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Preface

The 3rd Volume of Integrated Sci-Tech: Interdisciplinary Research Approach book is published by the Research Institute and Community Services, University of Lampung. It integrates engineering, life sciences and biomedical engineering, and agriculture engineering and food sciences. The aim was to provide a cross section roadmap from basic research, technological and developments, processes development, and their applications and integrity in the real-world usage. The motivation for this Volume-3 book was to provide a suitable reference text for those who interested in the interdisciplinary studies and research. The book was also planned to provide advanced orientation and understanding for related industries and governments to looking across industrial partnerships, business strategic, and policy and regulations, with expected for a wider range of readers.

This book consists of several chapters divided into four sections i.e., Engineering and Technology, Life and Applied Sciences, Medical Sciences and Biomedical Engineering and also Agricultural Engineering and Food Science. Each chapter is a completely self-directed contribution in chained discussion which aims to bring academia, researcher, practitioners and students rise to speed with the novel developments within the particular area. In order to enhance the reader experience, each book chapter contains its own abstract, instruction, main body, as well as conclusion sections. Moreover, bibliography resources are available at the end of each chapter.

We are pleased and thankful for all distinguish authors and reviewers for their contribution that have made this book possible. We do hope that you will enjoy this book and find it as a useful guide and reference.

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Keynote and Invited Speaker

**Integrated Sci-Tech :
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Indonesia Supergrid : Enabler for 100% Renewable Energy

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Abstract. *Moving toward renewable energy is a must rather an option. Indonesia has abundant renewable energy resources that enough to fulfill our demand on energy. Unfortunately, renewable energy resources are distributed unevenly and sometimes faraway from the load centers. In order to solve the problem, a concept of Indonesia supergrid is proposed. By using this supergrid, all renewable energy resources can be utilized effectively. By using supergrid, economic development can be distributed more evenly. The supergrid can be implemented by using AC or DC grids, or combination of the two. A simple concept of how to fund the construction of Indonesia Supergrid is proposed.*

Keywords: *supergrid, renewable energy*

Chemical Engineering Approach for the Design and Evaluation of Sound Material Cycle Network

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Abstract. *Chemical engineering concept and methodology were applied for the minimization of environmental load from industrial and agricultural processes, and our daily activities in the regional area. The results of material flow analysis on those processes and regional area are conveniently used to evaluate the materials input and the consumption, and thus the resource productivity as well as the environment loading. The results of material flow analysis and their evaluation were essential for the design and evaluation of sound material flow/recycle network. In this presentation, design and evaluation of biomass residue recycle system in the plantation and that of wastes recycle system in a regional material area will be illustratively shown based on material flow analysis. Through the presentation, it will be emphasized the importance of material and energy flow analyses to achieve the sustainable development goals with less consumption of resources and less environment loading while providing sufficient services to our daily life*

Keywords: *material cycle, waste management*

Sustainable Land Use Management for Mitigating Greenhouse Gas Emission

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Abstract. Food shortage and climate change due to greenhouse gas (GHG) emissions are currently receiving considerable attention worldwide. While most of the increase of global warming is due to CO₂ from fossil fuel, in fact, land uses and agriculture globally account for around 30% of global warming. Difference compared to fossil fuel sectors, however, land uses including agriculture and forest have opportunity to mitigate GHG emission. The strategies are by implementing sustainable land use management practices such as (1) sustainable soil management, (2) carbon rich farming, (3) perennial/agroforest farming, (4) sustainable grassland management, and (5) sustainable forest management. The objectives of this paper are to review the influence of some sustainable land use managements on CO₂ emission, C stock and C sequestration. From long-term no-tillage (NT) research (29 years of cropping), it revealed that cumulative CO₂ emission of conventional tillage (CT) was 2.0 ton CO₂-C/ha/season, minimum tillage (MT) was 1.5 ton CO₂-C/ha/season and NT was 1.0 ton CO₂-C/ha/season. Soil C stock under NT corn at 0-20 cm depth was 34,03 ton C/ha, or 11.1% higher than CT. Soil C sequestration rate by NT was the highest, that was 118.4 kg C/ha/yr; while in contrast, soil C sequestration under CT was the lowest (-20.7 kg C ha⁻¹yr⁻¹). In soil profile, C stock under NT corn in upper horizon was higher than CT, but decreased with depth. In 5 years of sugarcane research, it turned out that after 5 years of treatment applications, NT had significantly stored 39.82 ton C/ha, or 23.7% higher than CT. While mulching with 150 ton bagasse/ha had stored 38.91 ton C/ha, or 17.6% higher than without mulching. Soil C sequestration rate under NT sugarcane was 2.40 Mg C/ha/year, while in CT was only 0.81 Mg C/ha/year. Mean while, bagasse mulch with 150 ton/ha contributed 2.07 ton C/ha/year, and treatment with no mulch contributed 1.15 tonC/ha /year. In peatland, emission of CO₂ average of three years of measurements (2011-2013) from Acacia (Ac) was the highest among land uses (59 ton CO₂/ha/yr); while CO₂ emissions from mixed forest (Mf), and tall forest (Tf) were 28, and 27 ton CO₂/ha/yr, respectively. Compared to business as usual value, the CO₂ emission from Ac was 44% lower, but still 5% higher than that of bare peatland. The carbon sequestration of Ac biomass was equal to 97 ton CO₂/ha/yr. As a green campus, University of Lampung also sequestered above ground C as much as 35.5 ton C/ha or 2000 ton C/total area.

Keywords: Carbon stock and sequestration, sustainable land use management

Development of Porous Hydroxyapatite Biomaterials for Bone-Graft Substitute

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Abstract. *Hydroxyapatite is the main constituent material of bone and teeth. In this paper, a hydroxyapatite powder material was made from local limestone with a simple chemical method. The porous hydroxyapatite material is prepared by replica techniques using polymer sponges. The characterization of this hydroxyapatite material is carried out by chemical, physical and biological methods. The results of analysis using FTIR and XRD equipment showed that the hydroxyapatite characteristics are similar to natural ones. The result of measurement with TEM equipment shows that the invisible particles of this hydroxyapatite powder have a rod-like shape and are about 30 - 60 nm in size. The porous hydroxyapatite materials made with replica techniques revealed a pore size of about 200-500 μm and had good interconnections as determinate by SEM measurements. Biological test results in rabbit animals show that the implantation of this hydroxyapatite material can stimulate bone growth faster than if it is allowed to grow alone (control). Bone ingrowth was significantly increasing over the time between 3 and 6 weeks.*

Keywords: *porous hydroxyapatite, bone graft, polymer sponges, limestone.*

Biomechanical Tuning of Biomaterials, Extracellular Matrix, and Culture Model to Engineer the Angiogenesis and Microvascular Development

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Abstract. *The guidance of human endothelial cell (HEC) organization into a newly capillary-like network from the pre-existing ones (i.e., angiogenesis) has been a long standing challenge in the development of thick engineering tissue and artificial organ. Some efforts have been made to develop biomaterial, extracellular matrix environment and specific culture model for the promotion of capillary-like structure inside the engineering scaffold and artificial tissue constructs. Capillary-like structure and micro-vascular networks would mimic blood vessel function that can be used to subsequently facilitate oxygen and nutrient transport as well as biological waste removal inside the artificial tissue and organ system. Vascularization of engineering tissue is one of the most favorable strategies to overpass nutrient and oxygen supply limitation, which is often the major hurdle in developing a complete artificial organ. This paper aims to highlight the mechanical and biophysical properties of biomaterial, extracellular matrix and cell culture model for the purpose of angiogenesis and micro-vascular development studies. The recent in vitro investigation of Human Endothelial Cells (HECs) in a three-dimensional (3D) culture system for the guidance of HUVEC's angiogenesis development is also presented..*

Keywords: *biomechanical tuning, angiogenesis development, three-dimensional culture, endothelial cells.*

Synthesis and Characterization of Hydroxyapatite Material Performed from Indonesian Limestone by Precipitation Method

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Abstract. Limestone which is one of the raw materials for the manufacture of materials and medical devices obtained scattered in almost all provinces in Indonesia. In this paper, synthesis of hydroxyapatite using limestone as the raw material was studied. Synthesis of hydroxyapatite was done using precipitation method. The main material of forming a hydroxyapatite in this study is diammonium hydrogen phosphate and calcination of limestone at 900°C for 4 hours that produce calcium oxide (CaO). The pure calcium oxide was observed in order to know the effect of calcium solution addition rate and calcium precursor size. The calcium oxide precursor was prepared with high energy milling (HEM). HEM usage is intended to produce a precursor size of calcium in nano size. Furthermore, the characterization of second phase precursors using x-ray diffraction (XRD), analysis of morphology and element content using scanning electron microscopy-energy dispersive X-ray (SEM-EDX) and analyzes the size and distribution of particles of calcium resulted from milling using a particle size analyzer (PSA).

Keywords: Limestone, hydroxyapatite, precipitation method, x-ray diffraction, SEM-EDX, particle size analyzer.



Section I

Engineering and Technology

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A Conceptual Model on Integrating Supply Chain Operation Reference (SCOR) into Disaster Response Service Supply Chain FMEA (#588)

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Abstract. *Becoming country prone to the occurrence of natural disasters, determination on risk variables affecting successful operation of disaster response service supply chain using supply chain FMEA (Failure Mode and Effect Analysis) is undeniably important to support successfulness of humanitarian operation. However, scientific studies concerning on integrating SCOR into Risk evaluation of disaster response supply chain is rarely found in references. To response such gap, this paper presents a conceptual model on integrating disaster response supply chain FMEA with Supply Chain Operational Reference (SCOR) to determine a conceptual risk-based performance evaluation model in disaster response supply chain. A framework on integrating Service Supply Chain FMEA with SCOR is presented coupled with a decision support model for evaluating criticality of risk-based performance index and followed with discussions and new opportunity for further investigations.*

Keywords: *Service Supply Chain, FMEA, SCOR, Disaster Response, Risk.*

I. Introduction

During the last two decades, the world is witnessing the increasing number of global disastrous events. In the era of 1980s, the yearly average number of disastrous events was 180, however, in 2010 the number is increasing to 384, indicating three times increase [1]. The impact of that disaster is very huge, as for the year of 2011 alone as the example, total economic losses are reaching US \$ 109.3 Billion Dollars. In terms of the disasters' victim, during the past three decades, the number of reported disasters have increased fourfold, and around 6.1 billion people have been affected by disasters with an estimated damage of almost 2.3 Trillion dollars [2]. Among countries suffered from the natural –made global disastrous events, Indonesia, together with US, India, China, and The Philippines was among the five most frequent disaster sufferers. Considering large amount of its potential number of disaster's victim and unbearable economic impact, advancement of tools and methodology/techniques to improve quality of response in disaster relief operations is obviously very important for sustaining development of a country. According to [3], research intended to prevent failure in disaster relief operation is still becoming top priority in disaster prevention discipline and very rare references discussing developing a framework on embedding SCOR into disaster response risk assessment method within supply chain framework. Motivated by this discrepancy, the goal of this study in concerning on proposing a conceptual model on integrating a conceptual model on integrating SCOR (Supply chain Operation Reference) model into disaster response supply chain to guide failure prevention in operation of disaster response services. The structure of the paper is in followings. In

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section II, an overview of SCOR and Supply Chain FMEA is introduced and followed with a conceptual model on embedding SCOR concept into disaster response service supply chain FMEA in section III. Section V related to a risk-based decision support model for evaluating risk variables in disaster response Supply chain FMEA. Conclusions and new inquiries for further investigation are provided in section VI.

II. SCOR and Service Supply Chain FMEA-AN OVERVIEW

a. Supply Chain Operational Reference (SCOR)

Developed by the supply chain council, the SCOR model is a kind of reference model in operationalizing a typical supply chain. As the reference model, the major of supply chain process within SCOR framework are consisting of plan, make, source, deliver and return [4]. The use of the SCOR model enables decision makers to drive supply chain operation to reach the intended performance of the disaster response supply chain.



Figure 1. Schematic model of SCOR

b. Service Supply Chain Failure Mode and Effect Analysis

Service supply chain FMEA, as its name implies is a kind of failure mode and effect analysis model applied into supply chain level. Different from design and manufacturing type FMEA, the scope of service supply chain FMEA is exceeding companywide level with coverage on information, material and financial flow among suppliers, distributors and end customers. Becoming the risk appraisal tool in supply chain, service supply chain FMEA utilizes the risk priority number as product of adverse event probability occurrence level and estimated severity of its consequences in evaluating criticality of risky events. An exemplar on appraising the risk within supply chain can be referred into [5]. By implementing FMEA in service operation, decision makers enable to take any preventative measures to prevent the re-occurrence of adverse events derail operability of disaster response supply chain.

III. A Framework on Integrating SCOR into Disaster response Service Supply Chain FMEA

Integrating Risk Assessment method into SCOR enabling decision makers to prevent any preventative measures against the occurrence of any factors affecting disruptions in the operation of disaster response supply chain. A representation of framework in integrating Service Supply Chain FMEA into SCOR is presented in Figure 1.

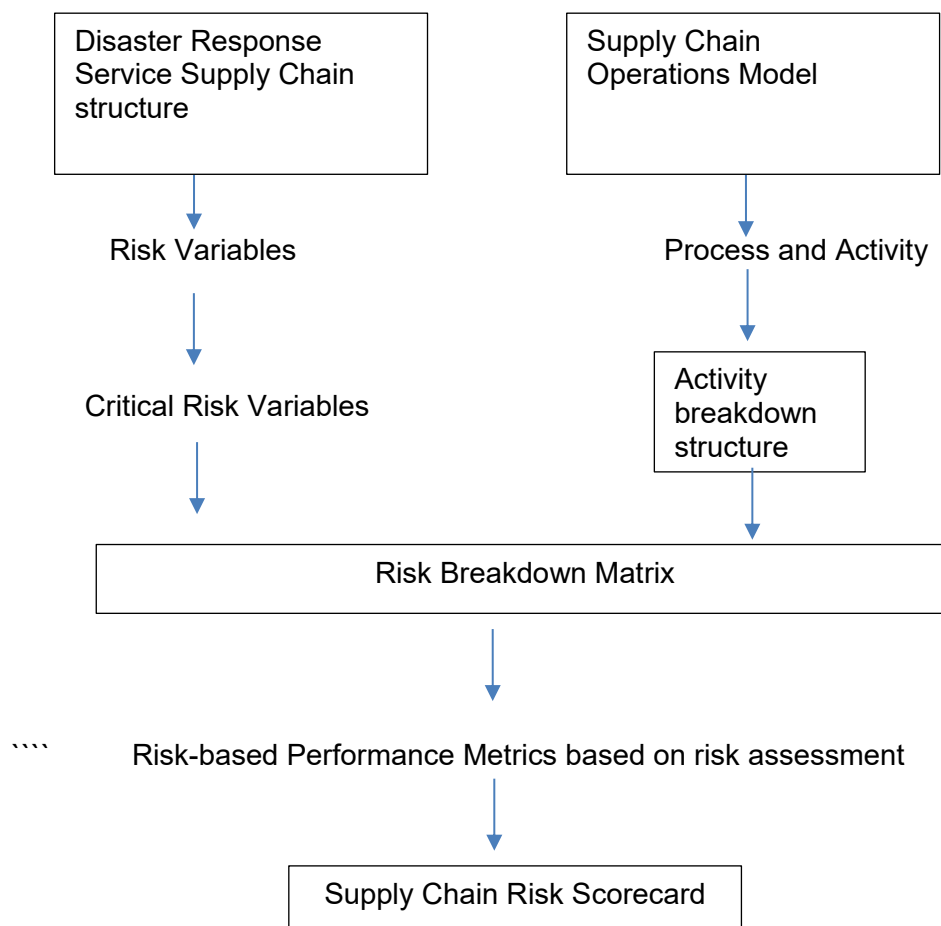


Figure 1. Integrating SCOR into Disaster Response Service FMEA

In Figure 1, disaster response service supply chain structures are used to map potential risk modes of disaster response supply chain. The result of this approach is the critical risk variables. At the other side, the SCOR model is used to determine related activity of disaster response supply chain. The outcome of mapping disaster response supply chain is the structure of relevant activity responding to disaster effect. Linking critical risk variables and activity structure will enable to determine the score of the supply chain risk variables in the form of Supply Chain Risk Score.

Properly linking SCOR into disaster response supply chain, it is necessary to identify relevant the SCOR elements and their corresponding risk indicators and affected supply chain performance dimensions. Using scientific study of [6], [7] and [8] as references, the linkage of the SCOR element with its risk variables and their affected Supply Chain performance in a typical disaster response supply chain is presented into the Table 1.

Table 1. Linking SCOR Elements into SC Risk Variables and Affected Performance Dimensions

First Layer Factors	Second Layer Factors	Exemplar of Potential Risk Variables	Affected Performance Dimension
Plan	Strategy	Inconsistent Strategic Objectives	Reliability
	Culture	Weak risk awareness	Flexibility
	Demand	Uncertain demand	Agility
Source	Purchasing	Low quality of purchased goods	Reliability
	Supply	Unreliable suppliers	Reliability
Make	Environment	Politics, economics and social Risk	Reliability
	Production	Technical production problems	Reliability
	Control	Inappropriate service control	Reliability
Deliver	Relation	Distrusted partners	Reliability
		Increasing commodity prices	Cost
	Transportation	Inappropriate distribution method	Reliability
	Origination	Improper delegation of supply chain authority	Responsiveness
Return	Return Way	Lack of consensus with customers	Responsiveness
	Return Procedure	Imperfect return process and rules	Responsiveness

Linking the SCOR elements of disaster response supply chain with their performance dimensions will enable decision makers to identify which SCOR elements correspond to the performance dimensions of disaster response supply chain. In Table 1, relationship among SCOR, risk variables and performance dimensions of supply chain is presented. Among other dimensions of supply chain, reliability is becoming the prime variables related to performability of disaster relief supply chain. Figure 2 represented the map of impact of a certain risk to an activity in a typical risk breakdown matrix

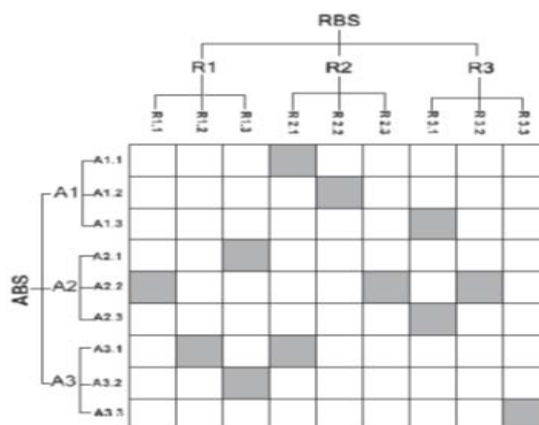


Figure 2. Chart depicting relationship between a risk variable and an activity [9]

IV. Quantifying Risk-Based Performance Index

Intended becoming tool to manage performability of disaster response supply chain, determination of an index as basis to estimate criticality of risk variables due to failure in reaping response operation is imperative. In this regard, the basis determination of such index is based on derivation of risk as product of likelihood of the risk variables occurrence and their severity scale. Considering that not all SCOR elements are having equal importance, weightage of SCOR using decision making technique such the AHP (Analytic Hierarchy Process) should be accomplished. Denote RPI_k as risk-based performance index k, OR_k as occurrence scale of risk variables k, WS_k represents the weight of a certain SCOR attribute and L_k as the estimated loss score because of occurrence risk variables k, then the score of the risk-based performance index of a certain supply chain performance variables is given in equation (1).

$$RPI_k = WS_k OR_k L_k \quad (1)$$

The score of L_k can be estimated using Taguchi Loss Functions. By identifying the threshold of critical risk, decision makers enable to determine appropriate corrective and preventative measures to prevent re-occurrence of critical risk variables.

In this paper, a model depicting integration of SCOR into disaster response supply chain is presented. Using the model enable decision makers to determine relationship among source of risk variables affecting supply chain performance dimensions. Ability to determine critical risk variables affecting performability of disaster response supply chain will become basis to take any measures preventing derailment of humanitarian service operation.

V. Conclusion

Driven by the frequent occurrences of natural disaster in Indonesia, endeavor to improve quality of risk assessment in disaster response supply chain is undeniably important to sustain country's development. In this paper, a conceptual model on integrating SCOR into disaster response risk assessment using FMEA framework is presented and followed with derivation on SCOR elements and their corresponding risk variables. Using this framework enables decision makers to anticipate any unintended outcomes of their response's operation thus will improve success operations of disaster alleviation. Opportunities for further investigations are viable in several ways, for example by undertaking empirical observation in testing appropriateness of the model and developing risk metrics of disaster response supply chain using vast array of multi attributes decision making techniques and linked it with performance evaluation techniques.

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Monitoring Temperature and Humidity Wireless Realtime-Based LabVIEW (#591)

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Abstract. *In this study, the temperature monitoring system used was the MyRIO with LabVIEW-based programming. LabVIEW-based programming is known for its versatility and ease of access to the hardware and internet technology. The instrument used was the DHT11 sensor to communicate with MyRIO, whereas to bridge the communication between MyRIO and CPU wireless communication was used. Then, the captured results were displayed on the CPU by using IEEE 802.11 Protocols. Based on the tests conducted on 10 experimental conditions, it was known that the DHT11 temperature sensor resulted in a 1.99% error rate. This value indicated the acceptable accuracy that is below 5% while the error rates of the humidity measurement varied, i.e. in the 5th to the 10th test conditions in which the acquired error rates enlarged up to 13.5%. This meant that humidity sensor accuracy had good accuracy in the 1st to the 4th testing conditions.*

Keywords : DHT 11, LabVIEW, MyRIO, temperature, humidity

I. Introduction

The observation system or remote monitoring currently has undergone very rapid developments, one of which is in measuring the monitoring system of new and renewable energy parameters. Various systems have been proposed with various methods, both in processing and in the process of data transmission, as well as data communication systems which are experiencing rapid development. With the standard protocol IEEE 802.11, communications between processor sensor to the collector become easier, one of which by using the zigbee protocol combined with an arduino with real-time monitoring system [1] which generates data in accordance with the data in the field, while the data transmission system with batching methods [2] generate compressed data per day which are sent and collected in the memory of the arduino sent per day as well. The use of zigbee protocols in a standalone process also used in monitoring the weather [3] at the lab scale by using LM 35 as well as DHT 11.

The combination of Zigbee Protocol and data transmission communications from sensors to hosts or to servers is performed by incorporating GSM technology [4], by using a GSM Modem and TCP/IP protocol the data is sent, generating considerable distance in accordance with GSM modem capabilities. Another system used in weather monitoring is a radio frequency (RF)[5] using the module 1020U-Kyl as a delivery medium.

The research conducted using this platform either incorporated the arduino or Zigbee and LabVIEW interface generated output in the form of MS Excel[6] using the sensor SHT 11 with communications systems that were quite different from others in order to connect to an arduino. Other studies using LIFA facilities (LABVIEW Interface For the Arduino)[7] although the sensor used was still LM35. In another study [8] the integration was performed on software ie Labview as the interface and KEIL software by using LM35 as the temperature sensor.

The integration of the above-mentioned systems was performed in order to use a sensor that has a communication pattern with other systems. LM35 temperature sensor output has an analog output with the increase rate of the current of 100mV/°C, the sensor can be directly accessed by LABVIEW, unlike SHT 11 or DHT 11 which uses single wire interface that needs a bit different handling.

DHT11 sensor, which had the sufficient capability, was used in the system that was being built. The form of DHT11 can be seen in Figure 1 below

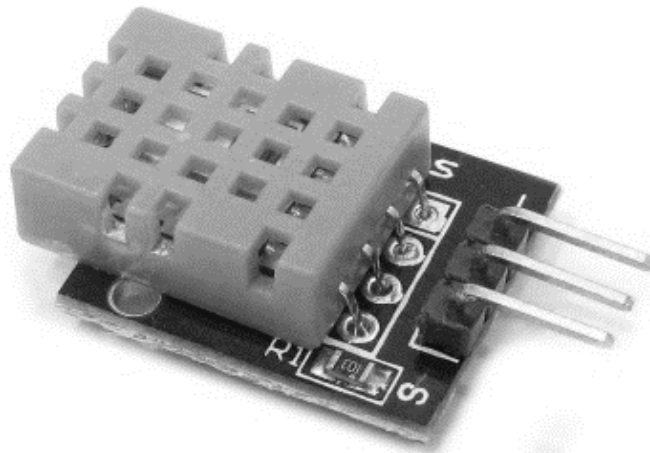


Figure 1. DHT11 Temperature and Humidity sensor

This DHT sensor has a quite unique communication with the transmitted data of 40 bits with the accuracy of ± 4% RH and resolution temperature of 1°C. Make this sensor is quite sought after and used in various temperature and humidity metering systems.

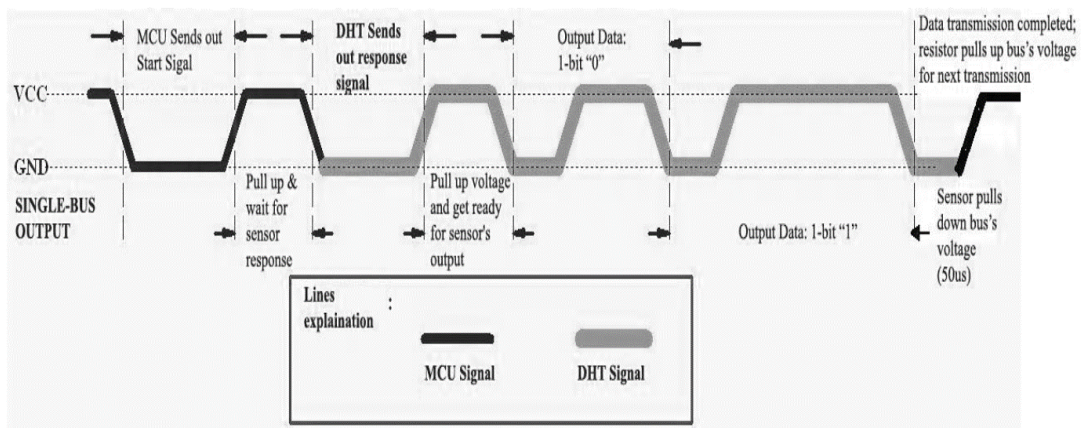


Figure 2. DHT11 Communication Process

Figure 2 shows the DHT11 working process which depends on the MCU signal. When the signal goes into the sensor, the DHT will be turned into running-mode, and then send a 40 bits signal including the humidity and temperature data. In the absence of signals from the MCU, DHT11 will not give the input signal [9].

As for the MCU, MyRIO, which is the product of National Instrument, was used. It has Z-7010 Xilinx processors with a speed of 667 MHz and has a non-volatile memory of 256 MB and 512 MB DDR memory. While for communication, MyRIO has wireless connection IEEE 802.11 b, g, n with 2.4 GHz frequency band with 20 MHz channel depth, MyRIO is equipped with Digital I/O and Analog I/O with 12-bit resolution.

