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PREFACE

We would like to present, with great pleasure, the first volume of a new scholarly journal, *International Journal of Science, Engineering, and Information Technology (IJSEIT)*. This journal is part of the Engineering Faculty in the University of Trunojoyo Madura, and is devoted to the gamut of science, engineering and information technology issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

IJSEIT publishes both theoretical and experimental papers of permanent interest, not previously published in journals which aims to promote the theory and practice of science, engineering and information technology. In addition to peer-reviewed original research papers, the Editorial Board welcomes original research reports, state-of-the-art reviews and communications in the broadly defined field of science, engineering and information technology.

The scope of IJSEIT includes a wide spectrum of subjects including:

Science; Mathematics, Physics, Biology, Chemistry, Social Science, Material Sciences, Food Sciences, Environmental Science, Earth Science, Space Science, Agricultural Science, Sustainable Development, Applied Physics, Communicable Diseases, Emergency Medicine, Micro-Nano Sciences, Environmental Health.

Engineering; Automotive Technologies, Construction Materials, Design and Manufacturing, Dynamics and Control, Energy Generation, Utilization, Conversion, Fluid Mechanics and Hydraulics, Heat and Mass Transfer, Renewable and Sustainable Energy Technologies, Robotics and Mechatronics, Solid Mechanics and Structure, Thermal Sciences, Computer Vision and Robotics, Control Theory, Electromagnetic Waves, Microwave Techniques and Antennas, Embedded Systems, Integrated Circuits, VLSI Design, Testing, Microelectromechanical Systems, Microelectronics, Electronic Devices and Circuits, Power, Energy, and Signal.

Information Technology and Systems; Coding, Cryptography, and Information Protection, Communications, Networks, Mobile Computing and Distributed Systems, Compilers and Operating Systems, Computer Architecture, Supply Chain Management, Image Processing, Speech Processing, Strategy, Change Management, Human Resources, System Development and Implementation, Communications, Software Engineering, Technology Developments, Technology Futures, Data Mining, Information Retrieval, Big Data, Internet, Cloud Data Management, E-Government, Smart City, Knowledge Management, Service Innovation, Digital Enablement, Business Process Management, Web Semantics, Visual and Audio Information Systems, Scientific Computing, and Organisational Behaviour.

Many scientists and institutions have contributed to the creation and the success of this community. We are very thankful to everybody within that community who supported the idea of creating the IJSEIT. We are certain that this very first issue will be followed by many others, reporting new developments in the science, engineering and information technology field. This issue would not have been possible without the great support of the Editorial Board members, and we would like to express our sincere thanks to all of them. It is our hope that this fine collection of articles will be a valuable resource for IJSEIT readers and will stimulate further research into the vibrant area of science, engineering and information technology field.

July 2018,

Nurwahyu Alamsyah
Editorial Board

ENHANCEMENT OF E-GSM CHANNEL CAPACITY WITH FUNCTION DIVERSION OF 3G TO 2G FREQUENCY

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Abstract

The main observation of this research is the installation and analysis of frequency function diversion from 3G to 2G network to enhance the Channel capacity. The frequency 850 MHz that is previously owned by Telkom Flexi, then shifted to belong to Smartfren and will be transferred to become 2G GSM operated by Telkomsel Madura.

The result shows that the transfer process of the frequency function goes well. This produces that the average value of drive test before diversion are Rx Level = 87.969%, Rx Qual = 87.791%, SQI = 80.809%. The average value of drive test after diversion are Rx Level = 91.967%, Rx Qual = 89.926%, SQI = 82.049%. The traffic value before diversion is 503.296 Erlang and 627 Erlang for after diversion. While the blocking before diversion is 24.36% and the blocking after diversion is 1.6%.

Keywords: *Enhancement, Channel Capacity, Frequency Function Diversion.*

INTRODUCTION

The development in telecommunication network system widely affects through the world. The increasing of subscribers of any services must be followed by good coverage, capacity and quality of service. The telecommunication technology moves on from 2G, 3G up to 4G. It causes the old technology slowly is abandoned.

But this fact is not suitable to Madura Island. Madura island consists of 4 regencies (Bangkalan, Sampang, Pamekasan and Sumenep). Almost of them are included into regencies that the indigence level is very high. 2G handset users are still very high. The majority of Madura people use telephone and SMS as the main telecommunication activities. The population of handsets in Madura, according to Telkomsel Paper Lesson Learned Sharing : Network Service Optimization of 2G GSM on Telkomsel Madura Using E-GSM Band, is shown in figure 1.

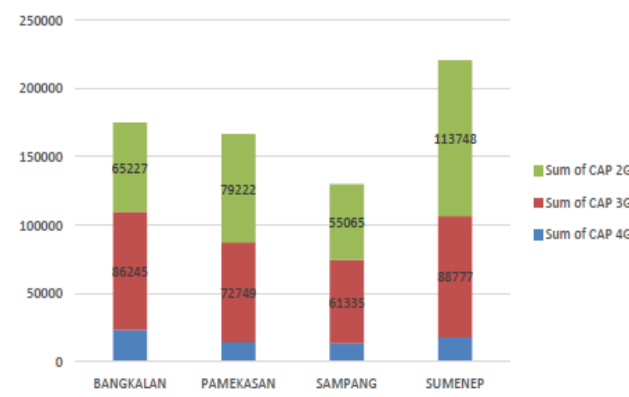


Figure-1. Graph of Handsets population in Madura, November 2016

The high demand of 2G network in Madura must be anticipated in order to provide good service to the subscriber. One method that is proposed to be applied in this research is E-GSM frequency function diversion to enhance channel capacity of 2G network. The ex-smartfren frequency is used in expanding capacity of Telkomsel Madura, while the smartfren applies 4G.

This research idea begins from other researchs especially in analysis, planning and optimization of telecommunication network. There are many research in analysis and optimization of telecommunication networks. In network performance analysis and network planning analysis, there are papers for example, comparative analysis and RF planning in mobile communication on different sites with drive test based assessment proposed by Govind and Sonika, (2015), analysis of methods in capacity improvement of GSM network observed by Nura, (2015), comparative analysis of signal strength of GSM and IS-95 CDMA Network observed by Makanjuola et. al., (2015), review on 2G, 3G and 4G radio network planning observed by Tushar et. al., (2013), interference analysis of CDMA network with dynamic channel assignment algorithm observed by Ohaneme et. al., (2012), analysis of short call drive test of GSM network observed by Atif et. al., (2015), and capacity enhancement metods review in cellular systemproposed by Bharat et. al., (2011).

In network performance optimization, there are many papers such as, GSM network performance enhancement with intelligent optimization method and drive test based proposed by Richa et. al., (2012), GSM access network evaluation and performance optimization proposed by Mudassar et. al., (2010), cellular network optimization with frequency reuse technique proposed by Adegoke et. al., (2015), capacity enhancement of CDMA network with cell splitting technique proposed by Sohrab et. al., (2013), efficiency improvement and handover performance optimization of GSM network proposed by Arulananth et. al., (2015), identifying the causes of call setup failure in GSM service test area and necessitate steps to increase the call success rate with drive test based observed by Syed et. al., (2014), minimizing the hand off failure probability by increasing the total number of channel with help cell splitting proposed by Ranjan and Debabrata, (2015), and coverage optimization of CDMA network in South- Eastern Nigeria proposed by Shoewu et. al., (2011). This research proposes to optimize and enhance the channel capacity of E-GSM by diverting the frequency function from 3G to 2G Network and then to analyze the performance through drive test.

METHODOLOGY

The main idea of this research is frequency function diversion of 3G to 2G network, to enhance channel capacity with E-GSM in Telkomsel Madura. The sites that are observed are shown in table 1.

Table-1. Observed Sites

Site Name	Cell Name
Pademawu	Pademawumg2
Taroan	Taroanmg1
Samatanproppotbg	Samatanproppotbg1
Samatanproppotbg	Samatanproppotbg3
Kardulukpragaantbg	Kardulukpragaantbgmg3
Pademawu timur	Pademawu timur-0
Pademawu timur	Pademawu timur-3
Kalianget	Kaliangetmg1
Kalianget	Kaliangetmg2
Batangbatangmadura	Batangbatangmaduramg2
Marengan daya	Marengan daya-0
Marengan daya	Marengan daya-1
Babangapurapti	Babangapuraptimg1
Andulanggapuratbg	Andulanggapuratbgmg3

Upgrading TRX is applied by taking and using the Smartfren frequency that is diverted and shown in table 2. The observation is applied by drive test before and after frequency function diversion process. Then, the next observation is about the value of traffic and blocking probability of the cellular network before and after frequency function diversion process.

Table-2. Applied ARFCN (Absolute Radio Frequency Channel Number) on E-Band

Operator	Smartfren			Guard Band (~1 MHz)		
ARFCN	975	...	1006	1007	...	1011
UL Frequency	880.2	...	886.4	886.6	...	887.4

DL Frequency	925.2	...	931.4	931.6	...	932.4
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The quality parameters of drive test are described by :

Rx Level (Received Signal Level) : the level of received signal of each signal emission.

$$R_xLevel = \frac{Sample}{Total\ Sample} \times 100\% \quad (1)$$

Rx Qual (Received Signal Quality) : the quality of received signal that is measured from Bit Error Rate (BER).

$$R_xQual = \frac{Sample}{Total\ Sample} \times 100\% \quad (2)$$

SQI (Signal Quality) : the quality level of voice at the time of call.

$$SQI = \frac{Sample}{Total\ Sample} \times 100\% \quad (3)$$

The observation result is compared to the standard of Key Performance Information (KPI) that is applied by Service Quality Assurance Department, ICT Network Management, East Java Division of Telkomsel.

Table-3. The KPI standard of Telkomsel

KPI	Quality (Colour)				
	Very Good	Good	Enough	Bad	Very Bad
Rx Level	-75 to -10	-85 to -75	-95 to -85	-100 to -95	-120 to -100
Rx Qual	0 to 2	2 to 4	4 to 6		6 to 7
SQI	18 to 30		0 to 18		-18 to 0

Other performance parameters are defined by offered traffic, blocking probability and the use of time slot, that is observed before and after frequency function diversion process. The blocking probability parameter is also measured specially on TCH (Traffic Channel) and SDCCH (Stand alone Dedicated Control Channel) that is observed in 3 weeks after the frequency function diversion.

RESULT AND DISCUSSION

The result of the research can be defined as upgrading TRX and the change of configuration before and after frequency function diversion process. It is described as follow,

Site Pademawu. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 14 TRX with configuration 4/6/4. Upgrading TRX is applied on ARFCN 997 and 999.

Site Taroan. The capacity before diversion is 21 TRX with configuration 4/6/6/5 and capacity after diversion is 23 TRX with configuration 6/6/6/5. Upgrading TRX is applied on ARFCN 1000 and 1004.

Site Samatan Proppo. The capacity before diversion is 14 TRX with configuration 4/6/4 and capacity after diversion is 18 TRX with configuration 6/6/6. Upgrading TRX is applied on ARFCN 989, 991 and 993, 995.

Site Karduluk Pragaan. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 16 TRX with configuration 4/4/8. Upgrading TRX is applied on ARFCN 1003, 1005, 1009 and 1011.

Site Pademawu Timur. The capacity before diversion is 12 TRX with configuration 3/3/3/3 and capacity after diversion is 18 TRX with configuration 6/3/3/6. Upgrading TRX is applied on ARFCN 990, 992, 998 and 994, 996, 1000.

Site Kalianget. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 16 TRX with configuration 6/6/4. Upgrading TRX is applied on ARFCN 995, and 997.

Site Batang Batang Madura. Capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 16 TRX with configuration 4/8/4. Upgrading TRX is applied on ARFCN 989, 991, 993 and 995.

Site Marengan Daya. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 18 TRX with configuration 8/6/4. Upgrading TRX is applied on ARFCN 994, 996 and 1002, 1010.

Site Babangapurapti. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 14 TRX with configuration 6/4/4. Upgrading TRX is applied on ARFCN 988 and 990.

Site Andulanggapura. The capacity before diversion is 12 TRX with configuration 4/4/4 and capacity after diversion is 14 TRX with configuration 4/4/6. Upgrading TRX is applied on ARFCN 993 and 995.

The descriptions show that all frequency function diversion process from 3G to 2G network to enhance channel capacity with E-GSM in Telkomsel Madura is successful. The next step is assessment process to examine the performance of the frequency function diversion process. The first assessment is defined from the drive test result that is shown in table 7. The example of drive test results are shown by table 4 for Rx Level, table 5 for Rx Qual and table 6 for SQI. All of the examples are taken from site Pademawu.

Table-4. Rx Level values of the drive test result on site Pademawu

RxLevel	Range	Before	After
	-75 to -10	96.91%	99.40%
	-85 to -75	3.09%	0.60%
	-95 to -85	0.00%	0.00%
	-100 to -95	0.00%	0.00%
	-120 to -100	0.00%	0.00%
	Total	100.00%	100.00%

Table-5. Rx Qual values of the drive test result on site Pademawu

Rx Qual	Range	Before	After
	0 to 2	90.35%	91.34%
	2 to 4	3.38%	3.78%
	4 to 6	3.52%	3.81%
	6 to 7	2.75%	1.06%
	Total	100.00%	100.00%

Table-6. SQI values of the drive test result on site Pademawu

SQI	Range	Percentage	Percentage
	18 to 30	81.82%	84.42%
	0 to 18	17.92%	15.58%
	-18 to 0	0.26%	0.00%
	Total	100.00%	100.00%

Table 7 shows that the performance of the diversion process is good. The best mean value of Rx level increases from 87.969% to 91.967%. The best mean value of Rx Qual also increases from 87.791% to 89.92%. so does the best SQI mean value, from 80.809% to 82.49%.

Table-7. The mean value of Rx Level, Rx Qual and SQI of observed sites

KPI	Range	Before	After
RX Level	-75 to -10	87.969%	91.967%
RX Qual	0 to 2	87.791%	89.92%
SQI	18 to 30	80.809%	82.49%

Beside that, the performance of the frequency function diversion process is shown by figure 2 that shows about offered traffic value before and after diversion process and figure 3 that shows about blocking probability before and after diversion process.

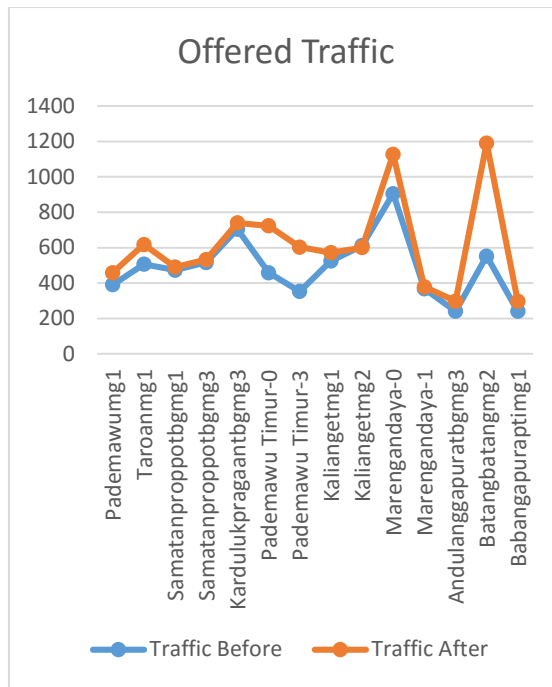


Figure-2. Graph of offered traffic before and after diversion process

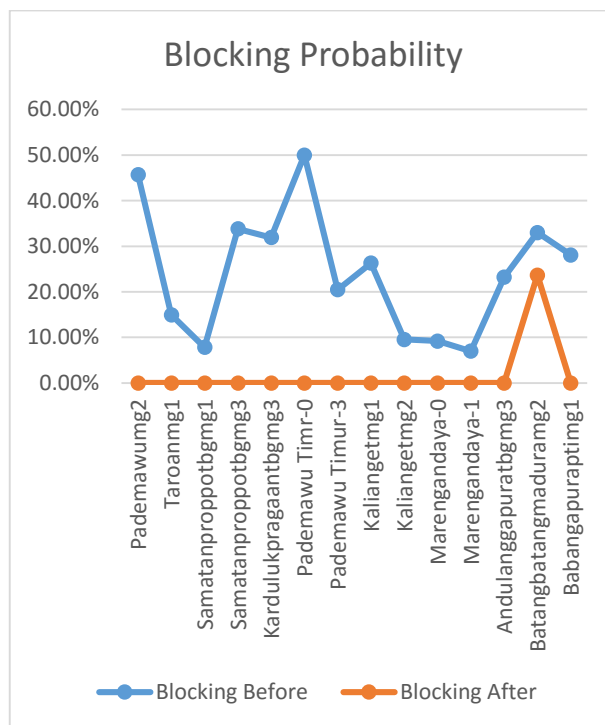


Figure-3. Graph of blocking probability before and after diversion process

From figure 2, the offered traffic after diversion process is greater than before diversion process. The mean of offered traffic before diversion process is 503.296 E and it becomes 627 E for after diversion process. It means that the channel capacity after diversion greater than before and the diversion process is successful.

From figure 3, the blocking probability after diversion process is lower than before diversion process, even almost all of the values are zero. The mean of blocking probability before diversion process is 24.36% and it becomes 1.6% for after diversion process. It means that the channel capacity after diversion greater than before and the diversion process is successful.

The blocking probability is also measured specially on TCH (see figure 4) and SDDCH (see figure 5).

