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Feasibility Study of Fiber Optic Infrastructure Development Plan in Indonesia

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Abstract

Demands for high-speed and reliable internet service significantly increase. Optical fiber, as a transmission media, has better performance and speed when compared to wireless media. However, optical fiber network development is challenging on the last mile mainly due to higher investment costs than wireless networks. This paper presents the feasibility study of the fiber optic network development plan in Indonesia. The analysis showed that the optical fiber network development was not feasible in many regions if it relied only on private sectors. In this regard, the government should facilitate the development of optical fiber networks so that telecommunication operators can develop a network in previously unreachable areas

Keywords
fiber optic; feasibility study; investment cost; revenue

I. Introduction

Fixed broadband service in Indonesia is still unequally distributed. Fiber optic fixed broadband has not reached every district in the country. Ministry of Communication and Informatics of the Republic of Indonesia reports that the fiber optic network covered only 2,562 (35.71%) out of 7,175 districts in Indonesia (Ministry of Communication and Informatics of the Republic of Indonesia, 2021). The following figure 1 displays the country's fiber optic networks, represented by Optical distribution point (ODP).

***Figure 1**. ODP distribution per district*

Equal telecommunication access is vital in supporting a country's economic development. According to Internal Telecommunication Union (ITU), a 10% increase in internet access is correlated with a 1.2% increase in the economic growth of developing countries (ITU,2019). As fixed broadband has not been evenly distributed, the

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telecommunication sector likely finds it challenging to contribute to Indonesia's economic growth.

Despite its unequal distribution, the demand for fixed broadband increases significantly, even in rural areas. Internet is used for various purposes, including education, economy (creative business, online business, micro-, and small-scale business, tourism promotion), health, and other purposes. An Indonesian Internet Service Provider Association (APJII) survey shows that there are 171.2 million internet users, making up 64.8% of the country's population (APJII, 2020).

However, deployment of fixed broadband access in Indonesia is challenging since many facilities and infrastructure are required prior to the deployment, including road infrastructure, electricity, poles, and ducting availability, among others. Hence, designing a technology solution plan and investment assessment is necessary. Technology solutions for telecommunication access deployment in each region may vary depending on geographic conditions. Thus, the accuracy of technology strategy and solution is pivotal. Organization must have a goal to be achieved by the organizational members (Niati et al., 2021). The success of leadership is partly determined by the ability of leaders to develop their organizational culture. (Arif, 2019).

To reach a 60% fiber optic network in 2024, fiberization acceleration at the district level is urgently necessary. Most previous studies focus on the technical aspect of fiber optic (Atsushi Nobiki, 2019; Cardoso et al., 2021; Kang, 2000). Meanwhile, this study focuses on examining the feasibility of fiber optic deployment in Indonesian districts by calculating capital expenditure and demands in each district. This feasibility study is expected to help the government plan the budget and policy for fiber optic network development to reach every community in the country.

II. Research Method

The research method is one of the most important points in a study. It serves as the primary foundation for the next stages of the investigation. The designed steps should be harmonious and integrated (the next steps depend on the previous results), as reasonable steps reflect good thinking processes.

In general, designing research methods help consultants to set the program output and maintain a good, well-planned, organized, and systematic process. The research design should avoid data collection, processing, and concluding mistakes.

This research comprises five main stages as follows:

1. Preparation Stage
2. Data and Information Collection Stage;
3. Data Processing Stage
4. Analysis Stage
5. Reporting Stage

2.1 Preparation Stage

a. Research Problem Formulation and Goal Identification

The first stage of a study is identifying phenomena and indicators of a problem. This is the most crucial stage that may determine the next steps in a study.

In this study context, the problems related to fiber optic network development are as follows:

a. Unequal access to fixed broadband service in Indonesia.
b. Equal telecommunication access is essential to support economic growth.

c. Needs for access to fixed broadband service, particularly the internet, increase even at the village level.
d. It is challenging to deploy fixed broadband telecommunication network in Indonesia.
e. It is necessary to study the fiberization acceleration method at the district level to achieve a target of 60% of districts with fiber optic networks in 2024.