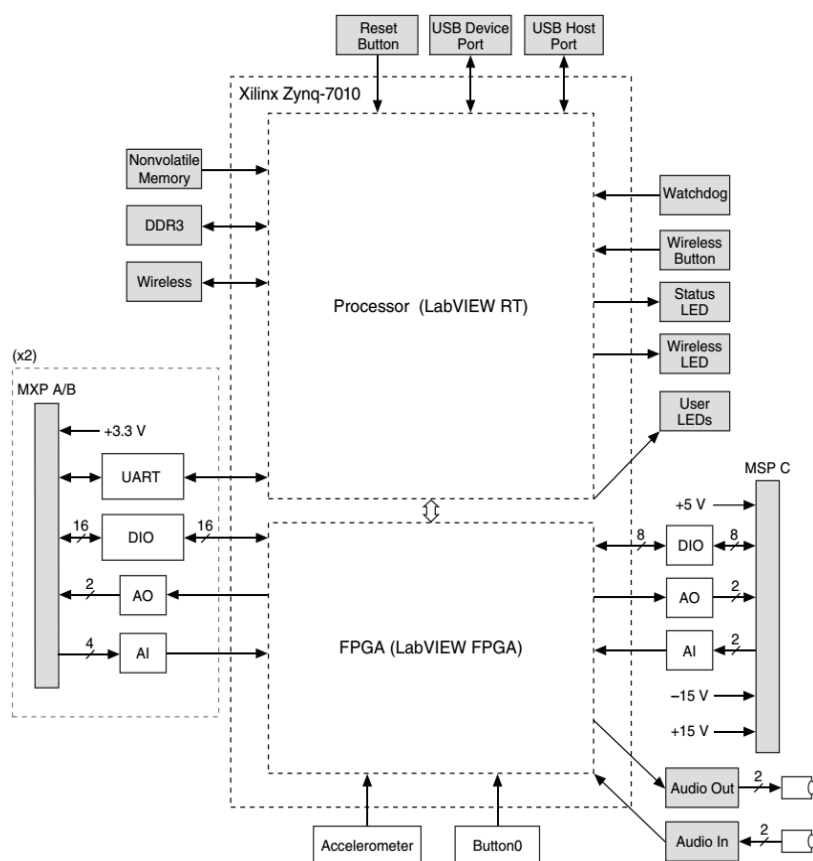


Figure 3. MyRIO 1900 Diagram Block

II. Procedure

A. System Plan

The developed system consisted of 2 parts namely, system sensor and MCU consisting of temperature and humidity sensor as well as the MCU in the form of MyRIO 1900, and also a recipient that is CPU. The communication between MyRIO 1900 and the CPU was performed by using IEEE 802.11b network with 2.4 GHz working frequency. In this developed system, the access point used in MyRIO presents on the system itself without external reinforcement.

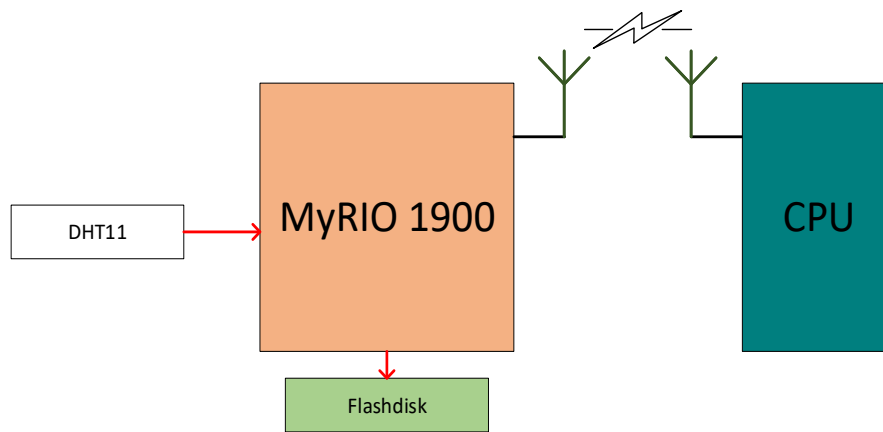


Figure 4. Block Diagram of Temperature and Humidity Monitoring Hardware

The mechanism of the block diagram can be seen in the flowchart below, the first process was the initialization program that would prepare the necessary things for processing temperature and humidity data. Figure 5 is a flow diagram of the system.

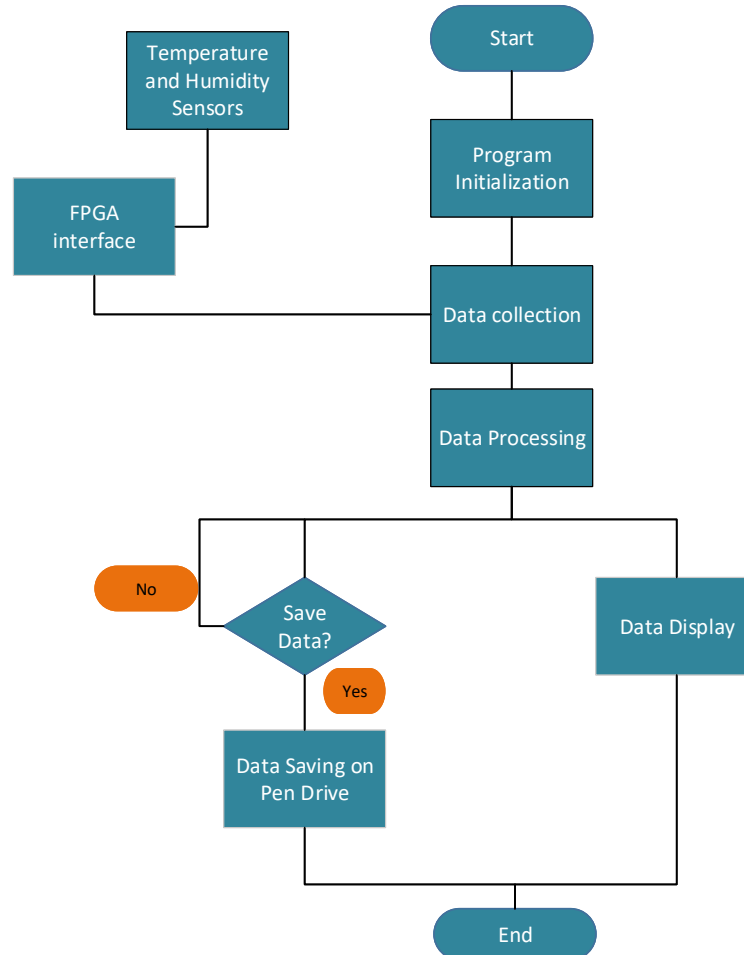


Figure 5. Flowchart

This data was then processed to be displayed in graphical form in real time and stored in the form of excel. As for storage media, a Pendrive, which was connected with MyRIO, was used. However, this data still could be accessed from the CPU.

The following figure shows what was displayed in the settings panel which was the front panel of the LabVIEW system. This view was accessed from the CPU using wireless 2.4 GHz consisted of a graphics display, storage options, and other settings.

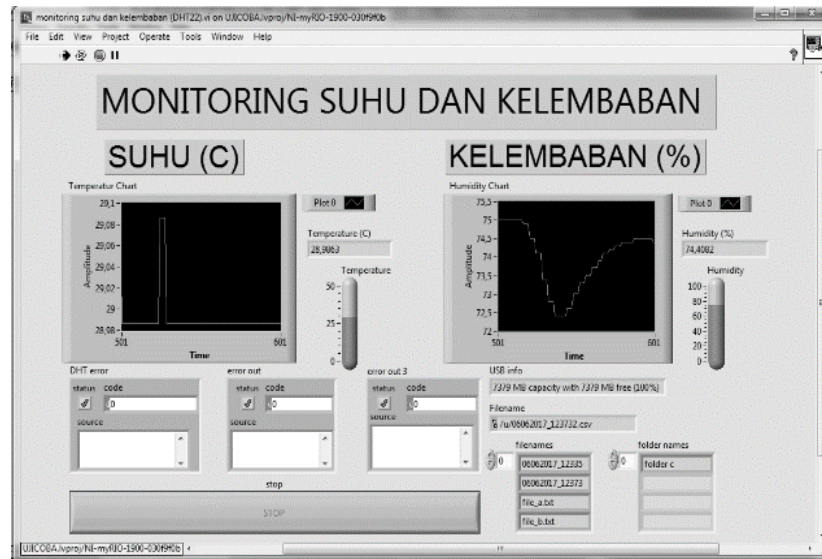


Figure 6. LabVIEW Front Panel

B. Result

In order to get the results, then a series of tests was performed by comparing the DHT11 sensor with a measuring instrument so that two data that could be displayed in graphical form. The series of tests performed is shown in the picture below.

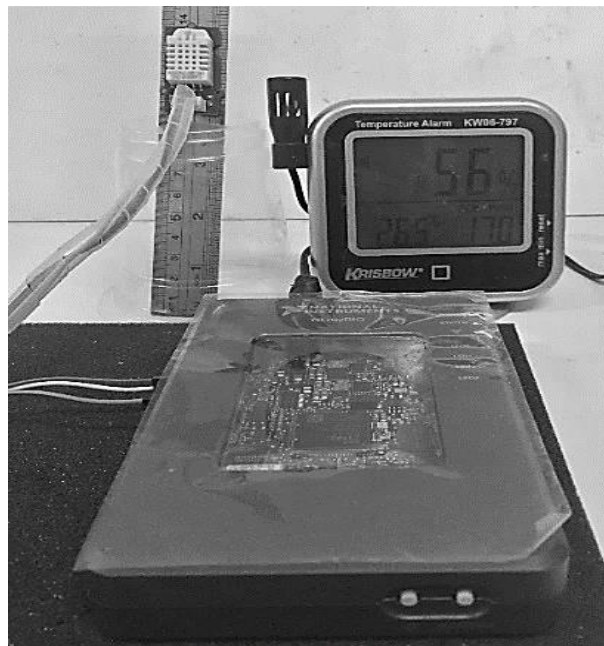


Figure 7. System Testing

With a series like the one above, the test was performed with varying temperature and humidity resulting in the graph which is a comparison of the measuring instrument.

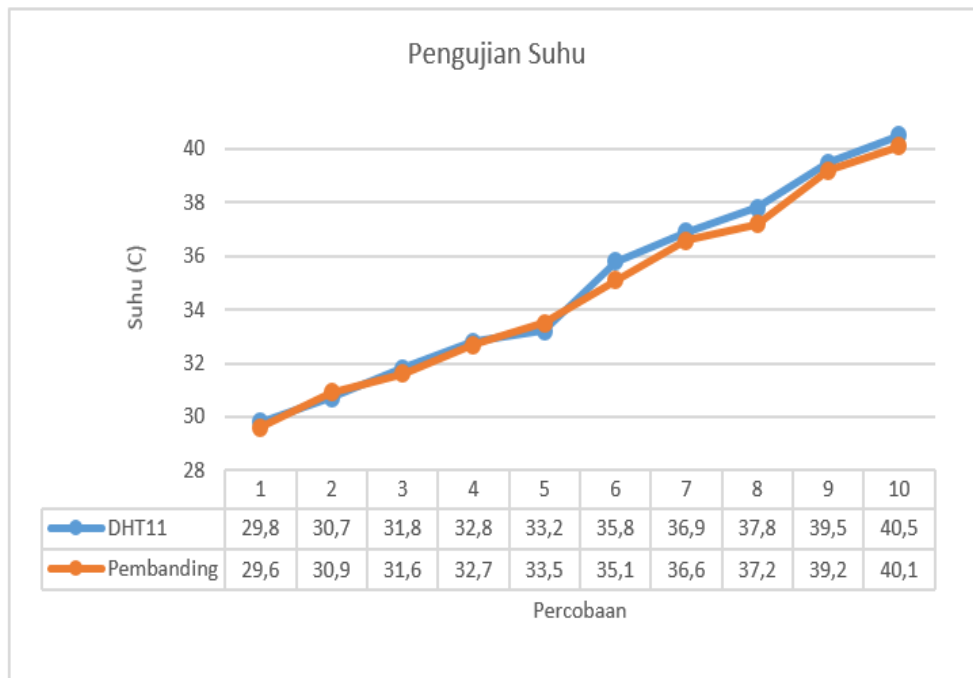


Fig 8. Temperatur Testing

The test was carried out at the lowest temperature of 29.6°C and the highest one was 40.1°C. As can be seen the temperature rate was rising. Based on the calculation, the smallest error difference was 0.31% and the largest difference error was 1.99% so there was an error range of ± 1.5%.

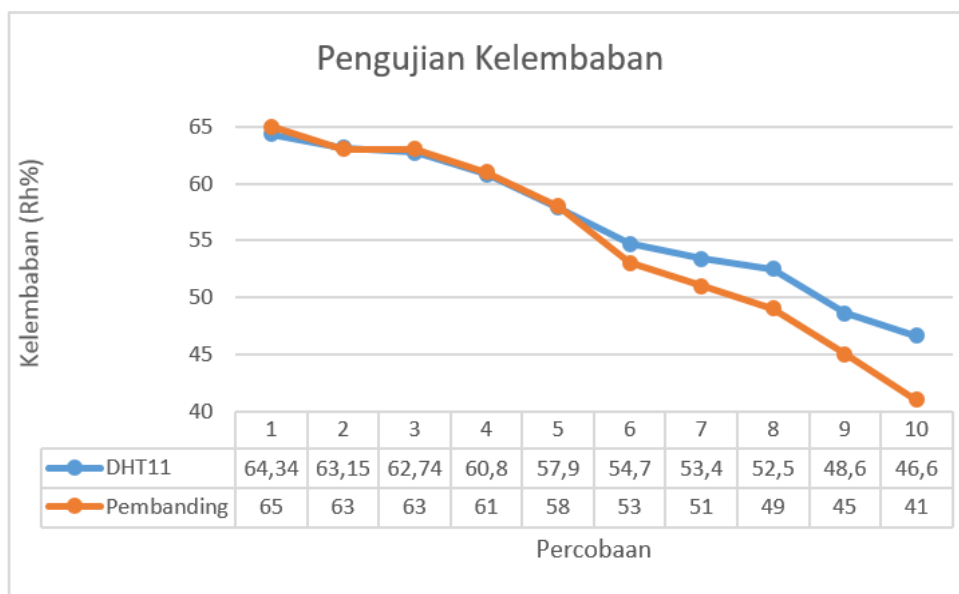


Figure 9. Humidity Testing

Meanwhile, in humidity testing, there were differences of error as the shown in the graph below. The test was carried out in humidity range 65% to 41%, the minimum error was 0.17% and maximum error was 13.66%, so the range of error was about $\pm 13, 50\%$.

The use of LabVIEW with MyRIO Hardware simplified the tools configuration used for the connection both between MyRIO and the sensor and between MyRIO and the computer to display measurement results and data storage. The use of wireless communication with the IEEE 802.11 protocol b, g, n facilitated communication link.

The test results could be accessed by using the webpage as shown below

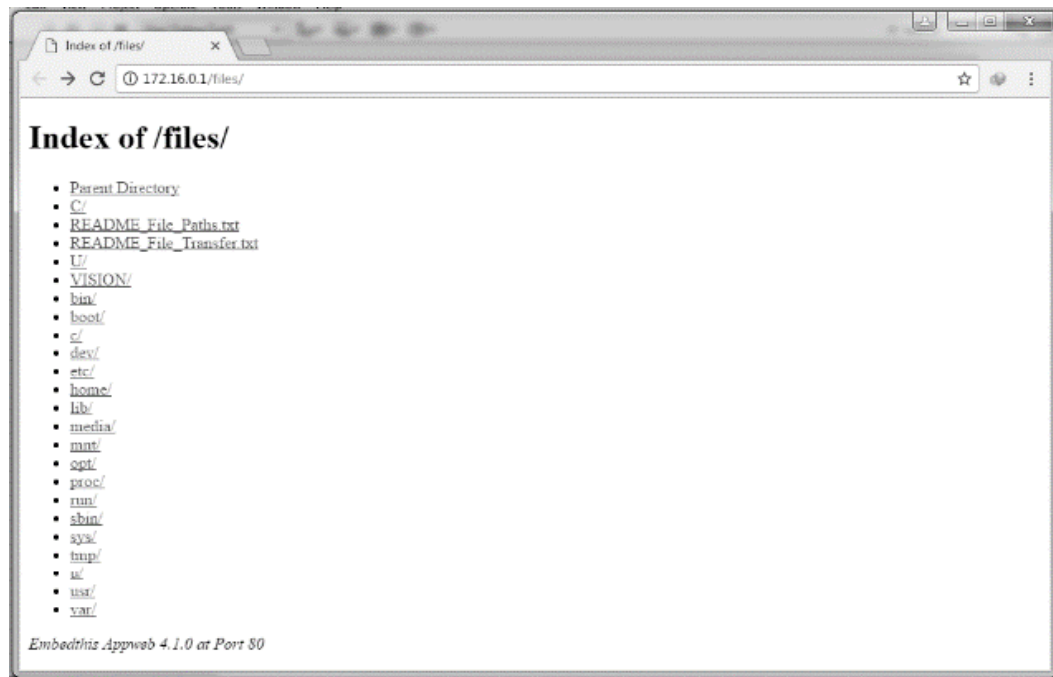


Figure 10. Data acces using MyRIO wifi

which will generate the CSV data in accordance with the desired sampling time.

III. Conclusions

Temperature and humidity monitoring systems using LabVIEW and MCU MyRIO and DHT11 sensor managed to sense temperature and humidity even though DHT11 used/equipped with (dilengkapi) a rare-use single-wire interface. This could be overcome by using the FPGA interface so that the data communications could be stored and displayed with adjustable sampling rates.

The results obtained from the humidity and temperature test which was performed by using DHT 22 sensor resulted in test error rate under 5% that is, at the smallest rates, 0.31% and 1.99%. Whereas, for the humidity, there was the biggest error i.e. 13.5%. One of the things which led to the existence of a fairly large error was the construction of DHT which had a hollow. It could cause humidity, especially because water still clung to the hollow.

The test resulted in a comparison between the DHT11 sensor with other test equipment. Although the measurement range was not so wide but still able to know the performance of the system created, this can be seen based on the number of experiments. Meanwhile, the error in the temperature test was fairly good.

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Interaction Effectiveness Measurement on Traditional Game for Children using Relative Manipulation Time Method (#614)

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Abstract. *Game application has lacked in training children's cognitive and motoric skills. However, a number of reviews stated that game application is able to help children in training children's motoric skill especially in the period of children's motoric development. Based on that, a study related to measuring the use of interaction tool to determine the extent of the game application in helping motoric development was conducted. In this study, several pairs of children were involved by playing the "congklak" game based on mouse, touch screen and using traditional equipment as value benchmark. Evaluation was conducted by identifying the variable value in calculating interaction which has been determined. The result showed that interaction based on touch screen has higher value in training children's motoric and cognitive skills compared to interaction based on mouse. The score was better compared to traditional equipment at several variables.*

Keywords : *Game Application, Interaction, indirect physical manipulation, 'congklak', user experience, touch screen, mouse, traditional.*

I. Introduction

Nowdays, technology has developed rapidly and been able to create things related to children's daily activities, especially in the form of digital games. Some reports also stated that children are increasingly using computer technology[7]. Children are using computers to perform tasks related to their occupation as a school student, to support their hobbies and leisure interests[8]. This kind of game enables us to carry out an act in indirect physical interaction and provides a user experience which can resemble the real thing.

A number of assumptions are around in which by helping users carry out something using digital equipment, it will then be more beneficial. What is meant by beneficial here is it is more efficient and effective [1]. However, this is in contrast to the statement that all kinds of human cognitive activities will weaken if the use of hands are obstructed. [1]. From the assumptions, they indirectly state that indirect physical manipulation is not preferable in training cognitive and motoric skills. Especially in this context, it is on children. This is important to be learned because especially for children, the role of hands is essential in children's growth and development in terms of cognitive skill [6].

Referring to the above assumptions, in this study, interaction value calculation based on certain variables will be conducted and its effectivity will be analysed, in which it is closely related to supporting child's growth and development. The study will use the game of 'congklak'. It was chosen because according to child's psychologist, the game of 'congklak' is able to train child's cognitive and motoric skills.

II. Literature Review

'Congklak' Traditional Game

'Congklak' is a game consisting of two equipments. The equipment is a long board usually made of wood. The board has hollows/holes on the right and left sides and a larger hole at both ends. This game is played using seeds or rocks. The seeds can be from 'sawo', candle-nut, corn, etc. It even can be played using rocks or shells [2]. Figure 1 is 'congklak' traditional game equipment.

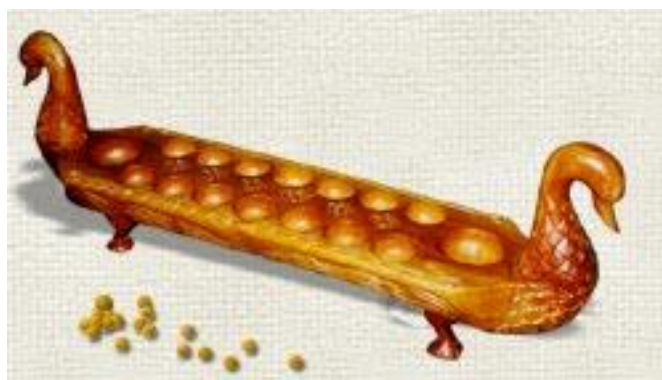


Figure 1. 'congklak' traditional game equipment

Each side of the board consists of 5-9 holes depending on the origin of the board. For boards which have seven holes on each sides, the total number of seeds is therefore 98 'congklak' seeds. The following is how 'congklak' is played in general [3]:

- 1) Make sure that there are seven seeds in each own's hole and opponent's hole. Keep the end home hole (located at the very ends) empty.
- 2) Determine the first player. (Can be done by tossing/making a deal)
- 3) The first player will take the seeds from his/her side and will place a seed in each hole clockwise, but will skip the opponent's home.
- 4) When the last hole is given a seed and there are seeds already inside, continue playing like the beginning.
- 5) When the last hole filled with seeds is the player's own hole, continue playing as the beginning.
- 6) When the last hole filled with seeds is actually empty, the turn therefore ends.
- 7) When the last hole filled with seeds is actually empty and the hole is the player's own, check the opponent's hole. If there are seeds then the seeds can be taken and put into the player's own home hole.

8) The game ends when the players run out of seeds in each of the holes on his/her side.

9) The winner is the one with the most seeds in the home hole.

With the development of time, there are more technological *games* which can create a *user interface* and *experience* resembling the original games. There are many forms of interactions that can be used, one of which is interaction using *touch screen* and *mouse*.

In figure2, it is an example of 'conglak' game which can be downloaded in *playstore*. In the beginning of the game, players will touch the hole to select which seeds to be distributed. The distribution of seeds will move automatically. Besides movement automation, score can also be shown by the system. Similar to the *mouse* based. The only difference is on the use of *amouse* to manipulate the game.



Figure 2. Sample of touch screen based 'conglak' Child (*Late Childhood*)

Childhood period basically begins from the age of 2 years up to 12 or 13 years. This period is divided into two namely Early childhood at the age of 2 – 6/7 years and Late Childhood at the age of 6/7 – 12/13 years [6]. The term children is usually elementary school age children. Besides that at the period of growth children have the characteristics of the period when they learn to adapt, likes to be in groups, there is an urge to achieve, fight/argue, etc. Some research reported that by the time children grow up, their skill at tapping and dragging items on digital skill are getting better[10]. These are factors that must be considered in child growth:

- 1) Increasing physical and motoric ability. Fine motoric for example are writing and drawing. Gross motoric are for example games and sports.
- 2) Building a healthy attitude about themselves.
- 3) Developing basic skills of reading, writing and counting.
- 4) Developing concepts on the surrounding/the environment.
- 5) Developing moral behaviour.
- 6) Learning to cooperate with peers.
- 7) Learning to play a role according to gender.

- 8) Developing an attitude towards social groups.
- 9) Learning to become an individual who can be independent.

B. Cognitive and Motoric

Motoric development is one in the element of body movement control through the coordinated activities of the central nervous system, neurons and muscles. Motoric development consists of two kinds: gross and soft motoric. Gross motoric is activities carried out by the large muscle such as running, standing up, walking, etc. Soft motoric is activities conducted by small muscles namely writing, reaching for things, etc[6].

Child's cognitive development at the age of 6-12 years is put into the 3rd period. In this period, a child develops his/her brain for thinking systematically but limited to objects or behaviour which is concrete. Surely they are now able to carry out variety of mental operations. For example, they are able to communicate, clarify, do mathematical operations, and connect series of facts [6]. For the children itself, different kind of interaction style can trigger different kind of communication[9]. Based on Piaget's theory, there are four stages of cognitive development [11]:

1. **Sensorimotor stage**: In this stage child begin to develop new intellectual abilities. They start to recognize some symbol.
2. **Pre-operational stage** (Toddler and Early Childhood): In this stage, children understand the use of symbols and language use matures. Memory and imagination are developed, but thinking is done in a nonlogical, nonreversible manner.
3. **Concrete operational stage** (Elementary and early adolescence): They start to understand logical and systematic manipulation of symbols related to concrete objects. Operational thinking develops (mental actions that are reversible).
4. **Formal operational stage** (Adolescence and adulthood): In this stage, they start to understand about abstract concepts.

C. Interaction Style

Interaction *style* is all kinds of ways that can be done to communicate or interact between computer and *users*[4]. The selection of an interaction also can affect the dialog process being conducted. There are several kinds of *interaction styles* which are generally used [5], namely Command Line *Interface*, menu, natural language, query dialog, form-fills, WIMP, point-and-click, three-dimensional *interfaces*.

D. Interaction Testing Variable

In order to explore interaction value based on *mouse* and *touch screen*, testing using method by considering several variables which have been determined is conducted. These

variables will be tested using the formula of *Relative Manipulation Time* (RMT). The following is the explanation of variables which will be used for this case [1].

1. *Time to First Completion*

The entire time needed from starting the *task* to the end of *task* is for the first time. In this case, children are allowed to play more than once. However, what is to be used as test material is the session in which the children play for the first time.

2. *Time Spent Manipulating Pieces*

This variable will calculate time which the *users* spend to manipulate object in the *task* in the first time game. There are three *tasks* which will be considered by this variable, namely:

- *Relative manipulation time* (RMT) : When *users* starts touching the object to manipulate up to releasing the object.
- *On task but non-touch* (ONT): When *users* should deal with a *task*, but is not doing it or is not touching the object.
- *Off task* (OffT): Time when *users* is actually not at the time of doing *task*.

3. *Direct Placement*

Condition when a *user* is doing object manipulation quickly and without a doubt. In this case, the *user* will directly take a specific object without a doubt and hand follows eye direction. For example, when children decide to take seeds from a hole without thinking further.