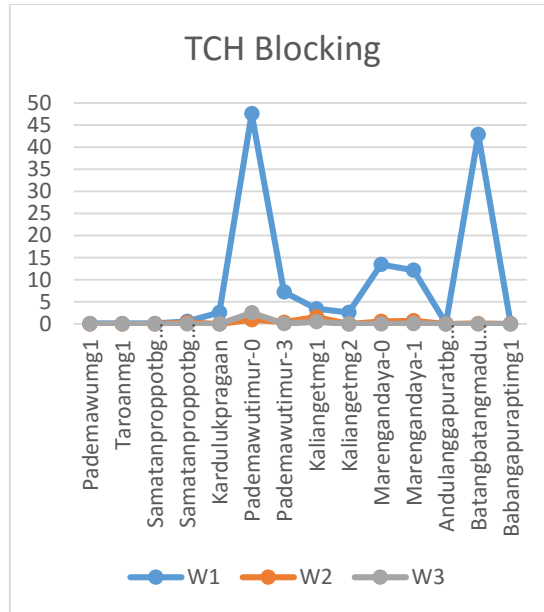


Figure-4. The blocking probability of TCH

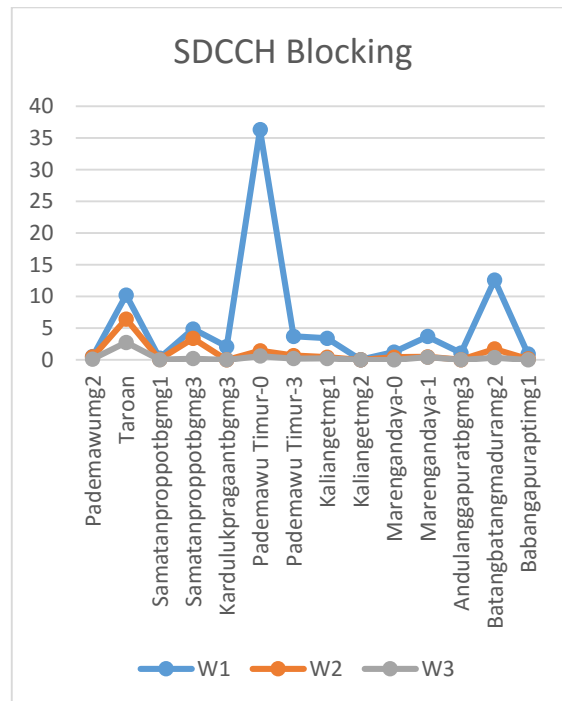


Figure-5. The blocking probability of SDCCH

From figure 4 and figure 5, the blocking probability of TCH and SDCCH were observed in one week before diversion process (W1), in the week of diversion process (W2) and one week after diversion process (W3). Both of them show that the blocking probability before diversion process of frequency function are high. But they decrease deeply after diversion process. It shows that the channel capacity has been enlarged and the diversion process is successful.

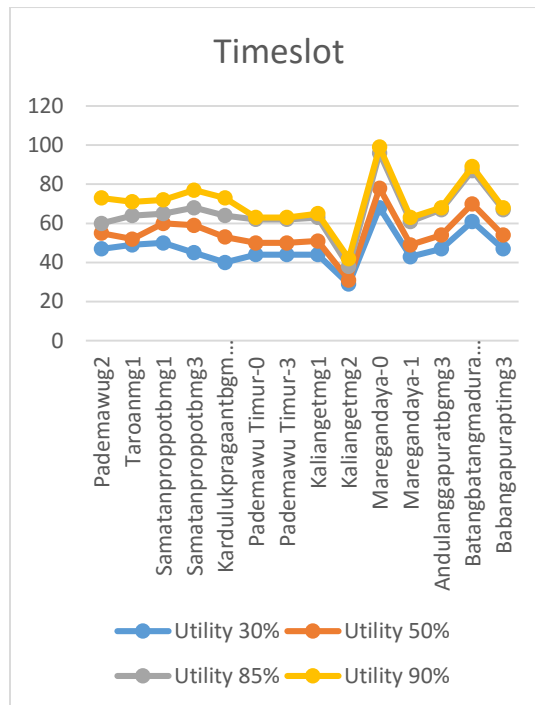


Figure-6. Graph of time slot number that is used with different network utility after diversion process of frequency function

Figure 6 shows about the use of time slot that is measured after diversion process of frequency function, with different network utility. When the network utility increases from 30% up to 90%, then the use of time slot also increases linearly. It means, the enhancement of E-GSM channel capacity compresses the blocking probability.

CONCLUSION

The diversion process of frequency function from 3G to 2G network on Telkomsel Madura is successful. It increases the channel capacity of 2G network in there. It is supported by proofs that :

1. The best mean values of Rx Level, Rx Qual and SQI of the drive test after diversion are higher than before diversion.
2. The mean of network blocking probability after diversion is lower than before diversion.
3. Even specifically, the blocking probability of TCH and SDCCH after diversion are lower than before diversion.
4. The mean value of offered traffic after diversion process is greater than before diversion process.
5. The use of time slot increases linearly to the increasing of the network utility, even almost no blocking.

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SENTIMENT ANALYSIS TO PREDICTION DKI JAKARTA GOVERNOR 2017 ON INDONESIAN TWITTER

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Abstract

This study was conducted to test opinion data tweet of three candidates for governor Jakarta, 2017. Data only in Indonesian tweet, data tweet 100 tweets with keywords AHY, 100 tweets with keywords Ahok, and 100 tweets with keywords Anies. Data taken by random either from a normal user or online media at Twitter. Indonesian tweet opinion with three candidates for governor Jakarta in 2017 divided into three sentiment: positive, neutral and negative. Preprocessing data is, Lower Case Tokens, Normalization, Tokenization, Cleansing and Filtering. Classification method in this study using Naïve Bayes classifier (NBC), because this method is the most widely performed for sentiment analysis and proven always produce highest accuracy. Results of classification, Precision AHY data scored the highest with 95% and 95% Recall, while Ahok data lowest Precision scores with 81.6% and 82% recall.

Keywords— data mining; machine learning; sentiment analysis; jakarta governor candidate 2017; naïve bayes classifier

INTRODUCTION

Social media, especially Twitter lately bustling discussing Jakarta Governor Election will be held soon in 2017. Schedule Jakarta Governor Election has been set [1]. Since registration and set a candidate for Governor Jakarta in 2017, names of candidates many discussed, in real world or the virtual world. Everyone is think free opine on Jakarta governor candidate in 2017 so many opinions, not only positive or neutral opinion but negative. Media development so quickly, much online media from news media to social media. Social media alone so much, from Facebook, Twitter, Path, Instagram, Google+, Tumblr, LinkedIn and so many more [2]. Social media today is not only used as a means of friendship, make friends, but it already used to other activities. Promo merchandise, buying and selling up promo political or campaigns candidate legislative and presidential candidate,

Social media especially Twitter today being a communication device is very popular in internet users. Official Twitter developer conference Chirp, 2010, the company delivered the statistics regarding site and Twitter users. The statistics said in April 2010, Twitter has 106 million accounts and 180 million unique visitors each month. Number of Twitter users mentioned user continues increase to 300,000 per day [3]. Digital Buzz blog a site provides statistics infographic mentions same statistical data. Successor team of candidates the governor or mayor can justify any means in campaign of the candidate. Especially on governor election campaign or mayor the region, there is the term Black Campaign, especially in social media. Because the current promotions, imaging campaigns not only in real world but also in cyberspace. Social media, especially Twitter now become one of the promotions or campaigns are effective and efficient.

Sentiment analysis or opinion mining is the process of understanding, extract and process the textual data automatically to get the sentiment of information contained in an opinion sentence. The magnitude of effect and benefits to research sentiment analysis, sentiment analysis based applications is growing rapidly. Even in America, there are about 20-30 companies that focus on sentiment analysis service [4]. Social network mining (SNM) has become one of main themes on agenda of research data mining lately. Partly resulting from this research, we can extract information from a variety of social media, but the sources of information to develop dynamically requires a flexible approach [5]. In addition to sentiment analysis, data mining has also been developed for the prediction of precipitation such as those used to predict rainfall in Malaysia [6]. In this study used the data mining sentiment analysis of public opinion in Twitter to Jakarta governor candidate in 2017. There are three data for candidates for Governor Jakarta in 2017 were categorized into positive opinion, neutral and negative. The amount of sentiment to Jakarta governor candidate in 2017 could be one of the parameters of victory or defeat of a candidate.

Research by Merfat M. Altawaier [7] uses machine learning to classify sentiment tweet in Arabic Twitter. Three methods of classification used is Naïve Bayes classifier (NBC), Decision Tree (DT) and Support Vector Machine (SVM). This study determined classification of sentiment tweet Arabic Twitter, tweet about politics and arts with two sentiment: positive and negative. Weighting was conducted using TF-IDF (Term Frequency - Inverse

Document Frequency) and use a Arabic stemming algorithm. of three techniques or classification methods, Decision Tree (DT) method best the other method with f-measure of 78%.

Research by Mesut Kaya [8] uses machine learning to classify the Turkish political news. This study determined classification of sentiment Turkish political news and political news to determine whether Turkey has a positive or negative sentiment. feature of Turkish political news machine learning algorithms extracted with Naïve Bayes classifier (NBC), Maximum Entropy (ME) and Support Vector Machine (SVM) to generate a classification model. This study obtained Accuracy 72.05% for the Naïve Bayes classifier (NBC), Maximum Entropy Accuracy 69.44% and 66.81% for the SVM to use bigram tokenization.

Researches other using machine learning made by Pak. and Paurobek [9]. Use emoticons to build a corpus of English Twitter with sentiment positive, negative and neutral. For the class of neutral Pak and Paurobek take data tweet from account English media. Classification used Naïve Bayes classifier (NBC), tokenization method used unigram, Bigram and n-grams. Best performasi generated when using classification Naive Bayes classifier (NBC) and tokenization method Bigram.

Research machine learning for sentiment classification the 2014 presidential candidates G.A.Buntoro [10]. This research holds views and opinions of the people by dividing them into five class attribute, which is very positive, positive, neutral, negative and very negative. The classification process in this study using the classification method Naive Bayes classifier (NBC) with the preprocessing data using tokenization, cleansing and filtering. data tweet in Indonesian Twitter about Indonesia Presidential candidate 2014, dataset of 900 tweets were distributed evenly into five class attribute. The highest of results accuracy obtained when using a Naive Bayes classifier (NBC) tokenization n-gram, stopword list WEKA and emoticons, with accuracy 71.9%, 71.6% Precision, 71.9% recall, 66,1% TP rate and 65% TN rate.

With machine learning research by Frangky [11] tried to repeat experiment sentiment classification movie review by Pang to Indonesian. In connection with not be training corpora for Indonesian, then applied to machine translation tools to translate English corpus created Pang native to ndonesian and the results are used to train translate classification. Wide choice of machine translation is used from commercial tools to simple translation word by word and text classification methods attempted. Average accuracy of the results obtained for the Naïve Bayes method was 74.6% and 75.62% for SVM method. Best results are obtained together with that obtained when using experiments in English.

METHODOLOGY

This study was conducted to test data tweet to opinion of three candidates for governor Jakarta, 2017. Data only tweet in Indonesian, which is 100 tweets with keywords AHY, 100 tweets with keywords Ahok, and 100 tweets with keywords Anies. Data taken at random either from a normal user or online media at Twitter. Tweet Indonesian opinion with the three candidates for governor Jakarta in 2017 and then divided into three sentiment: positive, neutral and negative. Preprocessing Data is, Lower Case Tokens, Normalization, Tokenization, Cleansing and Filtering. The Classification method in this study using Naïve Bayes classifier (NBC), because this method the most powerfully performed for sentiment analysis and proven always produce the highest accuracy. Research steps in accordance with the flow of the study are:

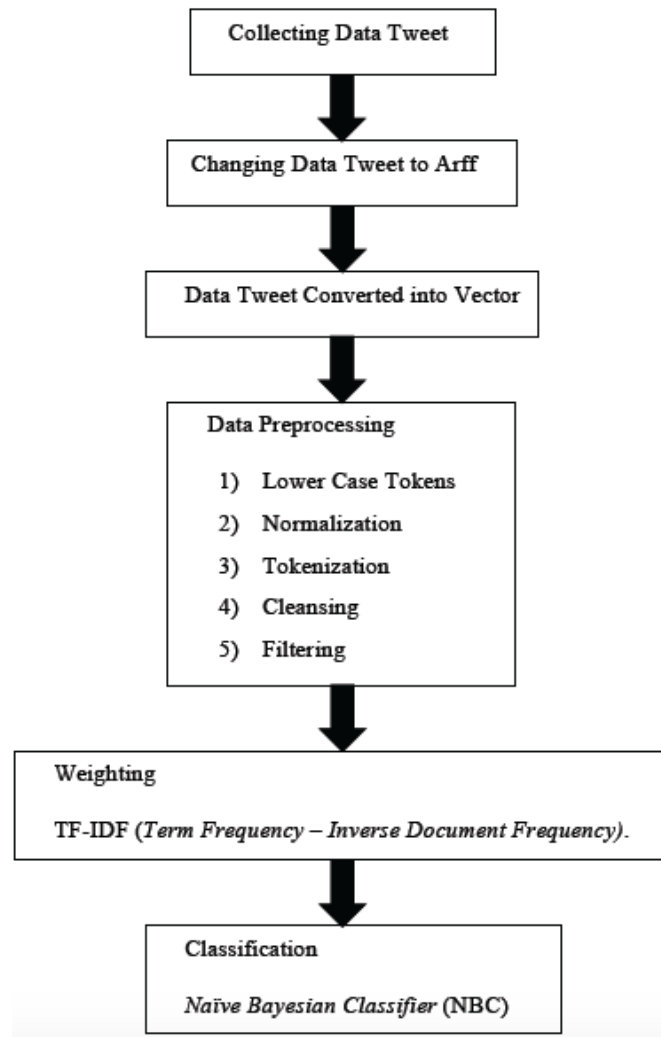


Figure-1 Flowchart Method

Collect data tweet

Data taken with Crawling tweet from social media Twitter. Data only tweet in Indonesian, which is 100 tweets with keywords AHY, 100 tweets with keywords Ahok, and 100 tweets with keywords Anies. Data taken at random either from a normal user or online media at Twitter.

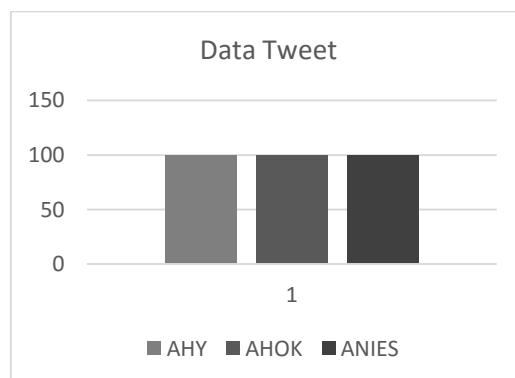


Figure-2 Data tweet

Converts data into a format tweet ARFF

Data tweet collected in text, then converts to ARFF file (Attribute Relation File Format) [12]. To manufacture file ARFF by manual.

Data tweet converted into vector

Data tweet has been shaped ARFF, then converted into a file vector [14]. How to turn data into vector by selecting StringToWordVector in WEKA tool.

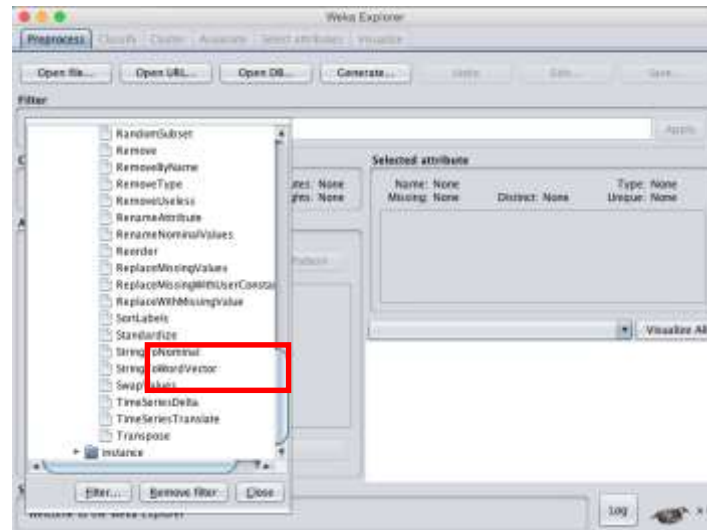


Figure-3 Data tweet converted into vector

The result of the conversion of the ARFF file into vector shapes can be seen in Figure 3.

weka.filters.unsupervised.attribute.StringToWordVector	184: masyarakat	185: masyarakat	186: may	187: melanjutkan	188: memilih	189: memperhatikan	190: mendukung
2.092108	0.0	0.0	0.0	0.0	0.0	0.0	2.33402
0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Figure-4 Contoh vektor dari data tweet

In Figure 3. The part which inside red box are words that exist in the data tweet. For each row of data representing each tweet. On line 1 the blue box can be seen word " masyarakat" has a value of 2.092108 and the word "mendukung" has a value of 2.33402. While others worth 0.0, it means the word "masyarakat" and "mendukung" contained in first data tweet.

