Analysis of 5G Network Development in Indonesia : A Literature Review

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***Abstract*— This research aims to analyze the development of 5G networks in Indonesia, focusing on telecommunications infrastructure, regulatory challenges, and socio-economic implications. Using data from academic journals, government reports, and industry white papers, a comprehensive literature review was conducted to synthesize key findings. This method involves examining the opportunities and challenges in 5G implementation to provide actionable insights. The results show that 5G technology has significant potential to accelerate digital transformation in various sectors such as healthcare, education, and industrial automation. The Indonesian government has initiated various efforts, including regulatory adjustments and pilot projects, to support the adoption of this technology. However, challenges such as limited frequency spectrum, high infrastructure costs, and network readiness gaps between urban and rural areas remain major obstacles. Overcoming these requires collaborative efforts among stakeholders, including the government, telecom service providers, and regulators. Strategic measures such as tax incentives, infrastructure sharing policies, and efficient spectrum reallocation are needed to improve accessibility and inclusiveness. These findings suggest that successful 5G implementation can boost Indonesia's digital economy, increase global competitiveness, and reduce the digital divide. Implications for future research include detailed assessments of the impact of 5G on specific industries and exploration of adaptive regulatory frameworks to support sustainable development. This research provides an important foundation for policymakers and industry leaders to ensure a comprehensive, inclusive, and effective 5G rollout in Indonesia.**

***Keywords*— 5G network, digital transformation, Indonesia, socio-economic impact, telecommunications infrastructure.**

Manuscript received 21 Sept. 2024; revised 1 Dec. 2024; accepted 12 Jan. 2025. Date of publication 3 Mei. 2025.

I. INTRODUCTION

The development of telecommunications technology in Indonesia has reached a new chapter with the start of 5G network implementation. Although a number of countries have started 5G implementation with various favorable business case studies, Indonesia faces significant challenges. Some of the major concerns in the implementation process include telecommunications infrastructure, existing policies and regulations, and the innovation ecosystem needed to support the adoption of this technology. On the other hand, there are also key enablers, such as high demand from customers, efforts to reduce operational costs, and the potential additional revenue that can be earned by mobile network operators.

Since the beginning of 5G development, Indonesia has experienced delays in the adoption of mobile technology compared to other countries. Although 4G technology has been introduced globally since 2009, Indonesia is just starting to feel the positive impact of the technology. This shows the need for careful preparation to face the 5G era so as not to experience the same delay as before[1].

The implementation of 5G technology is expected to drive digital transformation in various sectors, including industry, education, and healthcare. With data rates reaching 20 Gbps and extremely low latency, 5G has the potential to revolutionize the way we interact with technology and improve operational efficiency in many

areas. However, to achieve this potential, Indonesia needs to make large investments in network infrastructure and adjustments to existing regulations.

One of the key challenges in 5G implementation is the readiness of the existing telecommunications infrastructure. Infrastructure designed to support 4G technology is not fully adequate to meet the capacity and speed requirements offered by 5G. Research shows that infrastructure modernization, including the installation of small cells and the adoption of edge computing, are critical steps to ensure optimal performance of 5G networks[2].

In order to overcome these challenges, collaboration between the government, telecom service providers, and regulators is necessary. The Indonesian government has issued policies to encourage the adoption of 5G and granted licenses to telecom operators to build the necessary infrastructure. In addition, it is important for all parties to develop a clear roadmap so that 5G development can be carried out in a planned and sustainable manner[3].

From an economic perspective, the implementation of 5G technology is expected to accelerate the growth of Indonesia's digital economy. With the ability to support the Internet of Things (IoT), autonomous vehicles, and smart cities, 5G has the potential to open up new opportunities for innovation and investment in these sectors[1]. However, challenges related to investment costs and spectrum regulations must be overcome so that the benefits of this technology can be widely felt by the public.

In conclusion, analyzing the development of 5G networks in Indonesia is a crucial first step in understanding the dynamics of implementing this technology. With the right approach and cross-sector cooperation, Indonesia has a great opportunity to become one of the leading countries in the utilization of 5G technology in the Southeast Asia region.

II. MATERIALS AND METHOD

This research uses a literature review approach to analyze the development of 5G networks in Indonesia. The materials used include various reliable sources, including academic journals, government reports, industry white papers, as well as conference proceedings documents related to 5G technology. These sources were selected based on their relevance to the research topic, namely the implementation of 5G in Indonesia, with a focus on infrastructure, regulatory aspects, and socio-economic impacts. The literature used includes technical analysis of telecommunications infrastructure readiness, spectrum regulations, as well as case studies of 5G implementation in other countries that can serve as lessons learned for Indonesia.