Goal identification is one of the essential steps to set the study purpose. This study aims to examine the fiberization acceleration method at the district level to achieve 60% district with fiber optic network in 2024.

b. Method design and Research Approach

This section presents stages that need to be exercised in this study. It is designed to obtain a complete, systematic depiction to solve the research problem. It is presented in several stages representing the consultant's proposed framework.

This study applied a descriptive analysis; an approach commonly used to map, depict, and describe:

1. The facilitation business model between Telecommunication providers and regional government for easier network deployment.
2. Mapping areas with no ODP or fiber optic to be prioritized in the facilitation program.
3. Road map of Telecommunication Provider-Regional government facilitation until 2024 to achieve the 60% district with fiber optic.
4. Recommendations of policies to support the facilitation program.
5. Feasibility study to calculate costs and benefits of the facilitation program until 2024.

The study was conducted through Focus Group Discussion in Jakarta and several other places. The research object was the fiberization acceleration in Indonesia, especially at the district level. This study reviews the network deployment facilitation business model, mapping of priority areas with no ODP or fiber optic, Road map of facilitation program until 2024, policies to support the facilitation program, and feasibility study to calculate costs.

2.2 Data and Information Collection Stage

Data are empirical representations of a phenomenon, which could be in the form of measures (quantitative, in number) or words (qualitative). It could be described and is observable and is called primary data when it is taken directly from the data sources. Meanwhile, it is called secondary data if it has been processed and documented. Data are categorized into primary and secondary and quantitative and qualitative data.
The following section presents steps in data and information collection:

a. Data and Information Collection Preparation

The preparation was performed to design the next steps through the following activities:

1. Data requirement identification
2. Data source identification;
3. Designing research instrument;
4. Determining data collection technique;
5. Estimating data and information collection period.

While the secondary data could be collected anytime, the primary data collection process should be designed for its time and place (e.g., interview, FGD).

b. Data requirement identification

This section presents the data needed to study the fiberization acceleration method at the district level. Primary data were collected through FGD and regional

government facilitation. They included:

a. Hindrances encountered by telecommunication providers related to:
   - Permit
   - Retribution
   - Funding
   - RoW (*Right of Way*)
   - Non-monopolistic opportunities.

b. Solution from the ministry/institutions and regional government related to:
   - Funding model
   - Permit coordination
   - Ease of Access
   - Tax and retribution incentives.
   - RoW (Right of Way) Coordination.

The secondary data needed in this study included:

a. Feasibility Study and Financial Analysis Data:
   - Size of regencies/municipalities
   - Population density
   - Gross Regional Domestic Product
   - Demand
   - Palapa Ring.

b. Regulation and Laws:
   - Law no. 36 of 1999 on Telecommunication;
   - Law no. 23 of 2014 on Regional Government;
   - Law no. 52 of 2000 on Telecommunication Administration;
   - Presidential Regulation no. 96 of 2014 on the 2014-2019 Indonesian Broadband Plan;
   - Presidential Regulation no. 68 of 2019 on State Ministerial Organization
   - Regulation Minister of Communication and Informatics no 6 of 2018 on organization and Work procedure in Ministry of Communication and Informatics
   - Relevant Regional Government Regulation.

c. Focus Group Discussion (FGD)

A focused group discussion is conducted to collect qualitative data. It usually involves open-ended questions that allow participants to present their answers and underlying explanations.

Before conducting FGD, the discussion topic was set. The questions were developed following the topic and designed in a sequence. Facilitators direct the discussion process using this question guideline.

The FGD participants were fifteen people, including a panelist and facilitator. Participants represent the regulator (ministry of communication and informatics, relevant ministries and institutions, state-owned enterprises, Telecommunication provider association, Telecommunication operators, and regional government.

d. Telecommunication Operator-Regional Government Facilitation Meeting

The facilitation meeting between the telecommunication operator and the regional government is similar to FDG, in which the research team, along with the regulator, telecommunication operator, and regional government, discusses further the need to facilitate fiberization acceleration at the district level.