Preprocessing Data

Perform preprocessing data tweet. Preprocessing data include lower case tokens, normalization, tokenization cleansing and filtering. All stages of preprocessing data using WEKA 3.8.1 tools. Stages preprocessing conducted as:

- 1) *Lower Case Tokens* tweet is to make the data be all lowercase, for example of capital letters to lowercase.
- 2) *Normalization* is to normalize words that are not standard, for example slang word, Alay word in Indonesian.
- 3) *Tokenization* is to break down the tweet into some word or set of words that stand alone. This study uses three methods tokenization, unigram, Bigram, and n-gram with a minimum value $n = 1$ and maximum $n = 3$. The process tokenization use existing menu in WEKA. In tokenizer select tokenization choose and select the method that will be used.
- 4) *Cleansing* is process removing the symbols of little importance in a tweet, that the data could interfere with the classification process will be. This process is by using the menu on WEKA delimiters.
- 5) *Filtering* is to remove the words are less important or less affect the classification process will be. This process is by using stop word list. Stop word list in this study is stop word list WEKA and Indonesian stop word list by Tala [13].

Weighting

In next stage is to give weight to each word (term). Weighting is to get the value of a word successfully extracted. The method used for assigning weights in this study is TF-IDF (Term Frequency - Inverse Document Frequency). Because this method works best when combined with the classification method Naive Bayes classifier (NBC).



Figure-5 TF-IDF (Term Frequency – Inverse Document Frequency)

Classification

In this study, classification data using WEKA 3.8.1 tools. Classification methods used in this study the Naïve Bayes classifier (NBC). Naïve Bayes Classifier (NBC) is a method of classifier based on Bayesian probability theorem and assuming that each variable X is free (independence). In other words, Naïve Bayesian Classifier (NBC) assuming the presence of an attribute (variable) has nothing to do with being of attributes (variables) to another. Here is the formula.

$$P(H|X) = \frac{P(X|H)P(H)}{P(X)} \tag{1}$$

In the process of classification data tested using 10-fold cross validation [15]. The dataset will be divided into two, namely 10 parts by 9/10 parts used for the training process and 1/10 part is used for the testing process. Iteration lasts 10 times with a variety of data, training and testing using a combination of 10 parts data.

Pengujian	Dataset									
1	█									
2		█								
3			█							
4				█						
5					█					
6						█				
7							█			
8								█		
9									█	
10										█

Figure-6 Illustration 10 fold cross validation

Evaluation Results

To evaluate the performance of TP rate, FP rate, Precision, Recall and F-measure of the experiments that have been using. Evaluation using the Confusion Matrix is true positive rate (TP rate), true negative rate (TN rate), false positive rate (FP rate) and false negative rate (FN rate) as an indicator. TP rate is the percentage of positive successful class are classified as positive grade, while TN rate is the percentage of negative class who succeeded classified as negative class. FP rate is negative class are classified as positive class. FN rate is a positive grade classified as negative class [16].

TABLE I
CONFUSION MATRIX

		<i>Predicted</i>	
		<i>Negative</i>	<i>Positive</i>
<i>Actual</i>	<i>Negative</i>	<i>a</i>	<i>b</i>
	<i>Positif</i>	<i>c</i>	<i>d</i>

RESULT AND DISCUSSION

The dataset in this study using ARFF format collected from Twitter. Data taken only tweet in Indonesian. Tweet opinion on the three candidates for governor in 2017 DKI well drawn randomly from a normal user or online media at Twitter.

The dataset used by 300 Tweets, data is split equally (balanced) each class, because the data is not balanced (imbalanced), a classification that is built has a tendency to ignore the minority class [15]. Data is divided into about 100 for AHY tweet, tweet to Ahok 100, and 100 tweets for Anies. Labelling is done manually with the help of experts Indonesian.

TABLE II
DATASET DETAILS

Sentimen	AHY	Ahok	Anies
Positive	62	33	62
Neutral	25	10	26
Negative	13	57	12

A. Candidates for Governor AHY

The first experiments with data tweet AHY using the classification method Naïve Bayesian Classifier (NBC) produces Precision, Recall, and F-measure.

TABLE III
RESULT AHY DATASET

Sentimen	TP	FP	FN	Precision	Recall	F-measure
Positif	60	2	2	0,952	0,968	0,960
Netral	24	1	1	1,000	0,960	0,980
Negatif	11	2	2	0,846	0,846	0,846
Average	95	5		0,950	0,950	0,950

From Table 3, we can see Precision of positive sentiment was 95.2% and for Recall was 96.8%. For the neutral sentiment, Precision 100% and Recall 96%. For negative sentiment, Precision and Recall same is 84.6%. In experiments with this data is not much going misclassification, as evidenced by the value of precision and recall is very high.

B. Candidates for Governor Ahok

The second experiments with the data tweet Ahok using the classification method Naïve Bayesian Classifier (NBC) produces Precision, Recall, and F-measure.

TABLE IV
RESULT AHOK DATASET

Sentimen	TP	FP	FN	Precision	Recall	F-measure
Positif	29	4	4	0,853	0,879	0,866
Netral	4	1	5	0,444	0,400	0,421
Negatif	49	4	4	0,860	0,860	0,860
Average	82	9	13	0,816	0,820	0,818

From Table 4, we can see Precision of positive sentiment was 85.3%% and for Recall is 87.9%. For the neutral sentiment, Precision 44.4 %% and Recall 40%. For the negative sentiment Precision and Recall same is 86%. In experiments with this data, the error occurred at a neutral sentiment, as evidenced by the more neutral sentiment data is classified into another sentiment. So the value of precision and recall of neutral sentiment is quite small.

C. Candidates for Governor Anies

The third experiments with data tweet Anies using the classification method Naïve Bayesian Classifier (NBC) produces Precision, Recall, and F-measure.

TABLE V
RESULT ANIES DATASET

Sentimen	TP	FP	F N	Precisio n	Recal l	F- measure
Positif	54	1	0	0,885	0,871	0,878
Netral	19	6	1	0,655	0,731	0,691
Negatif	9	1	0	0,900	0,750	0,818
Average	82	8	1	0,827	0,820	0,822

From Table 5, we can see Precision of positive sentiment was 88.5% and for Recall is 87.1%. For the neutral sentiment Precision 65.5% and Recall 73.1%. For the negative sentiment Precision 90% and Recall 75%. Experiment with this data, pretty much an error occurred while neutral sentiment classification, although the value is not more neutral sentiment which was classified as neutral sentiment. So the value of precision and recall of neutral sentiment has been quite high.

D. Comparison of the data analysis of three candidates for Governor of DKI 2017

After experiments with the three dataset candidates for governor DKI Jakarta in 2017, the following average values Precision, Recall, and F-measure.

TABLE VI
RESULT DATASET ANALISIS

Calon	Precision	Recall	F-measure
AHY	0,950	0,950	0,950
Ahok	0,816	0,820	0,818
Anies	0,827	0,820	0,822

From Table 6, we can see the highest scored Precision, Recall and F-measure is AHY dataset with Precision 95.2%, Recall 96.8% and F-measure 95%. The Lowest scored Precision, Recall and F-measure is Ahok dataset with Precision 81.6%, Recall 82% and F-measure 81.8%. Data AHY get the highest score due to positive sentiment on the data AHY most successful classified as positive sentiment. As for the data Ahok be the lowest for the most successful negative sentiment classified as negative sentiment.

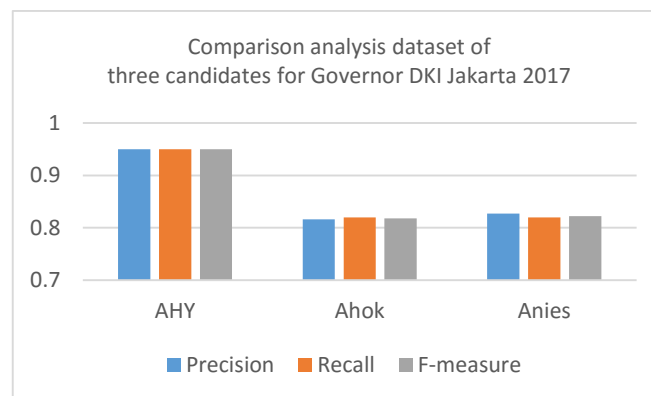


Figure-7 Comparison analysis dataset of three candidates for Governor DKI Jakarta 2017

CONCLUSIONS

This study was conducted to test the data tweet to the opinion of three candidates for governor of Jakarta, 2017. Data taken only tweet in Indonesian, which is 100 tweets with keywords AHY, 100 tweets with keywords Ahok, and 100 tweets with keywords Anies. Data taken at random either from a normal user or online media at Twitter. Tweet Indonesian opinion with the three candidates for governor of Jakarta in 2017 and then divided into three sentiment: positive, neutral and negative. Preprocessing Data is Lower Case Tokens, Normalization, tokenization, Cleansing and Filtering. For the method of classification in this study using Naïve Bayes classifier (NBC), because this method is the most powerfully performed for sentiment analysis and proven always produce the highest accuracy. From the results of the classification, the AHY dataset scored the highest with Precision 95% and Recall 95%, while Ahok dataset lowest scores with Precision 81.6% and Recall 82%. In this study also showed that the positive sentiment on the data AHY most successful classified as positive sentiment, as evidenced by the value of

precision and recall is very high. For the most successful negative sentiment classified as negative sentiment contained in the data Ahok. For further research needs to be tested was developed using more data and Real Time. Need to develop also stop word lists and Indonesian stemming were able to improve the accuracy of the Indonesian sentiment analysis.

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ANALYSIS OF RAW MATERIAL INVENTORY CONTROL FOR A MINIMUM TOTAL COST METHOD WITH EOQ (*ECONOMY ORDER QUANTITY*) DI PT. CITRA ABADI BOSCO GRESIK

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Abstract

PT Citra Abadi Bosco Gresik is a company engaged in the manufacturing industry that management production on plywood wood. The company is long established, but for the past two years the company has received orders from a market that is strong enough in the production of plywood types so the demand for plywood is very optimal. The optimal supply of raw materials is one of the ways emphasis in production cost. This effort is able to minimize the cost of inventory which is the trend of raw materials inventory among companies. Raw material inventory levels are efficient enough, not too much so as to minimize expenses such as ordering costs, raw material storage costs, the frequency of raw materials purchases and the amount of raw material needs optimal, the point of reorder so that companies can obtain optimal benefits. To anticipate fluctuations in demand, seasonal demand and out of stock resulting in customers moving to other companies, so far the company is in demand to be able to serve customer demand in a timely manner, appropriate materials and exact amount of production. Smooth process in production, it is necessary a control system to get a minimum total cost. One is the Economy Order Quantity (EOQ) method. Predicting past data by predicting future forecasts is very influential and helpful in predicting future production figures by requiring existing data in the past. The results of the calculations performed on the forecast using the method of winter multiplicative model obtained from meranti raw materials of 1892.146 m³, melamine raw material of 3188.136 liters, resin raw material of 6064,477 liters, and raw materials gumtape of 1727.495 kg. Control of plywood raw material inventory according to EOQ method can be seen that the value of raw materials meranti large amount economical order 19 m³. Frequency of booking every year 99 times. Timing between ordering of meranti timber 3 days. Safety stock 51 m³. Reorder point 76.47 m³. Total cost of supplies is Rp. 3,788,373,732. Melamine raw material large number of economical orders 152 liters. Frequency of booking every year 21 times. Intermediate time between melamine orders 17 days. Safety stock 96 liters. Reorder point 114.39 liters. Total inventory cost Rp.163.631.791. Raw material resin large amount of economic order amounted to 332 liters. Frequency of booking every year 18 times. Time between 20 days resin ordering. Safety stock 12 liters. Reorder point 47 liters. Total cost of inventory is Rp.93.732.802. Large gumtape raw material the order amount of economy 103 kg. Frequency of booking every year 16 times. The time between gumtape reservation 21 days. Safety stock of 0.699 kg. Reorder point 10 kg. Total cost of supplies Rp.35.853.476.

Keywords: Raw Material Inventory, Economy Order Quantity, Safety Stock, Reorder Point

INTRODUCTION

Developments in this era of globalization is a challenge for companies in growing and growing rapidly, so the company is required to have a stronger competitiveness from year to year. The company is currently in competition also has a goal to advance its business in order to grow rapidly and gain an optimal advantage. Enterprise management system also has an important role as a control tool to run the company's activities in order to move efficiently and able to generate optimal benefits. With the optimal inventory the company must also be able to determine how much the appropriate supply of raw materials, so as not to cause the nature of waste on the cost of suppression, because it can balance from the needs of raw materials are not too much or little (Taufiq, 2014).

Every manufacturing company must be able to determine the appropriate strategies and decisions in the supply of raw materials in accordance with the needs so that the production process can run smoothly. One of the inventory methods used is the Economy Order Quantity (EOQ) method or called the order amount. According to Heizer and Render (2011) said the EOQ method is a method of order quantity where one of the techniques used in control is very well known.

Jose L and Danial G. (2010) Economy Order Quantity and Reorder Point (EOQ/ROP) models have been used for years, but some companies have not been taken advantage of it. Quantity of economic orders can help in decide what it will become best optimal order quantity in your company lowest prices. Similar to EOQ, the reorder point will suggest when for place an order For Specific product c based on there historically demand

Stevenson and Choung (2014) explain that inventory is the stock or stock of goods held by the company in the inventory to be performed. Inventory is an existing property within the enterprise in the form of inventories of raw materials (raw materials), work in process (finished goods), and finished goods (Prawirosentomo, 2009). Forms of supply can be distinguished based on way and intent of purchase among others Batch stock or lot size inventory is a greater amount in the supply of the required amount while the use of and spending a small amount, Fluctuation stock is a stock that is available to deal with fluctuations requests that cannot be predicted and if there is fluctuation in demand, demand decreases, while Anticipation stock is the inventory to anticipate the demand for fluctuations that is predicted based on the seasonal pattern contained in one year.

According to Sumayang (2003) inventory cost consists of booking fees and storage costs and inventory shortage. The types of inventory can be grouped into inventories of raw materials, in-process goods, finished goods and spare parts (Sudana, 2011). Inventory may be interpreted as items to be stored for use or to be sold in the future or in the period to come.

The company in producing the product must be able to balance several factors regarding product quantity, product durability, cycle of production period, storage facility and inventory cost, distribution time requirement, capital adequacy, and risk in inventory (Maftukhah, 2013).

According to Donald Delmar (1985) in Harming and Mahfud (2017), planning and inventory control, there are several factors, namely, inventory turnover is a turnover frequency of inventory that has been replaced during a specific time period, Lead time is the time interval between the time pemesanan and receipt of orders supplies from the supplier, the Customer service level is a service provided by the customer from the percentage of orders based on the date of the approved date, Stock out cost is the cost of inventory shortage that occurs when the demand exceeds the level of inventory owned by the company, cost of inventory is the cost of ordering, storage costs and payment fees. Economy Order Quantity (EOQ) is an approach to establish the quantity of goods to be ordered to meet demand demand with minimized inventory cost (Fahmi, 2012).

Basically all companies in the planning and control of materials should also emphasize the cost to maximize profit from a certain time. In the planning and control of raw materials is the activity to maintain the amount of inventory at the level that will be desired with the policy of raw material inventory to be applied and used by the company. PT Citra Abadi Bosco is a company engaged in the manufacturing industry that performs wood processing into plywood and veener. The company was founded in 2008, but this new company engaged in the processing of wood into plywood and veneer products in 2015. Plywood is a board material composed of several layers of wood, while the wood veneer is a layer that has a certain thickness that is used to coat plywood (Kholidin, 2010). The company purchases raw materials in the form of local wood, but the products are plywood and veener which will be exported to India and Nepal. PT Citra Abadi Bosco develops and implements a management system to demonstrate its ability to comply with the applicable requirements and regulations to remain competitive to date. The underlying problem in this background is to establish the amount of raw material inventory to meet production needs and how to get the minimum total cost using EOQ method in PT. Citra Abadi Bosco Gresik.

METHODOLOGY

In any decision affecting the amount of inventory, variable costs include. Storage fee and booking fee. The stages in this study is to describe the application of EOQ in an effort to minimize the cost of raw material inventory. This research is done in the form of data of raw material needs in the past, raw material price, lead time and inventory cost. The data of raw material demand is done by using minitab software tool which, to predict some estimation of demand requirement in the future by Moving Average method, Single Exponential Smoothing, Double Exponential Smoothing, Winters' multiplicative. After the forecasting then select and form the smallest value of MSD to get the best forecasting method and can be used as further research.

Choosing the best forecasting method,

After data is forecasted with Moving Average method, Single Exponential Smoothing, Double Exponential Smoothing, Winters' multiplicative. Then select and specify the smallest MSD to get the best forecasting method, and use the forecasting as your next research. The data used for raw material needs for two years, raw material order data, warehouse cost data, and raw material price data.