The method used in this research is a synthesis of various research results and relevant reports to identify opportunities and challenges in implementing 5G technology. The analysis is conducted by reviewing data on infrastructure readiness, regulatory policies, and the potential impact of this technology on strategic sectors, such as health, education, and industry. The research also utilizes a descriptive approach to provide a detailed overview of the current state of 5G network development in Indonesia, including comparisons with other countries in the Southeast Asia region.

In addition, the research identifies key factors that influence the success of 5G implementation in Indonesia, such as collaboration between the government, telecom service providers, and regulators. Special emphasis is given to policies and strategic measures that can be taken to overcome obstacles, such as high investment costs, limited frequency spectrum, and infrastructure gaps between urban and rural areas. Through this approach, the research aims to provide a solid foundation for policy formulation as well as decision-making that supports inclusive and sustainable 5G implementation.

III. RESULT AND DISCUSSION

A. Opportunities for 5G Network Development in Indonesia

The 5G (Fifth Generation) network comes as an important breakthrough in the development of wireless communication technology. This technology provides much faster data transfer capabilities, very low latency, and a significant increase in capacity compared to previous generations. With these advantages, 5G opens up new opportunities to drive innovation and progress in various fields, providing more efficient and effective solutions to meet modern communication needs[4].

The development of 5G networks in Indonesia has great potential to support various sectors, such as the Internet of Things (IoT), smart cities, and industry 4.0. This technology provides faster and more stable connectivity, which is key in implementing advanced applications, including smart city management and industrial automation. The Indonesian government, through the Ministry of Communication and Information Technology (Kominfo), has taken strategic steps to accelerate the adoption of 5G[5], including by granting licenses to telecommunications operators and conducting various trials since 2017. These steps aim to ensure the necessary infrastructure readiness to support a more equitable digital transformation across Indonesia. In addition, collaboration between the government and telecommunications service providers is expected to overcome existing investment and regulatory obstacles, thus encouraging the accelerated implementation of 5G technology in Indonesia.

1) *Improved Infrastructure and Investment* : The development of 5G networks requires significant investment

in infrastructure. According to the study, to implement 5G technology, Indonesia must modernize its existing infrastructure, including increasing the density of transmitting stations and using edge computing technology to reduce latency[2]. This shows that while high cost challenges exist, the potential gains from increased. network capacity and speed are huge.

2) *Digital Transformation and the Economy* : The implementation of 5G networks is expected to accelerate digital transformation and improve national economic competitiveness. This technology will support various advanced applications, such as the Internet of Things (IoT), autonomous vehicles, and virtual reality, all of which will play an important role in driving digital economic growth [6]. Research shows that 5G adoption can bring significant benefits to Indonesia's economic growth, with a projected substantial contribution to GDP[2].

3) *Equal Distribution* : 5G networks also have the potential to improve internet access in remote areas. Currently, there are still many areas in Indonesia that are not well served by 4G networks. With the development of 5G, there is an opportunity to reach more people, especially in Frontier, Remote, and Disadvantaged (3T) areas that need better internet access[5].

4) *Regulatory and Infrastructure Challenges :* Despite the enormous opportunities, the development of 5G networks is also faced with a number of challenges that need to be overcome. One of the main issues is the limited frequency spectrum available for 5G networks, which could hamper network capacity and coverage. In addition, the need for better and structured regulation is also an important issue in the implementation of this technology. Clear and adaptive regulations are needed to optimally support the use of 5G, both in terms of technical, investment, and policy. Without proper regulations, the development of 5G infrastructure could be hampered, which in turn will slow down the progress and utilization of this technology in various sectors[2][4]. In addition, Indonesia's geographical condition consisting of many islands makes infrastructure deployment more complex and expensive.

5) *Public-Private Collaboration :* The successful development of 5G networks also depends on collaboration between governments, telecom service providers, and regulators. A strong strategy is needed to address infrastructure issues and ensure a successful transition from 4G to 5G technology[6].

Overall, despite the challenges in developing 5G networks in Indonesia, the potential benefits in improving connectivity, driving digital economic growth, and providing better internet access are immense.

B. Implementation Challenges

The implementation of 5G network technology in Indonesia faces major challenges, especially with regard to supporting infrastructure. One of the main obstacles is the high investment cost required. This is due to the need to build new infrastructure that complies with 5G technology specifications. For example, it requires the construction of gNodeBs, which are the main component in 5G networks, as well as the expansion of fiber optic networks to support them. This high cost is a significant obstacle to the development of 5G networks, especially since additional investment is required to ensure the network can function optimally in accordance with the needs of modern technology[7][8].In addition, one of the major challenges in implementing 5G networks in Indonesia is the uneven network readiness in all regions. This is a complex issue, especially in rural or remote areas, where telecommunications infrastructure is still limited. This imbalance creates gaps in network access, making it difficult to fully implement 5G technology. These conditions complicate efforts to develop 5G networks because they require special attention to ensure the availability of adequate infrastructure throughout the region, including in areas that currently lack access to modern telecommunications[9]. The experience of previous technology deployments, such as 3G and 4G, shows that infrastructure readiness is critical to the successful adoption of new technologies[8].

