Feasibility Analysis of Implementation 3G Macro Additional Sector JABO Area using Techno-Economic Approach

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Abstract
The increasing number of operators, making competition in the telecommunications industry are becoming increasingly stringent. These circumstances spurred operators to compete in achieving the best quality of services. Macro Additional 3G Sector (LTC) Project is one effort of the operator in maintaining the quality of data services. The general philosophy of the design of telecommunications networks are getting the best performance with minimal implementation costs. In this work will be analyzed with the techno-economic approach for the feasibility of the implementation of 3G Macro Additional Sector Project by operator telecommunication in Jakarta**.** Analysis model used is based on the principle of techno-economic by throughput and number of user approach with bottom-up models, to determine the design of 3G Macro Additional Sector Project, and then measure the feasibility of the costs incurred for the implementation of 3G Macro Additional the Sector Project.

Keywords*:* Low Throughput, users demand,, Revenue, CAPEX, OPEX, NPV, IRR, PBP

Abstrak
Meningkatnya jumlah operator, membuat persaingan di industri telekomunikasi menjadi semakin ketat. Keadaan ini membuat operator bersaing dalam mencapai kualitas layanan terbaik. Proyek Macro Additional 3G Sector (LTC) merupakan salah satu upaya operator dalam menjaga kualitas layanan data. Filosofi umum perancangan jaringan telekomunikasi mendapatkan kinerja terbaik dengan biaya implementasi minimal. Dalam karya ini akan dianalisis dengan pendekatan tekno-ekonomi untuk kelayakan pelaksanaan Proyek Sektoral Macro Macro oleh operator telekomunikasi di Jakarta. Model analisis yang digunakan didasarkan pada prinsip tekno-ekonomi melalui throughput dan jumlah pendekatan pengguna dengan model bottom-up, untuk mengetahui disain Proyek Sektor Tambahan Makro 3G, lalu mengukur kelayakan biaya yang dikeluarkan untuk implementasi 3G. Makro Tambahan Proyek Sektor.

Kata kunci: Throughput rendah, permintaan pengguna, Pendapatan, CAPEX, OPEX, NPV, IRR, PBP

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1. BACKGROUND

The development of Internet technology and wireless communication have changed the pattern of users of telecommunications services to stay connected and serviced anywhere, anytime and any application. Number of Internet users in Indonesia increased from year to year. Based on data from APJII, the data of internet users in 2006 reached 16 million, and increased from year to year, so that in 2012 reached 60 million. APJII projecting Internet users in 2015 reached 139 million. Increasing the number of Internet users is not separated from the 3G technology that makes it easy for Internet users to access mobile data. Increasing the number of subscribers will have an impact on the quality of data to be received. More users are accessing the data, then the quality will decline. The pattern of communication needs can be met with unlimited resources via the internet, especially on 3G networks. But along with these developments, experiences and satisfaction of users of telecommunications services are still not fulfilled as expected due to the speed and services are still limited. Besides, the number of data users is increasing every day.

It is a challenge for operators to always be able to meet the expectations of customers so that business operations can continue. Therefore operators try to implement 3G Macro Additional Sector Project which is expected to meet rising demand and customer satisfaction, particularly in data services. Here is the background of the problem that caused the operator to implementing 3G Macro Additional Sector Project:

1. The increasing number of users in the service of HSDPA.
2. The discovery of 3G cells which is very low throughput (below 400 Kbps) in the area with the number of users more than 40.
3. Prediction of 3G traffic will continue to increase along with the increasing number of subscribers and the volume of capacity required to meet the needs of customers annually.
4. Due to the three things above (high user, high traffic and low throughput) are advised to do the sharing for 3G traffic, this can be done in two ways:
    1. Develop / contruction of newsite.
    2. 3G Macro Additional Sector

2. LITERATURE REVIEW

Previous research related to this research are as following below:

1. Analisa Perbandingan Perancangan dan Kelayakan Implementasi Jaringan LTE dan wimax di Area Urban, Sub Urban dan Rural dengan pendekatan techno economy by Usep Taufiq Hidayat [18]

   In this research do the economic analyzed for implementation of LTE Release 10 network and mobile WiMAX on Surabaya. Determined of number of sites do by using methode of overage and capacity analysis. Result of number of sites needed obtained by looking at the highest number of sites based on result of coverage and capacity analysis. Based on overall

analysis show that mobile WiMAX implementation is more feasible compare to LTE implementation as shown as economic factor.

2. Analisa Biaya Pembangunan dan Dimensioning Jaringan Layanan Broadband Berbasis Long Term Evolution (LTE) Area Jakarta Barat by Usmiati .[19]
   In this research implementation of LTE release 8 on operator's existisng network by using co-existance scenario analyzed by technology and economic. Analysis model used is based on the principle of techno economic using capacity and coverage estimation methode to determine the design of LTE technology and the DCF method to analyze and measure the economic feasibility of costs incurred for the LTE implementation.