Do the calculation by EOQ method, Determine the amount of raw material that is economical and ordering frequency. EOQ aims to determine the amount of raw material each time the order and each period so as to minimize the total cost of inventory. In general, these inventory costs are outlined based on cost components such as purchase costs, procurement fees, storage costs, and inventory shortage costs. Economy Order Quantity with the equation:

Calculation of Economy Order Quantity (EOQ):

The optimal amount of raw material purchase every time a message with minimum cost.

$$Q = \frac{\sqrt{2 \cdot D \cdot S}}{H \cdot C} \quad (1)$$

Where:

Q = The EOQ order quantity

D = Usage or demand estimated per time period

S = Ordering cost per order

H = Storage cost per unit per time period

C = Unit Cost

Reorder Point (ROP)

Determining the point of reorder or Reorder point is the level of inventory where the ordering back must be done with the determination of ROP, when the amount of raw material inventory becomes zero, then the raw materials that have been ordered also to the exact time.

$$\text{Reorder Point} = \text{Daily usage} * \text{Lead Time (in days)} \quad (2)$$

When a safety stock is maintained, then the reorder point is written as the following :

$$\text{Reorder Point} = [\text{Daily usage} * \text{Lead Time (in days)}] + \text{safety stock} \quad (3)$$

Simple moving average

Calculating the demand of product based on the time period required (quarter, weekly, daily). Calculated over the periods length.

$$F = \frac{\sum_{i=1}^n S_{i-1}}{n} \quad (4)$$

Where,

F = the forecast of the period

S = the sales of the period

i = the periods

n = the fix period amount

Weighted moving average

The technique is similiar to the simple moving average, but each sale period is multiplied by a different weight which will total to 100 percent for the amount of period (Jose, 2010).

$$F = \frac{\sum_{i=1}^n W * S_{i-1}}{n} \quad (5)$$

Total Costing (TC)

The EOQ method refers to the determination of the same amount in each purchase. Therefore, the number of purchasing activities in one year can be known by dividing the material needs in one year with the number of purchases every time to place an order. Frequency of purchase according to Sritomo (2003):

$$TC = DP + \frac{D}{Q} S + \frac{Q}{2} H \quad (6)$$

Where:

TC = Total Cost

S = Booking fee

D = Number of requests

H = Storage cost

Q = Economy Order Quantity

P = Raw Material P

Security Supplies

Safety stock or inventory is a stock of goods held as a reserve when the ordering of goods come longer than the time of waiting (lead time) that has been set. Security provision can be explained in the formula:

$$SS = SD * Z \quad (7)$$

Where:

SS = Safety stock (safety stock)

SD = Standard Deviation

Z = The security factor is determined on the company's capability

Additional inventories are held to anticipate the occurrence of shortages or run out of raw materials.

Calculate standart deviation

$$SD = \sqrt{\frac{\sum (X - \bar{X})^2}{N}} \quad (8)$$

Where:

SD = Standard Deviation

X = Real usa

X bar = Estimated usage

N = Number of Data

Demand per day (d)

Demand per day is calculated by dividing the year request (D) by the number of working days in a year:

$$\text{Demand per day} = \frac{D}{\text{jumlah hari kerja per tahun}} \quad (9)$$

RESULT AND DISCUSSION

The data are evaluated for analysis and calculation in order to facilitate the calculation of safety stock and reorder point calculation.

Demand needs analysis by forecasting

Estimated demand requirement is done by using forecasting, among others Moving Average method, Single Exponential Smoothing, Double Exponential Smoothing, Winters' Multiplicative.

Choosing the Best Forecasting Method

After data is forecasted with Moving Average method, Single Exponential Smoothing, Double Exponential Smoothing, winters 'Multiplicative. Then select and specify the smallest MSD to get the best forecasting method, and use the forecasting as your next research.

Doing Calculations by EOQ Method

Determining the Number of Economical Raw Materials (EOQ) and Order Frequency. Economic Order Quantity is an amount of material purchase that will be able to achieve the most minimal inventory cost.

Data were extracted from January 2016 to December 2017. Data on demand for raw materials were collected and processed using Minitab software that could be used to predict future demand demand forecasts. The data will be used to forecast future demand periods, regarding raw material data shown in Table 1.

Table 1. Raw Material Requirement Data

Month	Meranti/kubik	Melamin/liter	Resin/liter	Gumtape/kg
1	150	270	480	140
2	160	280	480	160
3	180	275	500	150
4	170	270	520	140
5	180	260	500	145
6	160	260	480	150
7	180	265	480	140
8	170	250	520	140
9	160	270	500	150
10	160	260	500	120
11	170	265	480	140
12	180	260	480	150
13	160	270	500	140
14	180	280	520	160
15	170	275	500	150
16	160	270	480	140
17	160	260	480	145
18	160	260	520	150
19	170	265	500	140
20	170	250	500	140
21	160	270	480	150
22	160	260	480	120
23	170	265	500	140
24	160	260	520	150
Total	4000	6370	11900	3450

Source : Company Data Year 2016-2017

Cost Data

Cost data is the data or records of outgoing booking fees used to obtain information about the required raw materials (Sritomo, 2003).

a. The cost of booking

Data on the cost of ordering raw materials can be seen in Table 2.

Table 2. Booking Costs on Plywood Type

Type of material	Phone charges	Administrative costs	Total Cost
Meranti	10.000	10.000	20.000
Melamin	10.000	10.000	20.000
Resik	10.000	5.000	15.000
Gum tape	10.000	5.000	15.000

Source : Company Data Year 2016-2017

b. Raw material prices

Data on the price of raw materials obtained from interviews with the purchasing and data of the company, the price of this raw material can be indicated on.

Tabel 3. Raw material prices

Type of material	Cost
Meranti/kubik	2.000.000
Melamin/liter	50.000
Resin/liter	70.000
Gumtape/kg	20.000

Source : Company Data Year 2016-2017

Time Series Analysis

As a basis for determining forecasting model is to look at the initial plot of existing data series for meranti wood data, data plot can be shown in Figure 1.

Plot of Meranti Wood Raw Material Demand Data

As a basis for determining forecasting model is to see the initial plot of the existing data series for meranti wood data. Plot image data can be shown in Figure 1. The plot of demand data of meranti wood which does not give a clear indication about the existence of a certain pattern, so that it is necessary to search the optimal parameters which will result in the smallest MSD (Mean Square Deviation) value of the three methods used with minitab software.

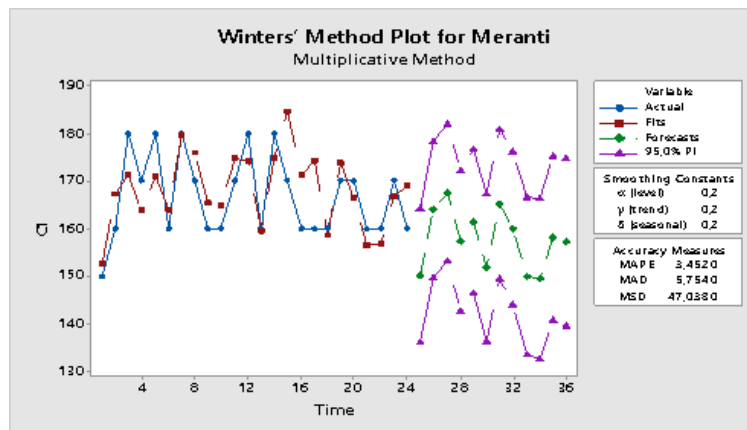


Figure 1. Plot of demand data of meranti wood raw material

From the data processing can be determined the optimal parameters for each method can be shown in Table 4. The optimal parameter values of meranti wood raw materials based on the value of MAPE, MAD, and MSD value.

Table 4. The optimal parameter values of meranti wood raw materials are based on MAPE, MAD, and MSD values

No	Forecasting Method	MAPE	MAD	MSD
1	<i>Moving Average</i>	3,8193	6,3235	51,0621
2	<i>Singel Exponential smoothing</i>	4,5831	7,6010	75,8768
3	<i>Double Exponential Smoothing</i>	4,9457	8,2465	90,5330
4	<i>Winters' multiplicative</i>	3,4520	5,7540	47,0380

Figure 2. Moving Average shows that this picture is a plot of demand data of meranti wood which has a value of 51.0621

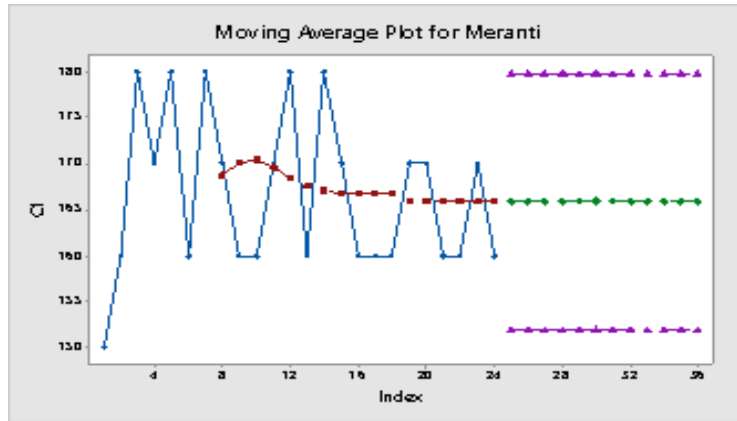


Figure 2. Moving Average plot of meranti wood raw material

While in Figure 3. Exponential Smoothing Singles shows that this image has a value of 75.8768. From data processing can be determined parameters in bried these values.

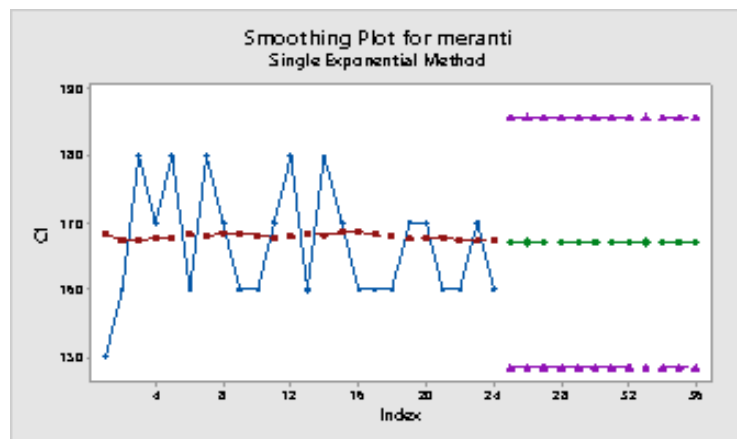


Figure 3. Singel Exponential Smoothing plot of meranti wood raw material

Double Exponential Smoothing shows that this image has a value of 90.5330, from the data processing can be determined the parameters in summary these values

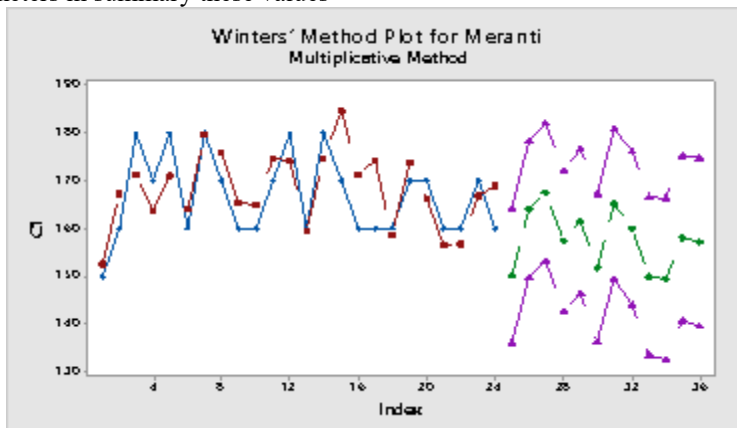


Figure 4. Winters' Multiplicative plot of Meranti wood raw material

Figure 4 Winters' Multiplicative shows that this image has a value of 47.0380, from the processing of data can be determined the parameters in summary these values

Analysis of Raw Material Inventory Control Using Method Economic Order Quantity

The value of the total minimum cost of controlling the supply of raw materials of plywood according to EOQ method can be seen that the value of raw materials meranti large amount economical order 19 m3. Frequency of booking every year 99 times. Timing between ordering of meranti timber 3 days. Safety stock 51 m3. Reorder

point 76.47 m3. Total cost of Rp. 3,788,373,732. Melamine raw material large number of economical orders 152 liters. Frequency of booking every year 21 times. Intermediate time between melamine orders 17 days. Safety stock 96 liters. Reorder point 114.39 liters. Total inventory cost Rp.163.631.791. To determine safety stock, assume normal distributed demand with service approach of 95% and obtained value of N equal to = 1.645.Q.

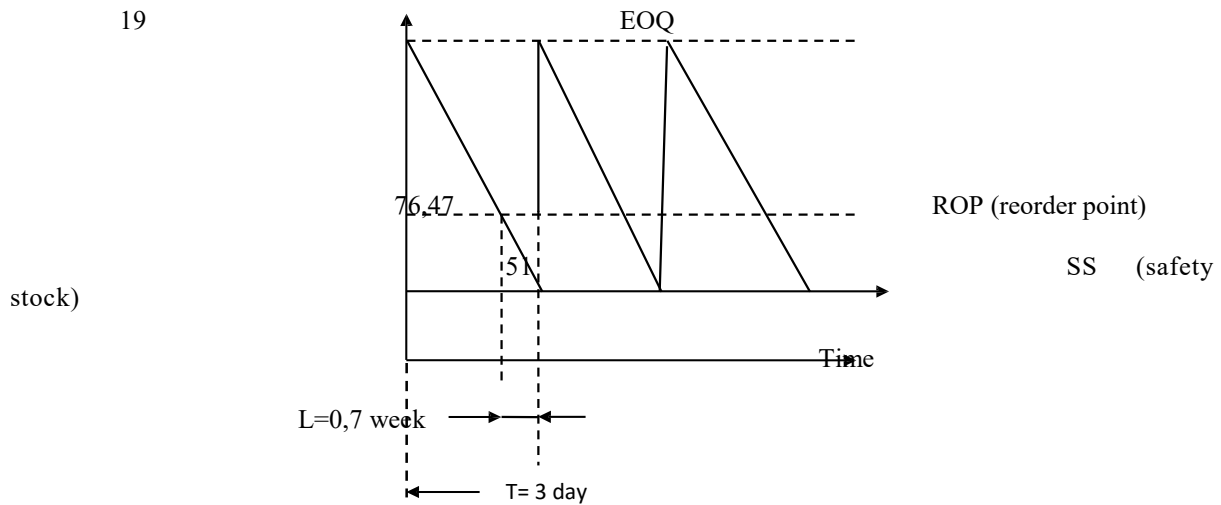


Figure 5. Meranti wood raw material inventory

From the results of data processing above can be determined the value of forecast of raw material needs for the period of 1 year ahead.

Table 5. The prediction of plywood raw material needs

Period of Need	Meranti/kubik	Melamin/liter	Resin/ liter	Gumtape/kg
25	150,114	268,819	495,702	139,271
26	163,918	279,150	506,643	159,433
27	167,628	274,504	506,743	149,699
28	157,434	269,816	507,023	139,916
29	161,460	260,085	498,131	145,096
30	151,748	260,317	509,909	150,266
31	165,167	265,532	499,921	140,385
32	160,023	250,674	520,468	140,504
33	150,005	270,890	500,904	150,651
34	149,401	260,993	501,753	120,597
35	158,099	266,135	503,125	140,774
36	157,149	261,221	514,155	150,903
Total	1892.146	3188.136	6064.477	1727.495

CONCLUSION

Based on the result of the calculation of raw material inventory control in chapter IV obtained the following conclusions: The value of the forecast using the method of winter multiplicative model of meranti raw materials of 1892.146 M3, raw material melamine 3188.136 liter, raw material resin 6064.477 liter, and raw materials gumtape 1727.495 kg. The value of the total minimum cost of controlling the supply of raw materials of plywood according to EOQ method can be seen that the value of raw materials meranti large amount economical order 19 m3. Frequency of booking every year 99 times. Timing between ordering of meranti timber 3 days. Safety stock 51 m3. Reorder point 76.47 m3. Total cost of Rp. 3,788,373,732. Melamine raw material large number of economical orders 152 liters. Frequency of booking every year 21 times. Intermediate time between melamine orders 17 days. Safety stock 96 liters. Reorder point 114.39 liters. Total inventory cost Rp.163.631.791. Raw material resin large amount of economic order 332 liters. Frequency of booking every year 18 times. Time between 20 days resin ordering. Safety stock 12 liters. Reorder point 47 liters. Total cost of inventory is Rp.93.732.802. Large gumtape raw material the order amount of economy 103 kg. Frequency of booking every year 16 times. The time between gumtape reservation 21 days. Safety stock 0.699 kg. Reorder point 10 kg. Total cost of supplies Rp.35.853.476, -

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PRELIMINARY STUDY OF TRAFFIC CHARACTERISTICS BASED ON DATA FLOW AND SPEED OF VEHICLES (CASE STUDY OF NGINDEN ROAD, SURABAYA)

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Abstract

An arterial road is a high capacity urban road used by various categories of vehicles. The arterial road characteristics composed of traffic flow, traffic density and speed of vehicles. Therefore, every arterial road has different characteristics depends on its type and actual data. In order to identify the characteristics of arterial road based on traffic density and speed of vehicles, this research implements a least square method into a case study in Surabaya assumed that the relationship of traffic density and vehicles speed is linear and the traffic characteristic model based on Greenshield. At the end, this research concludes that Nginden Road as case study has maximum vehicle speed at 26 km/h and traffic density at 166 pcu/km with the Greenshield model $S = 35,75 - 0,7942 \cdot D$, where S is the speed of vehicles and D is the traffic density.

Keyword: traffic flow, traffic density, speed of vehicles, traffic analysis

INTRODUCTION

Arterial road is an important road segment that connects various existing collector roads with different traffic density depends on various parameters such as road width, traffic volume, side obstacle factor, road conditions, rush hour and others (Li, Li, Zhu, Lan, & Chang, 2017; Mohan Rao & Ramachandra Rao, 2012; Taylor, Olstam, Bernhardsson, & Nitsche, 2017). As the main road, the arterial road has a very high traffic density affected by the speed of vehicles which depends on the type of vehicle, the emotions of the rider or the weather at that time (Corpuz, 2016; Hjalmdahl, Krupenia, & Thorslund, 2017; Thorslund, Strand, & Willstrand, 2017).