4. *Indirect Placement*

The condition when *users* need time to decide what to be done with the object by manipulating or thinking. In this case, cognitive plays a big role in physical action to be carried out. For example, when children take a moment of silence and observe seeds in the hole before taking one of them.

E. **Relative Manipulation Time**

Relative Manipulation Time (RMT) is a formula to calculate proportion of relative time spent by *users* to carry out *task* done according to the form of interaction [1]. In the calculation of interaction testing, a formula which can be used to calculate RMT, RONT, and RoffT was developed. From “Hands on What? Comparing Children’s Mouse-based and Tangible-based Interaction” paper by Antle, the following is example of formula used to calculate RMT.

$$RMT_{CT_1} = \frac{[MT_{CT_1} \text{ subject a} + MT_{CT_1} \text{ subject b}]}{[2 * CT_1]} \quad (1)$$

The above formula is used to calculate variables in *time spent manipulating pieces*. Here, MT (*manipulation time*) on subject is time used by *users* at condition of RMT, ONT, or OffT. CT (*completion time*) is game time from the beginning to the end. In general, RMT_{CT_1} is the total MTs from each *user* divided by n multiplied by CT_1 (where n is the total number of *users*). In this case n is 2 because each session is played by a pair of kids. For example, $T_{CT_1} = 0.75$ means 75% of time is used to manipulate objects to accomplish the game.

III. Methodology

a. Application Display

User interface(UI) that has been made will be used for both types of interaction based on *mouse* in PC device and based on *touch screen* in tab device. UI made is made based on several things prepared beforehand. These are :

- 1) Data collecting and observation on 'congklak' game and users.
- 2) Modelling user experience including within it analysing user's persona. After obtaining persona from each user, the user's persona will be grouped based on high persona user, middle persona user, and low persona user. The classification is based on their ability in manipulating technology and playing 'congklak'. For middle persona user with a relatively lower ability in playing, a special training is provided so that their ability is the same as high persona user.
- 3) Creating conceptual model which will become the base of application prototype.
- 4) The application prototype is tested on users using Heuristic Evaluation testing.

b. Interaction Variable Testing

After the *game* application is made based on data collected and going through *heuristic evaluation* testing phase, the application is ready to be used for interaction variable testing. Each of the three types of *s* interaction will be measured its interaction value and the interaction using traditional equipment will become a benchmark.

Figure 3 is the *sample pattern interaction play* carried out by a child in one game period. In one game period, a child conduct activities of RMT (orange), RoffT (blue), DP (red), and IP (green).

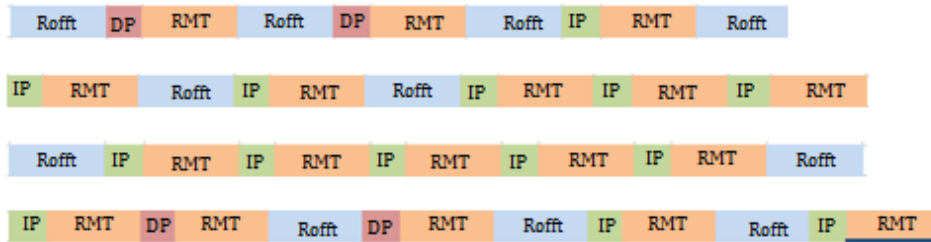


Figure 3. Sample of pattern formed in one game period Time to First Completion

In this variable, the average time spent by each pair in order to complete a game in an interaction was observed. Within 10 minutes, children are free to play. However, just as the definition given in the previous chapter, time here means the entire time used from starting the *task* to the end of the *task* for the first time. This means that time observed is time when first playing.

The following is the result of *time to first completion* calculation as shown in table 2.

Table 2: Table of time to first completion testing result

<i>Time to first completion Testing</i>				
Type of Interaction	Pair I	Pair II	Pair III	mean
Traditional	324 s	438 s	600 s	454 s
<i>Mouse-based</i>	509 s	401 s	418 s	442 s
<i>Touch screen-based</i>	355 s	298 s	300 s	317 s

It can be seen from the above data that the average longest time to play is found in traditional type interaction and the quickest is found in the *touch screen* based. This data shows that the hypothesis on game will be faster completed using *touch screen* based interaction type is proven.

Seeing from the child’s behavior in playing ‘congklak’, one of the factors why *mouse* based interaction is slower is because the child must keep holding the *mouse* and shifting the *mouse* to distribute ‘congklak’ seeds/beads. The shifts quite increase duration of playing time.

Besides that, the size and weight of mouse also give impact as the shape of children’s hands which is on average keementara at *touch screen* based interaction does not require tools and only by touching the screen. This direct hand movement is easier to be carried out than having to shift the *mouse*. Besides the effect of time of hand movement or object manipulation, time spent on thinking or other activities when playing also influence the duration of game. These aspects will be explained in the following variable.

c. Time Spent Manipulating Pieces

As explained, this variable will study in depth how long on average children spend in carrying out several types of object manipulation at each interaction. In this variable, the types of manipulation to be observed are as follows:

- 1) *Relative manipulation time* (RMT) : When *user* start touching the object to manipulate up to releasing the object.
- 2) *On task but non-touch* (ONT): When *user* should carry out a *task*, but fail to do so or does not touch the object.
- 3) *Off task* (OffT): When *user* actually is not at the time for doing the *task*.

In the case of 'congklak' game used, RMT is when children actively manipulate object or in this case seeds/beads, for example, when it is time for the child to take the 'congklak' seeds/beads one by one. ONT is when it is time for a child to manipulate an object (turn to play) but does not do so, for example, thinking for a while to work out a strategy. OffT is when a child is not playing or in this case waiting for his/her turn to play.

Seeing from the below data of *touch screen* interaction type, it can be seen that the majority of players spent their time in manipulating object effectively (RMT), considering from the previous data on average the games finish faster in *touch screen* interaction, which means that the RMT carried out in this interaction is faster and more effective than other interactions. This has proven the second hypothesis which is the *touch screen* interaction type, spend more time in conducting object manipulation effectively.

The following is the average result of *time spent manipulating pieces* calculation as shown in table 3.

Table 3: Table of time spent manipulating pieces testing result

<i>Time spent manipulating pieces Testing</i>			
JenisInteraksi	RMT	RONT	ROffT
Tradisional	40.7 %	8 %	49.8 %
<i>Mouse</i>	36.1 %	14.2 %	49.4 %
<i>Touch screen</i>	40.5 %	12.4 %	47.2 %

In the data, it can be seen that children spend their time in RONT more on *mouse* interaction than on *touch screen* interaction. More complete explanation can be seen in the following variable.

d. Indirect and Direct Placement

In this variable there are two things that are analyzed namely *direct placement* and *indirect placement*. In the *direct placement* variable, it is a situation in which children manipulate an object directly without the presence of thinking or cognitive activity. *Indirect placement* is a condition where a child carry out a thinking or cognitive activity before conducting object manipulation. Both variables are found in ONT condition. Besides DP and IP, there is Non DP-IP condition in which children do not carry out DP or IP at ONT but carry out activities such as talking/chatting, joking, eating, day-dreaming, etc. The following is the result of *time spent manipulating pieces* calculation average as shown in table 4.

Table 4: Table of DP & IP testing result

DP & IP Testing			
Type of Interaction	DP	IP	Non DP-IP
Traditional	23 %	52.1 %	25.1 %
<i>Mouse</i>	25.3 %	60.1 %	13.8 %
<i>Touch screen</i>	23.1 %	64.1 %	12.7 %

From the above data, it can be seen that IP figure in *mouse* interaction is far higher than DP. This data prove that the hypothesis on pairs will spend more time to conduct *direct placement* in *mouse* based interaction is proven wrong. However, for the hypothesis that pairs will spend time more on conducting *indirect placement* in *touch screen* based interaction is proven right.

Seen from both IP values in both interactions, it can be seen that both figures are higher than traditional. This is influenced by UI factor in *game* application which makes it easy for children to count the seeds/beads.

IV. Discussion

Based on the opinion of an expert in child psychology, a good and effective game of 'congklak' is when children can manipulate quickly and accurately. This is related to the child's motoric growth and development. Besides that, ideally children build strategy first by thinking or counting before they start to take the seeds.

a. Data Analysis Result

From the data obtained and based on opinion of expert, analysis obtained is as follows.

- 1) In *Time to First Completion* variable, it can be seen that the quickest playing time is found in *touch screen* based interaction and the slowest is found in *mouse*. This is because in interaction using *mouse* tool, it affects the child's movement. Shifts, *mouse*, weight and mouse size compared to a child's hand which is smaller become the main factor why a child's movement is slower. While *touch screen* interaction without using tools frees the players to move thus freer and faster.
- 2) In *Time Spent Manipulating Pieces* variable, it is proven that children spend time more on manipulating seeds effectively (RMT) found in *touch screen* based interaction.
- 3) In *direct & indirect placement* variable, seen from the IP figure which is higher than DP, children spend their time more on thinking at both interactions. The factor affecting this is figures at UI which show total number of seeds in the hole or in the hand. This can help a child in thinking and this convenience is able to attract the child's interest in thinking.
- 4) Both interactions basically can train a child's motoric and cognitive skills. However, from the motoric side, *touch screen* interaction has the fastest playing time and a high RMT value, which shows that *touch screen* interaction trains motoric better than *mouse*.

From the cognitive side, *indirect placement* value from both interactions are both higher than *direct* placement. However, IP figure in *touch screen* interaction is still higher than *mouse*. This shows that children spend their time more on thinking in this interaction. This can be influenced by the position of the child playing, which is horizontal which is similar to the original thus making it easier for children to conduct cognitive activity. For example, a child easily see the total number of seeds in game area and count. However, both interactions are still quite satisfactory in training a child's cognitive skill.

Seeing from the data analysis explained, we can see that there are several things that can be improved to increase interaction value. They are as follows:

- 1) Playing time in *mouse* based interaction still takes longer than the game of 'congklak'.
- 2) Ideally in playing, children must think about the strategy first before taking action. Seen from IP and DP figures, both interactions have fulfilled this. However, IP value from *mouse* interaction is still lower than *touch screen*.

Seeing from both aspects that should be improved, it can be concluded that interaction using *mouse* should be improved more. This proves that hypothesis on average variables in *touch screen* interaction testing will show higher effectivity figure is proven.

b. Recommendation for Value Increase

The following are recommendations that can be done in trying to increase such value:

- 1) By using *game* application with the same UX, *touch screen* based interaction has faster time than *mouse*. Therefore, improvement is focused more on *hardware* used. Use *mouse* in medium size and not too heavy so that children can shift the *mouse* well. Better yet, use good quality *mousepads*.
- 2) To increase IP more, it means similar to children who have to do more cognitive activities such as thinking. This depends on the individuals whether each person's thinking ability is already satisfactory or not, whether they wish to think or not. It is the most possible thing to conduct in increasing children's intention to think. This can be done by giving number help using attractive colors. Besides that, at the change of turns, 'conglak's' UI can swivel 180 degrees. Thus, each child is facing the appropriate side.

V. Conclusion

From the result of data and analysis of interaction variables in 'conglak' *game* application which has been processed. Result of variable measurement is a duration of game time in *mouse* interaction is slower than *touch screen* based interaction. The affecting factor is *interaction device* in the form of *mouse* which hampers a child's hand movements. In *time spent manipulating pieces*, the highest RMT time is found in *touch screen*. interaction. This shows that children spend time more on manipulating seeds of 'conglak' effectively (RMT) in *touch screen* interaction. The value of *Indirect placement* is quite high in both interactions namely *touch screen* and *mouse*. However, these variable figures are influenced by several aspects namely the value of repetition iteration in the testing of HE and *persona user*. In general, evaluation of *touch screen* based interaction is more effective in training child's cognitive and motoric than *mouse* based interaction. Factors that can be recommended to optimize interaction value is by considering the *interaction device* used and UI which attracts children's attention to trigger their willingness to thin.

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Geo-mechanics Data Analysis Applied to Hydraulic Fracturing Design in Lower Pematang Formation, Malacca Strait PSC (#656)

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Abstract—Oil and gas industry has huge impact to Indonesia economic growth. As major of oil producer, development of technology to improve the production should be as a priority. The Lower Pematang Formation is a high-temperature sandstone reservoir up to 350 F in the Central Sumatra Basin in Indonesia. It is a low-permeability reservoir around 0.5 to 3 mD, and so oil flow rates are often sub-commercial, despite high initial reservoir pressure and gas-lift. The obvious method to improve oil rates and recoveries in this reservoir is hydraulic fracturing. During simulating the hydraulic fracturing design, there some uncertainty parameter which effect to the geometry and fracturing propagation. Geo-mechanic data is one of most important data to be inputted in hydraulic fracturing design. The data source generate from core lab test, open-hole log, sonic log, formation leak of test or drilling report. Little is known about this formation and drilled cores are rare. Proposes of studying geo-mechanic are to analyze wellbore stability, elastic rock properties, in-situ stress distribution, to estimate pore pressure, to determine the prospect of hydraulic fracturing potential. Geo-mechanical calculation is one of main focused on this study in order to improve the Hydraulic fracturing design.

Keywords—Elastic Rock Properties, Geo-Mechanics, Hydraulic Fracturing, In-situ Stress, Pore Pressure

I. Introduction

THE technological one-two punch of horizontal drilling and hydraulic fracturing has created a remarkable energy boom and created hundreds of thousands of jobs in the U.S. The possibility of continuously low natural gas prices is turning the United States into a prime destination for chemical companies and other businesses that rely on abundant amounts of natural gas. That is one of the reasons of this research. Hydraulic fracturing makes a significant contribution to the worldwide oil and gas production. It has proved to be capable of increasing both well production and the ultimate recovery achievable from a particular well and/or field. Geo-mechanical modeling is one of the important parameter while hydraulic fracturing designs.

This study applied in Srikandi field well design which has undergone three development phases. The third development phase is hydraulic fracturing which started from 2008 until 2014. Hydraulic fracturing summary and oil production history can be seen in Figure 1.

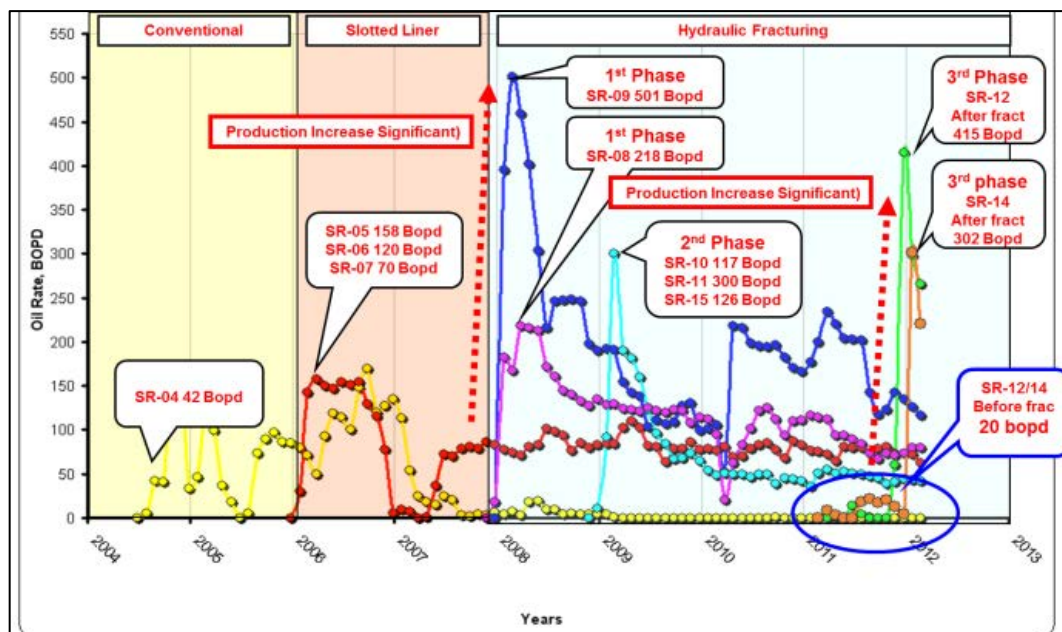


Figure 1. Srikandi field Production comparison [1]

Based on the history above, almost all wells was performed hydraulic fracturing in Lower Pematang CD so for the further hydraulic fracturing project will conduct in Lower Pematang AB which refer to success job in SR-12. The history of hydraulic fracturing in this field proves that the obvious method to improve oil rates and recoveries in this reservoir is hydraulic fracturing.

This study is chosen with several objectives as follow; Integrate and analyze the relevant logs, pressure survey and other data, to evaluate pore pressure and generate geo-mechanical modeling describing stress magnitude, stress orientation and rock mechanical properties then re-arrange the geo-mechanical modeling based on previous hydraulic fracturing result and current pressure data to improve hydraulic fracturing design and increase oil recovery and verify effect of geo-mechanical parameter to current hydraulic fracturing design compare with previous design.

II. Methodology

Geo-Mechanical Modeling is a description of formation geo-mechanic parameters which includes; a description of rock fabric; Rock elastic parameters, including young modulus and Poisson's ratio; Rock strength parameters - unconfined compressive strength, tensile strength and internal friction angle; and Stress model - vertical stress, minimum and maximum horizontal stress magnitudes and orientation and pore pressure

Rock mechanics is the study of the mechanical properties of a rock, especially those properties which are of significance to Engineers. It includes the determination and effects of physical properties such as bending strength, crushing strength, shear strength, moduli of elasticity, porosity, permeability and density, and their interrelationships.

The fundamental theory for pore pressure prediction is based on Terzaghi's and Biot's effective stress law (Terzaghi et al., 1996; Biot, 1941). This theory indicates that pore pressure in the formation is a function of total stress or overburden stress and effective stress. The overburden stress, effective vertical stress and pore pressure can be expressed in the following form:

$$P_p = \frac{\sigma_v - \sigma_e}{\alpha} \quad (1)$$

Where, P_p is the pore pressure, σ_v is the overburden stress; σ_e is the vertical effective stress; α is the Biot's effective stress coefficient. It is conventionally assumed $\alpha = 1$ in geo-pressure community

Rock Elastic Properties - The only tool that responds to the elastic properties of the formation is the sonic. When a pressure pulse is created in a wellbore filled with fluid, the complex phenomena that occur at the boundary between the wellbore and the formation result in the propagation of several types of waves into the formation [8].

Dynamic elastic properties can be calculated based on compressional and shear slowness data from sonic scanner. Together with bulk density logs data, dynamic elastic properties data for isotropic can be calculated by using equation from fjaer et al [7]. Dynamic shear modulus can be calculated by using equation below:

$$G_{dyn} = 13474.45 \left[\frac{\rho_b}{(\Delta t_s)^2} \right] \quad (2)$$

By substitution of equation 2 above, dynamic bulk modulus can be calculated by using equation below:

$$K_{dyn} = 13474.45 \rho_b \left[\frac{1}{(\Delta t_s)^2} \right] - \frac{4}{3} G_{dyn} \quad (3)$$

Based on shear and compressional slowness data from sonic, dynamic poisson's ratio can be calculate by using equation below:

$$v_{dyn} = \frac{\frac{1}{2}(\Delta t_s/\Delta t_c)^2 - 1}{(\Delta t_s/\Delta t_c)^2 - 1} \quad (4)$$

Rearrange the equation 3 and 4, so dynamic young modulus can be obtained by equation below:

$$E_{dyn} = 2G(1 + v) \quad (5)$$

The dynamic elastic properties are different from their static properties measurement. For hydraulic fracturing design need static elastic properties as input. To calibrate the parameter, Eissa's correlation can be used [4].

In-situ Stress - Vertical stress was computed by integrating formation bulk density from surface to total depth (TD). The overburden is the weight of the column of sediments.

Although it is not measured directly, it can be easily computed as the integral over depth of the bulk density:

$$\sigma_v = \int_0^z \rho_b(z) \cdot g \cdot dz \quad (6)$$

However, ρ_b is rarely measured up to the surface more than once in the lifetime of a field (i.e., for seismic profiling). Research may be necessary to obtain an estimate of ρ_b between the top of the log and the surface. Furthermore, for deep-water projects, the significant effect of the water column on σ_v must be included.

A continuous profile of σ_h is obtained by using the following equation with the Biot constant α as an ad hoc potentially lithology-dependent calibration parameter:

$$\sigma_h = \frac{v}{1-v} (\sigma_v - \alpha p) + \alpha p \quad (7)$$

Use of this model is reasonable for low-porosity, low-permeability sandstones, shale and carbonates

A. Geomechanical modeling Procedures

The Geo-Mechanical Modeling is built by mathematical calculation and calibrate by core and current data. The calculation procedure as below:

1. Prepare well survey to determine true vertical depth as basic calculation.
2. Prepare raw logs data such as Gama ray, porosity log, bulk density log, neutron log, water saturation, and volume clay from composite log
3. Select the target zone based on petro-physical and reservoir evaluation.
4. Prepare raw sonic logs consists of compressional, shear slowness and dynamic poisson's ratio
5. Dynamic elastic properties can be calculated based on compressional and shear slowness data from sonic scanner. Together with bulk density logs data, dynamic elastic properties data for isotropic can be calculated by using equation 2 until 5. As input to hydraulic fracturing design, need static values so the calibration of that parameters can be calculate by using Eissa's correlation [4] as follow:

$$E_S = 10^{[-0.11+0.77 \text{ Log}(\rho_b \cdot E_{dyn})]} \quad (8)$$

This equation applies for medium porosity around 15 - 20%.

6. Calculate the overburden gradient by using the equation below from Matthews, 1967:

$$\sigma_{ovg} = 0.433[(1 - \varphi)\rho_{ma} + (\varphi \cdot \rho_f)] \quad (9)$$

7. Calculate Pore pressure gradient by using Eaton's equation for sonic logs data as follow:

$$\sigma_p = \sigma_{ovg} - (\sigma_{ovg} - P_{ng}) \left(\frac{V_i}{V_n} \right)^x \quad (10)$$

Calculate Pore pressure Pp by using the equation below:

$$P_p = \sigma_p \cdot z \quad (11)$$

8. Calculate overburden pressure and define as vertical stress. The equation as follow:

$$P_{ovg} = \sigma_{ovg} \cdot z \quad (12)$$

9. Calculate minimum horizontal stress σ_h by using equation 7 with Biot's constant α as an ad hoc potentially lithology-dependent calibration parameter [6]. Calibrate the biot's constant α based on current history of hydraulic fracturing.
10. Determine maximum horizontal stress σ_H value by using tectonic value in this area by using Formation Micro imager log.

B. Hydraulic fracturing simulation

Prepare input data based on research well available data. The data will categorize as follow:

1. Well data input consists of well completion, tubular, and perforation
2. Zone, describe the type of zone, geo mechanical parameters and Petro-physical properties
3. Reservoir Fluid, describe PVT and fluid properties
4. Fluid frac, information about compatible frac which will use on design complete with fluid frac properties
5. Type of proppant and properties choice which will used on design
6. Schedule, to input schedule treatment as simulation type choice.
7. Execute, Simulation execution

III. Result

A. Geo-mechanical model data

Formation Micro Imager log - In this study, Bore-hole image data (FMI) are available for SR-08 well which is vertical and it allowed to determination of in-situ stress direction and stress contras.

Base on analysis of the formation micro imager, the maximum regional stress direction approximately N50°E and the minimum stress azimuth of N140°E. Resistive fractures show one preferred orientation as seen as Figure 2

Rock Mechanical Tri-axial Core testing result from Lower Pematang formation of SR-15 - The testing program consisted of single and multi-stage tri-axial compression tests on supplied plug samples at room temperature for obtaining Mohr-Coulomb failure envelope delineation, Young's modulus and Poisson's ratio. The summary of tri-axial compression testing was shown in Figure 3 for multi stage respectively.

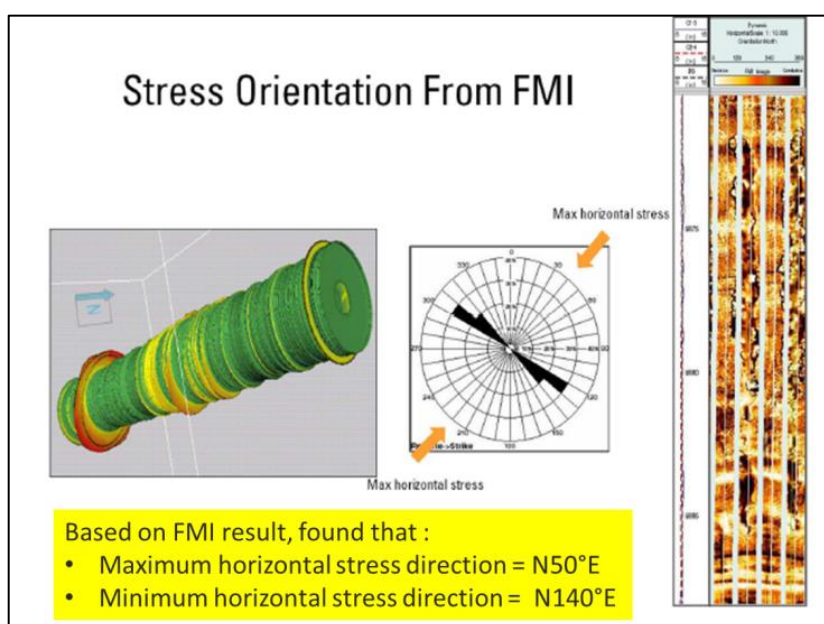


Figure 2. Formation Micro Imager result

sample ID	depth (ft)	orientation	Lithology	As-tested bulk density (gr/cm3)	Effective confining pressure (psi)	effective compressive strength (psi)	effective residual compressive strength (psi)	loading quasi-static young's modulus (psi)	loading quasi-static poisson's ratio
MS-3	6926.5	Vertical	sandstone	2427	415	8415		2.16E+06	0.31
					1245	14760		3.13E+06	0.28
					2283	19928		3.50E+06	0.28
					4105	26660		4.01E+06	0.25
					6226	38300	21450	4.32E+06	0.25
MS-2	6938.4	Vertical	shale	2436	882	13378		2.21E+06	0.23
					2425	20267		2.98E+06	0.29
					4410	29540	18480	3.15E+06	0.30

Figure 3. Summary of Multi-stage Triaxial Compression Tests

B. Geo-mechanical Calculation and Modeling

The geo-mechanical study was conducted in well SR-08 and SR-14 in Srikandi field. The study involved the integration and incorporation of a variety of logs, and field data to generate geo- mechanics model by using manual calculation based on several equation. Those two wells were chosen to compare between isotropic and anisotropic model, but SR-

14 not shown significant different trend compare with SR-08 due to formation type is mostly clean sand. Anisotropy effect only can be seen in layering shale formation type such as unconventional formation. This phenomenon should be studied in future.

a) Rock Elastic Properties

Rock elastic properties represent the elastic deformation behavior of the rock. For isotropic, the stress-strain behavior can be describe in two parameters, typically young modulus and Poisson's ratio.