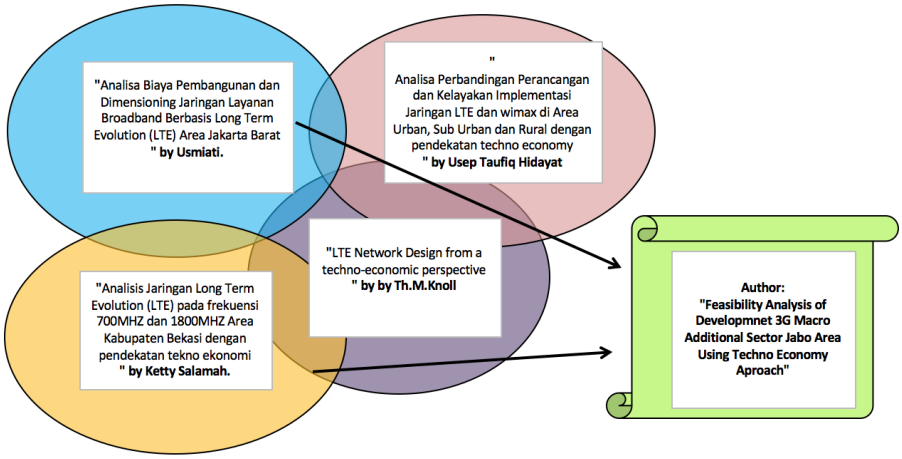

Figure 2.1. Venn Diagram of Research

3. Analisa Jaringan Long Term Evolution (LTE) pada frekuensi 700MHZ dan 1800MHZ Area Kabupaten Bekasi dengan pendekatan tekno ekonomi by Ketty siti salamah [7].
   Objective of this research is to provide the overview of site needed for implementation of LTE technology on frequency 700MHz and 1800MHz. using CBA method to analyzed economically and measure feasibility cost incurred for LTE implementation. Two scenario are used and distinguished by two frequencies, 700MHz and 1800MHz also by bandwidth 5MHz, 10MHz, 15MHz, and 20MHz. In order to make LTE implementation is feasible research result shown minimal bandwidth needed is 15MHz. Based on research result, in order to having LTE implementation is feasible research result minimal bandwidth needed is 15MHz.
4. Analisis LTE Network Design from a techno-economic perspective by Knoll, T.M.[8]
   The current roll-out of Long Term Evolution (LTE) mobile networks evolves ex- isting mobile networks towards homogeneous IP based next generation mobile net- works. Many technological options and migration paths are possible for this network evolution and operators and vendors need to find out, which solution and which tim- ing satisfy the roll-out objectives at minimal short-term and long-term cost. It is therefore

necessary to model the incurred capital expenditures (CAPEX) and operational expenditures (OPEX) in order to estimate the total cost of ownership (TCO) of the resulting setup. The conference contribution outlines the respective model aim, structure and assumptions based on a simple LTE roll-out example scenario and gives an overview on the techno-economic results.

2.1 3G Network Architecture

In principle, the transmission on the UMTS radio interface is different from the GSM 2.5G stage. therefore introduced UTRAN as the new RAN in UMTS.

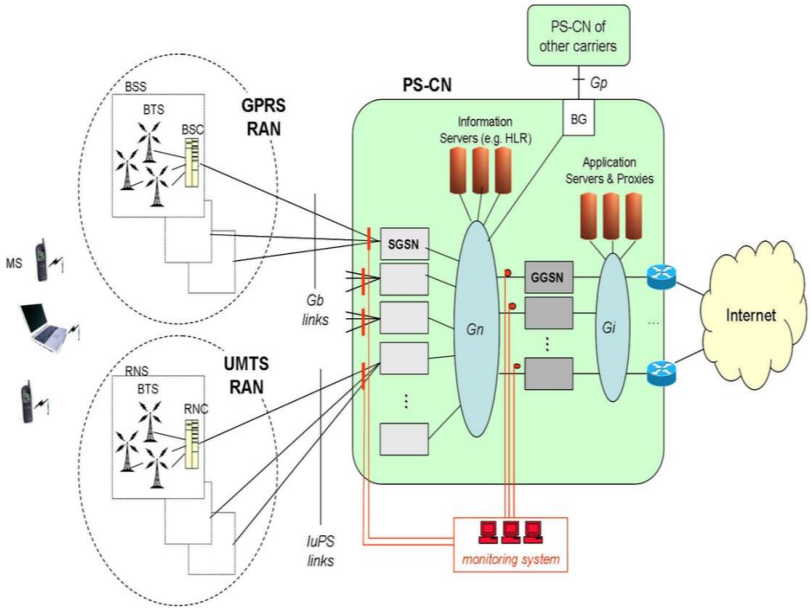

Figure 2.2 3G network architecture [2]

1.UTRAN

UMTSRAN consists of a radio network system (RNS) where each RNS includes RNC. Iub interface is open, meaning that the network operators can obtain from one vendor Node B and RNC from other vendors.

2. RNC

RNC controls the Node B called the CRNC (controlling RNC). CRNC responsible for manage the radio resources available to the Node B. RNC linking the EU and CN called SRNC (serving RNC).

3.Node B

Node B is the physical unit to send / receive frequencies in the cell. Single Node B can support both FDD and TDD mode and can be co-located with the GSM BTS.

2.2 Economic Model

Techno economic models commonly used in the telecommunications field is a bottom-up models. This model was chosen because it is quite common and comprehensive provides guidance for identifying inputs, outputs and function models. This model is also quite comprehensive because it provides all the basic parameters of the NPV calculation, and already qualified enough types of parameters used in the techno economic analysis because it incorporates elements of economics and engineering.[1]

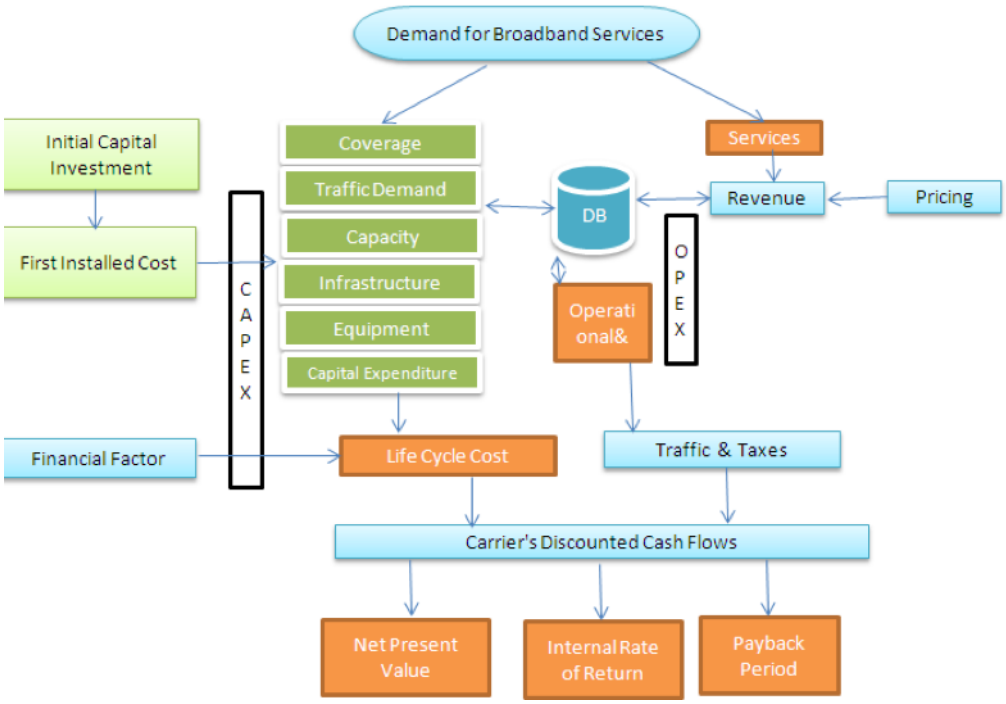

Figure 2.3 Techno-economic model [1]