Participants of the meeting are approximately 15 people, including panelists and facilitators. The invited participants are regulators (ministry of communication and informatics), telecommunication operators, and regional governments. The meeting will be conducted twice.

e. Data and Information Collection

This study collected two types of data relevant to the topic being studied: Primary and secondary data.

a. The primary data included the information obtained directly from focus group discussion and government facilitation, while
b. the secondary data were obtained from documents.

The data and information were collected thoroughly, considering that various factors, such as time, cost, energy, and collection method, may affect data availability.

2.3 Data Processing Stage

In this stage, the data were interpreted into meaningful information to solve the research problem. The data are processed qualitatively and quantitatively.

Quantitative data processing is more measurable due to their parameter, while qualitative data are processed by relying on experts' statements, discussions, and experiences.

This study uses the quantitative method and analysis to find solutions to the research problem. The data are processed in several steps as follows:

1. Compiling relevant regulation
2. Compiling data on the feasibility study and economic analysis:
   - Size of regencies/municipalities
   - Population density
   - Gross Regional Domestic Product
   - Demand
3. Result of Focus Group Discussion (FGD)

2.4 Analysis Stage

The data analysis in this study includes:

1. Priority location mapping;
2. Feasibility study of fiberization deployment to achieve the 60% target.
3. Policy strategy/incentives for fiberization acceleration;
4. Conclusion and Recommendation

2.5 Formulating Deliverables

Following the stages described in previous sections, the deliverables will include:

1. Mapping area with no ODP or fiber optic to be prioritized in the facilitation program.
2. Feasibility study of fiberization deployment to achieve the 60% target.
3. Recommendations of policies to support the facilitation program.
4. Conclusion and Recommendation.

2.6 Data Collection Method

This study collected two types of data relevant to the topic being studied: Primary and secondary data.

a. The primary data included the information obtained directly from focus group discussion and government facilitation, while
b. the secondary data were obtained from documents.

Since this study applied a quantitative approach (Fossey, 2022), the data processing activities could be divided into several steps:

1. Compiling relevant regulation
2. Compiling data on the feasibility study and economic analysis:
   - Size of regencies/municipalities
   - Population density
   - Gross Regional Domestic Product
   - Demand

III. Result and Discussion

3.1 Mapping of District deemed requiring ODP

The mapping conducted in this study includes:

- Mapping of regions with ODP and without ODP.
- Mapping regency/ municipality condition in terms of size, population, local economic potential, and fiber optic network availability.

Mapping districts with no ODP indicates the absence of fiber infrastructure in such areas. Data shows that Indonesia has 7195 districts, and 4175 districts have already had ODP, while 3020 districts have not had ODP. Table 1 displays ODP availability in terms of the province.

Table 1. Percentage of ODP availability per Island Group

No.	Province	No ODP	ODP
1	SUMATERA	43.12%	56.88%
2	JAWA - BALI	3.00%	97.00%
3	KALIMANTAN	47.98%	52.02%
4	SULAWESI	46.77%	53.23%
5	MALUKU -PAPUA	88.34%	11.66%
6	NUSA TENGGARA	60.09%	39.91%

Data on districts without ODP were further filtered to identify areas that urgently need fiber optic network deployment. In this study, the maximum cable length was 30 KM. The filter also includes twenty-three tourism destinations prioritized by the government. The following table 2 presents the data filtration results.

Table 2. Number of proposed districts

Island	Max 30 km	Description
Prioritized Tourism Destination	23	All
Sumatera	230	
Java - Bali	44	One inter-island/microwave
Nusa Tenggara	22	
Kalimantan	13	
Sulawesi	82	Two inter-island/ microwave
Maluku + Papua	2	One inter-island/microwave
Total	**416**	

3.2 Cost-Benefit Analysis

Cost is calculated using investment and operating expenses (Aji et al., 2017), while the benefit is calculated based on potential revenue from fiber optic network service in the area.