Dynamic elastic properties can be calculated based on compressional and shear slowness data from sonic scanner. Together with bulk density logs data, dynamic elastic properties data for isotropic can be calculated by using equation from fjaer et al., 1992.

The dynamic rock elastic parameters are different with their static parameters. As input to hydraulic fracturing design, need static values so the calibration of that parameters can be calculate by using Eissa's [4].

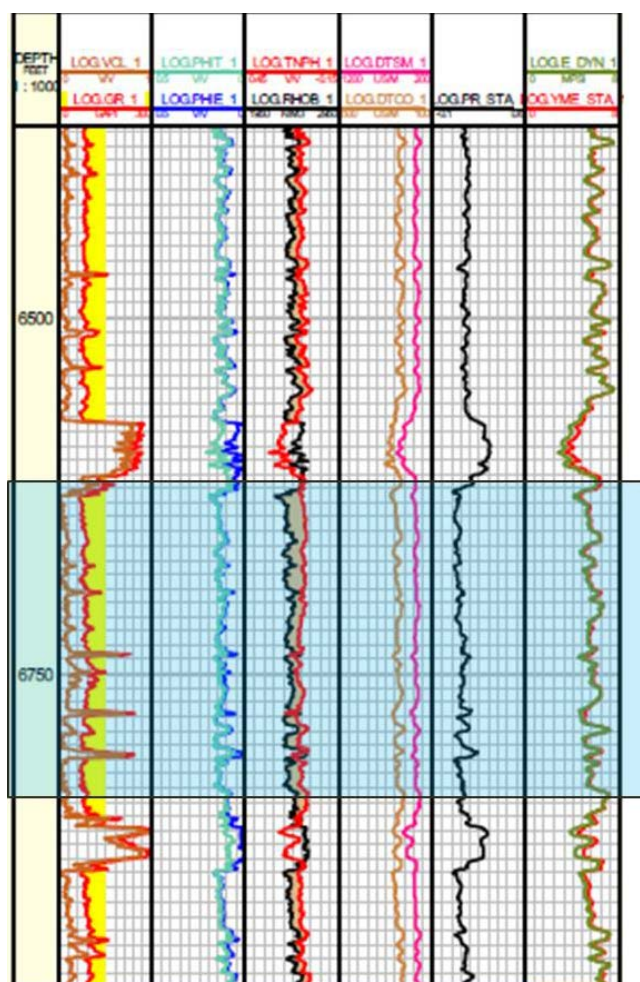


Figure 4. Rock elastic properties profile in SR-08

After calibration, the result of static rock elastic properties had shown in Figure 4. and 5. Track five and six describe the rock elastic properties such as poisson's ratio and young modulus as input of the calculation. The data was converted to static parameter and calibrated by using tri-axial core test data.

During the study of calibration dynamic to static poison's ratio, there is no direct relation between dynamic and static Poisson' ratio. Calibration of local data seems possible, but there is no universal correction factor.

Target zone in SR-08 is Lower Pematang AB in depth 6622 – 6737 ft.MD and perforated zone in 6630 – 6650 ft.MD. Based on isotropic calculation and calibrate with Eissa's correlation and core data, average value of sandstone young modulus in target zone is

around $4.26 \text{ E}+06$ psi and Poisson's ratio is around 0.25. The value of rock elastic properties in sandstone and shale is similar due to the sandstone in this formation typically tight formation with small permeability.

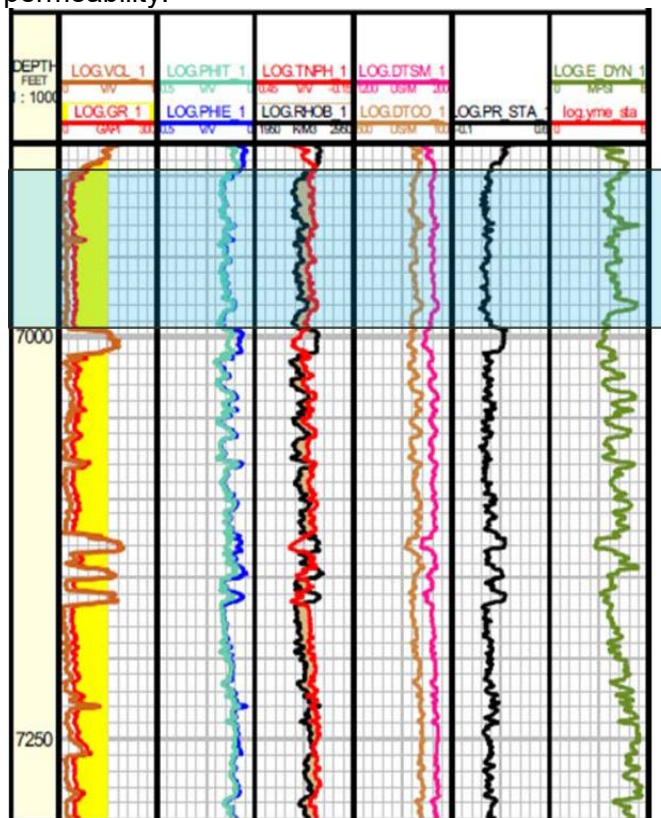


Figure 5. Rock elastic properties profile in SR-14

Figure 4. and 5. Has shown the calculation result of rock elastic properties in SR-14. Target zone in this well as same as SR-08 in Lower Pematang AB at depth 6890 feet until 7010 feet. The average Young's modulus is around $4.51\text{E}+06$ psi and Poisson's ratio around 0.22.

b) Pore Pressure Estimation

The pressure data had taken from the analog well which has same layer. Before the data used for calibration, it should be interpolated into the datum survey. Pore pressure in this formation verified by the pressure data. Pore pressure is calculated by delta time shear compressional which convert to velocity as shown in Figure 6 and 7.

The delta time shear compressional pick to find the normal compaction trend. There are two kind of normal compaction trend that is normal compaction trend in shale and sand. Based on the velocity and normal compaction trend, pore pressure can be calculated by using Eaton's equation.

The track five described the result of hydrostatic pressure in black line and pore pressure in green line. The hydrostatic pressure is calculated by fluid gradient and true vertical depth. Eaton's equation shown in equation 10 has "x" as Eaton's constant variable. This parameter is modified based on current pore pressure data to adjust the pore pressure value from calculation to pore pressure measurement. The modified was done by shift the green line into the black dot by changing the Eaton's constant variable until got matching line.

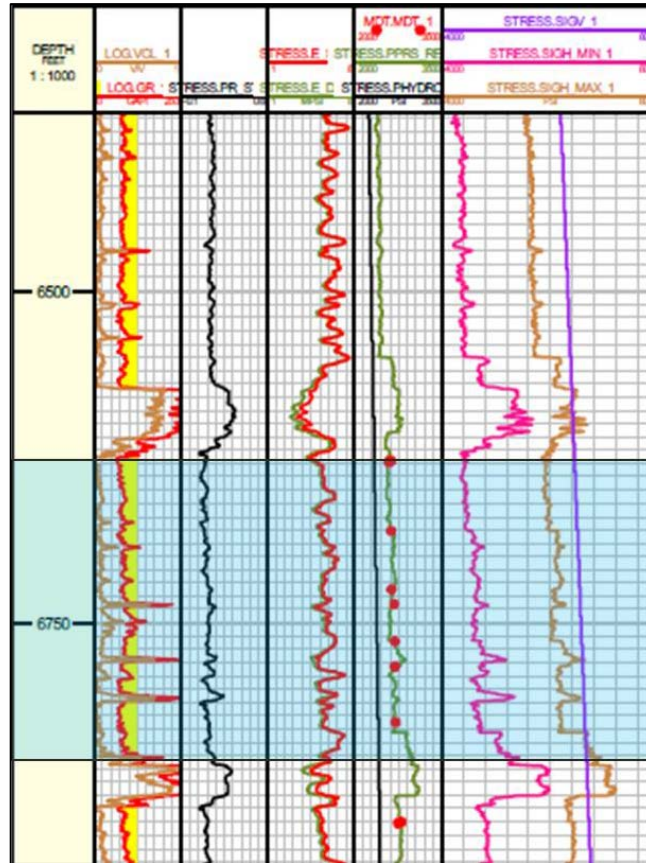


Figure 6. Stress profile in SR-08 after calibrated with current pressure data

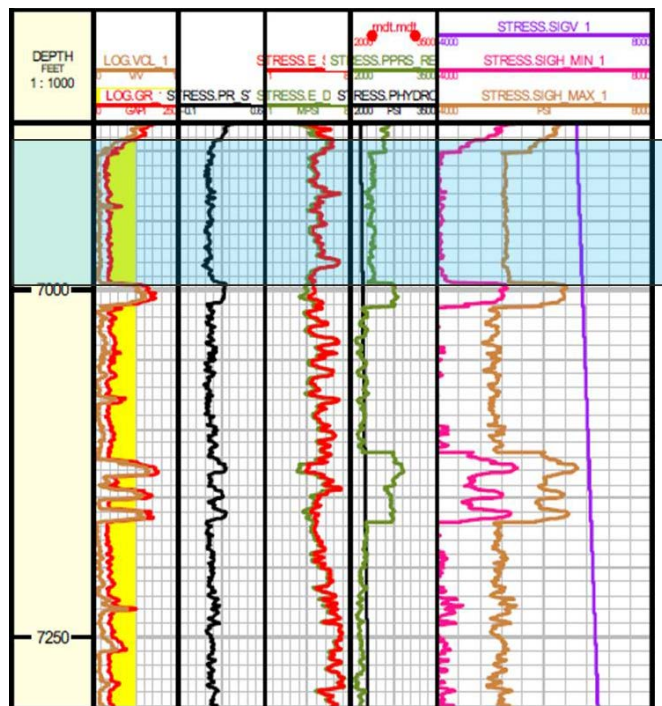


Figure 7. Stress profile in SR-14 after calibrated with current pressure data

c) Stress Profile Determination

The stress profile for both of wells is shown in Figure 6 and 7 specify in last track. Minimum horizontal stresses expressed the value of closure pressure in hydraulic fracturing design. This value calculated by using equation (Biot and Willis, 1957) with Biot’s constant α as an ad hoc potentially lithology-dependent calibration parameter (Economides, 2000).

C. Hydraulic Fracturing Design Optimization

The hydraulic fracturing design in this study is built by using fracturing simulation software.

a) Fluid fract

The fluid used in this simulation called as ThermaFract which compatible with high temperature type of well around 305 Fahrenheit

b) Proppant selection

The type of proppant and properties choice which will be used on design is carboHSP mesh 16/30. Carbo-ceramics proppant also have good roundness and sphericity. The major considerations of proppant type and size selection are optimizing conductivity versus beneficial.

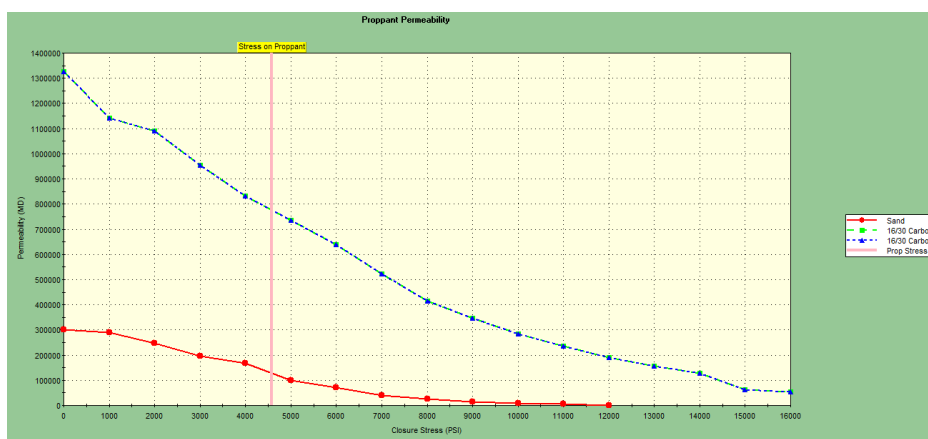


Figure 8. Proppant permeability vs closure stress

c) Execution

Simulation execution is final part of the simulation to generate the fracturing geometry result. Figure 9 is shown the result of hydraulic fracturing SR-08, which geo-mechanical parameters calculated by using isotropic concept. The result not showed good FCD compare with SR-14 in Figure 10. Those both of design will apply in Lower Pematang AB.

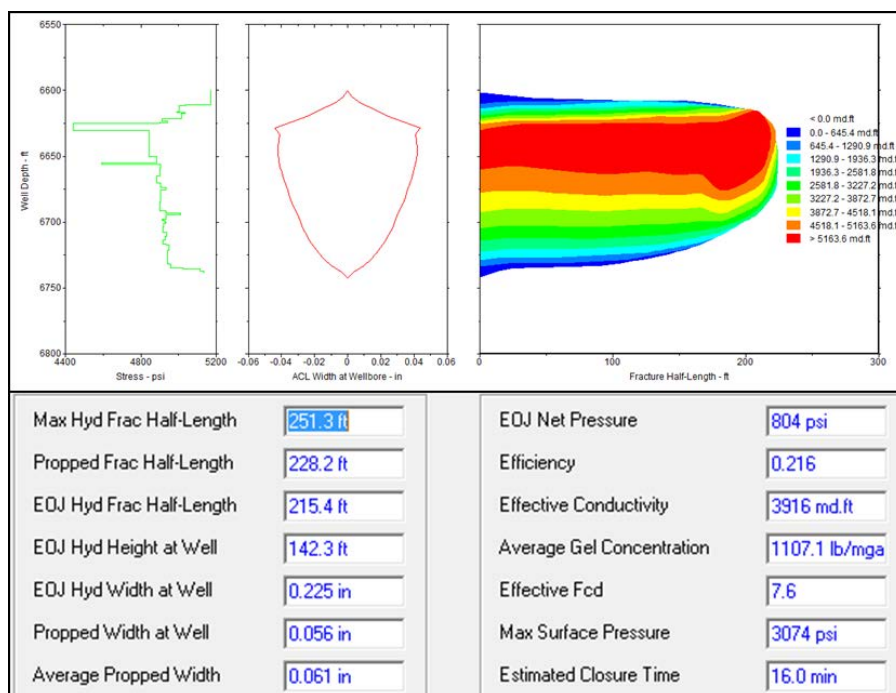


Figure 9. SR-08 Fracturing Geometry Result

Figure.11. is shown the result of SR-12 hydraulic fracturing design in previous campaign. This design has given good result which initial rate after hydraulic fracturing execution around 415 BOPD. So for both of two further propose of hydraulic fracturing which is SR-08 and SR-14 expect will give same result.

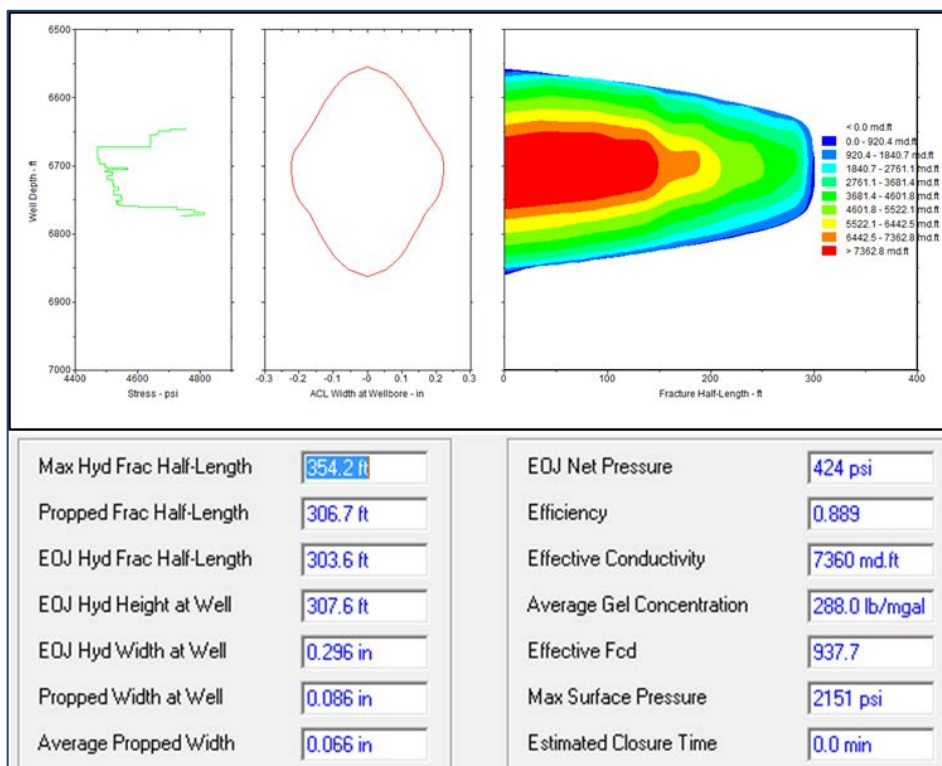


Figure 10. SR-14 Fracturing Geometry Result

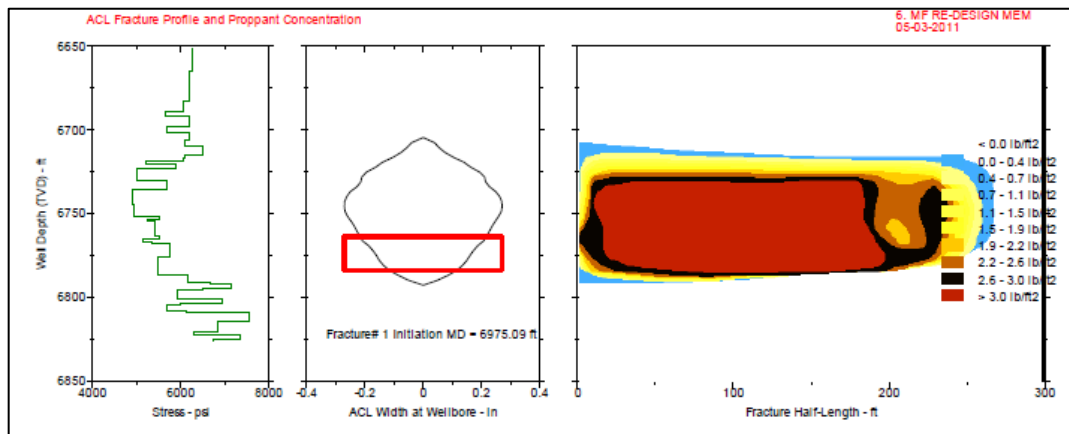


Figure 11. SR-12 Fracturing Geometry Result in Lower Pematang AB

IV. Conclusion

SR-14 previously studied for identify anisotropy effect into stress determination, but the formation target has clean sand so the anisotropy effect do not shown the significant different between isotropic but shown optimistic calculation. The main parameters calculate in geo mechanical modeling in Lower Pematang AB formation are rock elastic properties such as Young’s modulus and Poisson’s ratio, pore pressure, and stress profile. All those parameters are calibrated with current data. Treatment schedule was done by sensitivity to create the best fracture geometry design. SR-08 design by 90000 lb proppant with 29256 gal fluid and SR-14 design by 118600 lb proppant and 36561 gal

fluid. Based on the schedule treatment, fracturing job executed. The result of the design for SR-08 less than SR-14 due to SR-08 geo-mechanical calculation over estimated then SR-14 due to the geo mechanic parameter was generated by using anisotropy concept. SR-08 fracture geometry created in 228 ft half of length, 0.06 inch of width, and 3916 mD.ft of conductivity and SR-14 fracture geometry created in 306 ft half of length, 0.06 inch of width, and 7360 mD.ft of conductivity.

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Balinese Cultural Values in Partnership (659)

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Abstract. *An organization could establish a partnership with other organization to reach a particular purpose. Partnership between two or more organizations does not only transpire on intuition that works on the same sector, but also in different sectors (intersectoral). Furthermore, partnership could also be agreed between multinational companies, or multinational company and local company. Therefore, the stakeholders in partnership must be committed in maintaining and respecting the principles and values, which are commonly regulated as well as the local values in an operational area. The general principles that underline partnership are justice, trust, faith/ loyalty, wholeness/integrity, honesty, equality, human dignity, service, excellence/high quality, and growth. The value aspects needed in establishing partnership are leadership, customer satisfaction, mutual prosperity, friendship, innovation, security/ health/environment, teamwork, quality, and continuous improvement. Some cultural values of Balinese society that can support the partnership are the values of associating oneself to community (menyama braya), unity in joy and sorrow while respecting each other's point of view (sagilik-saguluk salunglung sabayantaka paras paros sarpanaya), reminding and caring as well as helping each other (saling asah saling asih saling asuh), and volunteerism/work as worship and worship in work (ngayah)*

Keywords: *Balinese, local culture, partnerships, principles, values*

I. Introduction

Many stakeholders realize that establishing a partnership is more profitable than competing to optimize the gained result. Partnership is a continuous form of strategic alliance/fellowship among various actors (multi-organizational and multi-sector) with an agreed purpose, both formally (written agreement) and informally (oral agreement), which is based on trust, equality and understanding towards rights and obligations, along with involving the exchange or sharing of resources, risks, and responsibilities ^{[1] [2] [3] [4]}. Some important elements related to partnership are its cross-border organizations nature, involving the sharing of resources and management (asset or competence, decision-making, supervision in complex structure), having mutually-agreed purposes (an agreement between partners towards particular purposes/*win-win solution*), being interdependence as a team, which involves commitment, trust and equality, and occurring in dynamic process^[2].

The terminology, which is used to describe partnerships, varies over time. In the 1970s-1980s, the term "*network*" was frequently used, then, in the early 1990s the used term was a consortium, and the term "*partnership*" began to be widely used in the early 2000s ^[2]. Nowadays, the term collaboration is widely used as a more flexible and more inclusive form of cooperation. However, there is no standard procedure or rule that binds the form of cooperation which must be applied in a partnership ^[5]. The most important thing to understand is that the collaborative process in partnership involves the process of the change of bussiness patterns from the usual. The different types of appliedpartnerships will

involve different levels of collaboration as well, depending on the expected goals and readiness of partners to change their business patterns.

Challenges in managing the complexity, due to the differences in economic, social and cultural circumstances, and types of stakeholders, which sometimes have conflicting interests and priorities, results in the inability to conform certain form of coordination mechanisms between two or more organizations/companies^{[6][7][8]}. In addition, the chosen supervision model in partnership will have a significant effect towards the long-term relationship sustainability^[9]. Thus, each partner needs to pay attention to the main reason as a trigger/stimulant of partnership, set the long-term goals, choose a supervision model of partnership, which is appropriate with the characteristics of the organization, and consider the success factors at each stage of the partnership.

Therefore, to support the success of a partnership, the stakeholders ought to have the same understanding and perception, which are supported by the suitability of personal values and organizational culture owned by every actor involved. The existing values could be the values/ norms which are applied in the community, either within the scope of local, national, regional, or international. This is necessary to avoid misunderstanding of an attitude or action that may occur due to different values of partners.

II. Principles and Values as a Success Factor in Partnership

A partnership could be realized and maintained if the principles and values could be held by each partner^[10]. Some underlying principles of partnership are justice, trust, faith/loyalty, integrity, honesty, equality, human dignity, service, excellence/ high quality and growth. The value aspects needed in partnership are leadership, customer satisfaction, stakeholder wealth, friendship, cooperation/ collaboration, innovation, technology, security/ health/environment, teamwork, quality, continuous improvement and a competitive world.

When we review the stages in the collaboration process (preparation, implementation, outcome), each requires a certain success factor^[11]. In the initial/preparation phase, the factors that need attention are communication, formulation of benefits obtained by each partner institution, political/social climate, trust/reward, the level of goal achievement, human resources involved, and the cross-section members. For the stages in which the partnership process has taken place, it is necessary to maintain the communication, trust/mutual respect supported by roles and responsibilities, and decision making. Meanwhile, the factors that still need to be considered after the visible achievement of the partnership results are communication, institutional benefits, goals achievement with expectations, and assessment of the impact of partnerships. Other things to consider in establishing cooperation/ partnership are (1) responsiveness and reciprocity, (2) inclusivity, (3) fairness and objectivity, (4) openness, transparency and credibility, as well as mutual respect^[12].

Factors that influence the process of collaboration could be categorized according to its scale, such as factors in macro, meso and micro scale^[13]. Macro-scale factor comprises of social, cultural, educational and professional systems. Meso-scale factor is a factor which arises due to conditions that occur within the organization (organizational factors), such as organizational structure and philosophy, resource support and management/ administrative, and coordination/communication mechanism within the company. Meanwhile, micro-scale factor depends on interpersonal relationships that exist between partner members (interactional factors), including willingness to collaborate, level of trust, communication and mutual respect.

These three factors could also be referred to as partnership drivers, which are grouped according to their origin ^[14]. The first is the external driving factor, the unity of political situation, socio-economic and cultural situation, and the rules within the area of partnership operations. The second is the organizational-level driving factor (unity of vision, mission and skills that are specifically involved for the partnership process). And thirdly, individual level driving factor is in the form of people who are directly involved in forming and implementing partnerships. When associated with the theory of organizational effectiveness, these factors are identical with the three essential elements of the organization, such as environment, process and person ^[10]. Therefore, the factors that influence the success of the partnership program are environmental factors (macro scale/external organization), process factor (meso scale/internal organization) and person factor (micro/individual scale).

The key issues to consider when designing cooperation processes between educational institutions and small and micro enterprises are: (1) cooperation is always related to people, (2) the school needs to understand the daily work of the company, (3) it is needed to set clear goals for cooperation, (4) it is necessary to make a mutual profitable situation (*win-win*), (5) to attract company interests, school managers need to demonstrate the most practical benefits in relatively short time after the partnership takes place, (6) it is needed to make a good planning, while maintaining flexibility, (7) it is necessary to make sure that there are prominent people who are mutually recognized in the cooperation process, (8) it is necessary to not underestimate the role of foremost people, (9) it is needed to prepare enough time for communication and connection, (10) all of those are all related to attitude^[15].

III. The Value of Bali's Local Wisdom related with Partnership

Besides the generally accepted principles and values as elaborated above, we also need to consider local socio-cultural contexts in a region. Bali, known for its cultural peculiarities that still retains the Balinese Hindu tradition, also has some local wisdom values related to the cooperative activities or partnerships. The forms of the values implementation are evident in the traditional social organization activities in Bali, among others, *tempekan* (neighborhood association), *banjar* (citizen organization) and *subak* (organization in agriculture). These organizations are formed on the basis of deliberation with the members (*krama*) in a meeting (*sangkep*) as outlined in the collective agreement (*pararem*) codified into statutes and bylaws (*awig-awig*). Those could also be applied in the establishment of an association (*sekaa*).