From the model, there are some parameters that can be analyzed to obtain models of techno economic truly comprehensive, namely:

1. The technical parameters
2. The parameters of non-technical

3. RESEARCH METHODOLOGY

3.1 Modelling System

In general, the analysis model used is based on the principle of techno-economic by user and Throughput approach. The Milestone of this research process shown as below flowchart:

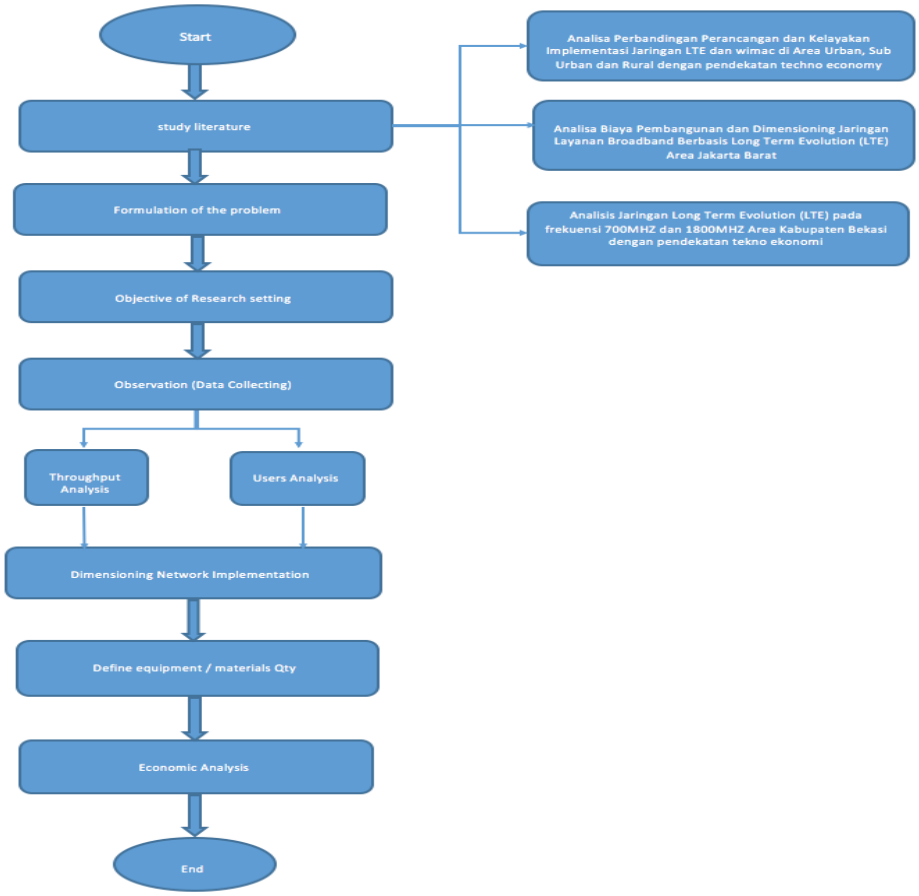

Figure 3.1. Research Process Flow Diagram

3.2 Existing Condition Jabo Area Telkomsel's 3G Network

Jakarta Special Capital Region has an area of ± 662.33 km including the Thousand Islands area of land spread in Jakarta Bay. Geographically Jakarta area is located between 106 ° 22 '42 "E to 106 ° 58' 18" E and -5 ° 19 '12 "latitude to -6 ° 23' 54" latitude. The boundaries of the area of Jakarta is:• Sebelah Utara berbatasan dengan Laut Jawa

- East side is bordered by Bekasi District
- South side is bordered by Bogor Regency
- West side is bordered by Tangerang Regency.

Telkomsel network spread throughout Indonesia, Java, Sumatra, Kalimantan, Sulawesi to Papua. For Jabodetabek area alone, consisting of 28 and 72 061 RNC cell. As seen in Figure 3.1 plot the results of the map info.

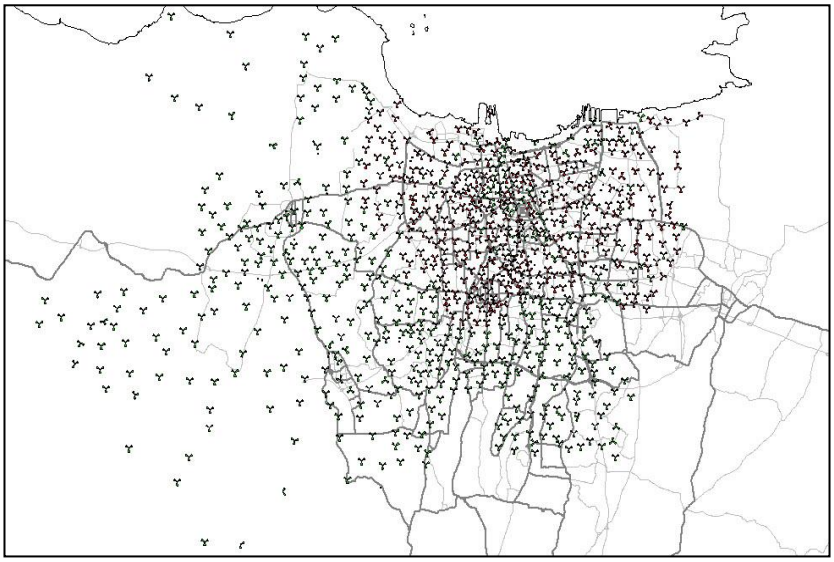

Figure 3.2 3G Network for Jabodetabek Area

By conducting statistical observations operator can monitor, collect data and analyze trends throughput, traffic and users today and can perform taskforced. It is a challenge for operators to always be able to meet the expectations of customers so that business operations can continue. Of statistical observations found in many cells with very low throughput (below 400 Kbps) in the area with the number of users more than 40. It causes inconvenience in the use of customer service and breaking the connection so strongly influence the level of customer satisfaction. Due to this it is suggested to do the sharing for 3G traffic.

