Business Analysis of Submarine Cable System Network Development Driven By Indonesia's New Capital Relocation using NPV, IRR, and PBP Methods

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Abstract. The province of East Kalimantan has good market potential, due to the relocation of Indonesia's capital city to East Kalimantan. Based on the results of population projections, it is estimated that in 2040 the population in East Kalimantan will reach 189.917.791 inhabitants. Unfortunately, there is only one landing station that connects East Kalimantan with the internet network, the Balikpapan landing station. This study conducted an analysis of the placement of landing station based on potential internet users, geographical conditions, network feasibility based on the value of Bit Error Rate (BER), Quality Factor (Q-Factor), Power Received, and business feasibility by the Net Present Value (NPV), Internal Rate of Return (IRR), and Payback Period (PBP). The technical simulation result showed BER value $3,94E^{-32}$, Q-Factor 11,7147, and power received -18,8614 dBm. Besides, for Capital Budgeting simulation results show that it takes 4 years 3 months for the PBP, NPV > 0 and, IRR of 31 %.

Keywords: Submarine Cable Network, Net Present Value, Internal Rate of Return, Payback Period, Indonesia Global Gateway (IGG).

1 Introduction

The Internet user is increasing rapidly based on a survey conducted by the Indonesia Internet Service Providers Association (APJII), there has been an increase in internet usage of 10,12 % in one year for the 2017-2018 period, from 54,65 % to 64,8 % [1]. West Kalimantan as the province that contributes the most to internet users on the island of Kalimantan with a percentage of 2,1 % has been handled by two SCCS networks connected to the Indonesian backbone network through the JASUKA (Java-Sumatra-Kalimantan) and JaKa2LaDeMa (Java-Kalimantan-Sulawesi-Denpasar-Makassar) [2]. Meanwhile, East Kalimantan which contributes 1,7 % of internet usage in Indonesia, only has one landing station connected to the Indonesia Global Gateway System (IGG network) through Balikpapan City [2]. Based on the increasing teledensity of internet usage in Indonesia and the factor of the movement of the Indonesian Capital to the Province of East Kalimantan, precisely between Kutai Kartanegara (blue boundaries) and Panajam Paser Utara (white boundaries) as shown in Fig 1, it is worried that this landing station will not be able to meet the very high user surges. As a comparison, in 2018 DKI Jakarta as the Capital City of the country with a population of 10,4 million inhabitants [3], with internet usage penetration of 80,4 % [1], there were at least 8.361.600 internet users in DKI Jakarta, whereas, in East Kalimantan with a population projection in 2040 it reached 189.917.891 people, with a projection of internet usage of 67,8 % (assuming the same in 2018), there were at least 128.764.330 internet users.

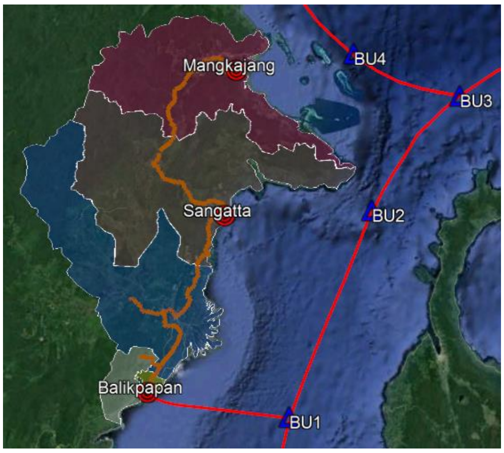

Fig. 1. Existing Landing Station Based on the Nation's Capital [2].

At present, the Province of East Kalimantan is only connected to one landing station via the Balikpapan Landing Station as shown in Fig 1, the challenge faced with the current conditions is the distance and geographical conditions in the area, considering that the optical cable affects the distance, which is the longer a link, fiber loss produced will be even greater (db/km) [4]. For example, as in Fig 2, the distance between the Balikpapan landing station and the central Tanjung Redep is 815 km, which if there is an additional Mangkajang landing station, the distance between the Mangkajang landing station and the central Tanjung Redep is only 70 km [2], in addition to producing the fiber loss that is not too large, cutting the distance in the terrestrial network is expected to reduce the potential for disruptions caused by natural disasters such as forest fires and landslides [5], considering the conditions in the Province of East Kalimantan which is mostly in the form of peatlands. It is important to know based on the recapitulation of forest and land fires that occurred in Indonesia from January to September 2019, an area of 500.560 square meters has occurred forest and land fires in East Kalimantan Province [6]. If in the future there are serious forest fires, it is worried that the terrestrial cable network that is planted in the Eastern Kalimantan region will experience cable faulty [5]. If there is a cable faulty in the terrestrial network in the area, there is a possibility of blackouts in the capital city because there are not enough backup links to cover internet services. Of course, this is a serious problem, because it covers state security (cybersecurity) if the internet network in the capital region dies entirely.