3.3 Investment cost

After figuring out districts requiring fiber optic deployment, the next step was calculating the total investment cost needed for those districts (n=416).

The total investment is estimated by referring to the architecture displayed in Figure 2. An optical network architecture in this study relates to the access network that uses fiber from Station Telecommunication Office to the user device.

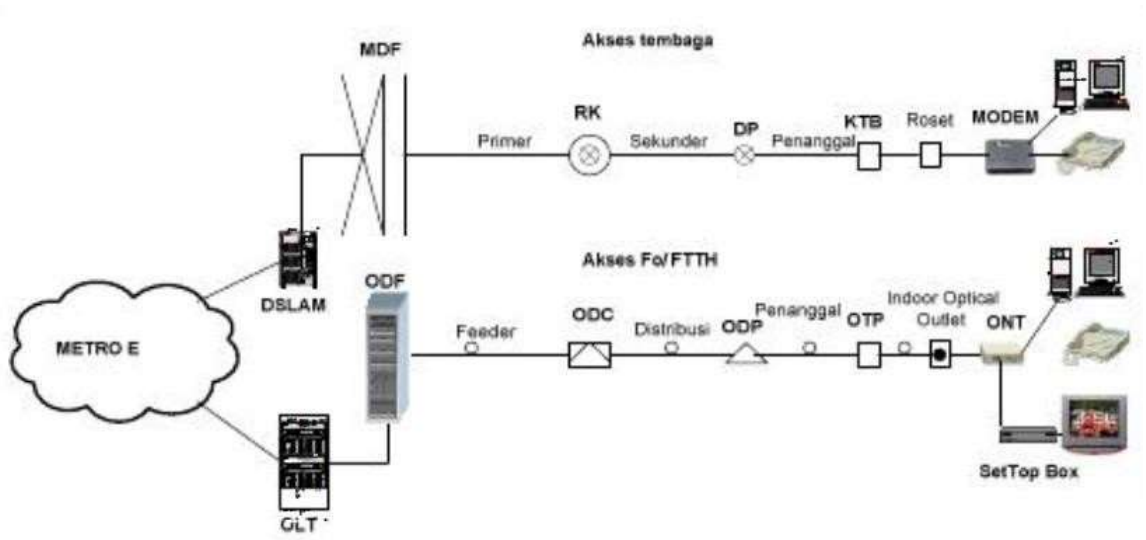

Figure 2. *Fiber and Copper Network Analogy*

Like the copper access network that contains supply segments, the optical access network also has feeder cables, distribution cables, drop cables, indoor cables, and active devices like OLT and ONU/ONT. Thus, the investment cost is calculated based on the following elements:

1. Procurement and Installation of aerial optical fiber cable Mode G 652 D (including a permit from the regional government, public work agency, and local people).
   Investment value = Multiplication of the distance between a district with ODP and the district where broadband optical network in meter unit and (material cost/meter plus service cost/meter).
2. Pole procurement and installation for aerial cable, casting foundation, accessories, and groundings.
   Investment value = division of the distance between a district with ODP and the district with the broadband optical network in meter units by 50 meters and multiplied by per unit material and service costs.

3.4 Operating Costs

The cost of network deployment and fiber optic broadband is estimated by considering the following elements:

1. Operating costs of technical and administrative human resources.
2. Operating costs of resources and supporting facilities (space/ building/ car

rental, etc.).
3. Operating cost of spare part procurement
4. Operating cost of marketing management
5. Operating costs of technical and administrative human resources.
6. Tax and non-tax expenditure
7. Usage of right cost frequency spectrum if radio communication network development is required.
8. Other costs
   Operational expenditure is estimated based on the district's assumption and data on network and broadband optical service costs. Its value ranges between 15%-30% of the investment in fiber broadband infrastructure.