3.3 Filter Low Throughput Cell

Throughput is the value that indicates the size of the actual amount of information that can be transferred within a certain time. Of statistical observations conducted over three weeks, the downward trend found in many cell throughput (Low Throughput Cell). Throughput 3G KPI value is <400 kbps, keep in mind that the value of each KPI in each operator can be different. The downward trend in the value of throughput KPI values in some RNC can be seen more clearly by analyzing statistical data as shown below:

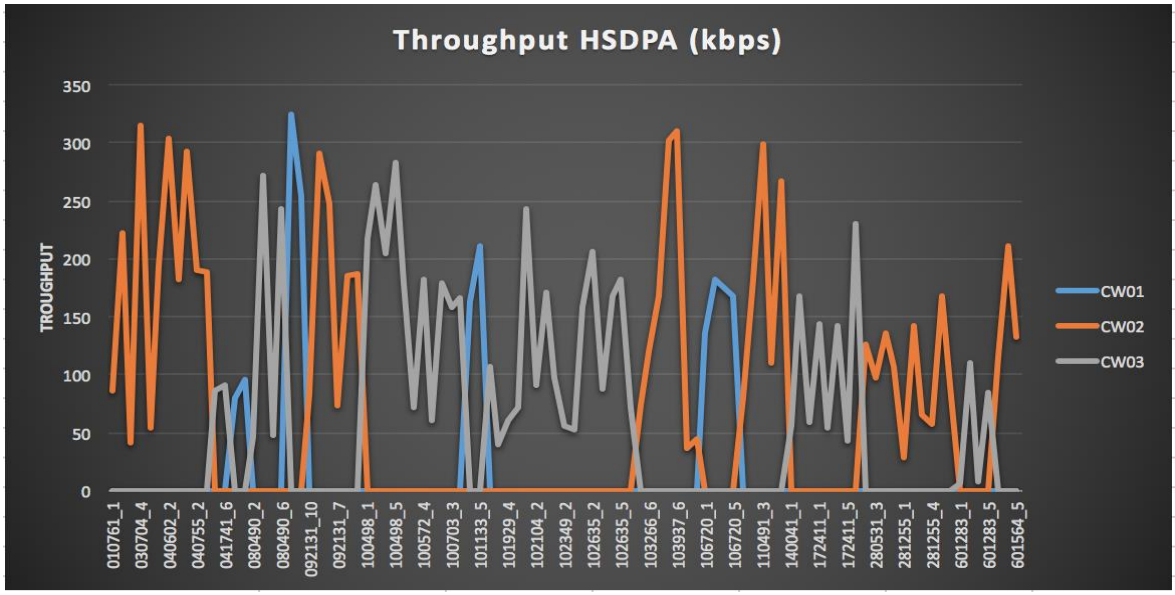

Figure 3.3 Graph of statistical data throughput

3.4 Number of User

One of the performance parameters of the network traffic is the number of users. Number of users in a cell determine the performance of a network, including 3G. More number of user in one cell, traffic will be congested as well. In this work, the value of KPI for 3G users in one cell is 40 (KPI value of each operator can be different). From the results of statistical taken for 3 weeks found some cells that have a number of user > 40. The following graphs show the number of users that occupy by each cell:

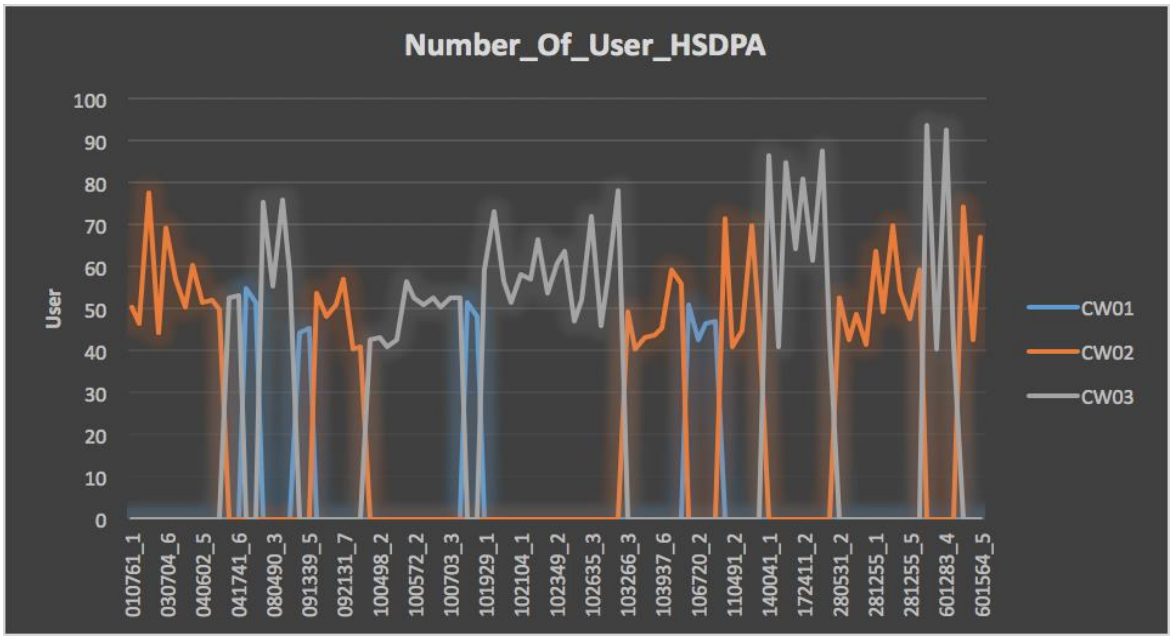

Figure 3.4 Graph of statistics of increment cell user

3.5 Network Planning

In principle for the construction of a network for 3G macro additional sector Project is just adding a few devices on the existing device, or replacing some of the old device. In this work, the design refers to the architecture of 3G networks in general, given the implementation is done in existing network 3G. In this scheme, operators benefit from the utilization of existing 3G networks. So as to reduce costs. The 3G macro additional sector Project planning for implementation at each site will be shown in the following scheme:

