERATURE REVIEW: Contains the concepts and theories related to this research such as Satria-1 and Starlink satellites, technical parameters, and economic parameters.
- CHAPTER III RESEARCH DESIGN: discusses the proposed system's research flow diagram, design, and calculation methods.
- CHAPTER IV ANALYSIS AND RESULTS: Contains the calculation results and analysis of the results obtained.
- CHAPTER V REVIEW: Contains the conclusions and suggestions of this research.