Therefore, this paper would examine the addition of a new landing station in Sangatta and Mangkajang that are connected to the IGG network to anticipate these problems. Indonesia Global Gateway System (IGG) network is one of the internet networks (backbone) in Indonesia, owned by one of the national telecommunications companies in Indonesia. IGG network has two international gateways that connect Indonesia with other countries, East Asia-Middle East-Western Europe 5 network (SEA-ME-WE 5 and South East Asia-United State (SEA-US). By connecting Indonesia with the SEA-ME-WE 5 and SEA-US networks, Indonesia can provide alternative direct backbone connections between Europe, Asia, and America [7].

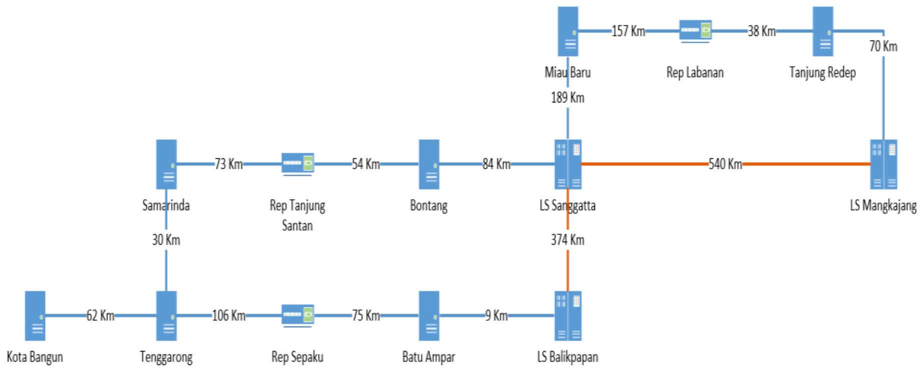

Fig. 2. Terrestrial Network Topology and SCCS Network.

2 Methodology

2.1 Bit Error Rate

Since Bit Error Rate (BER) is a statistical parameter, its value depends on the measurement time and on the factors that cause the errors. If the errors are due to Gaussian noise in a relatively stable transmission link, then a measurement time in which about 100 errors occur may be needed to ensure a statistically valid BER determination. Longer measurement times may be needed to ensure a statistically valid BER determination. Longer measurement times may be needed for systems in which bursts of errors can occur. For high-speed communications, the required BER typically needs to be 10^{-12} or lower. As an example, for a 10 Gb/s links a 10^{-12} BER means that one-bit error occurs every 100 seconds, such a level may be unacceptable, so even lower BER, such 10^{-15}, may be required to assure customers of a high grade of service [4].

2.2 Minimum Receiver Sensitivity

The receiver sensitivity is defined for the worst-case and end-of-life as the minimum acceptable value of mean received optical power at point Multi-Path Interface at the Receiver (MPI-R) to achieve a BER of $1x10^{-12}$ [8]. Power receive is determined by attenuation that occurs as long as the signal is sent, such as power transmit, cable loss, device attenuation, and amplifier gain on the network [4]. The minimum optical power received that is allowed usually depends on the type of Small Form-factor Pluggable (SFP) used, usually, the received power does not exceed a predetermined threshold, which is -40 dBm to +5 dBm [9].

2.3 Net Present Value

Net Present Value (NPV) is calculated as the difference between the discounted value or discounted cash flow (DCF) of future income and the amount of the initial investment. If the NPV value generated is positive or more than the value of the investment, then a project can be interpreted to be profitable. Conversely, if the NPV is negative or less than the value of the investment, then a project can be interpreted to be a loss or not profitable. If the NPV is 0 or the same as the investment value, then the project can be interpreted to be unprofitable and not loss-making [10].

2.4 Internal Rate of Return

Based on the interest rate or capital costs obtained in this condition (NPV equal to zero), known as the Internal Rate of Return (IRR). In other words, the IRR is the interest rate at the time the initial investment is equal to the future value of the cash flow for the life of the project or investment in progress. The greater the IRR value of a project the more profitable [10].