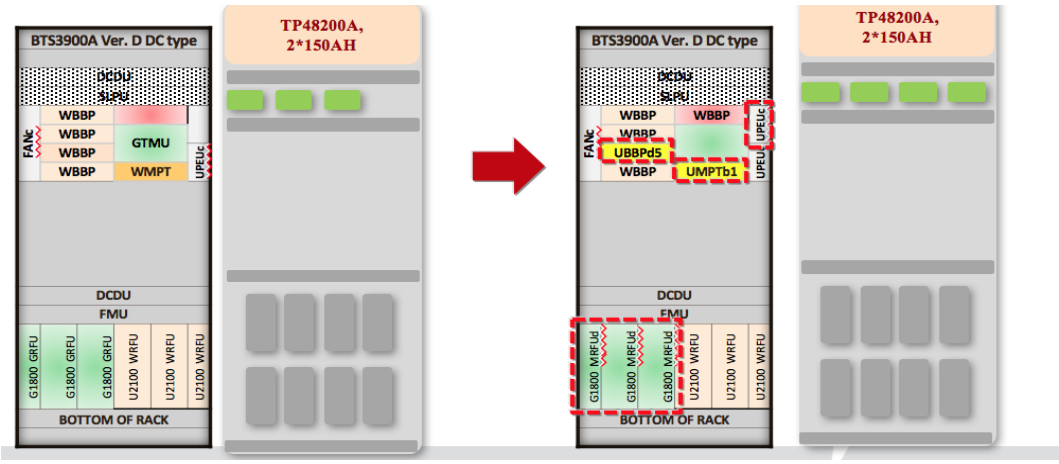

Figure 3.5 Ground Space Scheme for additional macro additional sector

Based on the above scheme, needed some upgrading network hardware and software in existing network, because the project is also prepared to support the LTE network for the future. So when the construction of LTE for the sites that has been implemented using the 3G macro additional sector does not need to turn the device or software upgrades.

4. ANALYSIS AND SIMULATION

4.1 Network Design, Users and Throughput Analysis

Based on the results of the calculation of the number of cells that need to be upgraded (via a statistical observation of OSS), obtained the number of cells that need to be upgraded as much as 97 cells with a total of 30 sites. Take 5 sites from totally 30 sites to be trial sites for Implementation of 3G Macro Additional Sector. Then, after implementation do the OSS observation, based on OSS observation there was a significantly increment of number of user (the increment average is 174%) after implementation. This average value is used as reference for calculate or analyze the number of users.

Table 4.1 Number of user before and after implementation

site	Total user before	Total user after	Persentage
100664	2788.73	3510.67	126%
102104	2179.21	3523.63	162%
280531	1252.97	3062.96	244%
92131	4314.54	4771.76	111%
601283	1326.92	3017.07	227%
Average increment number of users			174%

After Implementation also do observation by OSS for throughput as well user. Based on OSS observation, throughput increase significantly. Below following table shows the result of OSS observation before and after implementation.

Table 4.2 Throughput before and after implementation

Site	Total Throughput before (Kbps)	Total Throughput After (Kbps)	Persentage
100664	179.2022286	346.6996	193%
102104	243.5295	480.83785	197%
280531	42.43927143	402.6402143	949%
92131	247.2031286	533.2677143	216%
601283	93.79921429	606.2204	646%
Average Incerement Throughput			440%

4.2 Equipment Needed

On this planning implementation of 3G macro additional sector project, additional equipment needed are:

- Software
  - ✓ Need software upgrade on node B (BTS) and RNC
  - ✓ Licences

- Hardware
  - ✓ UPEUc board with accessories
  - ✓ Universal RF Module with accessories
  - ✓ Baseband Unit
  - ✓ Universal main processing unit with accessories
  - ✓ Universal inter-Connection Infrastructure Unit

4.3 Techno Economic Analysis

In this work, economic analysis using the economic model of bottom-up. This model was chosen because it is quite common and comprehensive provides guidance for identifying input. This model is also quite comprehensive because it provides all the basic parameters of the NPV calculation, and already qualified enough types of parameters used in the techno economic analysis because they are already incorporating elements of economics and engineering.

Market parameters relating to the service area and market segment, output are NPV, IRR, CAPEX, OPEX per year. Output may include sensitivity analysis and cost details.

4.3.1 Capital Expenditure (CAPEX)

Based on data from the reference vendor telecom operators regarding the price per unit for the device, and then do the calculation, the following costs CAPEX required:

Table 4.3 CAPEX Estimation

CAPEX ESTIMATION 3G MACRO ADDITIONAL SECTOR						
Model	**Equipment**	**Total Cost (IDR)**		**Kurs Rate**	**Total Cost (USD)**	
RNC + Node B	RNC Software	IDR	241,003,200.00	13098	USD	18,400.00
	NodeB Hardware + Software	IDR	138,327,650,550.00		USD	10,560,975.00
Service	Installation fee	IDR	195,000,000.00	13098	USD	14,887.77
	Survey fee	IDR	45,000,000.00		USD	3,435.64
TOTAL	**TOTAL**	**IDR**	**138,808,653,750.00**	13098	**USD**	**10,597,698.41**

4.3.2 Operational Expenditure (OPEX)

The value of OPEX for 3G Macro Additional Sector Project can be projected as the following table:

Table 4.4 OPEX Estimation

OPEX COST ESTIMATION 3G LTC Macro Additional Sector Project JABODETABEK				
Tahun	**General and Administrative**	**Operational & Maintenance Existing**	**Insurance cost**	**Total OPEX**
2016	IDR105,056,000	IDR6,940,432,688	IDR7,045,488,687	IDR14,090,977,374
2017	IDR182,799,089	IDR347,021,634.38	IDR7,045,488,687	IDR7,575,309,410
2018	IDR318,073,284	IDR17,351,082	IDR7,045,488,687	IDR7,380,913,053
2019	IDR553,452,508	IDR867,554.09	IDR7,045,488,687	IDR7,599,808,749
2020	IDR963,016,052	IDR43,377.70	IDR7,045,488,687	IDR8,008,548,117
2021	IDR1,675,663,049	IDR0	IDR7,045,488,687	IDR8,721,151,736
2022	IDR2,915,680,012	IDR0	IDR7,045,488,687	IDR9,961,168,699
2023	IDR5,073,328,996	IDR0	IDR7,045,488,687	IDR12,118,817,683
2024	IDR8,827,672,100	IDR0	IDR7,045,488,687	IDR15,873,160,787

4.3.3 Revenue

By doing the multiplication of the number of customers in each service multiplied by the rate for each of these services, the obtained value of revenue. The following is an analysis of the calculation of revenue generated by the network that Macro Additional Sector has been built.

Table 4.5 Revenue Estimation for LTC 3G Macro Additional Sector

	REVENUE							
Year	**As**		**Simpati**		**Halo**		**TOTAL**	
2016	IDR	3,697,819,479.37	IDR	4,816,646,911.59	IDR	1,991,133,566	IDR	10,505,599,957
2017	IDR	6,434,263,947.39	IDR	8,381,041,244.30	IDR	3,464,603,664	IDR	18,279,908,855.67
2018	IDR	11,195,720,282.10	IDR	14,583,143,341.81	IDR	6,028,464,767	IDR	31,807,328,391.19
2019	IDR	19,480,729,056.15	IDR	25,374,898,360.32	IDR	10,489,623,338	IDR	55,345,250,754.40
2020	IDR	33,896,774,392.10	IDR	44,152,721,515.86	IDR	18,252,109,288	IDR	96,301,605,196.01
2021	IDR	58,980,919,598.89	IDR	76,826,428,605.73	IDR	31,758,956,707	IDR	167,566,304,911.71
2022	IDR	102,627,726,062.97	IDR	133,679,191,897.41	IDR	55,261,083,265	IDR	291,568,001,225.06
2023	IDR	178,573,854,536.09	IDR	232,603,892,575.21	IDR	96,155,152,443	IDR	507,332,899,553.81
2024	IDR	310,721,310,382.63	IDR	404,734,424,806.09	IDR	167,311,474,821	IDR	882,767,210,010.14

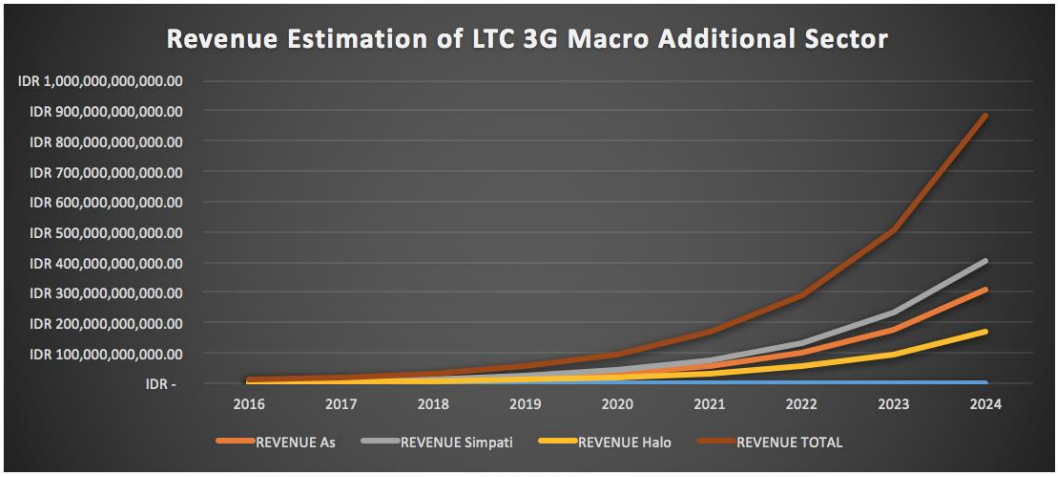

Figure 4.1 Revenue Estimation 3G Macro Additional Sector

4.3.4 Economic Analysis

Calculation of the economy in this work is used the following parameters:

Table 4.6 Economic Parameter

Parameter	Value
Rate	IDR. 13.098/$
MARR	17%
Period	8 Year
Tax	25%

From the above parameters used MARR value of 17%, assuming that the margin due to the risk factor of 5% plus the 12% tax rate so that the value of MARR is 17%. While the tax parameters used was 25%, based on Law No. 36 Year 2008 regarding Income Tax. Here are the results of techno economic feasibility analysis:

Table 4.7 Economic feasibility analysis

Parameter	Value	Summary
NPV	IDR345,845,544,931	Feasible
IRR	48%	Feasible
Pay Back Period	0 Year 0 Month 25days	Feasible

Based on above table NPV on positive value with IRR 48% and PBP 0 year 0 month 25 days means this project not waiting for long time to get the capital invested returned, only need 25 days after on air and billing on operator system.