The limited frequency spectrum is also one of the major challenges in implementing 5G networks in Indonesia. The currently available frequency spectrum is considered insufficient to optimally meet the needs of 5G technology. One of the crucial frequencies, 700 MHz, is still used for analog television broadcasting, hindering full allocation for 5G networks. This condition poses additional challenges for the government and telecommunications service providers in managing the limited spectrum, while finding solutions so that the required frequencies can be immediately transferred to support the development of 5G technology throughout Indonesia[9]. After the implementation of Analog Switch-Off (ASO), the 700 MHz frequency spectrum is expected to be allocated to support 5G networks. However, this process cannot be done quickly because it requires a long time and appropriate regulatory support. This transition involves various stages, such as coordination between related parties, technology adjustments, and the implementation of appropriate policies. In addition, a well-thought-out strategy is needed to ensure that the spectrum can be used efficiently without disrupting other existing services during the transition period. This shows that while the potential of this spectrum is great, its implementation requires comprehensive planning and execution[11][12]. In addition, the 3.5 GHz spectrum that is ideal for 5G is also still being used for fixed satellite services, which requires evaluation and regulatory adjustments.

The digital divide between urban and rural areas is one of the main challenges in implementing 5G networks in Indonesia. Currently, the development of 5G technology tends to be focused on urban areas, given that these areas have greater economic potential and better-prepared infrastructure. In contrast, rural areas are often left behind, both in terms of access to technology and the availability of telecommunications infrastructure. This widens the digital

divide, preventing people in rural areas from directly benefiting from 5G technology. This challenge necessitates specific strategies to ensure equitable access, including the development of infrastructure that supports 5G technology in underserved areas[13][14]. This could widen the digital shadow, as 5G offers much higher speeds and capacities than previous technologies[9]. To address this issue, policies that encourage infrastructure investment in rural areas and ensure more equitable distribution of services are needed[13].

Supportive regulations and policies play a crucial role in overcoming various challenges in the implementation of 5G in Indonesia. The government is expected to formulate policies that are able to encourage investment in this technology sector while ensuring more efficient use of the frequency spectrum. For example, tax incentives can be provided to telecommunications companies to reduce the burden of investment costs, so that they are more motivated to develop 5G networks. In addition, the implementation of infrastructure sharing policies can also be an effective solution, allowing various service providers to utilize shared infrastructure to save costs and speed up implementation. Such strategic measures are expected to accelerate the adoption of 5G technology evenly across Indonesia[10]. In addition, clear and supportive regulations are urgently needed to optimize the use of the frequency spectrum, which is a critical element in 5G deployment. Strict rules regarding spectrum allocation, usage, and management must be well-designed to suit the needs of this technology. Such regulations aim to ensure that the available frequency spectrum can be utilized efficiently and equitably by various service providers. With supportive policies in place, challenges in frequency allocation can be minimized, so that the implementation of 5G networks can run more smoothly and provide maximum benefits for all Indonesians[11]. Without proper regulations in place, the various barriers faced in the implementation of 5G in Indonesia have the potential to become a major hindrance to the development of this technology. The lack of clear rules regarding frequency spectrum management, investment incentives, as well as infrastructure sharing mechanisms could slow down the adoption of 5G in various regions. This will not only slow down the growth of communication technology, but also widen the digital divide between urban and rural areas. Therefore, targeted and supportive regulations are essential to ensure the development of 5G can go according to plan and provide benefits to all levels of society.

5G network deployment in Indonesia faces a number of challenges, such as infrastructure constraints, limited frequency spectrum, and the digital divide between urban and rural areas. Overcoming these requires major investments in infrastructure development, adjustments to spectrum regulations, and policies that support equitable distribution of services. By addressing these challenges, Indonesia can maximize the potential of 5G technology to drive economic and social growth.

c. Socio-Economic Implications

1) *Impact of 5G implementation on the digital economy* : The implementation of 5G technology brings significant socio-economic impacts, especially in encouraging the acceleration of digital technology adoption in the community. The technology enables better access to digital services, such as education and healthcare, which were previously difficult to reach in remote areas. Studies conducted by Ericsson show that 5G connectivity in rural areas can reduce the digital divide by 35% within ten years[15]. In addition, 5G technology is also expected to encourage the growth of entrepreneurial activities by providing better access to technology and digital markets. With higher connection speeds and capacity, businesses can more easily develop innovations and increase productivity. In addition, 5G also has the potential to accelerate the development of people's digital skills, so that they are better prepared to face the needs of the workforce in the technological era. All of this will ultimately have a positive impact on Indonesia's digital economy[16].

