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

Iwan Krisnadi and Intan Kumalasari Tanjung

Electrical Engineering, Mercu Buana University, Jakarta
Intan.kumalasari1@yahoo.com; intanadjah@gmail.com

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 Sector Project.

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

Abstrak

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

In this research implementation of LTE release 8 on operator’s existing 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 method 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.

3. Analisa Jaringan Long Term Evolution (LTE) pada frekuensi 700MHz dan 1800MHz Area Kabupaten Bekasi dengan pendekatan teknio 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.

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.

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.

Figure 2.2 3G network architecture [2]
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]

![Techno-economic model](image)

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:
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.
By conducting statistical observations, operators can monitor, collect data, and analyze trends in throughput, traffic, and users. It is a challenge for operators to always meet customer expectations so that business operations can continue. Statistical observations have found many cells with very low throughput (<400 Kbps) in areas with more than 40 users. This causes inconvenience in customer service and breaks the connection, strongly influencing customer satisfaction. Due to this, it is suggested to share 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. Throughput is monitored over three weeks, and the downward trend found in many cells (Low Throughput Cell). Throughput for 3G KPI values is <400 kbps, keeping in mind that the value of each KPI can differ between operators. The downward trend in the value of throughput KPI values in some RNCs can be seen more clearly by analyzing statistical data as shown below.
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:
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](image)

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

<table>
<thead>
<tr>
<th>Site</th>
<th>Total user before</th>
<th>Total user after</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>100664</td>
<td>2788.73</td>
<td>3510.67</td>
<td>126%</td>
</tr>
<tr>
<td>102104</td>
<td>2179.21</td>
<td>3523.63</td>
<td>162%</td>
</tr>
<tr>
<td>280531</td>
<td>1252.97</td>
<td>3062.96</td>
<td>244%</td>
</tr>
<tr>
<td>92131</td>
<td>4314.54</td>
<td>4771.76</td>
<td>111%</td>
</tr>
<tr>
<td>601283</td>
<td>1326.92</td>
<td>3017.07</td>
<td>227%</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Site</th>
<th>Total Throughput before (Kbps)</th>
<th>Total Throughput After (Kbps)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>100664</td>
<td>179.2022286</td>
<td>346.6996</td>
<td>193%</td>
</tr>
<tr>
<td>102104</td>
<td>243.5295</td>
<td>480.83785</td>
<td>197%</td>
</tr>
<tr>
<td>280531</td>
<td>42.43927143</td>
<td>402.6402143</td>
<td>949%</td>
</tr>
<tr>
<td>92131</td>
<td>247.2031286</td>
<td>533.2677143</td>
<td>216%</td>
</tr>
<tr>
<td>601283</td>
<td>93.79921429</td>
<td>606.2204</td>
<td>646%</td>
</tr>
</tbody>
</table>

Average Increment 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>
<thead>
<tr>
<th>Model</th>
<th>Equipment</th>
<th>Total Cost (IDR)</th>
<th>Kurs Rate</th>
<th>Total Cost (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RNC + Node B</td>
<td>RNC Software</td>
<td>IDR 241,003,203.00</td>
<td>13906.00</td>
<td>USD 18,410.00</td>
</tr>
<tr>
<td></td>
<td>NodeB Hardware +</td>
<td>IDR 138,327,850.00</td>
<td>13906.00</td>
<td>USD 10,560,975.00</td>
</tr>
<tr>
<td>Service</td>
<td>Installation fees</td>
<td>IDR 795,000.00</td>
<td>13906.00</td>
<td>USD 59,817.77</td>
</tr>
<tr>
<td></td>
<td>Survey fee</td>
<td>IDR 45,000,000.00</td>
<td></td>
<td>USD 3,358.54</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>IDR 138,808,653.750</td>
<td>13906.00</td>
<td>USD 10,997,088.41</td>
</tr>
</tbody>
</table>