Below is a graph of cumulative net cash yearly as follows:

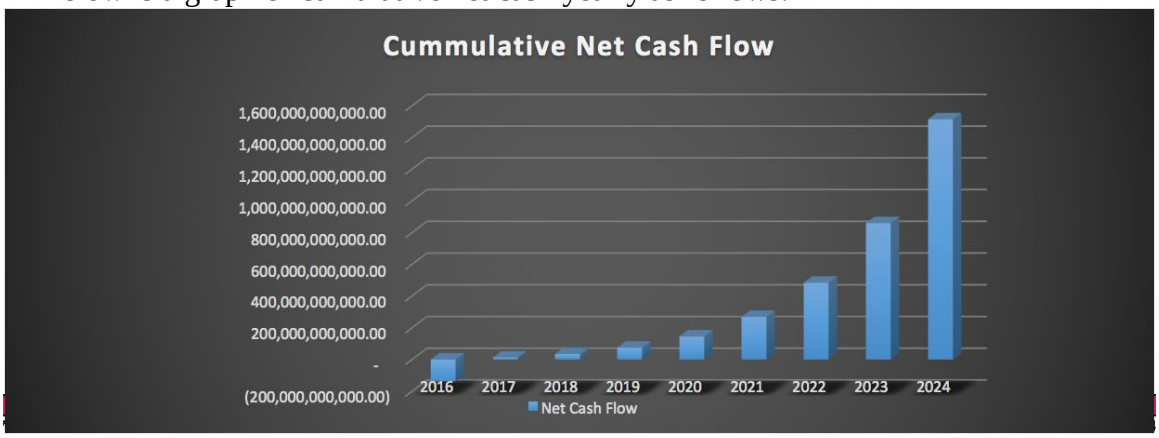

Figure 4.2 Cummulative Net Cash Flow

4.3.5 Sensitivity Analysis

As we know that the value of the market rate or we are familiar with Minimum Attractive Rate of Return (MARR)greatly affect NPV. In this work MARR used was 17%, so that the resulting NPV is IDR 345,845,544,931.27. With NPV sensitivity analysis of the MARR, we can see in the chart below that the NPV will be negative when the MARR worth more than 50%. It means 3G Macro Additional Sector investment is not feasible to be implemented if the market rate reaches 50%.

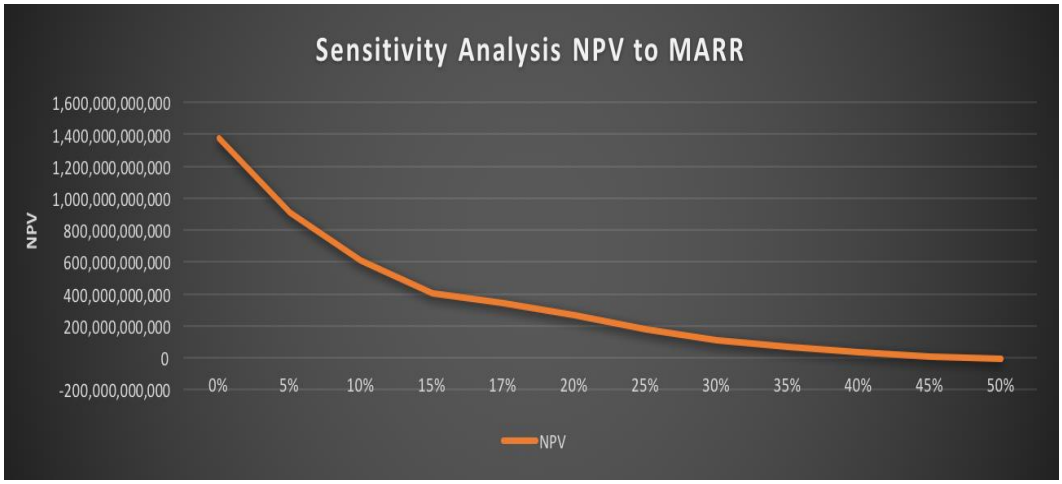

Figure 4.8 Sensitivity Analysis NPV to MARR

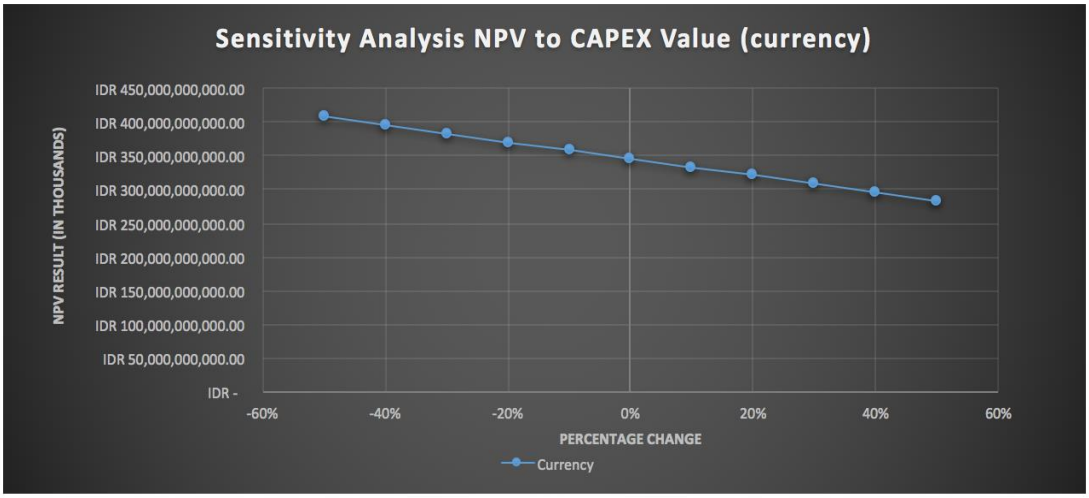

Figure 4.9 NPV Sensitivity Analysis to value of CAPEX (change of exchange value)

From the graph above it can be seen that changes in currency exchange rates affect the value of eligibility. Based on the data obtained, the NPV would be drastically reduced when there is an increase exchange rate is above 30% of the value of the currency, which is Rp.17.027 / USD.

Here is an NPV sensitivity analysis to OPEX.