2.5 Payback Period

The payback period is the period required to recoup an investment expenditure initial cash investment using cash flow. In other words, PBP is the ratio between initial cash investment and cash flow where the disbursement of PBP is in the form of a time unit [10]. PBP rule is applied are different from the cash flows to which the NPV is applied, this is because the PBP does not involve DCF, whereas the NPV with most other capital budgeting decision rules is based on discounting consideration [11]. The investor can use the payback period to make quick judgments about their investment.

2.6 Submarine Technology

Telecommunication technology achievements represented by the exponential growth of internet traffic have resulted in the technical availability to satisfy the foreseen intense demand for broadband services. Almost all types of traffic are expected to run over the internet. Therefore the demand for transmission bandwidth will be huge in the near future. New technologies as Dense Wavelength Division Multiplexing (DWDM) and other emerging photonic technologies are expected to be necessary for solving those problems. The development of transmission systems based on DWDM technology, like Optical Crossconects (OXC), Reconfigurable Optical Add-Drop Multiplexers (ROADM), and optical amplifiers will make the possible building of completely optical networks where all information will be transmitted and processed entirely in the optical domain [12].

Multi Protocol Lambda Switching (MPλS) as an extension of Multi Protocol Label Switching (MPLS) will extends the label-switching concept to include wavelength-route and-switched lightpaths. As its name implies, in MPλS the wavelength of the light serves as its label. The technology can be considered to be a simplified version of MPLS without label stacking or per-packet forwarding. These are several synergies between Label Switching Router (LSRs) and wavelength switches, and between a Label Switched Path (LSP) and an optical channel trail. In analogy to switching labels in an LSR, an optical switch switches wavelengths from input to output port. As in LSRs, the photonic switch needs routing protocols like Open Shortest Path First (OSPF) and Intermediate System to Intermediate System (IS-IS) to exchange link-state topology and other optical resource availability information for path computation. They also need signaling protocols like Resource Reservation Protocol (RSVP) and Label Distributing Protocol (LDP) to automate the path establishment process [12]. MPλS intended to cover the shortcomings of MPLS, which in MPλS allows being able to control in the domain optics [13].

3 Simulation Scheme

Based on data released by the Central Bureau of Statistics (BPS) for 2012 to 2020, population projections are made for the next twenty years in East Kalimantan Province will be carried out using the arithmetic methods and geometric methods. After obtaining the population projections data, a desktop study was conducted to determine network configuration and selection of lane with the placement of landing stations following applicable regulations. After knowing the network configuration based on a desktop study, a simulation of the network is carried out by taking into account the output value in the form of a minimum BER, Q-Factor, and power received. Finally, conducting business feasibility analysis using the NPV, IRR, and PBP methods.

3.1 Population Projection

In carrying out population projections, two approaches are used, the geometric method and the arithmetic method. The geometric method assumes that the population will increase geometrically using the basis of compound interest calculation, the rate of population growth is considered to be the same for each year [14]. The arithmetic method assumes that the population in the future will increase by the same amount each year [14].

Table 1. Projected Population of the Capital Area for 20 Years.

City	Population of 2020	Rate of Growth	Population of 2040
Kutai Kartanegara	802.903	2,43 %	41.192.985
East Kutai (Sangatta)	390.991	4,37 %	28.666.762
Berau (Mangkajang)	238.214	2,84 %	13.191.913
Panajam Paser Utara	162.518	1,19 %	6.572.010
Balikpapan	664.201	1,66 %	29.450.750

3.2 Selection of Paths and Landing Station

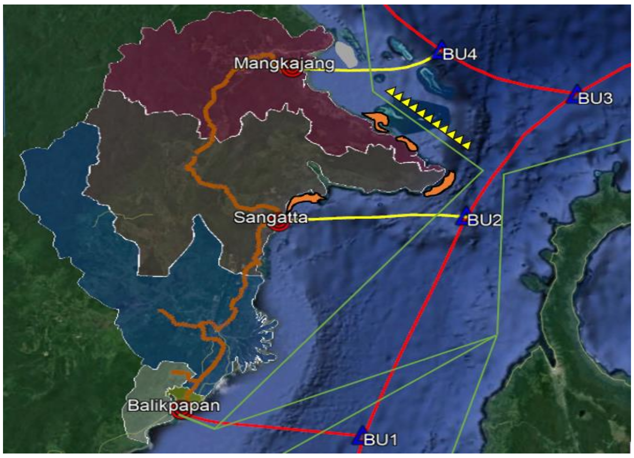

Fig. 3. The Placement of Landing Station and Selection Lane.