Sekaa is an institution or social group or a group of several people who gather themselves based on the same interest as its purpose ^[16]. *Sekaa* in Bali could be classified into several types according to the aspects of its members' social life. *Sekaa*, which engages in arts, for example *sekaa gong* (groups which play gamelan gong musical instruments) and *sekaa kecak* (groups of people who dance Kecak). *Sekaa* that operates on the economic life aspect, for example, *sekaa nenggala* and *sekaa manyi* in the field of agriculture, *sekaa jukung* (group of boat owners) in the field of fishing, *sekaa pengetengan* (group of traders who jointly entrust one of the members to save daily dues for the amount which has been agreed) in the field of trade, and so on. In the social life aspect, there are *sekaa patus* (neighboring group which helps each other in case of death), *sekaa tempek* (neighboring group in certain areas in *banjar* environment that help each other if every occasion, both joy and sorrow), and *sekaa sambang* (groups which visit each member when there is

anoccasion) and *sekaa teruna*. There is also a classification of *sekaa* in customary and religious life aspect, such as *sekaa pemaksan* in a temple (a group of people who associated in *sekaa* to organize and to liven up the ceremony in the same ancestor/clan altogether), *sekaa pesantian* (groups for studying and deepening the religion), *sekaa kidung* (group of ceremony accompanists with the singing of sacred songs and worship songs), and so on.

An association/*sekaa* operates in accordance with its rules (*awig-awig*) which has been agreed upon by each member (*krama*). *Awig-awig sekaa* contains all matters related to the *sekaa* organization management, including the rights and obligations of the members and sanctions for members who violate the rules. If it is equated in a partnership between two or more agencies, *awig-awig* is a memorandum of understanding (MoU) that will bind each member during the cooperation process.

In its operations, every *sekaa* and other Balinese social groups possess/hold the values which constitute local wisdom that has been entrenched and based on religious philosophy. In the teachings of Hinduism, the ultimate goal of the adherent is releasing themselves from secular bond in the form of the real happiness in the world and hereafter. To achieve it, every people must hold on the *tri hita karana* concept, the three harmonious relationships in human life, namely the harmonious relationship with God (*parhyangan*), the harmonious relationship with other people (*pawongan*), and harmonious relationship with nature (*palemahan*). Activity in social groups, including *sekaa*, is a form of human interaction with other human beings, thus referring to the *pawongan* concept. In maintaining the harmony of this relationship among human beings, there are several values that have been rooted in Balinese culture, such as *menyama braya*, *sagilik-saguluk salunglung sabayantaka paras paras sarpanaya*, *saling asah saling asih saling asuh*, and *ngayah*.

The first value, the *menyama braya*, is a noble value that binds members of society by assuming that each person is supposed to be their own brother (*nyama* = brother, *braya* = people around/society). Thus, in order to achieve the harmony in social or other organizational relationships, this principle or value system emphasizes the sense of brotherhood as the basis for relationships. By assuming others like our own brothers, it will increase the sense of family in the organization so that there will be an intimacy and solidarity in performing tasks. *Paras paras sarpanaya* value means the willingness to accept differences in decision making. Every individual has a sense of mutual respect for each other opinions, and willing to *berembug/* deliberate to find the word “*mufakat*” (consensus/ win-win solution). This value is very important in establishing a partnership, where each partner should be able to recognize the strengths of each partner and respect each other's differences and be willing to coordinate with each other in their bonds/relationship (from planning, implementation, monitoring and evaluation, as well as the determination of follow-up program).

After reaching a mutual agreement, each partner should always hold on to the value of slogan *sagilik-saguluk salunglung sabayantaka* which has the meaning of togetherness, the willingness to work hand in hand through the life challenges, both in the state of joy and sorrow (one sense, one soul, being in the same fate and holding the same matters). In the organizational context, this value demonstrates the determination of each element to endure various situations in order to achieve the same goals. Each member/element in management mutually supports and synergizes in carrying out every planned program altogether. In addition, each element/member needs to have a sense of mutual care, *asah-asih-asuh* (reminding each other, caring, and helping). Therefore, a sense of togetherness and solidarity will strengthen the foundation of cooperation, and ensure to achieve the goals optimally and sustainably.

In spite of being based on a sense of togetherness, every individual in the organization must also has the spirit to work hard in carrying out every task and responsibility covered. This is related to the spirit of *ngayah*, which means dedication/loyalty to the responsibilities held. The concept of *ngayah* is the essence of the philosophical value of religion, which is "work as worship" and "worship in the work". In the teachings of Hinduism, there are four ways that can be taken in implementing religious teachings, such as through devotion and worship (*bhakti marga*), action/work sincerely (*karma marga*), the practice of science and experience possessed (*jnana marga*), and meditation (*rajamarga*). Thus, the spirit of *ngayah* is a form of religious teachings through work (*karma marga*). This is shown by the eagerness of doing the job/obligation sincerely. The term *ngayah* also figuratively means working together. Thus, the aforementioned local wisdom values are also linked to this concept of *ngayah*.

Therefore, the values contained in the slogan of *menyama braya, sagilik-saguluk salunglung sabayantaka paras paras sarpanaya, saling asah saling asih saling asuh, and ngayah* are interconnected in an effort to create a harmonious situation in relationship among human beings. It is also very supportive in strengthening the foundation in establishing a cooperation or partnership, because the awareness has been rooted in the culture of the surrounding society. Thus, the local wisdom values need to be considered in building and running a partnership in Bali. With the values of local wisdom held as guidance/operational basis of partnership, it is expected that the partnership process becomes more entrenched and sustainable.

IV. Conclusion

Partnerships could be well-established and sustainable if the partners have the same understanding and perception which is supported by the suitability of personal values and organizational culture owned by every actor involved. The main actor in the partnership is the people, who have certain principles and values. Besides holding principles and values which are generally accepted, they are also influenced by the local values within the society in which the partnership takes place. In Bali, the values which could support the success of the partnership are *menyama braya, sagilik-saguluk salunglung sabayantaka paras paras sarpanaya, saling asah saling asih saling asuh, and ngayah*. Those values have connection to each other in supporting the harmony in relationships among human beings.

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Estimation of Bearing Degradation Trend Using Least Square Support Vector Machine and Exponential Regression (#721)

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Abstract—Bearings are frequently found in rotating machinery as the load-bearing members. They play as the critical component in the machine. Their failure can interrupt the production and causing unscheduled downtime. So the bearing monitoring become very important in the bearing maintenance policy. Monitoring involves measurement of bearing signals using certain sensors. Vibration sensor is the most used sensor to monitor the bearing condition. Any damage to a bearing will cause a vibration signal to degrade from its normal state. By tracing this degradation trend, one can obtain the bearing condition and predict its future state. This work is aimed to estimate bearing degradation trend of a bearing using least square support vector machine (LS-SVM) and compare the result using conventional exponential regression. The estimation was performed on the bearing signal obtained from bearing run to failure experiment. The degradation trend was constructed from a time series of degradation indicators extracted from raw vibration signal. The degradation indicator used in this paper are two statistical feature in time domain. They are root mean square and kurtosis. The estimation performance was measured using root mean square error and mean absolute error. The results show that LS-SVM function estimation method work better than conventional exponential regression to estimate the bearing degradation trend.

Keywords—Bearing, degradation trend, estimation, lssvm, exponential regression.

I. Introduction

Bearing is a mechanical element that commonly be found in rotating machines. They are not only supports the load but also permits relative motion between two parts, such as shaft and the housing. They are the critical component to the machine function and often the cause of failure.

The presence of faults in bearings results in severe vibrations of rotating machinery. Unexpected bearing failures can interrupt the production, cause unscheduled downtime and economic losses to the customer. Thus for the last decades, bearing condition based maintenance (CBM) has been the subject of extensive research. CBM is the use of machinery run-time data to determine the machinery or their components condition and hence their current fault condition which can be used to schedul the required repair and maintenance prior to breakdown [1]. A significant objective of CBM is to predict the machine health and the remaining useful life (RUL) instead of their service time, which leads to anticipate usage of the machine, reduction in downtime and enhanced operational safety.

The researches on bearing condition monitoring generally can be divided into two categories, they are fault diagnosis and prognosis. In the fault diagnosis, researchers have been developing methodologies to detect the bearing fault, isolate which component is faulty, and decide on the potential impact to the machinery. The researches have been covered traditional method like usage of demodulation or enveloping based method [2],[3],and[4], until the usage of artificial intelligent as artificial neural network, and support vector machine [5], [6], [7], and [8].

The second category is the bearing prognosis. Researches in this area attempt to predict accurately the remaining useful life (RUL) of a faulty bearing. Some researches in the bearing prognosis are summarized in [9].

In the practice, the life of a bearing can be divided into two stages. The first stage is referred to as the normal stage where no significant deviation from the normal operation. The second stage is called the failure delay period, since a defect may be initiated, and progressively develop into an actual failure. With the help of conditioning monitoring, hidden defects already present in the bearing may be detected. And for maintenance planning purpose, the prediction of the initiation of the second stage and the residual life thereafter is important. [10].

Assessment of bearing condition can be done by estimation the bearing degradation trend. The degradation trend is represented by a series of statistical features that are obtained from vibration signal. These features are nonlinear and complex. So it is need function estimation to the bearing degradation trend for the remaining useful life prediction. Several researches in this area can be mentioned as [11], [12], and [13].

Least square support vector machine (LS-SVM) is one of the machine learning technique. It is a least squares modification to the Support Vector Machine (SVM). The major advantage of LS-SVM is that it is computationally very cheap while it still possesses some important properties of the SVM. Application of the LSSVM can be used for non linear classification, function estimation, and density estimation. One of the potential application of LSSVM is for time series degradation [14], [15], [16], and [17]

This paper is attempt to estimate the bearing degradation trend using LSSVM function estimation on time series of bearing signal extracted feature to monitor the bearing condition predict its future state.

II. Least Square Support Vector Machine

Support vector machine (SVM) is a machine learning method that is widely used for data analyzing and pattern recognizing including classification and regression. The algorithm was invented by Vapnik [18]. The LS-SVM is reformulations to standard SVMs which lead to solving linear Karush Kun Tucker (KKT) system. LS-SVM are closely related to regularization network and Gaussian processes but additionally emphasize and exploit primal-dual interpretation. An LS-SVM formulation employs the quality constraints and sum-squared error (SSE) cost function, instead of quadratic program in traditional SVM. In this section, it will be described a brief theory about LS-SVM method for non linear function estimation [19] and [20]

Consider first a model in the primal weight space in the following form:

$$y(x) = w^T \varphi(x) + b \quad (1)$$

Where $x \in \mathfrak{R}^n$, $y \in \mathfrak{R}$, $\varphi(\cdot): \mathfrak{R}^n \rightarrow \mathfrak{R}^{nh}$ is the mapping into the high dimensional space and potential infinite feature space.

Giving a training set $\{x_k, y_k\}_{k=1}^N$, we can formulate then the following optimization problem in the primal weight space:

$$\min J_p(w, \varepsilon) = \frac{1}{2} w^T w + \gamma \frac{1}{2} \sum_{k=1}^N \varepsilon_k^2$$

$$\text{Such that } y_i = w^T \varphi(x_i) + b + \varepsilon_i, \quad i = 1, \dots, N \quad (2)$$

Where the fitting error is denoted by ε_i . The hyper-parameter γ controls the trade-off between the smoothness of the function and the accuracy of the fitting. This optimization problem leads to a solution,

$$\hat{f}(x) = \sum_{i=1}^N \alpha_i K(x, x_i) + b \quad (3)$$

Where α_i are the coefficients and $K(x, x_i) = \varphi(x) \varphi(x_i)$ is the kernel. A common choice for the kernel is the Gaussian RBF,

$$K(x, x_i) = \exp\left(-\frac{\|x - x_i\|^2}{2\sigma^2}\right) \quad (4)$$

The main benefit of the LS-SVM technique is that it transforms the traditional quadratic problem to a simultaneous linear system problem, thus ensuring simplicity in computations, fast convergence and high precision.

III. Methodology

A. Bearing Data Collection

The bearing data used in the paper was obtained from the experiment generated by NSF I/UCR Center on Intelligent Maintenance Systems (<http://www.imscenter.net/>). The description of the data is as follow: Four bearings were installed on one shaft. The rotation speed was kept constantly at 2000 RPM. 6000lb radial load is placed onto the shaft and bearing by a spring mechanism. All bearings are forced lubricated. On each bearing two PCB 353B33 High Sensitivity Quartz ICP Accelerometer were installed for a total of 8 accelerometers (one vertical Y and one horizontal X on each). The signal was sampling using frequency of 20 kHz. The Figure 1 below shows the test rig and illustrates sensor placement.

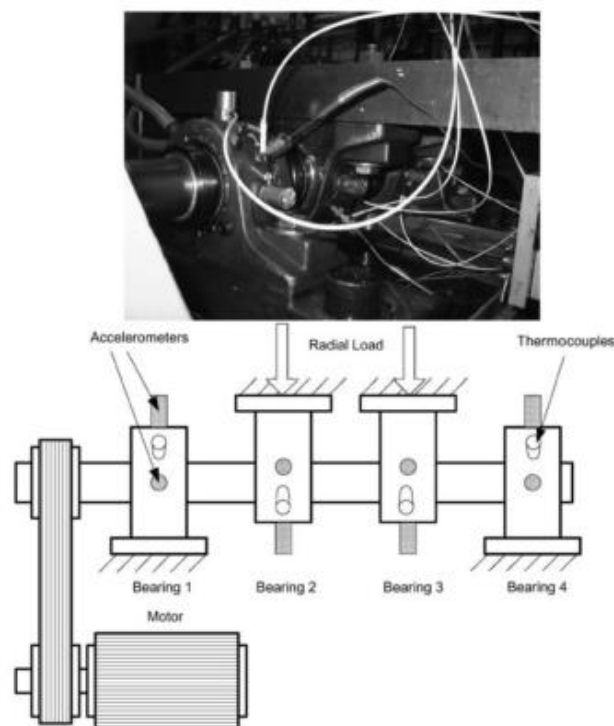


Figure 1. Bearing test rig and sensor placement illustration.

B. Feature Extraction and time Series Construction

Feature extraction to find sensitive feature to the bearing incipient fault is important. Refer to [6] and [23], two statistical features in the time domain used in this paper. They were extracted from the raw vibration signal obtained from run to failure experiment. These features are root mean square and kurtosis.

The rms and kurtosis were taken from successive vibration measurements. Total measurement amounted to 2156. Then, these features were constructed to form a bearing state time series. The function estimation was applied to these time series.

C. LS-SVM Training

The LS-SVM training process was done to get the model for function estimation. The hyperparameters λ and σ^2 would be obtained from this process. The optimization using simplex method with cost function of leaveoneout and kernel function of radial basis function (RBF)

D. Fuction Estimation of Bearing Degradation Trend

The bearing degradation trend was estimated using LS-SVM method and double exponential regression. These methods were applied on the time series of features that contain normal state and faulty condition of bearing.

E. Performance Evaluation

The estimation performance was evaluated using two parameter, i.e. : Mean Absolute Error (MAE), and Root Mean Square Error (RMSE). The MAE give the measure absolute deviation of estimated values from the measured data. It shows the magnitude of overall error occurred due to predicting. For a good estimation, the obtained MAE should be small as small as possible.

Meanwhile the RMSE measure the quare root deviation of the estimated values. The RMSE emphasizes the fact that the total estimation error is in fact affected by large individual error. This error gives an overall idea of the error ocured during estimation.

The MAE and RMSE are formulated as follows:

$$MAE = \frac{1}{n} \sum_{i=1}^n |y_i - \bar{y}_i| \quad (6)$$

$$RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^n [x(i) - \bar{x}(i)]^2} \quad (5)$$

Where y_i and x_i are the measured data, and \bar{y}_i and \bar{x}_i are the estimation.

IV. Result and Discussion

Usually the bearing life cycle will follow the normal condition and faulty condition. Before undergo faulty condition usually there is a transition from normal to faulty condition. The vibration signal acquired at those three conditions in the bearing run to failure testing are shown in the Figure 2 until Figure 4.

From those signals, it can be seen that there is change in the signal amplitudes, and finally the vibration amplitudes change drastically at the faulty condition.

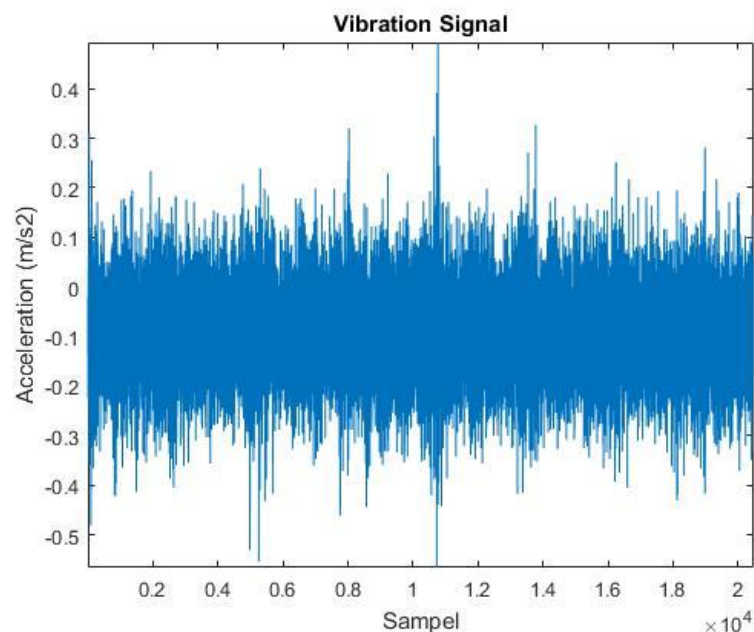


Figure 2. Bearing vibration signal at normal condition

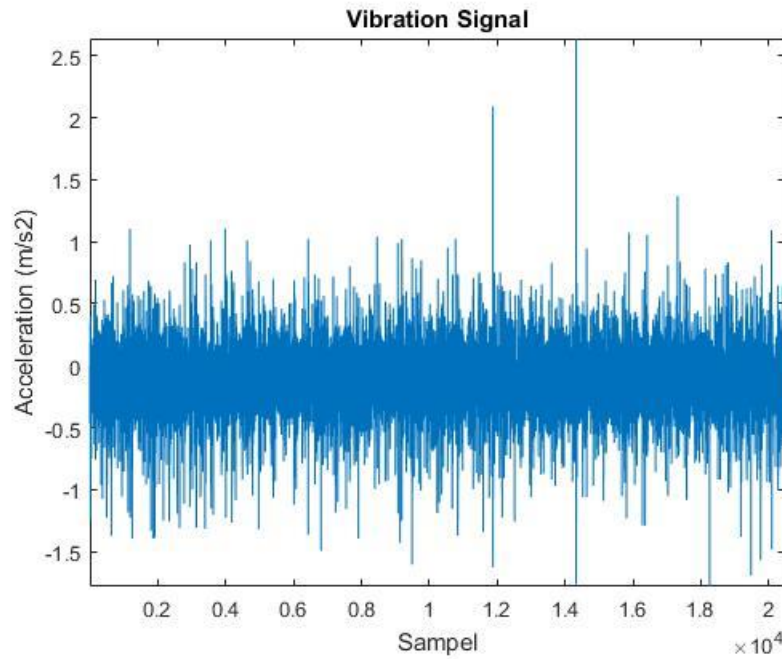


Figure 3. Bearing vibration signal at transition from normal to faulty condition

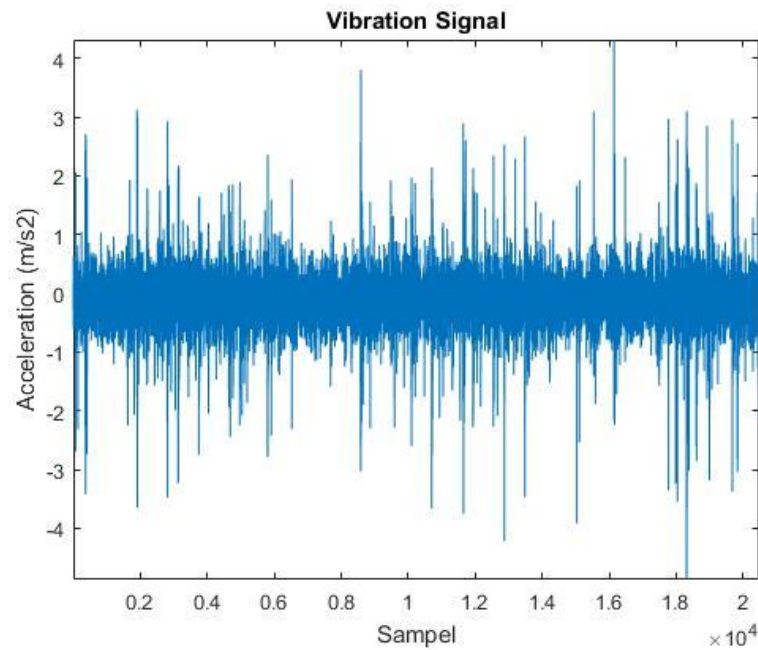


Figure 4. Bearing vibration signal at faulty condition.

To make observation of the change of bearing condition more clear, it is needed to construct a bearing degradation trend. So, it will need features extracted from bearing signal that can reflect the bearing condition. In this paper, two features are selected. They are rms and kurtosis feature. These features were extracted from series measurements of vibration signal from totally 2156 measurements. The results are shown in the Figure 5 and Figure 6.

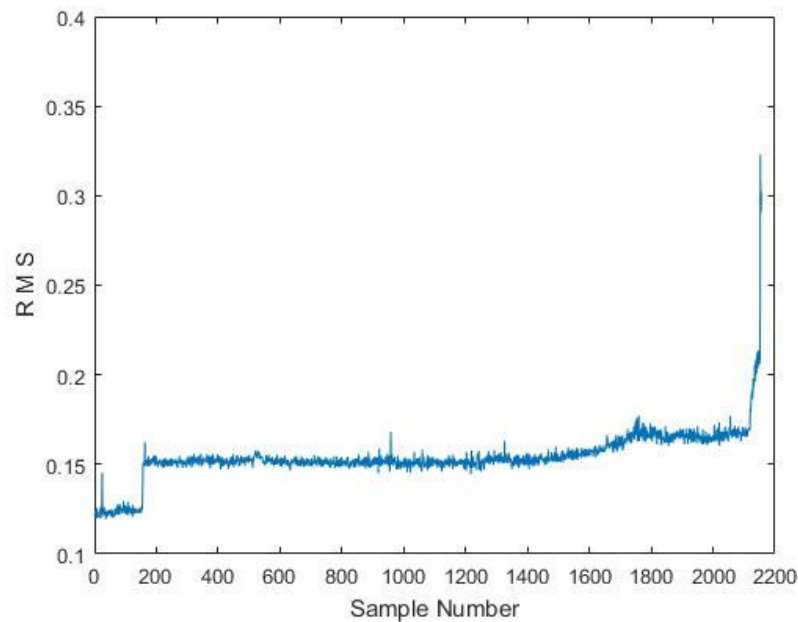


Figure 5. RMS feature

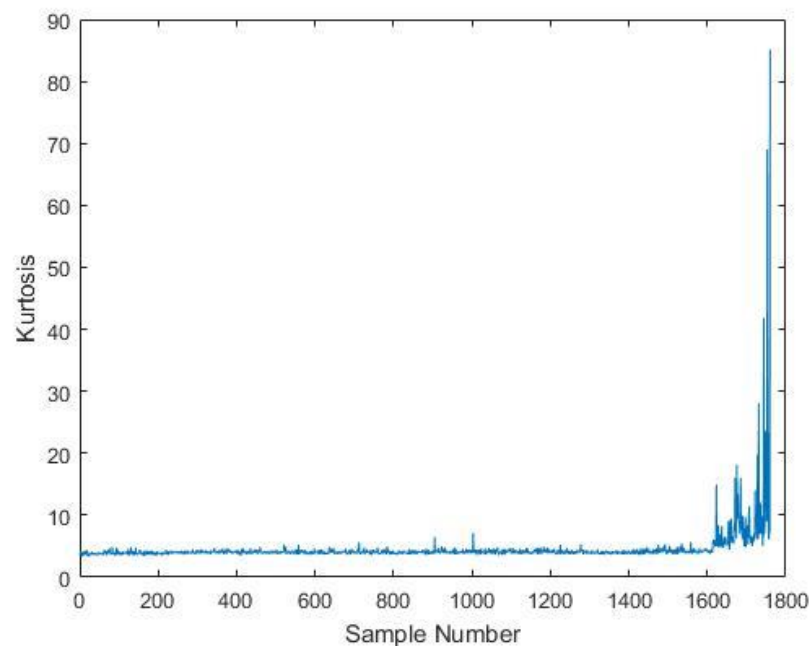


Figure 6. Kurtosis feature

Now, it can be seen clearly the degradation process of the bearing. If we adopt the failure threshold of bearing when the kurtosis value is 40 as mention in the reference [5], we can state that at the sample number 1 until 1600, the bearing was running normally, sample number 1601 until 1743 were the transition between normal to faulty condition, and then the bearing was fail at the sample number of 1744 when the kurtosis value exceed 40.

In the maintenance perspective, we have to avoid bearing catastrophic failure, because it will bring significant impact to the system. So, tracking the bearing condition should be done by generating an approximation function that can estimate the bearing degradation trend. For this purpose, the degradation data is taken 1000 series sample numbers from normal condition until the the bearing experince failure. So that the time series still represent normal,

transition, and faulty condition. Two methods applied in this function estimation. They are LS-SVM method and double exponential regression. The results are presented in the Fig 7 until Figure 10.

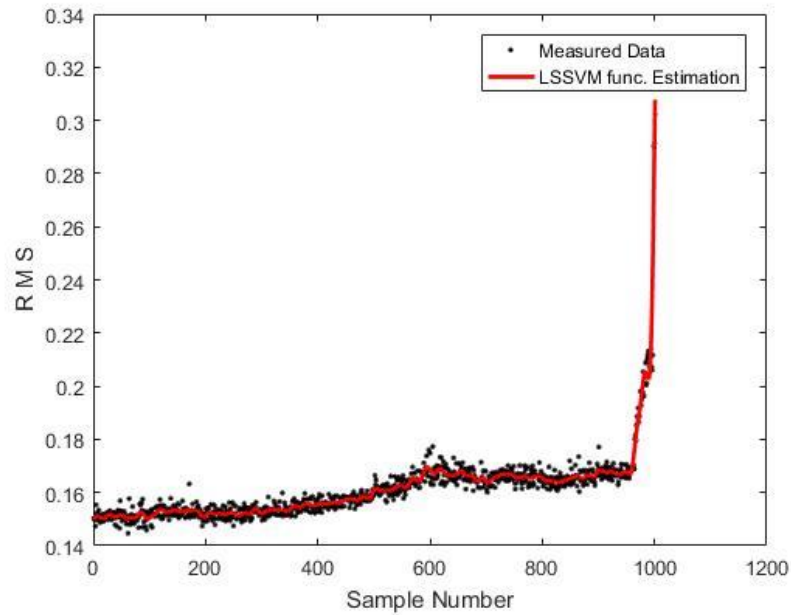


Figure 7. Bearing degradation trend estimation using LS-SVM for rms feature.