Nginden road is one of the arterial road in Surabaya with high traffic dynamics, especially during the rush hour in the morning or afternoon or the times during which the most people commute.

Previous research stated there is a tight relationship between traffic flow, traffic density and the speed of vehicles (Wibisana H., Utomo N., 2017). It said that the speed of vehicles depends on the traffic density to avoid a traffic jam and a high traffic flow will reduce the speed of vehicles to avoid the friction among vehicles that can cause a traffic accident (Cao, Yang, & Zuo, 2017; Dickerson, Peirson, & Vickerman, 1998; Renuraj, Varathan, & Satkunanathan, 2015)

This study aims to identify the characteristics of the Nginden road as a case study that presents the traffic flow, traffic density and speed vehicles in mathematical relationship. In this study, the Greenshield approach is used whose quite simple model to implement and assumes that the relationship of traffic density and vehicles speed is linear as shown in equation 2.

TRAFFIC CHARACTERISTIC

The relationship between variables that build traffic characteristics is given by the equation model as follows (Tamin, 2003):

$$V = D \cdot S \quad (1)$$

Where: V is the traffic flow variable (pcu/hour), D is the traffic density (pcu/km), and S is the vehicle speed (km/h).

The Greenshield model states the mathematical relationship between vehicle speed and traffic density is expressed by the model form of the equation:

$$S = S_{ff} - \frac{S_{ff}}{D_j} \cdot D \quad (2)$$

Where the S_{ff} is a free flow speed and D_j is a density at saturated flow.

If the mathematical equation 2 is modified based on the equation 1, so that, a mathematical model presents the relationship between traffic flow with the speed of the vehicle by replacing the variable D with the form V / S which later, produced a model equation 3 below.

$$V = D_j \cdot S - \frac{D_j}{S_{ff}} \cdot S^2 \quad (3)$$

Similarly, if the mathematical equation (2) is modified by substituting the S variable to form V / D, a new equation will be generated which states the relationship between traffic flows with the traffic density shown in equation 4.

$$V = S_{ff} \cdot D - \frac{S_{ff}}{D_j} \cdot D^2 \quad (4)$$

From equations above, a traffic characteristic model will be formed based on Greenshield approach. Beside that, the maximum value both of vehicle speed and traffic density at study case will be achieved.

METHODOLOGY

To collect the actual data in this study, a field observation is necessary. In order to calculate the traffic volume of Nginden Road in vehicles per hour, a digital stopwatch and flag meter are used. A flag meter will be placed as a start and finish line of observation point for every 50 m to measure the speed of vehicles. This observation witnesses the time of the front wheels of the passed vehicle at flag meter 1 until its back wheel reach the flag meter 2. So that, by measuring the time with digital stopwatch in second unit, a meter/second will be converted into km/h. The various types of vehicles in this observation consists of light vehicle (LV), heavy vehicle (HV), and motorcycle (MC). This study held on January 14, 2018 with the selection of rush hour in the morning from 06.00 am until 09.00 pm for 3 hours running with lapse record every 15 minutes, therefore, 12 data traffic volume is obtained.

LINIER REGRESSION

Linear regression analysis can be done by converting the recorded field data into pcu/hour, an then those data will be processed to obtain the mathematical equation model: $y = a + bx$, where y is the independent variable and x is the independent variable, a and b are the coefficients of each variable.

The purpose of linear regression analysis is to achieve the value of coefficients a and b, where the value of b is obtained by these formulas:

$$b = \frac{S_{xy}}{S_{xx}} \quad (5)$$

$$b = \frac{N \cdot \sum xy - \sum x \cdot \sum y}{N \cdot \sum x^2 - \sum x \cdot \sum x} \quad (6)$$

$$a = \frac{\sum y}{n} - b \cdot \frac{\sum x}{n} \quad (7)$$

After obtaining the value of coefficients a and b, modifying and converting the Greenshield equation model for the relationship of traffic characteristics which consists of traffic flow, traffic density and vehicle speed are conducted.

The correlation coefficient R2 will be calculated to determine the strength of the relationship of each variable on the linear regression using the following equation:

$$R = \frac{S_{xy} \cdot S_{xy}}{S_{xx} \cdot S_{yy}} \quad (8)$$

LINIER REGRESSION ON GREESHIELD MODELS

The form of the accepted linear regression equation is:

$$y = a + bx \quad (9)$$

Where : y is a dependent variable, x is a independent variable while a and b is a coefficient of variable.

The Greenshield equation model states that the linear relationship between the speed of the vehicle and the traffic density which is expressed in equation (2). In equation (2), the variable S can be written as variable y, at the same time, variable D can be inserted as x. From this calculation, the coefficient a and b as shown in equation (9) can be associated with the value of S_{ff} and D_j on the Greenshield model, where $a = S_{ff}$ dan nilai $b = \frac{S_{ff}}{D_j}$ atau $D_j = \frac{S_{ff}}{b}$.

By obtaining the value of the free current velocity of S_{ff} and the density of the current saturated D_j then the whole Greenshield model can be fully modeled. After the Greenshield model finished, the next step is to obtain maximum speed and maximum traffic density, the model will be differentiated in level 1 of mathematical differentiation and assume the result would be $\frac{dV}{ds} = 0$ dan $\frac{dV}{dD} = 0$.

RESULT AND DISCUSSION

Based on the results of field observation, the traffic volume data can be presented as it shown in Table 1. This collected data consists of several types of vehicles, therefore the total volume of traffic per hour is the total volume of those passed vehicles on Nginden road.

Table 1. Calculation of Traffic Volume at Nginden Road on January 14 2018.

Q tot (pcu/h)	MC (pcu/hr)	LV (pcu/hr)	HV (pcu/hr)
1437	870	538	29
1672	989	649	34
1684	1032	631	21
1825	1321	479	25
1357	905	436	16
1429	1033	382	14
1461	947	495	19
1528	1079	437	12
1365	1027	315	23
1176	759	388	29
944	409	512	23
1039	526	483	30

MC= motor cycle; LV= light vehicles ;HV= heavy vehicles (kendaraan berat); Qtot= Volume lalu lintas (MC+LV+HV)

From Table 1., the total volume of motor vehicle traffic passing through the Nginden road segment for 12 data retrieval periods was obtained from the observation of the V speed of vehicle S in the final unit as km / h and the results of this record are shown in Table 2 , where the existing traffic density D is a calculation of the traffic flow divided by the speed of the vehicle.

Table 2. Result from calculation density (D), Volume of traffic (V) and speed of vehicles (S) at Nginden mainroad

Nginden Mainroad			
No	V (pcu/hr)	S (km/hr)	D (pcu/hr)
1	1437	29,4	48,878
2	1672	28,5	58,667
3	1684	26,7	63,071
4	1825	26,3	69,392
5	1357	28,4	47,782
6	1429	27,9	51,219
7	1461	31,2	46,827
8	1528	28,5	53,614
9	1365	30,6	44,608
10	1176	31,9	36,865
11	944	34,2	27,602
12	1039	33,7	30,831

Source : field calculation

With the used of least square for calculating data which presented in Table 2., the result shown linier regression equation with the value of R = 0,91 as a :

$$y = 39,3075 - 0,1974. x$$

Where :

$$A = 39,3075$$

$$B = -0,1974$$

The value of the coefficient then modified in the Greenshield model and the value of Dj became :

$$A = S_{ff} = 39,3075$$

$$b = -\frac{S_{ff}}{Dj}$$

$$Dj = \frac{-39,3075}{-0,1974}$$

$$Dj = 199,082 \text{ pcu/km}$$

Rounded to :

$$Dj = 199 \text{ smp/km}$$

The Greenshield model equations for the relation of vehicle speed to the traffic density becomes

$$S = S_{ff} - \frac{S_{ff}}{Dj} \cdot D$$

$$S = 39,3075 - 0,1974 \cdot D$$

This means that every increase in traffic density of 1 unit will decrease vehicle speed by 0.1974 km / h, the graphical display is shown in Figure 1.

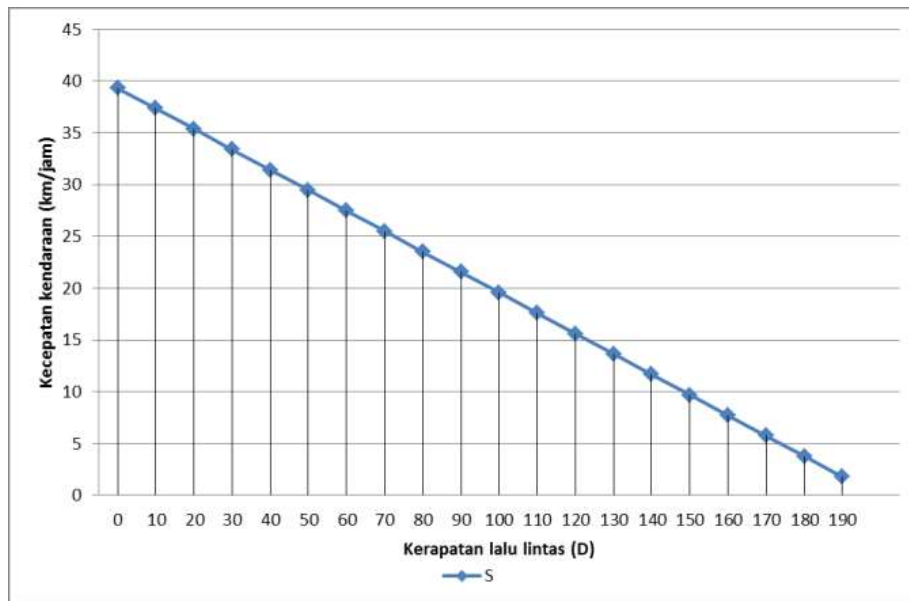


Figure 1. The Greenshield model equations for the relation of vehicle speed to the traffic density

To see the relationship between traffic flow variable and vehicle speed, the Greenshield model equation for equation (3)

$$V = Dj \cdot S - \frac{Dj}{S_{ff}} \cdot S^2$$

By entering the known values of Sff and Dj then the equation model becomes:

$$V = 199,082 \cdot S - 5,065 \cdot S^2$$

The mathematical meaning of the equation model is that each increase of 1 unit from the speed of the vehicle on the Nginden highway will cause the value of the traffic flow will increase until it reaches the maximum value at speed of 20 km / hour traffic flow will decrease the number of vehicles passing in the road Nginden highway as seen in Figure 2.

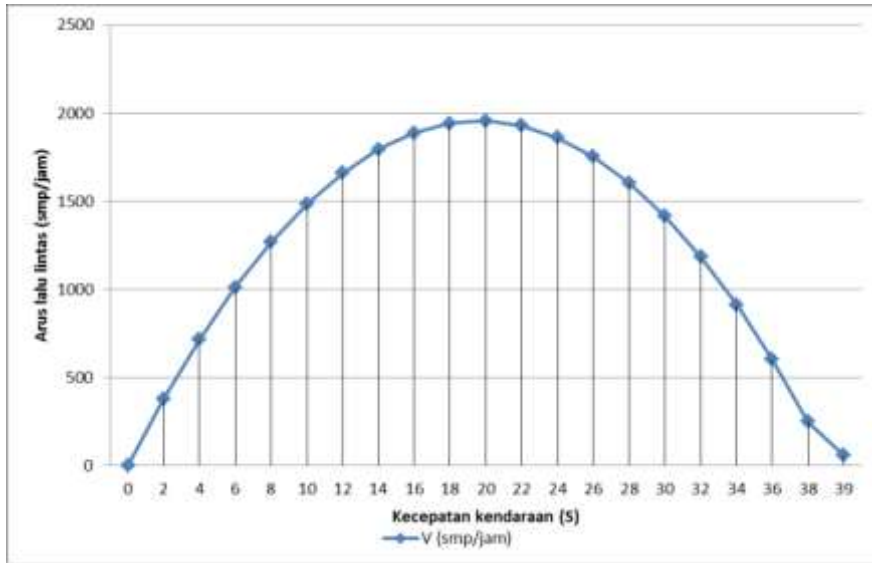


Figure 2. The Greenshield model equations for the relation of vehicle speed to the traffic volume

Otherwise for the relationship between the traffic variable with the traffic density in the Greenshield models are corresponded with the equation (4) like :

$$V = S_{ff} \cdot D - \frac{S_{ff}}{D_j} \cdot D^2$$

By entering a value like Sff and Dj the result for the models :

$$V = 39,3075 \cdot D - 0,1974 \cdot D^2$$

The mathematical equation model means that for every increase of one unit of traffic density (D) then the traffic flow will increase to limit when the D value reaches 100 vehicles per kilometer and then it will decrease until it reaches the lowest limit of 200 for a gasoline cracker, for a density greater than that value the Greenshield model will provide a negative value for the traffic flow, whereas this phenomenon is unlikely to occur, so it can be said that the interval for traffic density that can represent real traffic flows is 0 to 200 vehicles per kilometer, where the graph's peripheral hose will form a parabola that has a maximum value for the existing traffic density as shown in Figure 3.

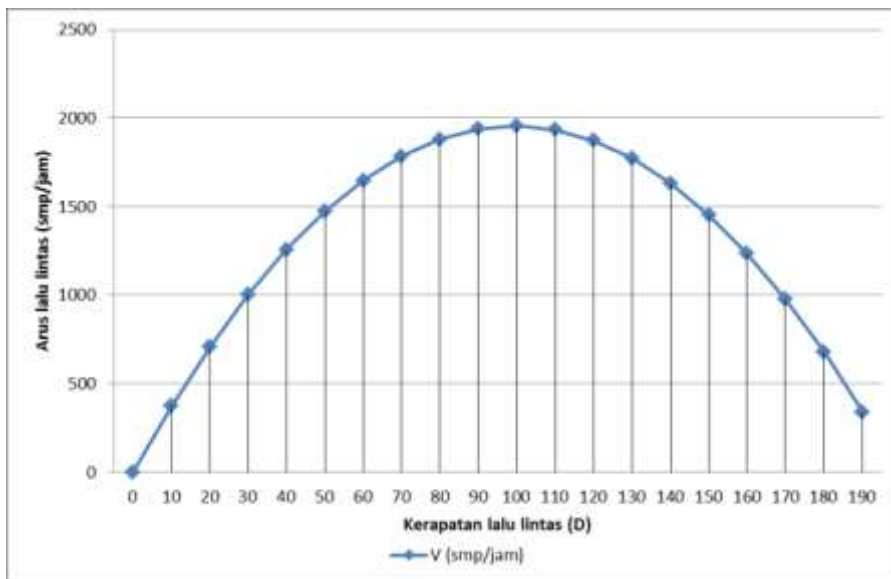


Figure 3. The Greenshield model equations for the relation of traffic density to the traffic volume

CONCLUSION

The mainroad of Nginden has the traffic characteristic models with the expression of mathematical equation : $S = 39,3075 - 0,1974 \cdot D$ for the relationship between traffic density and vehicle speed, $V = 199,082 \cdot S - 5,065 \cdot S^2$ for the relationship between traffic flow with the vehicle speed, and $V = 39,3075 \cdot D - 0,1974 \cdot D^2$ for the relationship between traffic flow with the traffic density.