2) *Potential to Boost Global Competitiveness* : The implementation of 5G technology in Indonesia has great potential to improve the country's competitiveness in the global arena. By adopting this advanced technology, Indonesia can attract more foreign investors while strengthening its position in international market competition. In addition, 5G technology supports industrial automation and improves operational efficiency, giving Indonesian companies a competitive advantage in the global market[17]. In addition, the utilization of 5G technology allows Indonesia to accelerate the digital transformation process, which is an important element in efforts to improve its competitiveness at the global level[18]. With a robust 5G infrastructure in place, companies can develop technology-based products and services that are more competitive in the global market. According to McKinsey, countries that lead the adoption of 5G are expected to dominate 40% of the global digital economy market by 2030[19].

3) *The Importance of Inclusivity in Technology Implementation :* While 5G technology provides many advantages, it is important to ensure that its implementation is inclusive and does not exacerbate the digital divide. Currently, 5G implementation tends to be more concentrated in urban areas due to economic factors, which risks creating access inequality in rural areas[13]. For this reason, policies that support inclusiveness are needed so that the benefits of 5G technology can be enjoyed by all people without exception. One step that can be taken is to provide tax incentives to service providers to encourage them to expand network coverage to remote areas. In addition, infrastructure sharing policies also need to be implemented to reduce development costs and accelerate accessibility in all regions, including rural areas. With this approach, the implementation of 5G can be done more evenly, so that the benefits can be felt by people from various backgrounds and regions[20].

4) *Challenges and Opportunities in 5G Implementation :* The implementation of 5G technology in Indonesia is inseparable from various challenges that need to be overcome.

One of the main challenges is the readiness of telecommunications infrastructure that is not yet fully adequate to support this technology. In addition, relevant regulations also require adjustments in order to optimally support the implementation of 5G. The combination of these two factors is an obstacle that must be faced to ensure 5G technology can be implemented successfully throughout Indonesia[7]. Behind these challenges, there are great opportunities that can be utilized through the application of 5G technology. These opportunities include the development of innovative business models that meet the needs of the digital era as well as the creation of new market opportunities that can drive economic growth. By resolving these barriers, Indonesia can not only maximize the benefits of 5G technology, but also accelerate its digital transformation process. This will pave the way for the development of strategic sectors and improve national competitiveness at the global level[21].

5) *Socioeconomic Implications :* Overall, the implementation of 5G technology in Indonesia has the potential to have a huge socio-economic impact. This technology is not only able to improve the quality of telecommunications services, but also become a key driver for the creation of various new innovations. In addition, 5G can accelerate the development of the digital economy, which is one of the important pillars in driving overall national economic growth. Thus, this technology is expected to bring significant positive changes to society and the industrial sector in Indonesia[22]. However, it is important to ensure that the implementation of 5G is carried out in an inclusive and sustainable manner, so that all levels of society can benefit[13]. As such, 5G technology will not only be a key catalyst in driving economic growth, but also serve as a means to create greater social and economic inclusiveness. By providing more equitable access to advanced technologies, 5G has the potential to reduce the digital divide and strengthen the participation of different walks of life in economic development.

IV. CONLUSION

The development of 5G networks in Indonesia is an important step in supporting digital transformation and improving the competitiveness of the national economy. The technology offers a range of benefits, including increased network speed and capacity, support for the Internet of Things (IoT), as well as opportunities to accelerate digitalization in strategic sectors such as education, healthcare, and industry. However, 5G implementation also faces a number of challenges, such as the need for large investments for infrastructure modernization, frequency spectrum limitations, and access gaps between urban and rural areas.

To overcome these obstacles, close collaboration between the government, telecommunications service providers, and regulators is required. Supportive policies, such as tax incentives, shared infrastructure, and efficient spectrum planning, are essential to ensure inclusive and sustainable implementation. These strategic measures will not only accelerate 5G adoption, but also help reduce the digital divide in Indonesia.

Overall, 5G implementation in Indonesia has great potential to drive innovation, digital economic growth, and socio-economic inclusiveness. However, the success of its implementation is highly dependent on infrastructure readiness, adaptive regulations, and cross-sector coordination. With a planned approach and the right policy support, Indonesia can capitalize on the 5G opportunity to become a major player in the digital economy in the Southeast Asian region and improve the overall welfare of society.

ACKNOWLEDGMENT

My gratitude goes to Dr. Nasrul, ST, M.Kom as a teaching lecturer who has provided knowledge and inspiration during the lecture process. My gratitude also goes to my family for their prayers and motivation. Criticism and suggestions from readers are very much expected for the improvement of this journal. Hopefully this journal will be useful for the development of science and technology.

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