Based on the statement of the President of The Republic of Indonesia regarding the relocation of the capital that will move from Jakarta to East Kalimantan [15], the province of East Kalimantan is expected to experience a surge in population in the next few years, as seen in Table 1. In determining the landing station placement, in addition to considering the projected population as a request, it also considers the shipping lanes, ports, and sea geographic in the area that will be used as the landing station. Fig. 3 shows the location of the construction of the landing station with the proposed lane that will be built. The red line represents the existing path of the SCCS, the yellow line shows the SCCS path that will be built along with its landing station, the green line shows the shipping lane, the gray boundary means that the area consists of hard and gravel rocks, orange boundary means fringing reefs, and yellow triangles indicate barrier reefs [16].

3.3 Network Simulation

The system design in this paper is based on an analysis of field data and data used by one of the national telecommunications companies in Indonesia. It assumed that are 20 channels (wavelength) that will be transmitted. From the landing station Balikpapan (BTA) brings 20 wavelengths for communication to the Sangatta landing station (SG1), and Sangatta landing station (SG1) brings 20 wavelengths for communication to the Mangkajang landing station (MK1). Table 2 shows a simulation result that has been done.

Table 2. Simulation Result.

Link	Length (km)	Power Rx (dBm)	BER	Q-Factor
BTA-SG1	374	-5,7747	$2{,}79E^{-32}$	11,7421
SG1-MK1	540	-18,8614	$3{,}94E^{-32}$	11,7147

3.4 Business Analysis

Table 3. Assumption Bill of Quality.

Description	Scope	Unit Cost (IDR)
OSP Wet Plant	540 km	39.260.000.000
Equipment & Service	2 NOC	17.335.187.000
Sitac	2 NOC	1.543.455.000
Civil & ME	2 NOC	1.687.000.000
Rectifier	2 NOC	500.000.000
Generator 45 KVA	2 NOC	406.558.000
Optical Power Meter	2 NOC	60.000.000
OTDR	2 NOC	150.000.000
Laptop	2 NOC	30.000.000
Total		60.972.200.000

Table 3 shows the assumption for the Bill of Quality (BoQ) for the new landing station or Network Operation Center (NOC), which are the Mangkajang landing station and Sangatta landing station. This BoQ becomes a reference to determine the amount of network rental prices to be offered as seen in Table 5. With the worst assumption, that there are only two tenants who rent the networks for the Balikpapan-Sangatta-Mangkajang link (STM-16 / 2,5 Gbps) with a rental fee of 206.080.000 IDR for one tenant each month, an income is earned in one year is 4.945.920.000 IDR for two tenants. Based on annual income, the amount of PBP, NPV, and IRR can be determined as seen in Table 4, using interest rates of 5 % and 30 % [17], Cost of Goods Sold (COGS) 10 %, Operational Expenditure (OPEX) 10 %, Capital Expenditure (CAPEX) 10 %, and TAX 25 %. Income in Table 4 is net income after deducting COGS, OPEX, CAPEX, and tax.

Table 4. Payback Period (PBP).

Years	Income (IDR)	Remaining Invest (IDR)	PV 5 % (IDR)	PV 30 % (IDR)
1	4.451.328.000	(56.520.872.000)	4.239.444.787	3.423.961.498
2	10.905.753.600	(45.615.118.400)	9.891.518.515	6.452.934.405
3	16.358.630.400	(29.256.488.000)	14.130.584.940	7.446.448.558
4	21.811.507.200	(7.444.980.800)	17.944.326.973	7.636.208.671
5	27.264.384.000	19.819.403.200	21.361.644.864	7.342.298.611
6	32.717.260.800	52.536.664.000	24.413.620.009	6.779.016.438
7	38.170.137.600	90.706.801.600	27.127.516.792	6.084.319.933
8	43.623.014.400	134.329.816.000	29.524.056.146	5.348.181.565
9	49.075.891.200	183.405.707.200	31.634.319.468	4.627.856.540
10	54.528.768.000	237.934.475.200	33.475.210.675	3.953.335.680
11	59.981.644.800	297.916.120.000	35.071.267.715	2.807.140.977
12	65.434.521.600	363.350.641.600	36.433.941.627	2.339.284.147
13	70.887.398.400	434.238.040.000	37.591.587.372	1.939.042.990
14	76.340.275.200	510.578.315.200	38.559.473.004	1.594.966.464
15	81.793.152.000	592.371.467.200	39.342.506.112	1.308.690.432
16	87.246.028.800	697.617.496.000	39.967.405.793	1.308.690.432
17	92.698.905.600	772.316.401.600	40.444.532.513	1.075.307.305
18	98.151.782.400	870.468.184.000	40.782.065.587	873.550.863
19	103.604.659.200	974.072.843.200	40.996.363.645	704.511.683
20	109.057.536.000	1.083.130.379.200	41.103.785.318	578.004.941
PV From Income (IDR)			604.035.171.855	75.662.037.481
Investment (IDR)			60.972.200.000	60.972.200.000
NPV			543.062.971.855	14.689.837.481