The maximum velocity value is derived from a first-rate derivative for the equation

$$V = 199,082 \cdot S - 5,065 \cdot S^2 \text{ dimana diperoleh untuk } S \text{ maksimum sebesar } \frac{1}{2} S_{ff} = 19,65 \text{ km/jam}$$

The maximum density value is derived from a level 1 derivative for a mathematical equation

$$V = S_{ff} \cdot D - \frac{S_{ff}}{D_j} \cdot D^2 \text{ where the value of } D \text{ maximum could be obtained by } \frac{1}{2} D_j = 99,54 \text{ pcu/km or round up with } D_{max} = 100 \text{ pcu/km}$$

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APPENDIX

Value of b in regression line can be obtained by the formula :

$$b = \frac{S_{xy}}{S_{xx}}$$
$$S_{xy} = \sum xy - n \cdot \sum \bar{x} \cdot \sum \bar{y}$$

And then

$$S_{xy} = N \cdot \sum xy - \sum x \cdot \sum y$$
$$S_{xx} = \sum x^2 - n \cdot \sum \bar{x} \cdot \sum \bar{x}$$

Or

$$S_{xx} = N \cdot \sum x^2 - \sum x \cdot \sum x$$

So the result :

$$b = \frac{N \cdot \sum xy - \sum x \cdot \sum y}{N \cdot \sum x^2 - \sum x \cdot \sum x}$$

$$a = \bar{y} - b \cdot \bar{x}$$
$$a = \frac{\sum y}{N} - b \cdot \frac{\sum x}{N}$$

Basic concept of characteristic of traffic flow

$$V = D \cdot S$$

Where :

V = traffic volume (pcu/ jam)

D = density of traffic (pcu/ km)

S = speed of vehicles (km/hour)

Model Greenshield :

The mathematical relationship between speed and traffic density

$$S = S_{ff} - \frac{S_{ff}}{D_j} \cdot D$$

The mathematical relationship between traffic flow and vehicle speed

$$S = S_{ff} - \frac{S_{ff}}{D_j} \cdot \frac{V}{S}$$

Both segments multiplied by S obtained:

$$S^2 = S \cdot S_{ff} - \frac{S_{ff}}{D_j} \cdot V$$

Both segment multiplied with $\frac{D_j}{S_{ff}}$ obtained:

$$S^2 \cdot \frac{D_j}{S_{ff}} = D_j \cdot S - V$$

Variable V moved to the left side, obtained:

$$V = D_j \cdot S - \frac{D_j}{S_{ff}} \cdot S^2$$

Mathematical relationship between traffic flow and traffic density:

$$S = S_{ff} - \frac{S_{ff}}{D_j} \cdot D$$

Variable of S changed with $\frac{V}{D}$: diperoleh

$$\frac{V}{D} = S_{ff} - \frac{S_{ff}}{D_j} \cdot D$$

Both segment multiplied by D, obtained:

$$V = S_{ff} \cdot D - \frac{S_{ff}}{D_j} \cdot D^2$$

To get the maximum D value:

$$\begin{aligned} \frac{dV}{dD} &= 0 \\ \frac{dV}{dD} &= S_{ff} - 2 \frac{S_{ff}}{D_j} \cdot D_{max} \\ S_{ff} &= 2 \frac{S_{ff}}{D_j} \cdot D_{max} \end{aligned}$$

Both segment divided by S_{ff} , obtained:

$$\begin{aligned} 1 &= 2 \cdot \frac{D_{max}}{D_j} \\ D_{max} &= \frac{1}{2} \cdot D_j \end{aligned}$$

To get the maximum S value:

$$\begin{aligned} \frac{dV}{dS} &= 0 \\ V &= D_j \cdot S - \frac{D_j}{S_{ff}} \cdot S^2 \end{aligned}$$

$$\frac{dV}{dS} = Dj - 2 \cdot \frac{Dj}{S_{ff}} \cdot S$$
$$Dj = 2 \cdot \frac{Dj}{S_{ff}} \cdot S$$

Both segment divided by Dj , obtained:

$$1 = 2 \cdot \frac{S_{max}}{S_{ff}}$$
$$S_{max} = \frac{1}{2} \cdot S_{ff}$$

DESIGN AND CALCULATION ANALYSIS FOR THERMAL CONTROL SYSTEM OF CUBESAT MODELING

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Abstract

Thermal control subsystem (TCS) as one of the satellite subsystems has a function for maintain a thermal control for over all the components of the satellite within their required temperature limits for all mission phase. This objective can be reached with keeping the balance of energy, among incoming energy and discharge energy. In this paper temperature distribution (*worst hot case* and *worst cold case*) of nanosatellite in low earth orbit using some data assumptions for calculating the spherical, solar array and sphere of the satellite are used. For the sphere of the satellite is not describes in this paper. Temperature distribution of a cubesat was computed using SCDE (*Spacecraft Control Design Engineering*) based on the Microsoft Excel. It was created self by author using some references. The thermal analysis results show that average the maximum and minimum temperature's based on low earth satellite's altitude (400 km to 700 km) are 32.62°C and -75.32°C for the spherical of the satellite, and 67.15°C and -75.12°C for the solar array of the satellite.

Keywords: Thermal, Temperature, Satellite, Spherical, Solar Array

INTRODUCTION

The main goal of Thermal Control Subsystem is to keeping all subsystem of the satellite in the allowable range at all mission phase. It is necessary subsystem for a satellites, even a nanosatellite has thermal control subsystem (Janson *et. al.*, 1993; Nazari and Emami, 2008). The thermal analysis and control provides the necessary means to control the temperature of the satellite during the harsh conditions in space. Spacecraft thermal control is a process of energy management in which environmental heating plays a major role (Wertz and Larson, 1991). Both of the thermal design role's are some parameters such as thermo optical properties of thermal surfaces, specific heat and thermal conductivity of materials, components power dissipations and thermal boundary conditions (direct solar flux, albedo reflected radiation, infrared radiation reflected from earth and heat generated by satellite's internal electronics), and too some orbitals elements data. Many thermal analyses have done with thermal models using both of software analysis or a thermal calculation analysis using the energy balance equations. All of them are gives us many experiences for satellite thermal control system analyzing. Nazari and Emami (2008) studied thermal control techniques about power consumption for observation satellite with compare between passive and active thermal control analysis. Bulut *et al.*, (2010) reported thermal design and analysis for hot and cold cases temperature of nanosatellite using ThermXL software. Da Silva *et al.*, (2014) reported thermal design control and analysis for payload temperatures of the Amazonia-1 satellite in three critical cases and verified using SINDA/FLUINT thermal analyzer. Nobari and Novinzade (2009) presented the thermal analysis of the satellite using the first law of thermodynamics where in elements number of thermal subsystem network can be solved with the energy balance equations. Arslantas *et al.*, (2017) presented the thermal analysis simulation model using six nodes and thermal physical parameters tolerance value based on ECSS standard for calculating the maximum and minimum temperatures of the thermal model surface of the satellite.

In this study, the model is constructed using the energy balance equations to compute the equilibrium temperature of the satellite using mathematical model technique. The development of nanosatellites is currently a trend technology in the area of space science and engineering research (government, universities, industry, aerospace, military, etc). The cubesat under this study is a cube shaped satellites have a mass approximately 1 kg based on the standard (Mehrpour, A., 2014), and surface dimension of 10 x 10 x 10 cm each. The geometry of cubesat model was built in Femap. Femap is *finite element modelling and post-processing* software that can be used to create geometry or import CAD geometry from other model software. The cubesat model also design approach is using passive thermal control with consideration of the simplicity, cost, the reliability, the limited mass and the lower power consumption (Bulut *et al.*, 2010). The passive thermal control too is mostly defined by its thermo optical properties. The highest and lowest temperatures on cubesat surface during on the orbit can be calculated with consideration the effect of thermo optical properties in order to find out how much the temperature that occurs on the satellite. The thermal analysis of cubesat in this study is used some data such as sun emissivity,

temperature absolute of sun surface, radius of sun and radius of earth for radiation calculation, because this parameter will be used in spherical, solar array and sphere for satellite (*Solar Constant In Appendix B*). In orbital heat fluxes, solar radiation has the maximum value of 1428 W/m^2 , and the minimum value of 1316 W/m^2 . The radiation of a black body is used at 288°K (emissivity of sun value is 1) (Abouel-Fotouh *et al.*, 2006). This paper describes the thermal design and calculation analysis of cubesat using the mathematical model in equation energy balance approach in SCDE (Spacecraft Control Design Engineering) based on Microsoft Excel for predicting worst hot and cold case distribution temperatures on the satellite.

Thermal control system of the satellite consists of active and passive thermal control elements in order to maintain the satellite components and structure within a controlled range of temperature throughout the mission of the spacecraft, from the Beginning of Life (BOL) to the End of Life (EOL) (da Silva *et al.*, 2014). The passive thermal controls are usually uses OSR (*Optical Solar Reflector*) and MLI (*Multi Layer Insulation*), and active thermal control are usually use heater and heat pipe. The heaters function to maintain the temperature of the battery and earth sensor (Tetsuo *et al.*, 2007), and in part of a thermal subsystem, a heater is too have responsible for maintaining ideal temperature range for the different satellite subsystems (Nobari and Novinzade, 2009).

METHODOLOGY

For the thermal analysis of a satellite the following data must be known as in the design process, meanwhile some data provision such as Stefan Boltzmann, earth radius, solar flux, and earth IR emission. The thermalization analysis process in this study could be implemented as the following process in Fig.1.

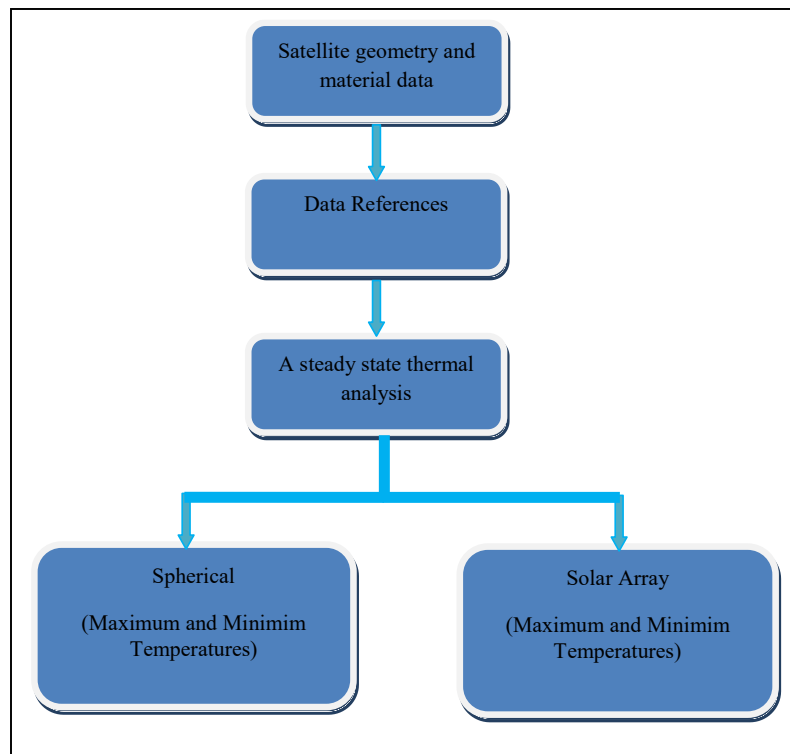


Figure-1. Athermalization calculation process

The geometry model of the cubesat in this study is presented by Fig.2, with a cube shape platform. The structure material uses an aluminum 7075-T651 with thermalphysical properties are presented in Table.1, in order to thermal analysis each that the thermal spherical spacecraft with an aluminum material panel have absorptivity and emissivity value are 0.6 and 0.8. For solar array panel are use absorptivity and emissivity on the top surface value are 0.68, and solar panel on the bottom surface used absorptivity and emissivity value are 0.6, whereas both the absorptivity and emissivity for sphere of the satellite have value are 0.6 and 0.8. Using SCDE for thermal spherical, solar array and sphere calculation was computed easily with derived all formula in Microsoft Excel. Using some data provisions constants and both data when we need, the worst hot and cold case can be calculated.

Table 1: Thermalphysical properties

Properties	Value	Unit
------------	-------	------

Conductivity, k	0.20139	W/mm°C
Specific Heat, Cp	77.28	J/Ton°C
Mass Density, ρ	2.59062E-4	Ton/mm ³

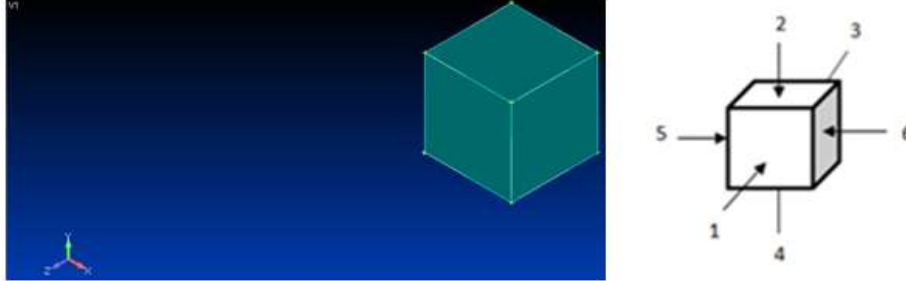


Figure-2. Cubesat model and configuration

RESULT AND DISCUSSION

Thermal control system in this study is managed using passive thermal control system with some considerations of an orbit environment for the cubesat, and appropriate the structure surface treatment by controlling thermal properties is used. The objective of the thermal control system is to keep the temperature of the satellite and its components within the allowed temperature ranges, and therefore for extremely severe temperatures ranging when satellite orbiting in space between -150°C to $+150^{\circ}\text{C}$, and basically often use the electronics and structure components in satellite based on COTS (*commercial off-the-shelf*) within temperatures operation range are between -20°C and $+80^{\circ}\text{C}$. It's still allowable in the satellite platform. The aim of thermal design is to provide the comfortable environment for all the components in the cubesat. The thermal control of the cubesat in orbit is usually achieved by balancing the thermal energy, dissipated by the internal electronics components and the energy absorbed from its environment with the energy emitted by a satellite. Its mean conservation of energy can be described as equation (1) (Czernik S., 2004).

$$Q_{in} = Q_{out}$$

$$Q_{sun} + Q_{albedo} + Q_{earth} + Q_P = Q_{sat-earth} + Q_{sat-space}$$

(1)

The temperature of an orbiting satellite with internal power dissipation Q_w , available area surface of the satellite A , and satellite cross sectional A_c , the radiation properties of its surface and orbital geometry are determined by its radiation environment (Hass and Schach, 1959). All of them are considered for a spherical satellite thermal calculation. The maximum and minimum temperatures for the spherical satellite thermal can be calculated by equation (2) and equation (3) (Col. John E. Keesee, *In Lecture Notes*).

$$T_{max} = \left[\frac{(A_c G_s \cdot \alpha) + (A F \cdot q_{1max} \cdot \varepsilon) + (G_s \cdot a \cdot \alpha \cdot K_a \cdot A F) + Q_w}{A \cdot \sigma \cdot \varepsilon} \right]^{1/4}$$

(2)

$$T_{min} = \left[\frac{(A F \cdot q_{1min} \cdot \varepsilon + Q_w)}{A \cdot \sigma \cdot \varepsilon} \right]^{1/4}$$

(3)

Where F is the view factor of cylinders ($= (1 - \cos \rho)/2$), the ρ is the angular radius of the earth, the A_c and A are the area of cylinders (m^2) and the satellite surface area (m^2), the G_s is solar flux (W/m^2) with a blackbody is equal to $1418 \text{ W}/\text{m}^2$, the σ and ε are absorptivity and emissivity of satellite surface, the σ is Stefan Boltzmann's constant, equal to $5.67 \times 10^{-8} \text{ W}/\text{m}^2\text{K}^4$, the a is albedo, equal to 0.3 up to 0.35. The q_{1min} and q_{1max} are the minimum

and maximum Earth IR emission, equal to 216 W/m² and 258 W/m², the K_a is the albedo reflection factor, and the Q_w is power dissipation on satellite.

Using equation (2) and equation (3), we can do hand calculation for both of steady state temperatures the satellite (T_{\max} and T_{\min}) with some data required as, radiation from the sun with effective area exposed to solar radiation is 0.06 m² and solar emitted heat flux is 1418 W/m². Radiation and albedo from the earth with infrared load is assumed to be 258 W/m², the albedo coefficient is 35% and maximum power dissipation is 1.8 Watts. The spherical maximum temperature for satellite can be calculation with equation 2 and its results is 58.07°C. Otherwise, when radiation and albedo from the earth with infrared minimum load is assumed to be 216 W/m² and minimum power dissipation is 1 Watt, the spherical minium temperature for satellite can be calculation using equation 3 and its results is -37.24°C, respectively.

Most satellites are used solar arrays as a primary power source for long lifetime the satellite operation in orbits. Furthermore, solar arrays are to be assisted by batteries that used as secondary power source to store and deliver energy. This store energy is needed by satellite when the operation of the satellite systems and charging the battery to supply power when in eclipse periods (McGuire, *et al.*, 2016). For this energy, it must be considered also the amount of solar array temperatures using equation (4) and equation (5) (Col. John E. Keesee, *In Lecture Notes*).

$$T_{\max(SA)} = \left[\frac{(G_s \cdot \alpha_t) + (F_p \cdot q_{1\max} \cdot \varepsilon_b) + (G_s \cdot a \cdot \alpha_b \cdot K_a \cdot F_p) - G_s \cdot \eta}{\sigma \cdot (\varepsilon_b + \varepsilon_t)} \right]^{1/4} \quad (4)$$

$$T_{\min(SA)} = \left[\frac{(F_p \cdot q_{1\min} \cdot \varepsilon_b)}{\sigma \cdot (\varepsilon_b + \varepsilon_t)} \right]^{1/4} \quad (5)$$

Where F_p is the view factors ($F_p = \sin^2 \rho$), the ε_t and the ε_b are the IR emissivity on the top and the bottom surface of solar arrays, the σ_t and the σ_b are the solar absorptivity on the top and the bottom surface of solar arrays, and the η is the solar array efficiency.

Using equation (4) and equation (5), we can do hand calculation for both of steady state temperatures the satellite (T_{\max} and T_{\min}) with some data required such as solar absorptivity and IR emissivity on the top surface of solar array are 0.68 and 0.88, and solar absorptivity and IR emissivity on the bottom surface of solar array are 0.6 and 0.8 with solar emitted heat flux is 1418 W/m². Radiation and albedo from the earth with infrared load is assumed to be 258 W/m², the albedo coefficient is 35% and maximum power required during daylight is 10 Watts. Finally the maximum solar array temperature for satellite can be calculated using equation 2 and its results is 68.43°C. Otherwise, when radiation and albedo from the earth with infrared minimum load is assumed to be 216 W/m² and minimum power required during eclipse is 5 Watts, the minium solar array temperature for satellite can be calculated using equation 3 and its results is -72.96°C. The goal of the implemented calculation by SCDE is to calculate the temperature profile of the satellite with Low Earth Orbit. Furthermore we can describe some amount of the temperatures for satellite based on the satellite altitude in orbit (400 km to 700 km) is plotted in Table 2.