3.5 Benefit Analysis

The benefit is estimated based on the potential revenue of network providers by providing optical fiber in the area with no network. Network Service Revenue is calculated using the following methods:

1. Network and broadband optical service revenues are calculated based on estimated demand, represented by a unit of FTTH customer. Estimated demand is represented by the most realistic number of customers, given that the end goal is to calculate the revenue. The estimated revenue is calculated by multiplying the average annual subscription price by the estimated number of FTTH customers. Estimated demand = number of households born by broadband optical service customer penetration in the district. Penetration is assumed to range between 1%-7% of the total family number.
2. Network and optical broadband service revenue are calculated based on the estimated MAXIMUM household spending for optical service (assumed to be 5-10% of Gross Regional Domestic Product per capita). Thus, network service and broadband optical service revenue are estimated by calculating estimated population spending for optical service (max= 10%) and multiplying it by gross regional domestic product per capita and total population.

The final calculation of network service revenue and broadband optical service is done as follows:

a. Revenue equals calculation result point 1 if the result is less than calculation result point 2.
b. Revenue equals calculation result point 2 if the result is less than calculation result point 1.

Cost-benefit calculation result showed that the total investment equals Rp. 596.4 Billion. Meanwhile, the operating cost and the total annual revenue were Rp. 119.3 billion and Rp. 163.7 billion, respectively, implying a surplus.

3.6 Feasibility Study Calculation

Economic feasibility is determined by calculating the cost of Broadband fiber infrastructure in all districts, provider revenue, and economic feasibility. Each calculation is presented in the following table.

Districts considered feasible in this desk study are those with a rate return higher than the Bank Indonesia Certificate and a Payback Period of fewer than five years. Table 3 partially presents the Feasibility Study Results. Due to the page limitation, this paper only shows 20 of 416 calculation results.

Table 3. Feasibility Study Calculation Result

No.	Provincial Government	District	Infrastructure Cost (IDR)	Operating and Maintenance Cost (IDR)	Average annual revenue (IDR)	kEconomic Feasibility
1	NTB	Janapria	850106615	195524521	1691800000	FEASIBLE
2	NTB	Southwest Praya	569963115	131091516	1156000000	FEASIBLE
3	NTB	Sembalun	1547485115	355921576	471360000	Not Feasible
4	NTT	Northwest Alor	2232942615	513576801	459220000	Not Feasible
5	NTT	Kelimutu	969316615	222942821	139840000	Not Feasible
6	NTT	West Satarmese	3013768115	693166666	378880000	Not Feasible
7	NTT	Sano Nggoang	3395240115	780905226	284580000	Not Feasible
8	NTT	Boleng	2811111115	646555556	378500000	Not Feasible
9	NTT	Mbeliling	1958759615	450514711	275160000	Not Feasible
10	NTT	East Poco Ranaka	3425042615	787759801	532000000	Not Feasible
11	NTT	Golewa	760699115	174960796	378280000	FEASIBLE
12	NTT	Bola	1309065115	301084976	215940000	Not Feasible
13	North Sulawesi	South Likupang	605726115	139317006	115800000	Not Feasible
14	North Sulawesi	West Likupang	1350788615	310681381	360400000	Not Feasible
15	North Sumatera	Silahisabungan	1440196115	331245106	104840000	Not Feasible
16	North Sumatera	Baktiraja	1374630615	316165041	151600000	Not Feasible
17	North Sumatera	Paranginan	796462115	183186286	296300000	Not Feasible
18	North Sumatera	Palipi	1553445615	357292491	364180000	Not Feasible
19	North Sumatera	Ronggur Nihuta	1237539115	284633996	193840000	Not Feasible
20	North Sumatera	Harian	1154092115	265441186	187940000	Not Feasible

IV. Conclusion

Based on the calculation result, the following conclusions are drawn:

- Districts considered feasible in this desk study are those with a rate return higher than the Bank Indonesia Certificate and a Payback Period of fewer than five years.
- Based on the economic feasibility study on 416 districts based on population, geographic, and potential economic mappings, ninety-four districts were deemed feasible, whereas 322 districts were deemed not feasible.
- This result shows that central and regional governments should facilitate telecommunication providers to build fiber infrastructure in districts with no ODP.

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