### 4.3.2 Operational Expenditure (OPEX)

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

<table>
<thead>
<tr>
<th>Tahun</th>
<th>General and Administrative</th>
<th>Operational &amp; Maintenance Existing</th>
<th>Insurance cost</th>
<th>Total OPEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>IDR 1,053,056.09</td>
<td>IDR 6,941,542.09</td>
<td>IDR 7,004,560.68</td>
<td>IDR 14,001,158.85</td>
</tr>
<tr>
<td>2017</td>
<td>IDR 2,900,849.09</td>
<td>IDR 1,031,044.30</td>
<td>IDR 7,004,560.68</td>
<td>IDR 14,936,453.61</td>
</tr>
<tr>
<td>2018</td>
<td>IDR 3,718,722.09</td>
<td>IDR 1,031,044.30</td>
<td>IDR 7,004,560.68</td>
<td>IDR 16,754,927.05</td>
</tr>
<tr>
<td>2019</td>
<td>IDR 4,535,612.09</td>
<td>IDR 1,031,044.30</td>
<td>IDR 7,004,560.68</td>
<td>IDR 18,571,223.64</td>
</tr>
<tr>
<td>2020</td>
<td>IDR 5,352,504.09</td>
<td>IDR 1,031,044.30</td>
<td>IDR 7,004,560.68</td>
<td>IDR 20,387,851.07</td>
</tr>
<tr>
<td>2021</td>
<td>IDR 6,169,396.09</td>
<td>IDR 1,031,044.30</td>
<td>IDR 7,004,560.68</td>
<td>IDR 22,204,419.74</td>
</tr>
<tr>
<td>2022</td>
<td>IDR 7,787,288.09</td>
<td>IDR 1,031,044.30</td>
<td>IDR 7,004,560.68</td>
<td>IDR 24,121,068.09</td>
</tr>
<tr>
<td>2023</td>
<td>IDR 8,605,180.09</td>
<td>IDR 1,031,044.30</td>
<td>IDR 7,004,560.68</td>
<td>IDR 26,037,897.07</td>
</tr>
<tr>
<td>2024</td>
<td>IDR 9,422,072.09</td>
<td>IDR 1,031,044.30</td>
<td>IDR 7,004,560.68</td>
<td>IDR 27,954,897.07</td>
</tr>
</tbody>
</table>

### 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>
<thead>
<tr>
<th>Year</th>
<th>As</th>
<th>Simpati</th>
<th>Hale</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>IDR 4,677,819,479.37</td>
<td>IDR 4,816,646,931.59</td>
<td>IDR 1,951,133,565</td>
<td>IDR 10,445,599,977.87</td>
</tr>
<tr>
<td>2017</td>
<td>IDR 4,641,265,047.39</td>
<td>IDR 8,501,041,244.30</td>
<td>IDR 3,484,003,664</td>
<td>IDR 18,626,529,155.87</td>
</tr>
<tr>
<td>2018</td>
<td>IDR 11,155,720,282.10</td>
<td>IDR 14,583,143,341.81</td>
<td>IDR 6,008,466,267</td>
<td>IDR 31,767,328,891.19</td>
</tr>
<tr>
<td>2019</td>
<td>IDR 19,486,725,056.15</td>
<td>IDR 25,174,895,360.32</td>
<td>IDR 10,489,625,329</td>
<td>IDR 55,554,250,745.80</td>
</tr>
<tr>
<td>2020</td>
<td>IDR 19,486,725,056.15</td>
<td>IDR 25,174,895,360.32</td>
<td>IDR 10,489,625,329</td>
<td>IDR 55,554,250,745.80</td>
</tr>
<tr>
<td>2021</td>
<td>IDR 58,960,915,098.89</td>
<td>IDR 70,826,426,605.73</td>
<td>IDR 31,258,956,797</td>
<td>IDR 167,046,372.12</td>
</tr>
<tr>
<td>2022</td>
<td>IDR 102,627,726,062.97</td>
<td>IDR 123,679,181,897.41</td>
<td>IDR 55,261,083,265</td>
<td>IDR 293,568,001,225.06</td>
</tr>
<tr>
<td>2023</td>
<td>IDR 178,573,854,536.09</td>
<td>IDR 220,623,892,575.21</td>
<td>IDR 96,155,152,445</td>
<td>IDR 507,332,895,553.81</td>
</tr>
<tr>
<td>2024</td>
<td>IDR 310,725,315,828.63</td>
<td>IDR 404,734,424,806.09</td>
<td>IDR 167,311,478,021</td>
<td>IDR 882,877,210,020.14</td>
</tr>
</tbody>
</table>
4.3.4 Economic Analysis

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

<table>
<thead>
<tr>
<th>Table 4.6 Economic Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>Rate</td>
</tr>
<tr>
<td>MARR</td>
</tr>
<tr>
<td>Period</td>
</tr>
<tr>
<td>Tax</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>NPV</td>
<td>IDR345,845,544,931</td>
<td>Feasible</td>
</tr>
<tr>
<td>IRR</td>
<td>48%</td>
<td>Feasible</td>
</tr>
<tr>
<td>Pay Back Period</td>
<td>0 Year 0 Month 25 days</td>
<td>Feasible</td>
</tr>
</tbody>
</table>

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:

![Cumulative Net Cash Flow](image)

**Figure 4.2 Cumulative 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%.
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.

![NPV Sensitivity Analysis to value of OPEX](image1)

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.

![NPV Sensitivity Analysis to change of Service Rate](image2)

Figure 4.11 NPV Sensitivity Analysis to change of Service Rate
Below is a graph of parameter sensitivity analysis on overall comparison:

![Sensitivity Analysis Implementation](image)

**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.
REFERENCES