Table 2: Temperature results based on satellite's altitude

Altitude (km)	Spherical Temperature		Solar Array Temperature	
	Max	Min	Max	Min
400	35.05°C	-72.30°C	68.43°C	-72.96°C
500	33.31°C	-74.45°C	67.56°C	-74.42°C
600	31.76°C	-76.38°C	66.71°C	-75.85°C
700	30.36°C	-78.15°C	65.89°C	-77.25°C
Average	32.62°C	-75.32°C	67.15°C	-75.12°C

CONCLUSION

Based on altitude, the satellites in low earth orbit have an experience a different maximum and minimum temperature environment and the usage of thermo optical properties properly have effect to the satellite. In this study, thermal control of the satellite model can be solved using the energy balance equations to compute the temperature gradients, the result of the thermal analysis both for spherical and solar array of the satellite based on satellite altitude have turned out of extremely for used in the satellite. The analysis results show that the average the maximum and minimum temperature's based on low earth satellite's altitude (400 km to 700 km) are 32.62°C

and -75.32°C for the spherical of the satellite, and 67.15°C and -75.12°C for the solar array of the satellite. The calculations show that the minimum temperature for solar array is need thermal active control system, and battery is needed for store the power energy solar array.

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OPTIMIZATION IN DEVELOP THE LTE SITE PLANNING JABODETABEK REGION USING LINEAR PROGRAMMING METHOD IN PYCHARM AND POM-QM SOFTWARE, CASE STUDY PT. XYZ

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Abstract

PT. XYZ is an open company developed in mobile telecommunication in Indonesia. The company was established to meet the needs of customers throughout all of the region in Indonesia. To determine how many sites should be built with limitations of budget would be the constraints, then it takes the objective function derived from calculations using linear programming methods. In this case, the calculation and analysis which aims to develop the plan of 4G LTE technology which has four types, those are LTE900, LTE1800, LTE2100, and LTE2300 in JABODETABEK region for this study by using pycharm software with PULP package and compared using POM-QM software. The results obtained by using both software shows the same number as follow, LTE types that must be built sequentially from the most to the least are LTE2100 12,580 sites, LTE2300 2.044 sites, LTE1800 390 sites, and LTE900 0 sites. Based on these results, if the company implemented these results in building the site for each type of LTE, then the maximum total revenue that can be obtained by the company is Rp 2.452.380.953.518,722.

Keywords: Linear Programming, Base Transceiver Station (Site), 4G LTE, CAPEX, OPEX, python, pycharm, PULP package, POM-QM.

INTRODUCTION

Currently PT. XYZ is one of the telecommunication companies in Indonesia that become one of the largest mobile telecommunication operator in Indonesia. PT. XYZ has consistency in implementing mobile technology such as 4G Long Term Evolution (LTE) technology. By the end of December 2016, the company already has 82.6 million users capable of using 3G/4G. Those number shows as much as 47.5% of its total customers (XYZ, 2016). Based on actual data that can be predicted until the end of 2018, the use of mobile communication facilities increased on mobile data using 4G LTE. Therefore, by 2018 PT. XYZ will 100% build 4G LTE only for their company development, while 2G and 3G will only be monitored against existing BTS (site). In the development of 4G LTE is also not limited to one type only because 4G LTE technology have four types, those are LTE 900, LTE 1800, LTE 2100, and LTE 2300 where each types has different functions with different frequencies. In this figure below shows the trend of 2G, 3G, and 4G usage by the data volume (payload) in one year before.

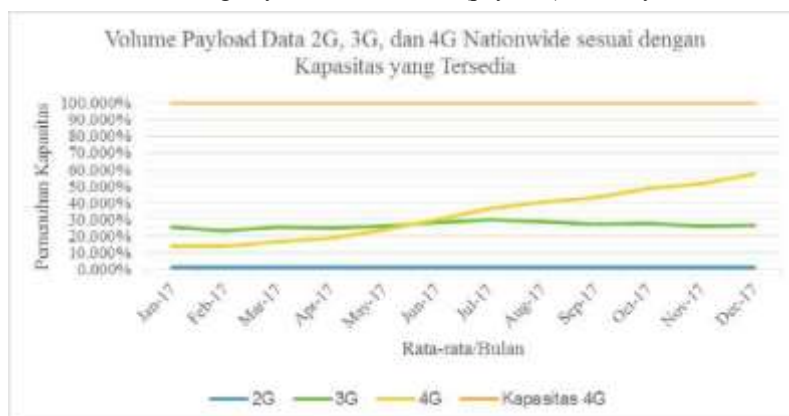


Figure- 1. Graph of 2G, 3G, and 4G LTE Monthly Data Volume in the National area opposite to Available Storage Places

To avoid the negative impact in misconceptions of allocation budget planning to build the sites and increase company's revenue, further analysis is needed in the development planning for the next year. Therefore, it needs more analysis (cause and effect analysis) using fishbone diagrams which can analyzed the decreased revenue if the company still develop (build) the 2G or 3G sites based on technical aspect, the amount of customer data usage in each BTS and financial aspects, CAPEX and OPEX cost. The both aspects has a significant impact on the effectiveness of the allocation of investment budget in BTS builders. The analysis was done by Fishbone Diagram using four categories, Information, Man Power (People), Method, and Machine/Tool (Hekmatpanah, 2011). The figure below is the result of the analysis using fishbone diagram.

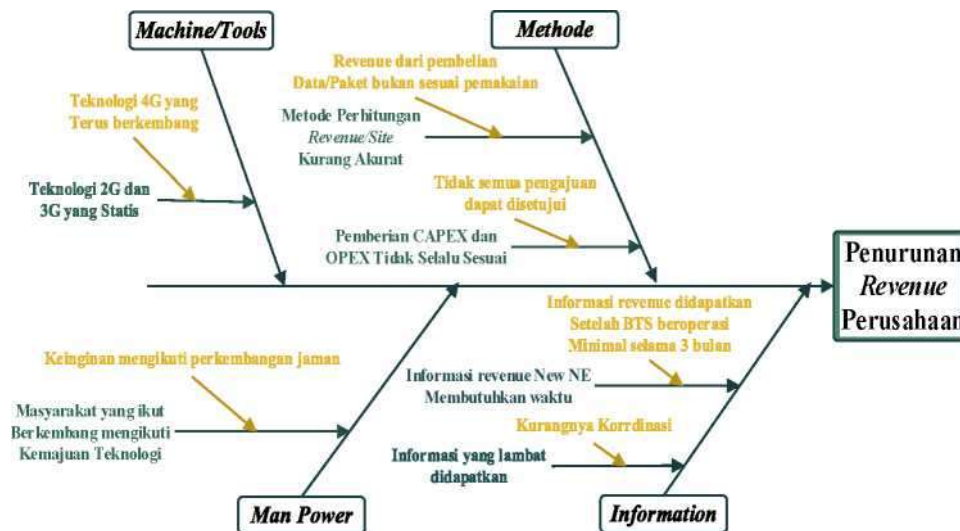


Figure- 2. Root Cause and Effect Analysis using Fishbone Diagram

METHODOLOGY

The methodology used in this research is Linear Programming method using python language in pycharm and POM- QM software to calculate and find the result.

A. Data Collection Stage

Data collection is done in network planning and budgeting division in PT.XYZ. The division's job is manage all the money that the company has used to determine the site development plan throughout the region such as the process of controlling the cost of site building, and so on. Specifically, this study focuses on the budgetting to perform all calculations in every programs for the economic scope. In this year, there is a program that is implemented, New Network Element (New Ne) and need to estimate how many new site that PT. XYZ should be build in various types of LTE technology in JABODETABEK region which become the object of this research.

1) Spectrum Network Strategy

The outline of network spectrum strategy owned by PT. XYZ can be describe as below (Adityawan, 2017).

a. 900MHz

At this time PT. XYZ has 7.5MHz in PBAND and 7.5MHz in EBAND. Then there would be a possibility for this company to have 900 when rearranged with another provider to get 5MHz in PBAND and 10MHz on EBAND. So the LTE900 can be upgraded to 10MHz in the future when the company has nearby 10MHz. LTE900 is one that will be used for coverage solution because of frequency owned by PT. XYZ is too small to be used as a capacity solution.

b. 1800MHz

This frequency will be used for DCS or which can be called 2G, and LTE. With LTE at frequency of 15 MHz, the DCS will probably have 4/4/4 TRX configuration. Therefore, LTE1800 at 17MHz will enable DCS using LTE band guard to provide 3/3/3 TRX configuration. LTE1800 can be used as a coverage and capacity solution because it has large enough of frequency so that coverage is also quite large with a large enough capacity as well (qualified).

c. 2100 MHz

The 3G spectrum can be recycled for LTE2100 as a capacity solution, as 3G traffic continues to be decline every year. Therefore, the new L2100 will be implemented this year because the development requires a spectrum of existing 3G. Therefore LTE type revenue needs to be projected from LTE1800 because it is considered to have the same characteristics. LTE2100 is expected to have revenue 20% of

- LTE1800.
- d. 2300MHz
PT. XYZ also has LTE2300 TDD that will be used as the next capacity solution. LTE2300 owned by the company now has a frequency up to 30MHz which will be designed as 2 carrier that is 10MHz and 20MHz.

2) Network Implementation Strategy

PT. XYZ implements four network types for LTE. One of them is LTE1800 which still based on coverage and capacity it has. Priority for the construction of LTE1800 in a particular location is based on it's over usage capacity, that can be increased to expand its reach. While the L900 will cover areas that can not be reached by LTE1800 to have a more detailed in reaching the hidden traffic. Usage density resulting in data traffic hampering will be met in sequences with L1800 (flexible bandwidth), L2300, L2100 and L900 (Adityawan, 2017).

When PT. XYZ launched the WBB program, then 20MHz will be the capacity layer, while 10Mhz as a special WBB layer. L2100 will allow its use for an area where 3G traffic can allow for renewal. In areas where 3G traffic can still accommodate usage capacity on 2 operators, the L2100 will be an additional capacity layer above L1800. L2100 or L900 can be used also on existing 3G where the site is capable of being used for LTE in rural areas that have new demand in order to meet the initial coverage and capacity activated only by SW, which is suitable for sub-urban & rural outside.




	LTE Types	COVCAP	COV Hole	CAP Ext.	Priority
URBAN 	LTE900		5M	5M**	4
	LTE1800	15M		~17M	1
	LTE2100			10M*	3
	LTE2300A			20M	2
	LTE2300B			10M	
SUB URBAN 	LTE900		5M	5M**	4
	LTE1800	15M		~17M	1
	LTE2100	5M		10M*	3
	LTE2300A			20M	2
	LTE2300B			10M	
RURAL 	LTE900	5M	5M		
	LTE1800	10/15M		15M	
	LTE2100	5M		5M*	
	LTE2300A				
	LTE2300B				

Figure- 3. Network Strategy - Deployment Guideline

3) Sitelist Criteria to be built

In each year, development plans in each region require a proposal for submission of sitelist in accordance with the analysis of sales and marketing areas that know the demand site in a particular location directly. Therefore, the area always give proposal that contains sitelist in each region respectively. The sitelist proposal in one program may exceed the budget allocation of the RKAP 2018, so a methodology for determining the priority sitelist will be based on a business & technical perspective with the 5 main parameters to be explained in subsequent chapters.

The three main criteria that need to be taken into account when a sitelist is not selected are:

1. Site belongs to non red site and non priority.
2. NPV <0.
3. In matrix 9 (M9) included into red zone.

4) Prioritization Method to be built

This prioritization method involves many parts of the company, including the network, budgeting, sales area, and also marketing. Each section has its own terms and conditions in determining the site to be built during

a future term shown in Figure-4 below.

Table- 1 Prioritization Methods Based on Each Part of the Company

Prioritization Method		
Network Trigger		18%
Red Site & P1	100%	18%
Red Site & P2 & P3	65%	11%
Red Site & Non Prio	40%	7%
Non Red Site & P1	70%	12%
Non Red Site & P2 & P3	35%	6%
Feasibility		22%
NPV>0,	100%	22%
IRR>WACC+3%	80%	17%
Productivity		24%
Blue	100%	24%
Green	75%	18%
Yellow	60%	14%
Sales Point of View		18%
New Demand	100%	18%
POI 2018	60%	11%
Special Treatment	50%	9%
Marketing Point of View		18%
City Prio-1	100%	18%
City Prio-2	85%	16%
City Prio-3	70%	13%

5) Type and Amount of Cost incurred

PT. XYZ has four LTE types planned to be built, where each type requires each cost that can be seen through Table-1 below. There are two types of costs, namely CAPEX which consists of the amount of CAPEX itself coupled with the price of antenna and NSR or OPEX.

Table- 2. Type and Amount of Cost incurred for Development Site

Detail Types	Capex	Antenna	Total Capex	NSR (OPEX)
New Site 4G LTE L900	Rp389,448,750	Rp39,000,000	Rp428,448,750	Rp16,500,000
New Site 4G LTE L1800 10 MHz	Rp240,243,031	Rp75,000,000	Rp315,243,031	Rp16,500,000
New Site 4G LTE L2100	Rp179,307,601	Rp0	Rp179,307,601	Rp0
New Site 4G LTE L2300 10 MHz	Rp304,290,000	Rp75,000,000	Rp379,290,000	Rp5,000,000

B. Data Processing Stage

Data Processing Stage is the stage where all data from data collection is processed. There are several processes at this stage include calculating the number of all LTE types using linear programming method with python language and PULP package in pycharm software, calculating calculating the number of all LTE types using linear programming method in POM-QM software. The results of this calculation should be the optimum objective function with maximum total revenue. To get those values, the calculation process needs to generate the optimal amount for each LTE type first.

- a. Determine the data processing stage using python programming language using pycharm software with PULP package In this study, the authors choose to use Python Programming Language because python is one of the high level language that can be interpreter, interactive, and object oriented (Kiusalaas, 2010). In the python

there are so many package that we can use, but in this study authors focused to use PULP which match with the method to be used, linear programming (LP). If its compared with other LP modeling tools such as AMPL, GAMS, mathprog, Opc ++, or pyomo and poams, PULP provides many advantages for its users, one of it is having a clear syntax (Mitchell, 2009). The determination of objective function, constraints, and variable declaration is done using python programming language with the help of application of IDE translator (Integrated Development Environment) called Pycharm, where the variables used are x1, x2, x3, and x4 with the definition of x1 is LTE900 , x2 is LTE1800, x3 is LTE2100, and x4 is LTE2300 which can be seen through picture 1.6 below.

```

import pulp as p

x1 =
p.LpVariable("x1",
0, 12580) x2 =
p.LpVariable("x2",
0, 12580) x3 =
p.LpVariable("x3",
0, 12580) x4 =
p.LpVariable("x4",
0, 12580)

prob = p.LpProblem("problem", p.LpMaximize)

prob += 428448750 * x1 + 315243031 * x2 + 179307601 * x3 + 379290000 * x4 <= 3154380350058
prob += 198000000 * x1 + 198000000 * x2 + 60000000 * x4 <= 200000000000
prob += x1 >= 0
prob += x2 >= 0
prob += x3 >= 0
prob += x4 >= 0

prob += 248224452 * x1 + 764070480 * x2 + 115421844 * x3 +
343320084 * x4 status = prob.solve()
print("This is the {} solution".format(p.LpStatus[status]))

print("To maximize profitability you have to sell {} x1, {} x2, {} x3
and {} x4".format(p.value(x1), p.value(x2), p.value(x3),
p.value(x4)))

print("The maximum profit to be
derived is Rp {}".
format(prob.objective.value()))

```

Figure- 4. Data Processing Using Pycharm Software with Python Programming Language

- b. Determine the data processing stage using POM-QM software
 As a comparison of the results as well as searching the right software can be used in solving the case of this study, the author use the software commonly used in calculating the case of Linear Programming called POM-QM software. POM-QM for Windows (also known as POM for Windows and QM for Windows) is the a software that most or commonly used because this is userfriendly software package available in the fields of production and operations management, quantitative methods, management science, or operations research (Malvar, et al., 2018). The following is the determination of variables, constraints, and the objective function in this study are shown using POM-QM software in Figure7 below.

Objective
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Maximize Revenue

	X1	X2	X3	X4		RHS	Equation form
Maximize	248224400	764070500	115421800	343320100			Max 2 482244E+08X1 +
Constraint 1	428448700	315243000	179307600	379290000	<=	31543800	4 284487E+08X1 +
Constraint 2	198000000	198000000	0	60000000	<=	20000000	1 98E+08X1 +
Constraint 3	1	0	0	0	>=	0	X1 >= 0
Constraint 4	0	1	0	0	>=	0	X2 >= 0
Constraint 5	0	0	1	0	>=	0	X3 >= 0
Constraint 6	0	0	0	1	>=	0	X4 >= 0
Constraint 7	1	0	0	0	<=	12580	X1 <= 12580
Constraint 8	0	1	0	0	<=	12580	X2 <= 12580
Constraint 9	0	0	1	0	<=	12580	X3 <= 12580
Constraint 10	0	0	0	1	<=	12580	X4 <= 12580

Figure- 5. Data Processing Using POM-QM Software

- c. Comparing The Result to Know The Computational Efficiency
After the result already obtained using both of software, authors will compare how many times the software takes to solve the problem to get the final result. It aims to know which software would be better to use by comparing the computational efficiency of each software.

RESULT AND DISCUSSION

In the way to obtain the best result with the methodology that authors already describe above, it need to generate the number of each LTE type for first, and the input will be shown in Table-2 below.