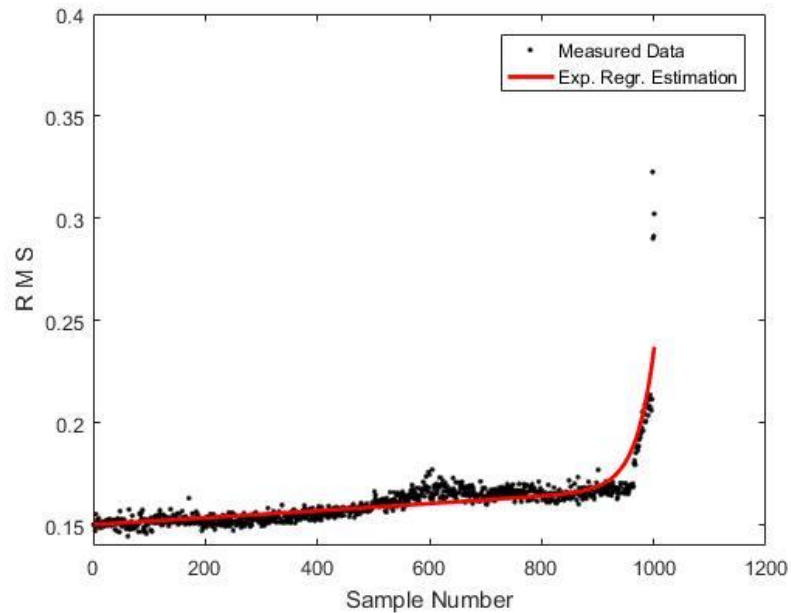


Figure 8. Bearing degradation trend estimation using double exponential regression for rms feature.

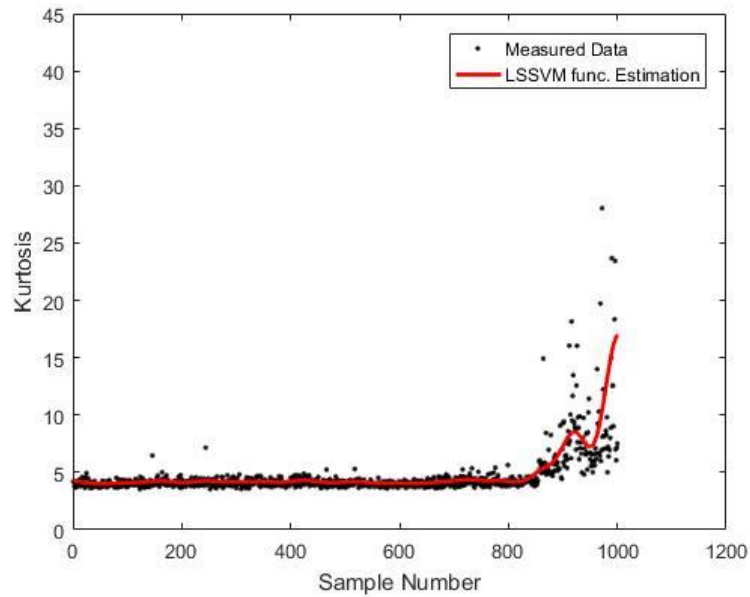


Figure 9. Bearing degradation trend estimation using LS-SVM for kurtosis feature.

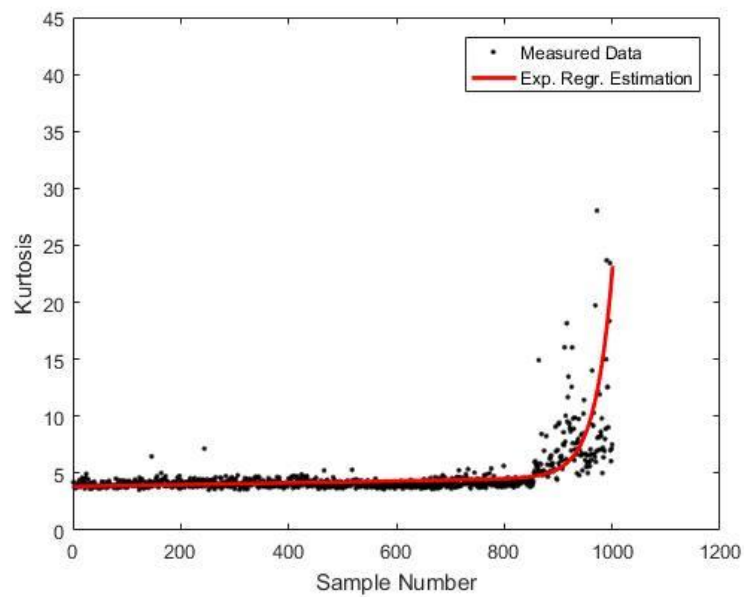


Figure 10. Bearing degradation trend estimation using double exponential regression for kurtosis feature.

The performance of those function estimation is summarized in the TABLE 1 below.

TABLE 1. Performance of function estimation.

Estimation Performance Criteria	Feature	LS-SVM	Double Exponential Regression
MAE	RMS	0.0018	0.0035
	Kurtosis	0.7254	0.8328
RSME	RMS	9.6500e-18	9.2253e-04
	Kurtosis	0.0425e-15	0,0561

The TABLE 1 shows that the overall performance the estimation are very good. All of the error are quite small. The LS-SVM method yield high accuracy in predicting the bearing degradation trend. It is outperform than double exponential regression method in all features for both MAE and RSME criteria. This make the LS-SVM method be a better candidate to be applied in remaining useful life prediction of bearing.

V. Conclusion

Bearing degradation trend estimation has been done in this paper using the LS-SVM method and Double Exponential Regression Function. The estimation was applied to the series of rms and kurtosis feature extracted from the bearing vibration signal.

The estimation performance of both methods are very good. However, the LS-SVM performance in estimation is much better than the exponential regression. This degradation trend estimation method can further be used for bearing future state prediction or RUL prediction that will be conducted in the future work.

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Study On The Influence of Jigging Operating Variables to Increase Monazite Concentration from Tin Ore Processing Plant (#736)

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Abstract. *In the process of tin mining, Cassiterite is the main mineral that has to be separated. Apart from cassiterite, there are some valuable minerals such as monazite which is a rare earth elements mineral that is wasted as tailings. The experiments conducted in this study aims to determine the effect of the variable length of the stroke, the speed of horizontal water flow and the type and size of ragging in the jigging process in order to obtain optimal results in increasing the percentage of monazite mineral fraction and reduce the losses that occur. Initial condition of the tin processing at KIP 11 dredge PT. Timah (Persero) Tbk, has not reached the company target due to the monazite mineral participated in the tailings. At the time of observation, the arrangement of the tool and the type of ragging that was used was not appropriate in capturing the monazite minerals so that it was disposed of as tailings. The study was conducted on 27 samples. Each sample represents a different set of variables to obtain optimal results for each variable. Variables that are done change is the length of stroke 5, 10, 20 mm. The speed of the horizontal water flow is 0,1; 0,2; 0,5 m/s. Ragging is transformed into Granite because it has a specific gravity between heavy and light minerals. Granite size is 1,5; 2,5; 3,5 inch. The percentage fraction of monazite and cassiterite minerals in each sample is equal to 15%. The optimal condition was obtained in capturing monazite minerals at 20 mm length, 0,2 m/s horizontal flow rate, and 2,5 cm granite ragging. The mineral fraction percentage of monazite and cassiterite at concentrate averaged > 35% with the highest percentage mineral weight fraction reaching > 55%. While the losses on the tailings were minimized with the percentage of monazite mineral fraction was only 0 - 0.17%. Newton's efficiency is 98. Experiments in this study succeeded in increasing the percentage of monazite fraction and reducing losses.*

Keywords: *Jigging, Monazite, Optimization*

I. Introduction

Tin ore processing conducted by PT. Tin (Persero) Tbk is now more concentrated on the grade and recovery of the major minerals contained in the tin ore is cassiterite (SnO_2), while the associated minerals such as monazite (Ce, La, Y, Th) PO_3 , as mineral carrier of the rare earth elements wasted in the process of processing that is at the concentration stage. The process of concentration on KIP 11 dredge starts with the sludge (slurry) which is inhaled and then supplied to the rotary filter (Trommel Screen). Undersize rotary filter will be channeled towards the jig to obtain a concentrate grade of 30-40% Sn, while Oversize will be thrown into the tailings. However oversized still contained impurity minerals among them monazite that go wasted because of less optimal performance of jigs so that the necessary

studies and efforts to optimize the performance of Jig that monazite discharged into the tailings can be minimized and recovery monazite in the processing of tin in the KIP 11 dredge increased.

Regional Geology

Bangka Island is the largest island in the Sunda-Sunda Shelf, and is a Sunda Peneplain, has a 692 m high mountain (Mount Maras) north of Bangka and Padang Mountain 654 m south (Bemmelem, 1949). "The Indonesian Tin Island" (The Indonesian Tin Island), as people call the tin-producing islands of Indonesia, is the southernmost tip of "The Southeast Asia Tin Belt" (Southeast Asia tin line or Southeast Asian tin belt). This tin belt stretches from Central Burma (southern Shan state) to Tenneserim and continues south including West Thailand, Southern Thailand, Western Malaya Peninsula, to Karimun Kundur, Singkep, Bangka, Belitung, Karimata islands and ends at West Kalimantan (Sujitno, 2007).

In Geological Map of North Bangka Sheet scale 1: 250.000, Mangga and Djamal (1994) published by Geological Development Research Center, stratigraphy of North Bangka region from old to young as follows: Pemali (CPp), Diabas Penyabung (PTd), Granit Kelabat (TJkg), Tanjunggenting Formation (Tt), Ranggam Formation (TQr) and Aluvium (QA). Strong and broken structures have many orientations. The general direction is north-south, northeast-southwest, and southeast-northwest. Fractures and stocks are closely related to folding (Katili, 1967). The fault is a fracture up, shear, and a normal fracture. The north-south trending fault pattern is the youngest fracture phase (Mangga and Djamal, 1994). The rising and normal fault has a relatively northwest-southeast direction, as well as a horizontal fault with a relatively north-south direction cuts a relatively older fault (Crow, 2005).

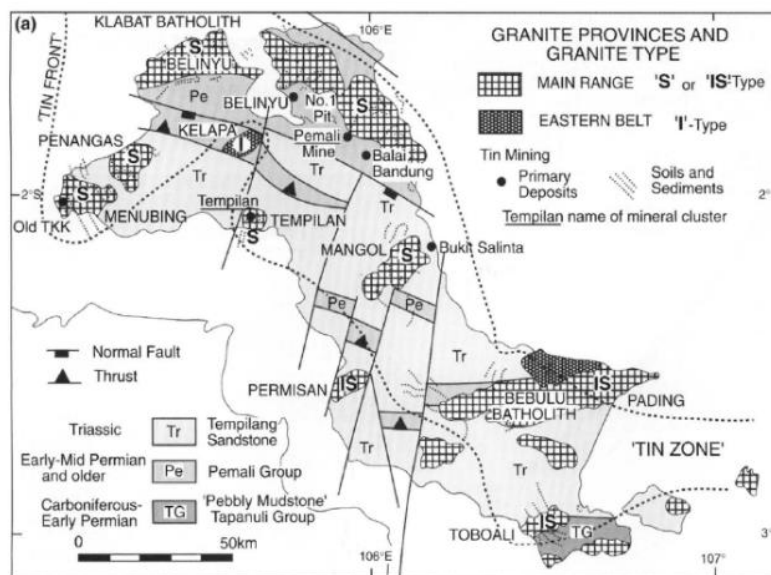


Figure 1. Primary Tin and Placer Location Map in Bangka (Crow and Van Leeuwen, 2005)

Material And Method

This experiment used a material of 27 (twenty seven) samples as a feed where each sample had the same percentage of composition that is 2000 gr of tailing of tin mining (quartz and mineral minerals), 100 gr monazite, and 200 gr of cassiterite. In addition to these samples, samples from KIP 11 suction boats were also taken for trial.



Figure 2. Mixing quartz, monazite and cassiterite samples as feeds

Experiments using Jig are done so that the separation of monazite minerals can be done optimally by changing the variable length of the stroke, horizontal water flow and the type of ragging and its size. While the other variables are fixed variables. Ragging used in this study using granite because granite has a specific gravity between monazite minerals with quartz hence more feasible when compared to ragging that has been used that is hematite. Granite stone to be used as ragging consists of 3 (three) sizes that is 1 "-2"; 2 "-3"; And 3 "-4".

The results of 60 (sixty) sample samples consisted of 27 (twenty seven) concentrate samples and 27 (twenty seven) sampling contents, and 3 (three) samples of concentrate samples and 3 (three) tailings samples which were samples of vessel KIP 11. Then the samples are delivered to the laboratory of PT. Tin (Persero) Tbk to be analyzed using GCA (grand counting analysis) method to know how much monazite and cassiterite content in the sample.

II. Result and Discussion

Design Laboratory Scale Jig

In this study, the study was conducted using a jig instrument with a smaller scale, which aims to optimize the course of research implementation. When the experiment was conducted using a Jig with a smaller scale, the jig was made to represent the jig used by the KIP 11 vessel either rheology or variation from intrinsic system conditions but with smaller scale or size.



Figure 3. JIG Apparatus

Variable Justification in Jig

In this research, this experiment is done by changing some variables on jig that is stroke length, horizontal water flow rate, and type and size of bed. These variables are chosen because the variables are significant in the jiggling process and it is quite easy to make changes or changes compared to other variables because it is arranged in such a way as the standard jig and if you want to change the variables need to dismantle the jig and require sufficient cost high.

Particle Model

The material used in the research of each sample has the same weight that is 2000 gr of quartz sand, 100 gr monazite, and 200 gr cassiterite This composition is chosen to facilitate the analysis side to be easily detected whether the monazite mineral losses still occur or not. In addition, if we use a sample with a limited weight and have little concentration concentrates it will be difficult to analyze the sample statistically. These materials are materials that are concentrated from the natural conditions, so that from the size and shape of the particles, these materials present the actual particle conditions.

Laboratory Test Results and Heavy Mineral Fraction Percentage

Through the results of laboratory analysis, we can determine which samples give the best results in our experiments. The best result parameters are the absence of the monazite minerals that are wasted on the tailings or the absence of monazite mineral losses in the tailings.

Table 3. Results of sampling experiment after variable change

No.	Weight of feed (gram) (F)	Percentage (%) of Monasit Fraction in Feed (fM)	Percentage (%) of Sn Fraction in Feed (fK)	Weight of Concentrate (%)		Weight of Tailing (%)		Total Percentage (%) of Heavy Mineral Fraction (Cassiterite + Monazite) In Concentrate	Total Percentage (%) of Heavy Mineral Fraction (Cassiterite + Monazite) In Tailing
				Cassiterite (cK)	Monazite (cM)	Cassiterite	Monazite		
1	2000	5	10	17,0	9,8			29,4	0
2	2000	5	10	9,2	18,5	0,43		55,4	0,029
3	2000	5	10	7,0	17,3	0,13	1,41	52,8	0,107
4	2000	5	10	9,8	6,9			20,7	0
5	2000	5	10	4,6	6,9			20,7	0
6	2000	5	10	11,7	11,3			33,7	0
7	2000	5	10	9,1	18,5			55,6	0
8	2000	5	10	13,7	11,5	0,04	0,24	34,6	0,025
9	2000	5	10	15,7	18,1			54,1	0
10	2000	5	10	13,9	7,3			21,7	0
11	2000	5	10	6,0	7,5			22,3	0
12	2000	5	10	13,2	11,9	0,01		35,7	0,001
13	2000	5	10	8,5	6,7	0,07		20,1	0,014
14	2000	5	10	6,0	6,6			19,9	0
15	2000	5	10	7,8	8,8			26,3	0
16	2000	5	10	11,8	11,6	0,08		34,9	0,007
17	2000	5	10	14,3	9,0	0,24		26,7	0,027
18	2000	5	10	11,4	7,8	0,5		23,2	0,070
19	2000	5	10	17,0	11,8	0,05		35,3	0,004
20	2000	5	10	15,3	6,1	0,15		18,4	0,041
21	2000	5	10	11,3	8,3	0,14		24,9	0,018
22	2000	5	10	8,4	7,7	0,79	0,43	22,9	0,174
23	2000	5	10	9,6	5,6	0,02	0,01	16,7	0,015
24	2000	5	10	12,3	10,6			31,6	0
25	2000	5	10	10,8	11,1	0,05		33,3	0,005
26	2000	5	10	12,3	10,6	0,06		31,6	0,006
27	2000	5	10	11,8	7,0			20,8	0

Table 3 is the result of laboratory test of PT. Tin (Persero) Tbk uses GCA method on 54 (fifty four) samples tested. The experimental results by changing the stroke length variable, the horizontal water flow rate, and the size and type of ragging show an increase in the % mineral fraction > 15% and the losses contained in the tailings are so small that the desired target of the experiment is achieved. From these data, the graph obtained as shown in Figure 4 shows that before the experiment, the monazite and cassiterite minerals fraction is equal to 15%. After an experiment on 27 samples, the monazite and cassiterite fractions at concentrates increased significantly, and the % monazite and cassiterite fractions in the tailings were close to 0%.

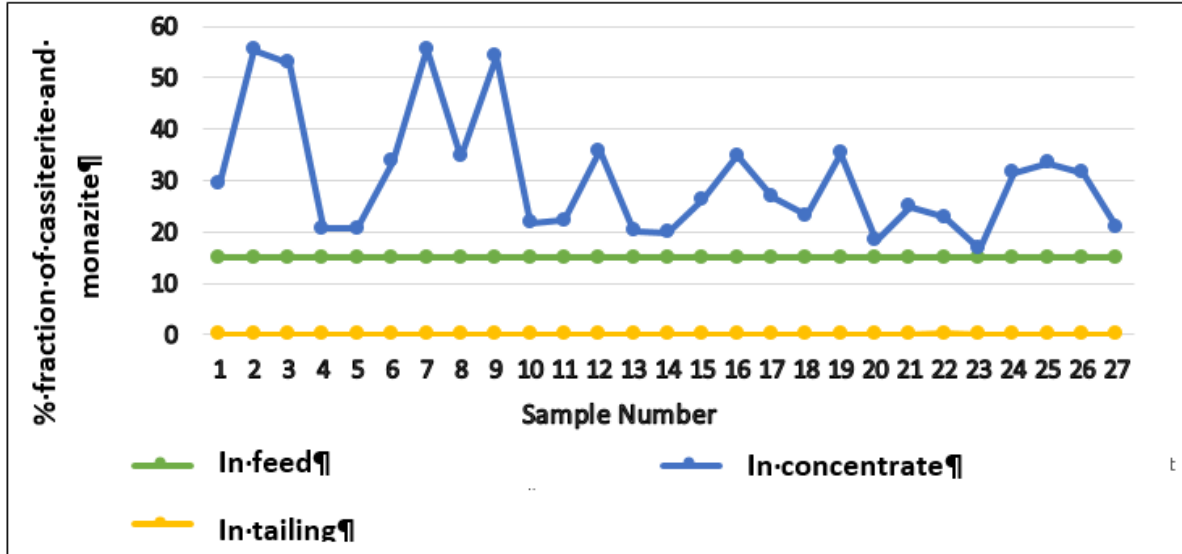


Figure 4. Percentage of monazite and cassiterite mineral fractions in bait, concentrate, and tailings

Newton's Efficiency

Newton's efficiency is a parameter that identifies the effectiveness of a separation process. Newton's efficiency formula is as follows:

$$\eta_N = R_c - (1 - R_{fa})$$

Where :

- η_N : Newton's efficiency;
- R_c : Recovery Monazite and Cassiterite (%);
- R_{fa} : Quartz Recovery (%).

Recovery of monazite, cassiterite, and quartz minerals is further formulated in material balance, based on monazite and cassiterite minerals in predicted feeding, concentrates and tailings, respectively as in the following equation:

$$R_c = \frac{C_c W_c}{C_f W_f} = \frac{(C_f - C_{fa}) C_c}{(C_c - C_{fa}) C_f} \times 100\%$$

$$R_{fa} = \frac{W_{fa} (1 - C_{fa})}{W_f (1 - C_f)} \frac{(C_f - C_c) (1 - C_{fa})}{(C_{fa} - C_c) (1 - C_f)} \times 100\%$$

Where :

- W_f = Weight of feed (kg);
- W_c = Monazite and Cassiterite Weights at Concentrate (kg);
- W_{fa} = Quartz Weight at Concentrate (kg);
- C_f = Monazite and Cassiterite Concentrations on Feed (%);
- C_c = Concentration of Monazite and Cassiterite at Concentrate (%);
- C_{fa} = Monazite Concentration on Tailings (%).

Table 4. Newton Efficiency calculation results

Number of Sample	Weight of Feed (gram)(F)	Weight of Monazite + Cassiterite in Concentrate	Weight of Quartz in Concentrate	Concentration of Monazite and Cassiterite in Feed	Concentration of Monazite and Cassiterite in Concentrate	Monazite Concentration in Tailing	Recovery of Monazite and Cassiterite	Recovery of Quartz	Newton's Efficiency
	Wf (gr)	Wc (gr)	Wfa (gr)	Cf (%)	Cc (%)	Cfa (%)	Rc (%)	Rfa (%)	η_N
1	2000	300	720	15	29,4	0,000	100,00	-3,50	95,50
2	2000	299,14	240,86	15	55,4	0,029	99,86	-5,06	93,80
3	2000	298,33	266,67	15	52,8	0,107	99,49	-4,57	93,91
4	2000	300	1150	15	20,7	0,000	100,00	-1,96	97,04
5	2000	300	1150	15	20,7	0,000	100,00	-1,96	97,04
6	2000	300	590	15	33,7	0,000	100,00	-3,96	95,04
7	2000	300	240	15	55,6	0,000	100,00	-5,21	93,79
8	2000	299,68	565,32	15	34,6	0,025	99,91	-3,95	94,95
9	2000	300	255	15	54,1	0,000	100,00	-5,16	93,84
10	2000	300	1080	15	21,7	0,000	100,00	-2,21	96,79
11	2000	300	1045	15	22,3	0,000	100,00	-2,34	96,66
12	2000	299,98	540,02	15	35,7	0,001	100,00	-4,14	94,86
13	2000	299,86	1190,14	15	20,1	0,014	99,98	-1,80	97,18
14	2000	300	1210	15	19,9	0,000	100,00	-1,75	97,25
15	2000	300	840	15	26,3	0,000	100,00	-3,07	95,93
16	2000	299,84	560,16	15	34,9	0,007	99,97	-4,04	94,93
17	2000	299,52	820,48	15	26,7	0,027	99,92	-3,05	95,87
18	2000	299	991	15	23,2	0,070	99,83	-2,35	96,48
19	2000	299,9	550,1	15	35,3	0,004	99,98	-4,09	94,89
20	2000	299,7	1330,3	15	18,4	0,041	99,95	-1,27	97,69
21	2000	299,72	905,28	15	24,9	0,018	99,95	-2,79	96,17
22	2000	297,99	1002,01	15	22,9	0,174	99,60	-2,05	96,54
23	2000	299,95	1500,05	15	16,7	0,015	99,99	-0,70	98,29
24	2000	300	650	15	31,6	0,000	100,00	-3,75	95,25
25	2000	299,9	600,1	15	33,3	0,005	99,98	-3,91	95,07
26	2000	299,88	650,12	15	31,6	0,006	99,98	-3,73	95,25
27	2000	300	1140	15	20,8	0,000	100,00	-2,00	97,00

Table results of newton efficiency calculations can be seen in Table 4. It can be seen that sample 23 has the highest efficiency newton value of 98,28. And sample 7 has the lowest efficiency newton value of 93,78.

Data Verification Using Samples Obtained From KIP Dredge 11

Research using experiments using the particle method with this smaller tool gives a positive result. To verify, an experiment was conducted using samples taken from a KIP 11 vessel. The consideration of the selection of the vessel location as it appears in the previous chapter of the Belo Sea, Muntok is a rich area of lead minerals and the KIP 11 vessel is a vessel that contributes to the monazite as concentrate on the tin processing.

Table 5 : Result of the KIP 11 dredge sampling, Belo Sea, Muntok

Sample Name	Weight Of Sample (gr)	Sn Content (%)	gr Sn /Hours	% Monazite	gr Monazite /hours
Tailing 1 KIP	10.46	-	-	-	-
Tailing 2 KIP	9.94	0.01	0,00099	-	-
Tailing 3 KIP	8.5	0.04	0,0034	-	-

Table 6 : Result of the experiment with changing some variables

Samples Name	Weight of Sample (kg)	% Sn	Kg Sn /Hours	% Monazite	Kg Monazite /Hours
Primary Tailing 1. Right	0,298	0,0038	0,204	0,01695	0,908
Primary Tailing 2. Right	0,204	0,00545	0,2	0,01781	0,654
Primary Tailing 1. Left	0,247	0,00273	0,121	0,01218	0,54
Primary Tailing 2. Left	0,204	0,00141	0,052	0,00753	0,276
Total of Primary Tailing Right and Left (A)			0,576		2,379
Tailing of Right Clean Up	0,119	0,00602	0,077	0,01879	0,241
Tailing of Left Clean Up	0,162	0,00189	0,033	0,00675	0,118
Total of Clean Up Tailing Right and left (B)			0,11		0,359
Total of Tailing (A+B)			0,687		2,738

With a fixed particle model, the particle size distribution and density of each mineral have not changed and it becomes an important parameter in determining the separation. Preliminary data in KIP 11 as shown in Table 5 shows that the monazite loss is about 2.7 kg / hr. The condition of mineral tin separation process followed by jigging process in KIP 11 dredge is still using bed hematite as one medium heavy mineral separator with light. It is known that the hematite density ranges from 4.9 to 5.3 whereas the lead minerals are monazite which will be concentrated as concentrate having a specific gravity ranging from 4.6 to 5.7. After the change, the original bed hematite converted into granite with specific gravity between 2.6-2.7 successfully separated the monazite as a concentrate and reduced the wasted monazite in the tailings band. The difference between before and after the experiment can be seen in Table 5 and Table 6 above.

Operational Visibility

When the monazite mineral succeeds in entering the concentrate, then the cassiterite which has a higher specific gravity than the monazite also concentrated into the concentrate so that the recovery will be high but the cassiterite level will decrease. Although the cassiterite level decreases, the quantity and quantity of cassiterite itself is not reduced. There is no significant effect on the concentration of the cassiterite minerals themselves if the monazite minerals are also concentrated as concentrates on the processing of the sand.