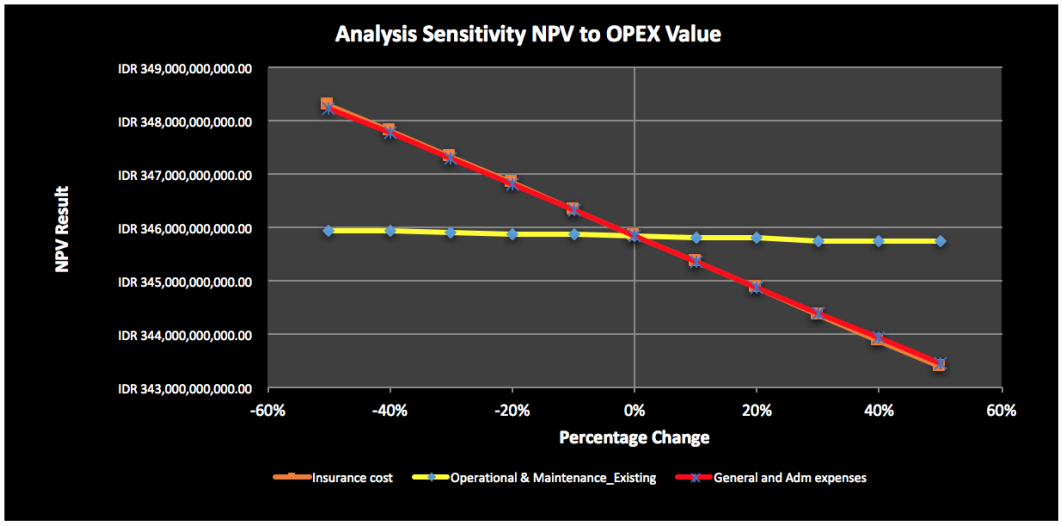

Figure 4.10 NPV Sensitivity Analysis to value of OPEX

From the graph above it can be seen that between the value of existing OPEX, general costs and adm is the largest operational cost with the steepest slope among other operational costs, which means the value of common costs and administration significantly affect NPV.

If performed sensitivity analysis of the service rate, will be seen the influence of operator revenue generated, which substantially affect the feasibility of an investment. The following is an analysis of the sensitivity of the NPV to changes in rates.

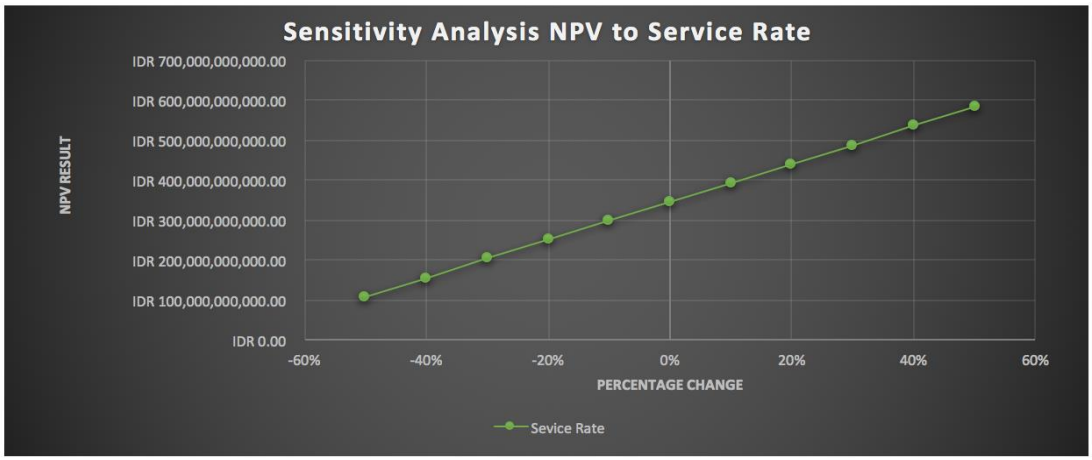

Figure 4.11 NPV Sensitivity Analysis to change of Service Rate

Below is a graph of parameter sensitivity analysis on overall comparison:

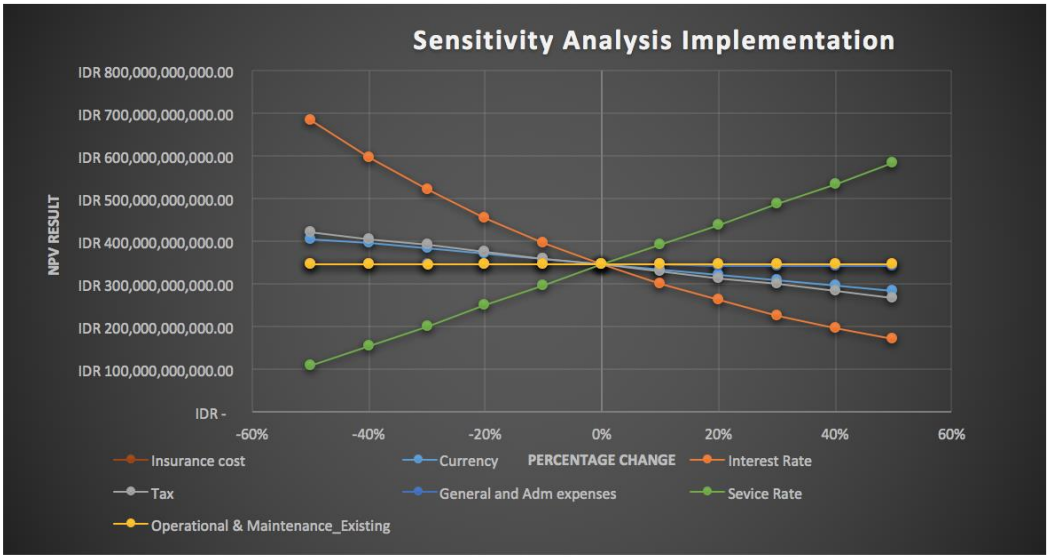

Figure 4.12 NPV Sensitivity Analysis

5. CONCLUSION

1. After making observations of statistics as well as to sensitivity analysis, the NPV of this project is influenced by the value of interest rates, foreign exchange rates, the value of OPEX as well as the determination of services rate.
2. From the techno economic analysis shows that the value of NPV positive is IDR 345,845,544,931.27 and IRR of 48% so that it can be concluded this investment worthy or feasible implemented.

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