Table- 3. CAPEX Price and OPEX Cost of each LTE Type

Regional	Detail SoW	Total Capex	NSR (OPEX)
R03 Jabotabek	New Site 4G LTE L900	Rp 428,448,750.00	Rp 16,500,000.00
R03 Jabotabek	New Site 4G LTE L1800 10 MHz	Rp 315,243,031.00	Rp 16,500,000.00
R03 Jabotabek	New Site 4G LTE L2100	Rp 179,307,601.00	Rp 0.00
R03 Jabotabek	New Site 4G LTE L2300 10 MHz	Rp 379,290,000.00	Rp 5,000,000.00

Table- 4. Budget CAPEX 1, Minimum Site, and Maximum OPEX for CAPEX 1

Budget CAPEX 1	Rp 3,154,380,350,058.00
Maximum New NE	12580 buah <i>site</i>
Maximum OPEX for CAPEX 1	Rp 200,000,000,000.00

1) Determining the Number of LTE900, LTE 1800, LTE2100 and LTE2300 Shoul be Built Using Pycharm and POM- QM Software

- a. Calculation Result Using Pycharm Software, PULP Package for Python

```
import pulp as p
x1 = p.LpVariable("x1", 0, 12580)
x2 = p.LpVariable("x2", 0, 12580)
x3 =
```

```

p.LpVariable("x3",
0, 12580) x4 =
p.LpVariable("x4",
0, 12580)

prob = p.LpProblem("problem", p.LpMaximize)

prob += 428448750 * x1 + 315243031 * x2 + 179307601 * x3 + 379290000 * x4 <= 3154380350058
prob += 198000000 * x1 + 198000000 * x2 + 60000000 * x4 <= 2000000000000
prob += x1 >= 0
prob += x2 >= 0
prob += x3 >= 0

prob += x4 >= 0

prob += 248224452 * x1 + 764070480 * x2 + 115421844 * x3 + 343320084 * x4 status = prob.solve()
print('This is the {} solution'.format(p.LpStatus[status]))

print("To maximize the company revenue you have to built {} x1, {} x2, {} x3 and {} x4".
format(p.value(x1), p.value(x2), p.value(x3), p.value(x4)))

print("The maximum revenue to be derived is Rp {}".format(prob.objective.value()))^

jin
"C:\Users\Amelia Fahmawati S\AppData\Local\Programs\Python\Python36-32\python.exe" "C:/Users/Amelia Fahmawati
S/PycharmProjects/ This is the Optimal solution
To maximize the company revenue you have to built 0.0 x1, 390.43552 x2, 12580.0 x3 and 2044.8961 x4 The maximum
revenue to be derived is Rp 2452380953518.722

Process finished with exit code 0

```

Figure- 6. Running Program Results Using Pycharm Software with Python Programming Language

After determining all of the data in Pycharm Software using PULP Package for Python, the best result obtained a formulation of LTE900, LTE1800, LTE2100, and LTE2300 sequentially should be done by the company is by building 0 X1, 390 X2, 12580 X3, and 2044 X4 with the objective function formula $248224452 X1 + 764070480 x2 + 115421844 x3 + 343320084 x4$, so the maximum total revenue that can be achieved by PT. XYZ is Rp 2,452,380,953,518,722.

b. Calculation Result Using POM-QM Software

Linear Programming Results

Maximize Revenue Solution

X1	X2	X3	X4	RHS	Dual		
Maximize		248224400	764070500	115421800	343320100		
Constraint 1		428448700	315243000	179307600	379290000	<=	31543800... .39
Constraint 2		198000000	198000000	0	60000000	<=	20000000... 3.23
Constraint 3		1	0	0	0	>=	0 -560441800
Constraint 4		0	1	0	0	>=	0 0
Constraint 5		0	0	1	0	>=	0 0
Constraint 6		0	0	0	1	>=	0 0
Constraint 7		1	0	0	0	<=	12580 0
Constraint 8		0	1	0	0	<=	12580 0
Constraint 9		0	0	1	0	<=	12580 44786340
Constraint 10		0	0	0	1	<=	12580 0
Solution		0	390.44	12580	2044.9		24523800...

Figure- 7. Running Program Results Using POM-QM Software

Based on data processing using POM-QM Software software, we get a formulation of the best function in developing LTE900, LTE1800, LTE2100 and LTE2300 in sequence which should be done by company that is by building 0 X1, 390 X2, 12580 X3, and 2044 X4 with function formula destination $248224452 x1 + 764070480 x2 + 115421844 x3 + 343320084 x4$, then obtained the total revenue that can be achieved by the company is Rp 2,452,380,953,518,722.

c. Computational Efficiency

Based on the results calculations in the above stages using both software, the results obtained the same number of each types of LTE should be built, 0 X1, 390 X2, 12580 X3, and 2044 X4 and the maximum revenue that can be achieved by the company is Rp 2.452.380.953.518,722. Eventhough the result shown the same, but from the efficiency of the computational that can be done for each software shows time difference in problem solving. The Pycharm Software needs 0.73 seconds to solve the problem and the POM-QM Software only needs 0.28 seconds. So the software better to used for this study is using POM-QM software.

CONCLUSION

So, from the result shown above, the conclusion for this study to determine the number of LTE900, LTE1800, LTE2100 and LTE2300 should company's build using linear programming method and supported by calculation using two software that is pycharm in PULP package with python programming language and POM-QM as comparison of result and comparison of software, got the same result in both software, which is build no site of LTE900, 390 sites of LTE1800, 12580 sites of LTE2100, and 20144 sites of LTE2300. So PT. XYZ gained the maximum revenue for company in amount of Rp 2.452.380.953.518,722. Based on time difference for both software in solving the problem, it shows that POM-QM software could give the faster result in 0.28 seconds. The conclusion from the computational efficiency, POM-QM software more efficient than the Pycharm Software.

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PERFORMANCE ANALYSIS OF UMTS NETWORKS AS REFERENCE OF SIGNAL INTERFERENCE HANDLING

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Abstract

A network, not apart from the existence of the maintenance process, not least in the telecommunications network. In the maintenance of telecommunication networks, especially 3G -UMTS network, it is necessary to report on UMTS network performance in the previous days. The purpose of this study is to conduct a study of network performance reports in the previous days to help the UMTS network maintainers in analyzing and determining corrective measures in the area in trouble. The results of this study indicate that the RTWP method is helpful in deciding whether Node-B is affected by interference at the maximum acceptance signal threshold of -92dBm / cell. The resulting report resumes can be used as a reference of areas where signal interference is occurring for improvement in the area in which the signal interference is occurring.

Keywords: Telecommunication network, maintenance, UMTS, performance reports, signal interference

INTRODUCTION

In the current era of information and communication technology, development is happening very quickly and rapidly. No exception to telecommunication technology. This development continues to be improved because of the need to communicate and exchange data quickly, easily and mobile (rfwireless,2012). One communication technology that has been widely implemented, especially in Indonesia is UMTS (Universal Mobile Telecommunication System) or 3G technology for mobile communications (Irawan,2015). UMTS technology or better known as 3G for mobile communications is a communication technology that evolved because of the demands of telecommunications technology that requires large data exchange, fast and can be used anywhere or mobile (w3ii,2016), (Effendi,2016), and (Oktaviani,2009). In the maintenance of a UMTS network, frequent signal interference occurs within the range of cells in a particular region. There are several ways to analyze signal interference on UMTS network, one of them is through RTWP report (Receive Total Wideband Power). The hypothesis is that the results of this study, it can be used for accurate references in taking steps to overcome signal interference in certain areas.

This paper will explain the performance analysis of UMTS through Interference and Analysis RTWP. After that of the method then done. Data from the results of practical work at PT. Indosat and library resources are linked to the main components of the UMTS network and its performance as a comparative instrument. One of the signals that affect the communication system on the network is the interference signal (Hidayat,2017). Signals that are not required for communication systems are also interference signals. Once again, the signals are not included in the internal system that appears on the RX frequency band but does not affect the performance of the system also called interference signals. Based on the source, interference is divided into two, namely from internal interference and external interference. Internal interferences include: Interference that is related to intermodulation on the send signal; Interference that is related to the transmission channel; Interference relates to receiver channel; self-excitation recipient; intermodulation due to send the signal at a receiver; unlocked situation; RTWP abnormal value due to frequency change; and congestion caused by a strong signal.

One of external interference is the interference between W-CDMA 2100 MHz and GSM 1900 MHz, where each other can not coexist. Interference due to non selective frequency design as well as an inaccurate repeater and reinforcement configurations result in noise interfering UE. The types of interference due to microwave transmission are bi-directional interference; widespread interference; and long-term interference. Non-linear components in large electromagnetic fields; Interference from the radar that occurs at certain moments; Interference from the handset that occurs at a specific time or on a continuous time; as well as during daytime

meetings. Interference from the handset may also be due to influence from government, military, hospital, or gas station; Intermodulation signals from various transmitters (especially TV stations). Interference handling in the field refers to the source of the interference, so to solve the interference problem needs to be done in-depth analysis on the site concerned. Vendors or providers of tools has made the guidelines or procedures for handling uplink interference starting with analyzing internal interference. If no interference source is found on the internal system, it then analyzes the source of external interference. By analyzing or troubleshooting thoroughly and profoundly on either an internal or an external system it will reach a point of problem-solving. Troubleshooting can be either a repair/replacement device on an internal system or coordination with other operators and site managers to re-adjust the current site conditions.

METHODOLOGY

RTWP (Receive Total Wideband Power)

RTWP on Node-B is the total uplink received power. The received power of the wideband includes the noise generated from the receiver at the bandwidth determined by the filtering pulse (Hamdana,2012). The reference point for measurement is the RX antenna connector. When parts of the cells have been established, the total power received on the wideband can be measured on the part of the cells (Adi,2012). PT. Indosat Tbk has a frequency range from 890 to 900 Mhz. In these frequencies, Indosat BTS emits Radio Frequency (RF) signals. In Cell Performance Indosat Network, limited between -92 to -105 dBm / Cell. If the Cell Performance value is greater than -99 (-91, -90, etc.) then it is known that the area is interfering. The following table describes Cell Performance in Bandung region.

Table-1. Cell performance sample

BSC6900UCell	CellID	10/16/2016	10/17/2016	10/18/2016	10/19/2016	10/20/2016
U_ISTANABUNGA_MT2	16988	-94.695	-93.833	-93.29	-93.496	-92.86
U_CICADAS_MT5_XYX	23875	-94.201	-96.361	-94.019	-94.034	-90.773
U_BIP_BDG6_XYX	23476	-91.471	-91.5	-91.257	-91.415	-91.541
_3G2_BEC_BDG4	15124	-92.797	-93.08	-94.962	-94.363	-94.137
U_CIKUTRA6_XYX	23526	-91.674	-91.353	-91.368	-91.422	-91.411
U_WIRAYUDA5	23855	-92.686	-92.908	-92.473	-92.729	-92.813
U_BUAHBATU5_XYX	23825	-92.794	-92.256	-92.331	-92.443	-92.322
U_KIARA_CONDONG6	23506	-92.041	-90.948	-90.897	-91.637	-91.725
U_DAGO_PAKAR5_XYX	26545	-92.699	-92.427	-92.635	-92.913	-92.657
U_RSI_SANTOSA4	23964	-92.928	-92.725	-92.21	-91.756	-92.617
U_CIKUTRA_IM5_XYX	23865	-92.872	-92.574	-91.839	-91.413	-91.843
U_GRANDPASUNDAN6	23996	-92.15	-92.576	-92.11	-92.255	-92.536
U_AEB_KOPO2	10988	-89.83	-92.048	-91.429	-92.243	-92.859

Interference Handling Procedures

In the Figure-1, it is seen that some areas in Bandung experience interference with marked yellow. RTWP helps decide whether Node-B is affected by the interference and location it affects.

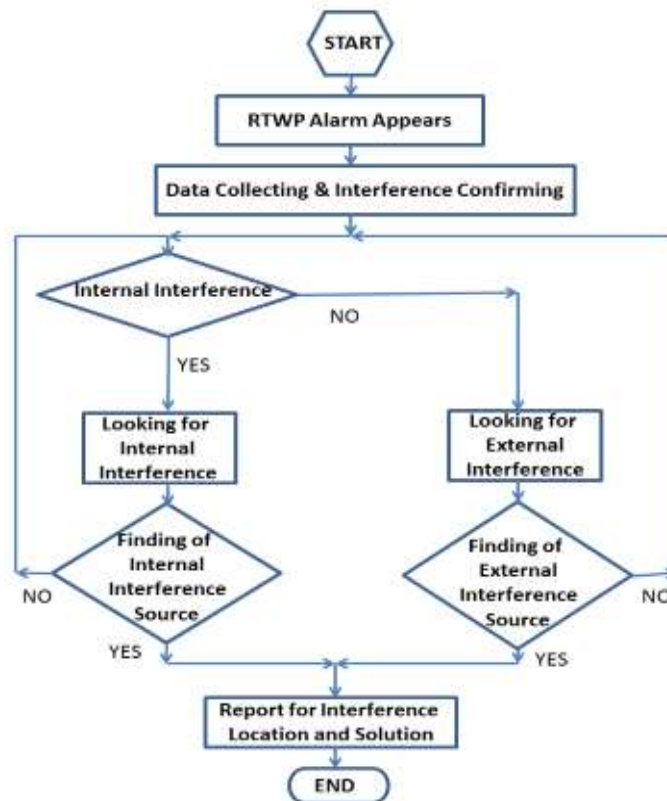


Figure-1. Flowchart of interference handling procedure

RTWP Alarm Monitoring

Maintenance of the UMTS network cannot be separated from the Supervision of BTS-BTS in West Java which is monitored through BSC (Base Station Controller) by TOC (Trunk Operation Center) by observing the alarms that appear in real-time from U2000 software.

Collecting Data and Confirming Interferences

This activity aims to confirm uplink interference on the site. To confirm required valid data based on the latest state that appears on i-Manager U2000 and in the field. It is necessary to check the frequency of the alarm and the change of the average value of the RTWP, whether the alarm appears on i-Manager U2000 or on field checking.

Source Analysis and Interference Location

When confirmed the uplink interference on a site then the next is to analyze in depth to find a breaking point.

Checking Configuration on RNC or Node-B

At this point, the authors were unable to perform any analysis regarding the configuration checks on RNC and NodeB because access was limited by the vendor.

Installation or Device Error

Before performing a physical check, you should check your device. Is there a connector and feeder that is not installed fast or even detached.

Solutions Report and Interference Location

The report works to get Troubleshooting Solutions and Locations. If the Solution handles problems with other operators then coordinate with the relevant operators on troubleshooting and shared steps to take.

RESULT AND DISCUSSION

Interference handling procedures have been performed. Based on existing data on the i-Manager U2000 application, it can be done per performance comparison of cells that have been in the procedure of handling interference as the following table.

Table-2. Cell Performance results after interference handling procedure

U_DAGO_PAKAR5_XYX	26545	-93.567	-93.212	-92.44	-93.456	-93.425	-93.602	-93.649
U_CIKUBANG2	17738	-95.393	-93.49	-93.596	-93.562	-93.312	-93.692	-93.717
U_PRKN_SAAAT6	24116	-91.568	-91.344	-91.217	-92.467	-92.077	-92.238	-93.748
U_CIKUTRA_IM1	14047	-96.384	-96.197	-95.892	-96.145	-94.499	-94.554	-93.766
U_BIP_BDG5_XYX	23475	-93.166	-93.096	-93.826	-94.011	-94.256	-93.956	-93.874
U_CIKAWAO_MT3_XYX	16759	-99.163	-99.828	-99.056	-98.542	-94.308	-89.174	-93.919
U_CIWARUGA3	14389	-92.161	-92.595	-92.688	-93.21	-93.593	-93.907	-94.023
U_TEGALEGA_MT5	23465	-94.088	-93.936	-94.458	-94.353	-94.085	-93.828	-94.025
U_LEUWIGOONG_TB3	27219	-95.162	-93.133	-92.606	-93.179	-94.501	-94.732	-94.031
U_JLJAMIKA_PL5	23975	-94.394	-94.078	-93.995	-94.064	-94.002	-93.874	-94.077
U_TANJUNGSARI1	10467	-94.281	-94.491	-93.691	-93.926	-93.545	-93.391	-94.09
U_HEGARMANAH_MT5	23545	-95.255	-92.905	-88.222	-89.971	-92.269	-91.229	-94.133
U_CIWIDEY1_XYX	11237	-100.982	-99.629	-89.852	-93.673	-95.682	-92.534	-94.186

From the Table-2, it can be seen that after the interference handling procedure, the performance on cell BTS becomes more stable (between -95 and -105). This activity is done routinely so that cell performance in each BTS remain stable and can provide good service and data exchange become smoothly.

Another way to eliminate interference can be done with the following methods, namely :

1. Change the design of the quality system by department engineer operator.
2. Optimize DCS configuration by operator RF department.
3. Eliminating external interferences such as PHS, repeater, and EU interference is very difficult for vendor equipment, so there must be cooperation between vendors and operators.
 - a. Interference PHS, that is by moving the WCDMA antenna as far as possible, high WCDMA antenna must be higher or lower than PHS.
 - b. GSM Interference, i.e. by using the right frequency according to a normal method for spectrum allocation.
 - c. Repeater, that is by changing the use of repeaters to ensure repeater selective frequency and ensure the stability of the repeater host link and set the repeater gain for the right range.
 - d. Interference of a microwave transmission, that is by adjusting to microwave frequency.

CONCLUSION

That to know the performance of UMTS network through RTWP analysis, the result of this research, can be used as an accurate reference in overcoming signal interference in the certain area. Given the cell performance is very important for the quality of service to consumers so for the future development is needed handling faster and more easily from interference problems that exist.

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