4 Discussion

4.1 Landing Station Placement and Network Path

According to Table. 1, Kutai Timur (Sangatta), and Berau (Mangkajang) were chosen as landing station locations because they have quite large population projections. In 2040, the two regencies are projected to have a population of 28.666.762 and 13.191.913 people respectively. Kutai Kartanegara (blue boundaries) is not used as a landing station location, because network distribution will be more efficient if it is channeled through the Balikpapan landing station rather than having to create a new landing station, as seen in Fig 2. The grey boundaries as seen in Fig 3 meaning that the area consists of hard rock and gravel, the orange boundaries and yellow triangle meaning fringing reef and barrier reef, the cable cannot pass through this area, because it will potentially damage the cable itself and potentially damage by the existing marine ecosystem. The green line meaning the shipping lane on the East Kalimantan coast, which is not a problem, because the shipping lane is not parallel with the cable lane to be built [18]. Fig 3 shows the landing station placement and network path that will be built.

4.2 Simulation Result

From the simulation results that have been carried out, obtained a good output value, so that the construction of the Sangatta-Mangkajang link can meet the specification standards as seen in Table. 2. The standard for minimum BER value is $1x10^{-12}$ [8], the power received not exceed a predetermined threshold, which is -40 dBm to + 5 dBm [9], and Q-Factor minimum is 6 [19]. By using the Reconfigurable Optical Add/Drop Multiplexer (ROADM) located in the branching unit (BU), it will make the possible building of completely optical networks where all information will be transmitted and processed entirely in the optical domain [13].

4.3 Business Analysis

Table 5. Assumption Rental Prices.

Link	Length	STM-4	STM-16	STM-64	STM-256
BPP-SG1	374 km	43.000.000	184.000.000	445.600.000	500.000.000
SG1-MK1	540 km	50.000.000	73.600.000	250.000.000	360.000.000
BPP-SG1-MK1	914 km	74.400.000	206.080.000	556.480.000	688.000.000

The network rental price will determine whether the investment from the Mangkajang-Sangatta network is profitable or not. Table.5 shows the assumption rental prices for one month in IDR. Assuming a minimum of two tenants with the Balikpapan-Sangatta-Mangkajang link with STM-16 (2,5 Gbps), with a selling price of 206.080.000 IDR per month, the revenue earned in one month is 412.160.000 IDR, and for income in one year 4.945.920.000 IDR. Then we get a payback period for 4 years 4 months as seen in Table 4, with an NPV value for 5% interest rates of 543.062.971.855 IDR, and for 30 % interest rates of 14.689.837.481 IDR, with an IRR of 31 %. Because the NPV value is positive or more than the value of the investment, and IRR value greater than initial interest rates, then a project can be interpreted to be profitable.

5 Conclusion

Based on the discussion above, the construction of the SCCS network for the Sangatta-Mangkajang link to meet the demands of the Indonesia capital city region is very profitable based on the projection that the population in 2040 will reach 189.917.891 inhabitants. BER obtained from the link with a distance of 540 km is

3,94E^{-32}, Q-Factor 11,7147, and power receive -18,8614 dBm. In terms of business, investment in this project can be said to be profitable, with a project lifetime of 20 years, obtained PBP for 4 years 3 months, NPV value 543.062.971.855 IDR, and an IRR of 31 %. The determination of the leased line rental assumption greatly affects the value of NPV, IRR, and PBP.

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