With the inclusion of monazite minerals and other minerals that have the same or higher concentrations into the concentrate, the amount of minerals entering the concentrate will be more than before. With the increase in the quantity of concentrate it is possible that the cost of transporting the concentrate to the next processing unit will be slightly higher than before. However, the advantages of tin follow-up minerals taken as concentrates are much higher than the cost of transporting concentrate from the concentration process on board to the next processing unit.

III. Conclusions

Based on the results of the discussion, can be drawn some conclusions is the changing the raggging of hematite into granite is considered successful in capturing the optimal monazite minerals. Setting the jig variable in tin concentration process succeeds in raising the% of monazite and cassiterite fractions on the concentrate and decreasing the amount of monazite and cassiterite mineral losses on the tailings. Using surface response method can be seen that the optimum value of the experiment is at the time of variable length stroke 20 mm, 0.2 m / s horizontal flow rate, granite raggging with 2.5 inch size can reduce the losses of monazite minerals with Newton Efficiency value 97. Using a 15 mm variable stroke, a horizontal water flow rate of 0.3 m / s, and a 2.5-inch raggging size, the Newton Efficiency we get can be > 98.

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Simulation Multilevel Inverter Single Phase Type H-Bridge With Resistive-Inductive Load (RL) (#767)

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Abstract - Inverter is an electronic circuit that serves to convert electric power Direct Current (DC) into the form of electric power Alternating Current (AC). Inverter basically produces harmonic distortion is large enough. Multilevel inverter reduces harmonic distortion inverter to increase the number of inverter level. The method in this study using multilevel inverter single phase with 3 stage, stage 5, and 7 stage H-bridge type. The output voltage of the multilevel inverter is the resultant V_{out} of each constituent level inverter. Extra levels of a multilevel inverter can reduce the Total Harmonic Distortion (THD) with the value of the RL load. THD_v value generated by above 47% and THD_i generated over 19%.

Keywords : FFT, H-Bridge, Harmonic, Inverter, Multilevel inverter, Total Harmonic Distortion (THD).

I. Introduction

Energy conversion technology is now growing with power electronics technology. One rapidly growing technology is an inverter that serves as a converter for converting electric power Direct Current (DC) in the form of electric power Alternating Current (AC). Inverters are used in renewable energy sources such as solar cell to convert DC into AC power that can be used in everyday life.

The working principle of the inverter uses electronic switching to generate the output waveform in the form of a sinusoidal wave. As a result of switching on the inverter electronics has resulted in a sinusoidal output waveform distortion harmonics. Harmonics that arise will result in inverter output power suffered losses and also can result in damage to the equipment.

Harmonics generated by the inverter can be reduced by using multilevel inverter type H-bridge. Multilevel inverters generate waveforms in the form of wave ladder or staircase. With each level of multilevel inverter voltage generated will produce output waveform is getting better too. In the multilevel inverter is not required high switching frequency to produce a sinusoidal waveform.

II. Research Methods

In this study, using the method Multilevel Inverter single phase H-bridge type. Large output voltage in the multilevel inverter is the sum of the output voltage of the inverter each level.

$$V_{out} = \sum_{i=1}^P V_{aci} \quad (2.1)$$

multilevel inverter H-bridge type having the simplest construction and arrangement is simple too. But pick a good wave output with the level of a high level. In multilevel inverter is

not required high switching frequency to produce a sinusoidal waveform. In multilevel inverter with separate DC source itself or will produce output voltage corresponding to the level of the inverter stage. Where to an inverter with two DC sources, the output voltage (V_o) will have five levels, namely $+2V_{dc}$ voltage, V_{dc} , 0 , $-V_{dc}$, and $-2V_{dc}$. [3]

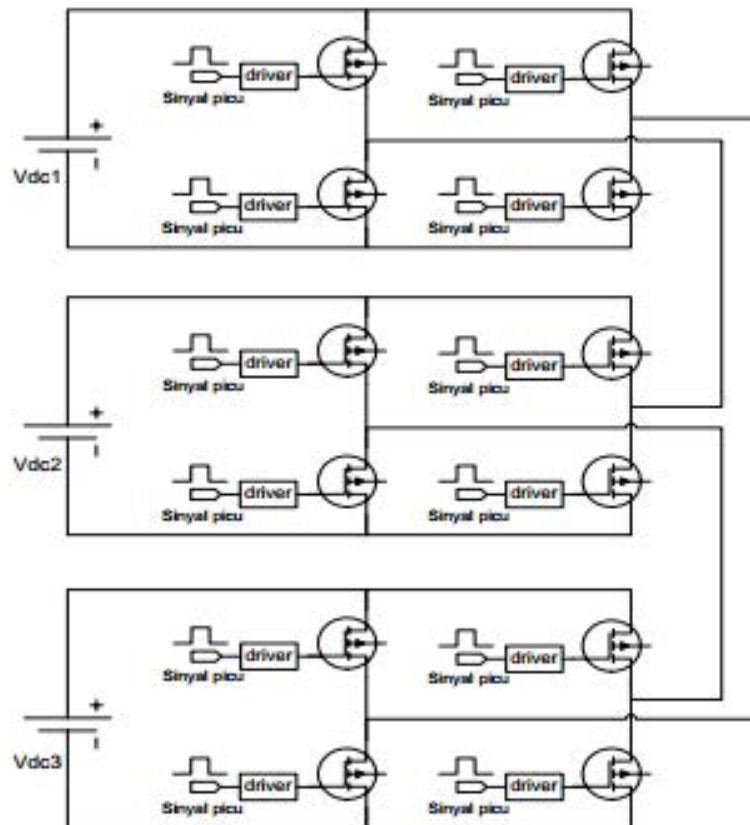


Figure1. Multilevel inverter type H-bridge

From the results of the series will be the effect of load R_L to the output waveform and harmonic waves and THDv and THDi the huge market for simulation results. In addition to the loading effect, will also show the effect of adding to the level of the multilevel inverter 3 stage, stage 5, and 7 stage against THD is generated. Software used in this study is the MATLAB Simulink R2014a. To view the results THDv and THDi generated in simulation using MATLAB FFT Analysis in software.

III. Circuit Simulation Research

The circuit used in this study is a multilevel inverter 3 stage, stage 5, and 7 stage. Switching components used are mosfet. In the third stage multilevel inverter using mosfet 12, using 20 mosfet stage 5 and 7 stage uses 28 mosfet. With an output voltage generated is approximately 220V. Where each inverter is given two Pulse Generator as input waveform for mosfet gate to generate a signal.

Variations load used with a value of $R = 50\text{ohm}$, 100ohm and 150ohm , while the load $L = 100\text{mH}$ and 147mH . An inverter circuit made in the form subsystem to simplify a string that is used in this study. The circuit is used as shown below:

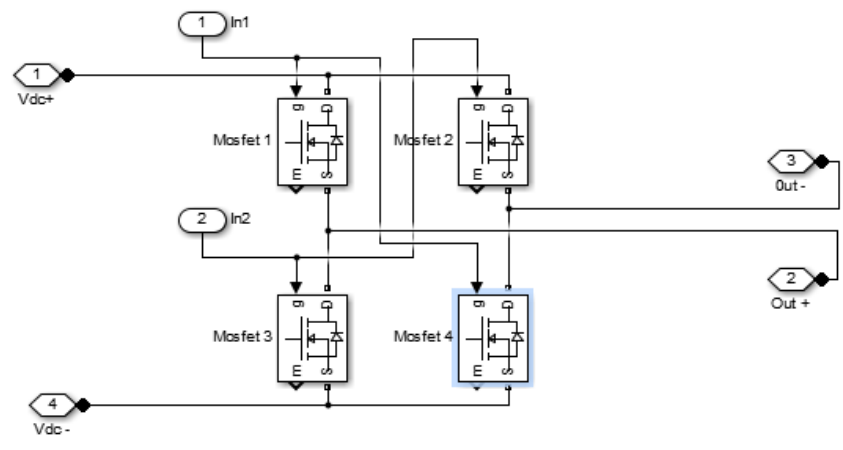


Figure 2 In the inverter circuit Subsystem

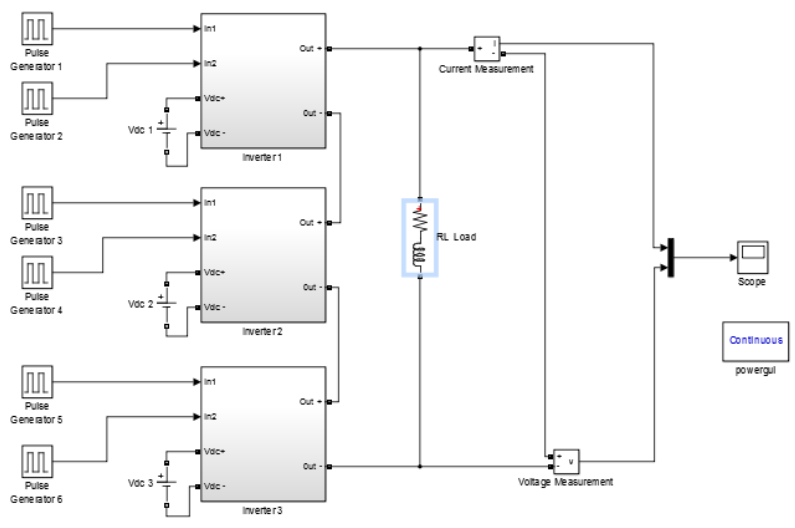


Figure 3. Multilevel Inverter 3 Stage with Load RL

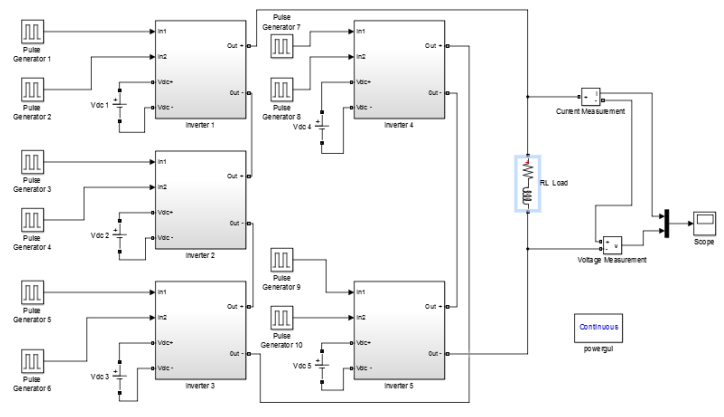


Figure 4 Multilevel Inverter 5 Stage with Load RL

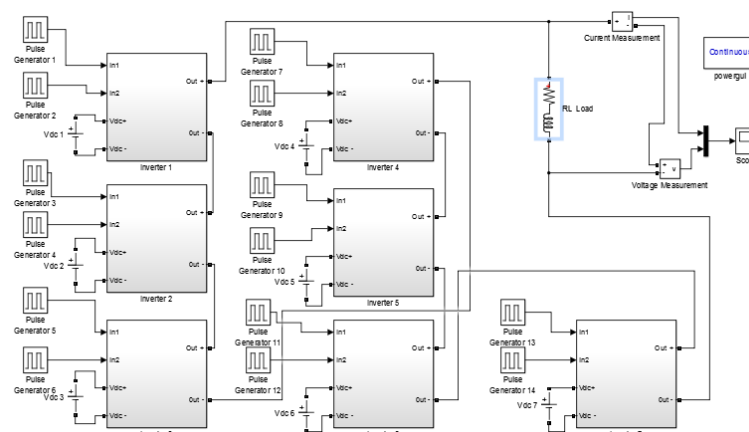


Figure 5 Multilevel Inverter 7 Stage with Load RL

IV. Research Result

Simulations in this study resulted in multilevel inverter voltage at the output of 225V. The following table test results with the resulting waveform:

Table 4.1 Results Data Load Voltage and Current in RL

LOAD		VOLTAGE (V)			FLOW (A)		
L (MH)	R (Ohm)	3 stage	5 stage	7 stage	3 stage	5 stage	7 stage
100	50	225	225	224	3.93	3.94	3.95
	100	225	225	224	2.2	2.2	2.2
	150	225	225	224	1:49	1:49	1.5
147	50	225	225	224	3:43	3:47	3:48
	100	225	225	224	2:12	2:12	2:12
	150	225	225	224	1:47	1:47	1:47

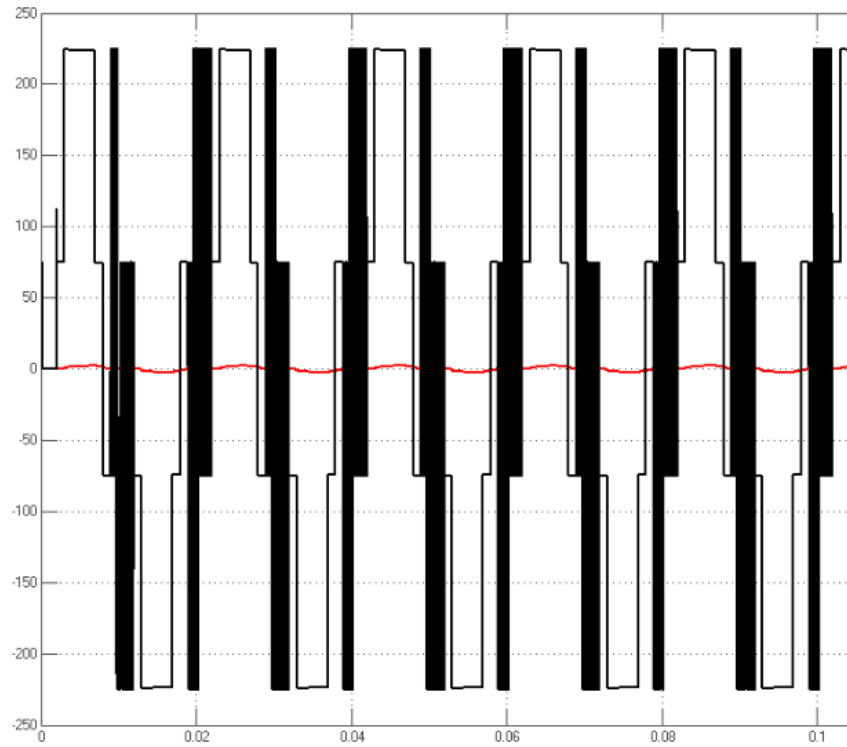


Figure 6 Multilevel wave Inverter 3 Stage Expenses R 100 Ohm and L 100mH

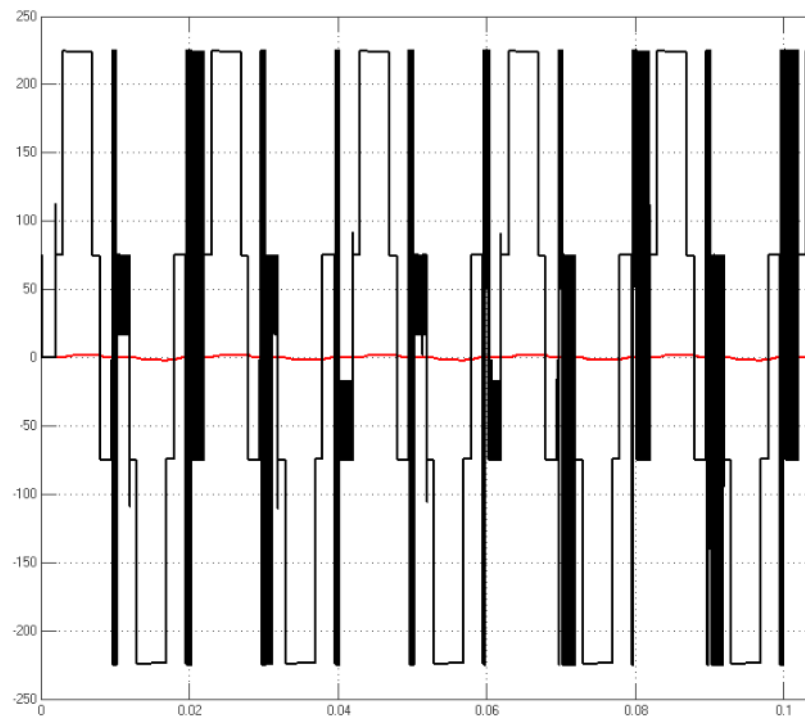


Figure 7 Multilevel wave Inverter 3 Stage Expenses R 100 Ohm and L 147mH

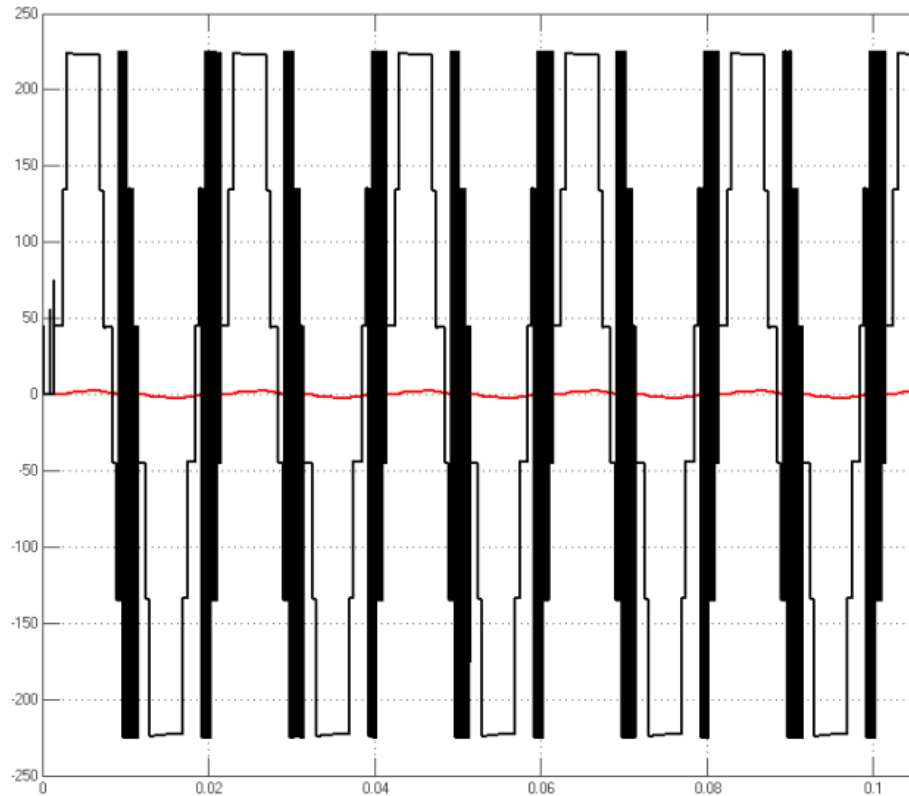


Figure 7 Multilevel wave Inverter 5 Stage R 100 Ohm Load and L 100mH

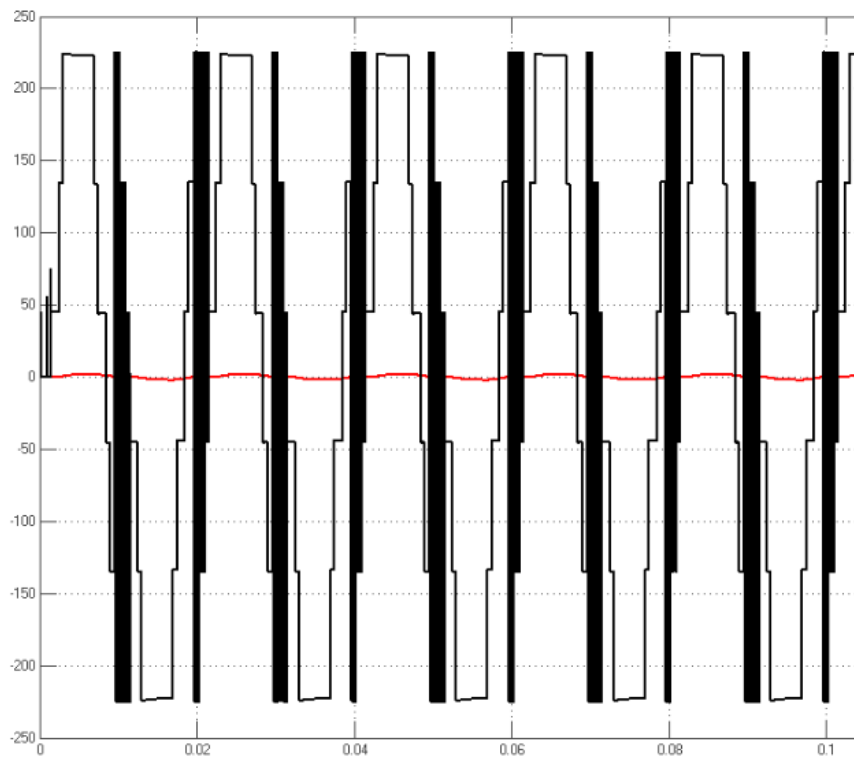


Figure 8 Multilevel wave Inverter 5 Stage R 100 Ohm Load and L 147mH

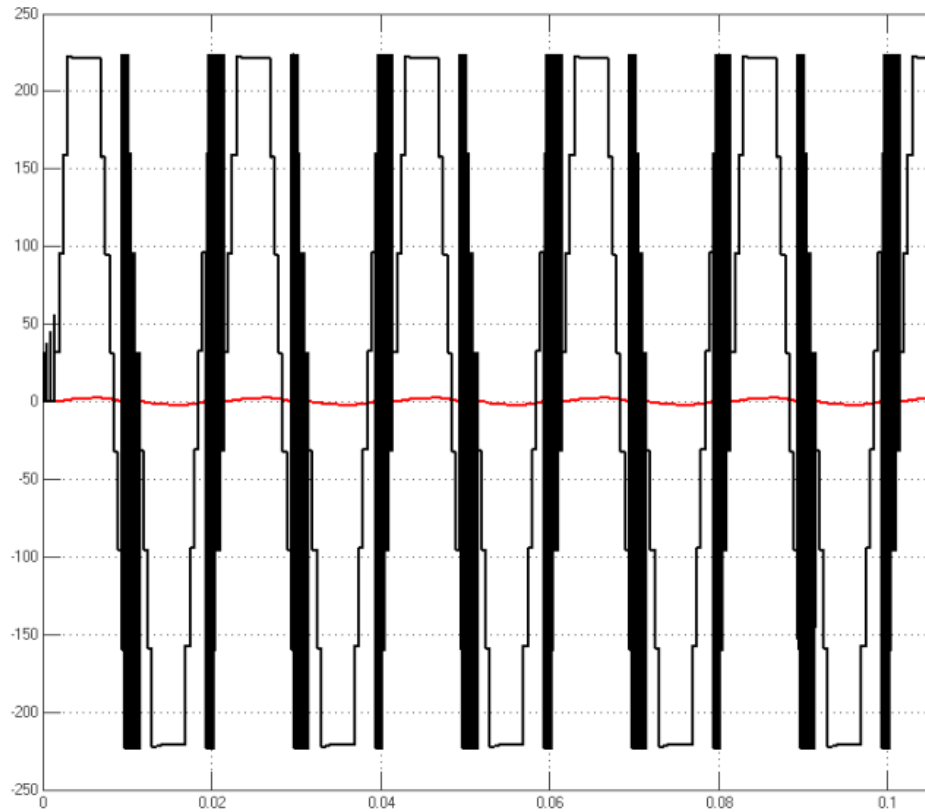


Figure 9 Multilevel wave Inverter 7 Stage Expenses R 100 Ohm and L 100mH

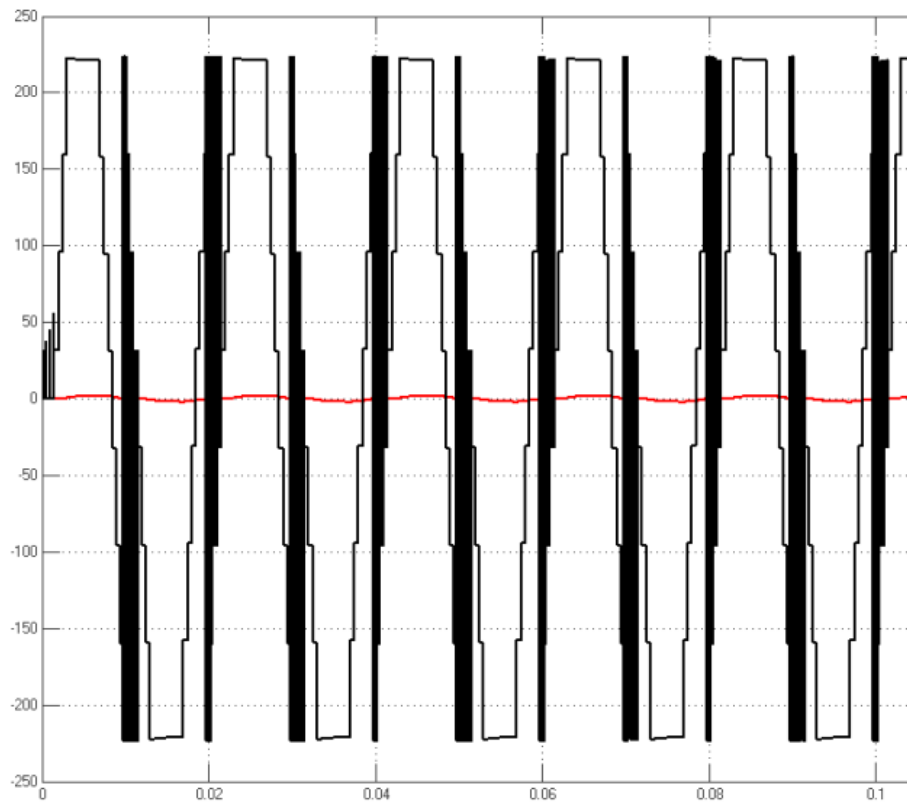


Figure 10 Multilevel wave Inverter 7 Stage Expenses R 100 Ohm and L 147mH

From Table 1 shows the test data voltage and current to the load R_L in multilevel inverter circuit. On the addition of inductive load on the string makes the magnitude of the resulting current is more stable on each additional level of the multilevel inverter. This occurs

because the current value proportional to the voltage value but is inversely proportional to the value of the load used (Ohm's law). Voltage waveform generated in the load testing is experiencing a lot of disruption resulting from the effects of adding inductive load. But the current wave produced better and closer to sinusoidal.

This is because the inductive load will save the electric current flowing in the load in the form of a magnetic field, and then returned to the load inducted mounted on a circuit. When the multilevel inverter switching circuit on condition on, then current will flow to the load and inductive load will keep the current flowing into the magnetic field. When conditions multilevel inverter switching circuit pad off condition, then the magnetic field stored in the inductive load will be the source to the circuit to induce a magnetic field that has been stored. Then, when the switching circuit upon the condition on, then re-storing inductive load electric current flowing to the load into a magnetic field to be induced back.

Having obtained the data from the voltage and current waveform, further testing is done to see the effect of inductive load on THDv and THDi in a multilevel inverter circuit. Here are results of test data load RL on multilevel inverter circuit:

Table 2Data Results THDv and THDi on Load RL

LOAD		THDv (%)			THDi (%)		
L (MH)	R (Ohm)	3 stage	5 stage	7 stage	3 stage	5 stage	7 stage
100	50	60.1	56.32	50.41	29.72	24.9	21.66
	100	67.09	54.9	45.65	37.47	29.58	25.86
	150	55.42	54.04	46.41	39.57	31.5	27.71
147	50	66.12	58.69	52.45	25.22	21.94	19:23
	100	69.41	57.12	47.74	33.65	27.28	23:54
	150	60.50	56.06	47.38	37.5	29.71	25.94

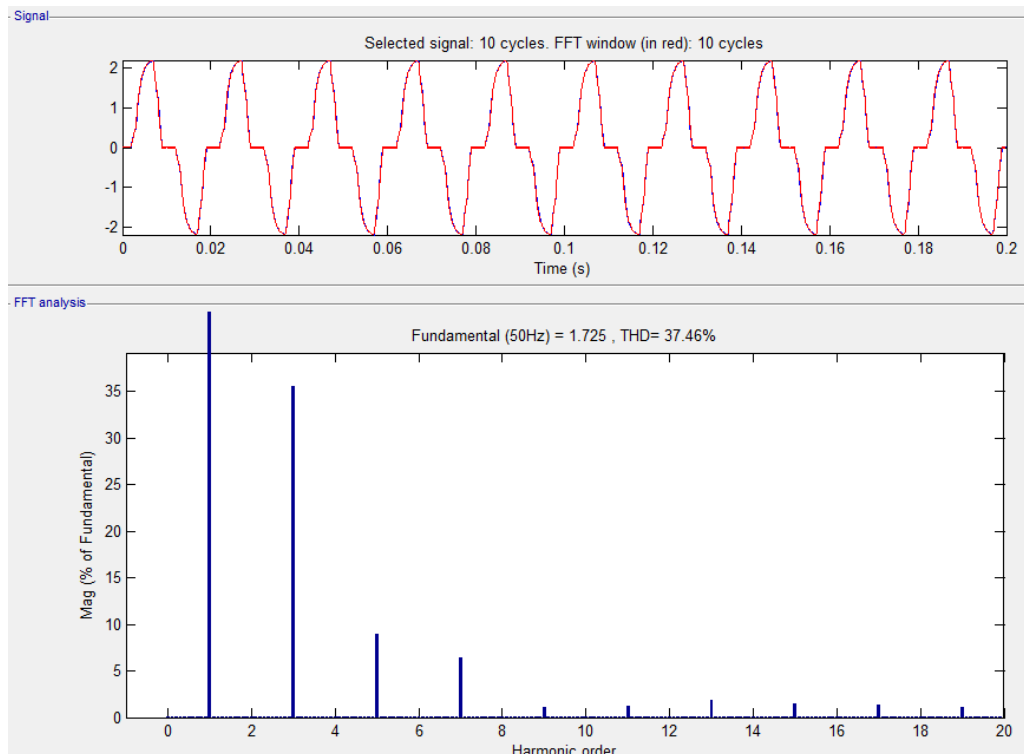


Figure 11THDi Multilevel Inverter 3 Stage Expenses R 100 Ohm and L 100mH

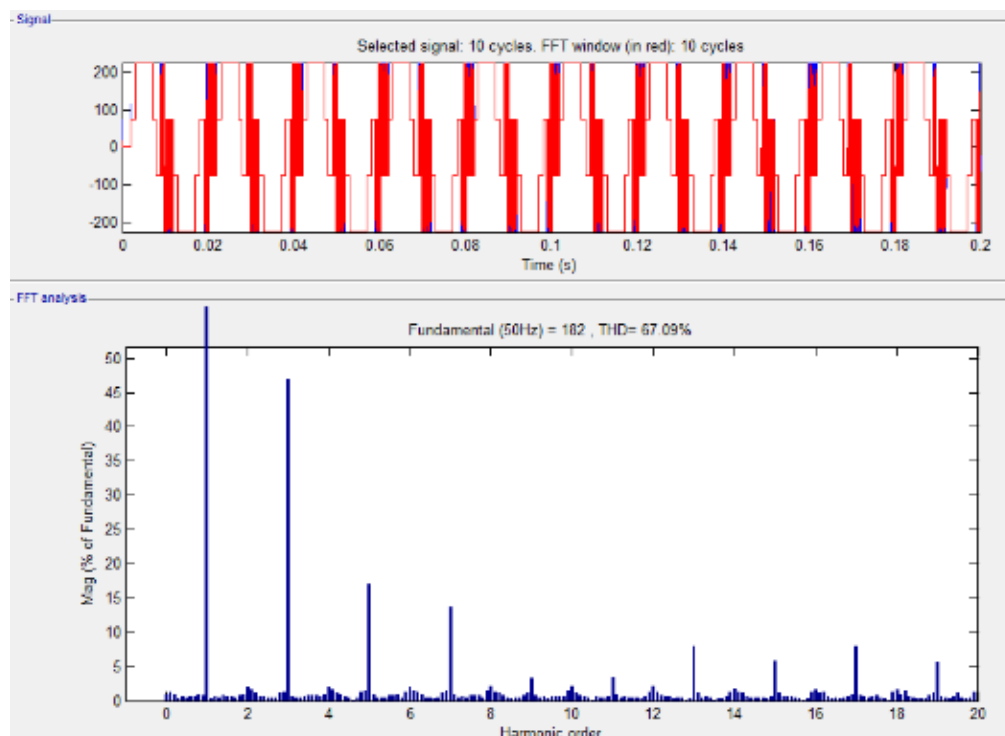


Figure 12THDv Multilevel Inverter 3 Stage Expenses R 100 Ohm and L 100mH

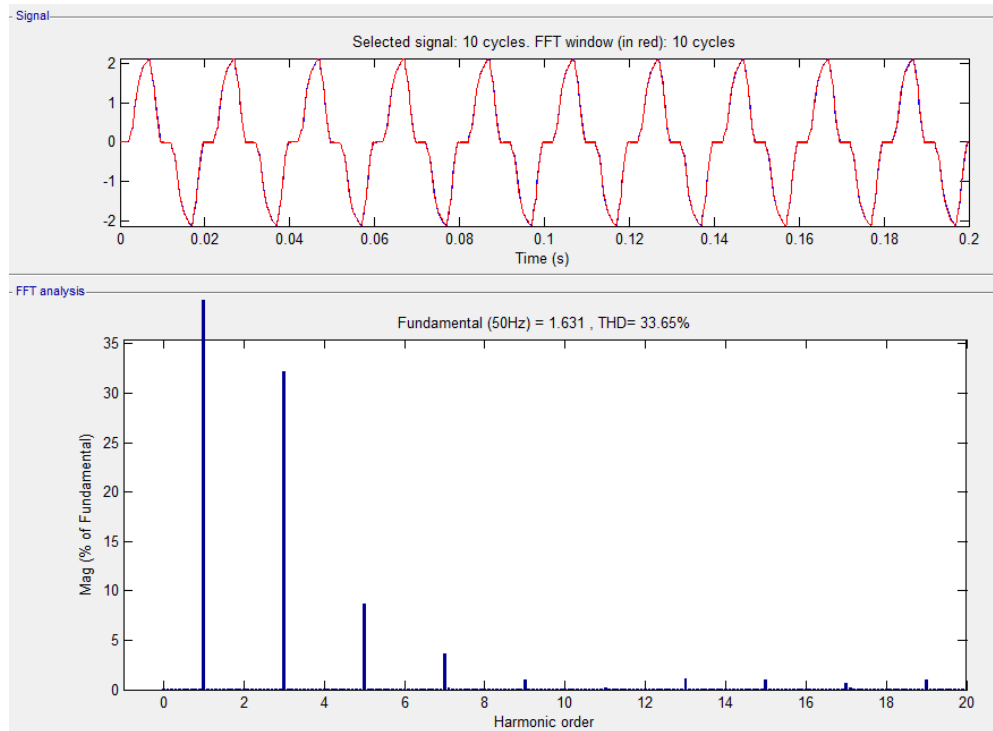


Figure 13THDi Multilevel Inverter 3 Stage Expenses R 100 Ohm and L 147mH

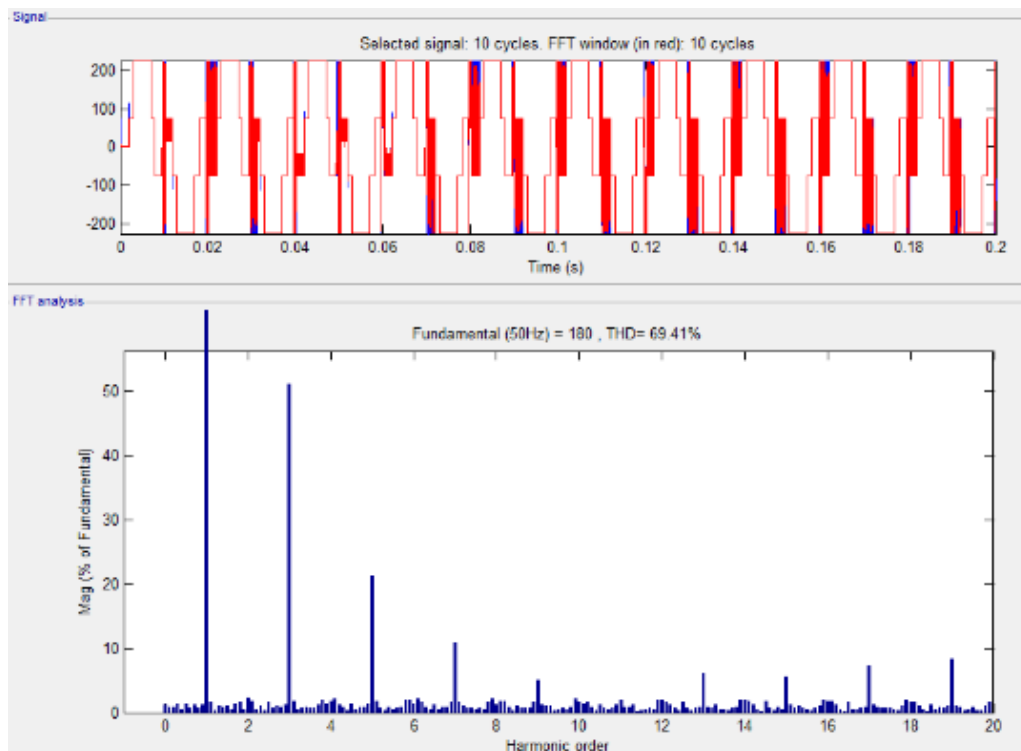


Figure 14THDv Multilevel Inverter 3 Stage Expenses R 100 Ohm and L 147mH

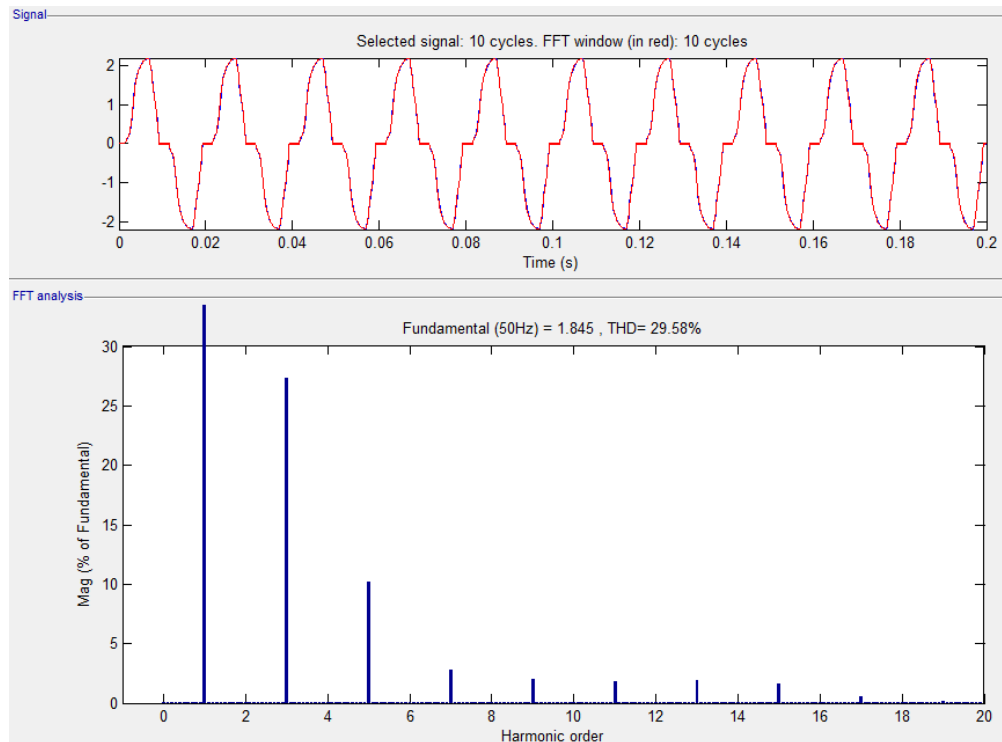


Figure 15THDi Multilevel Inverter 5 Stage R 100 Ohm Load and L 100mH

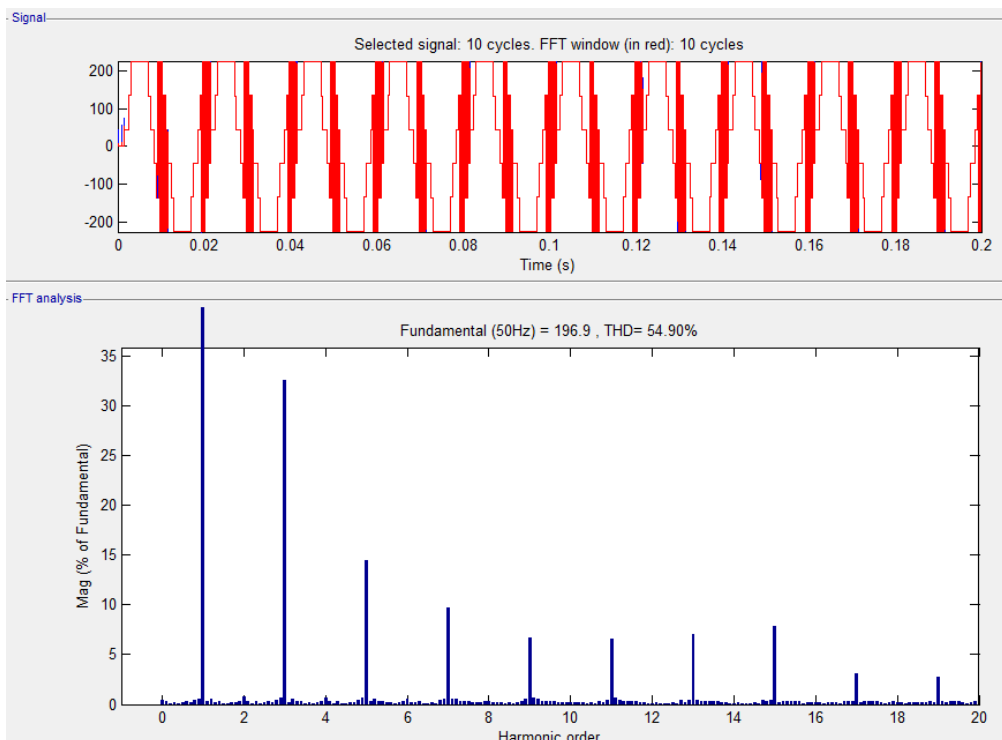


Figure 16THDv Multilevel Inverter 5 Stage R 100 Ohm Load and L 100mH

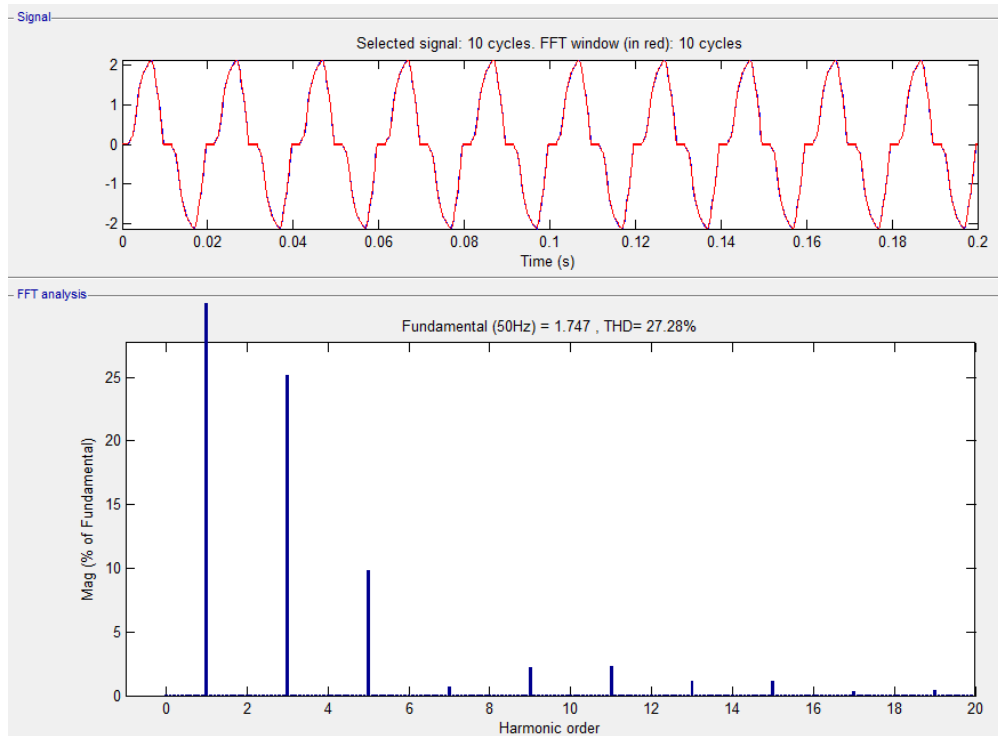


Figure 17 THDi Multilevel Inverter 5 Stage R 100 Ohm Load and L 147mH

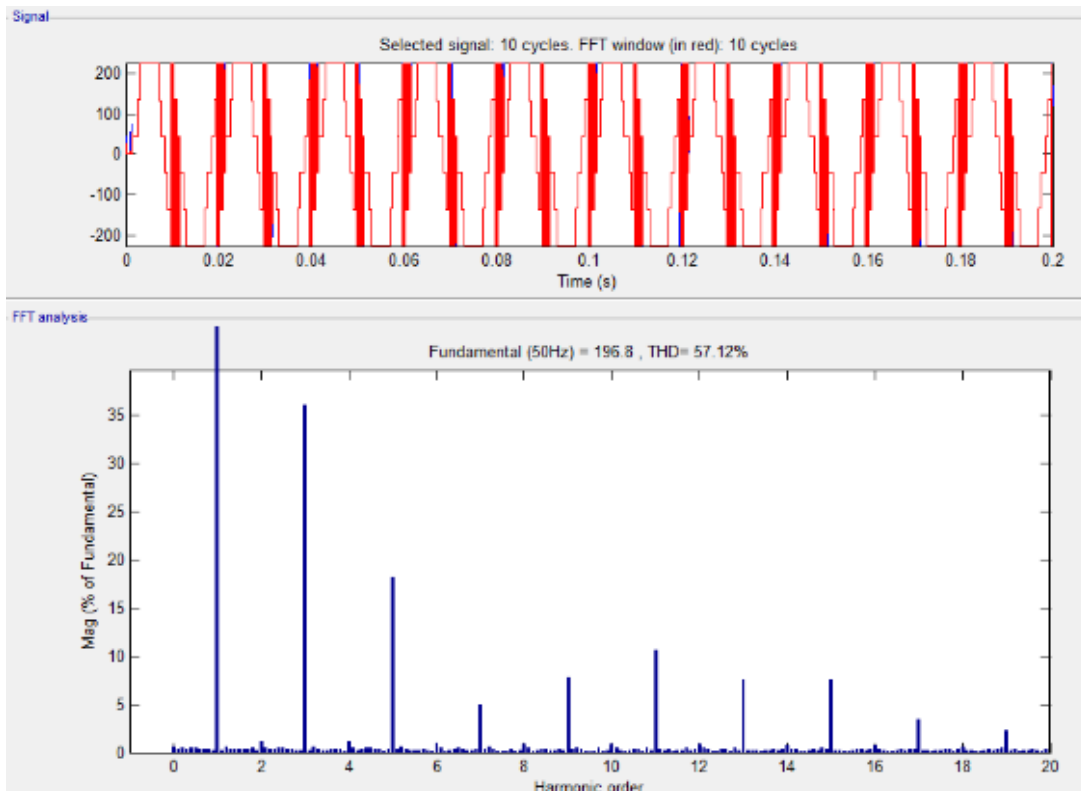


Figure 18 THDv Multilevel Inverter 5 Stage R 100 Ohm Load and L 147mH

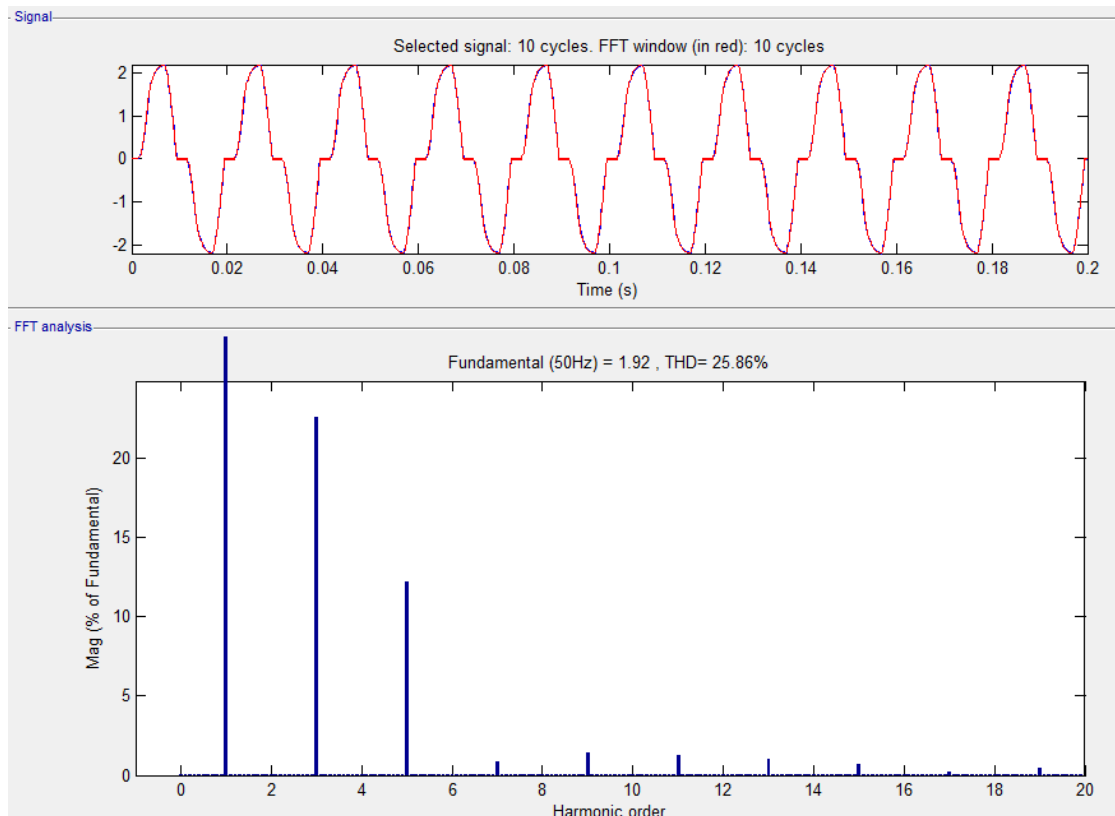


Figure 19 THDi Multilevel Inverter 7 Stage Expenses R 100 Ohm and L 100mH

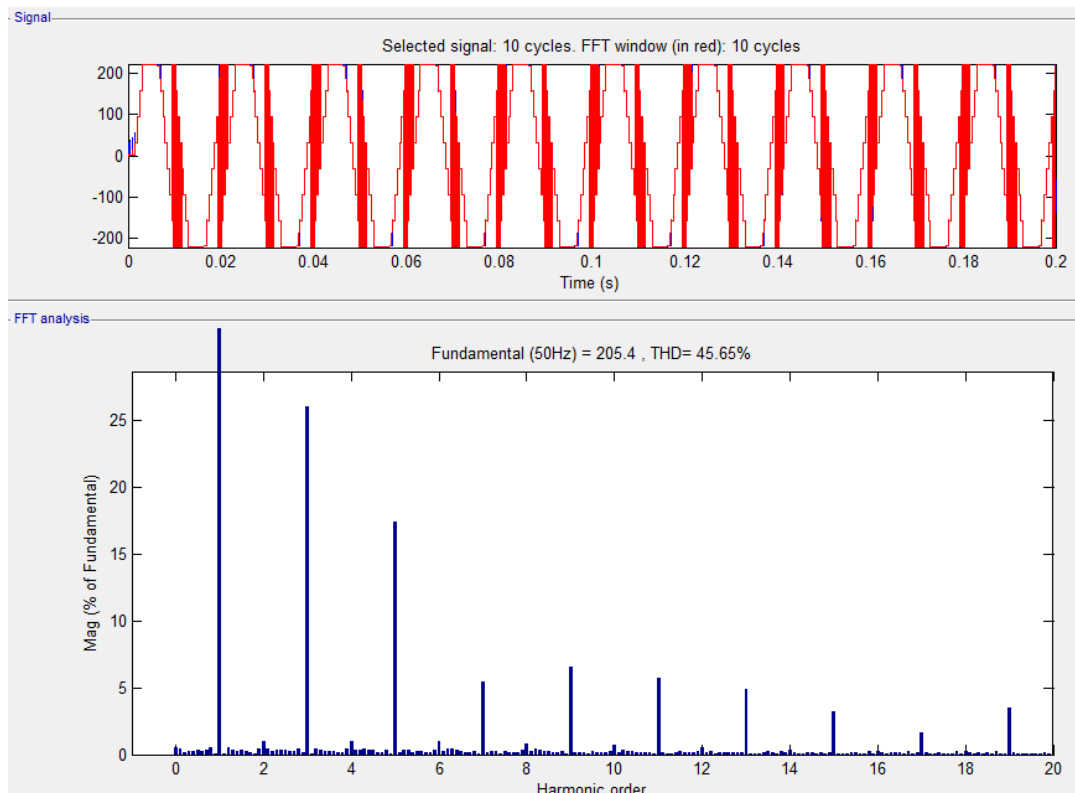


Figure 20 THDv Multilevel Inverter 7 Stage Expenses R 100 Ohm and L 100mH

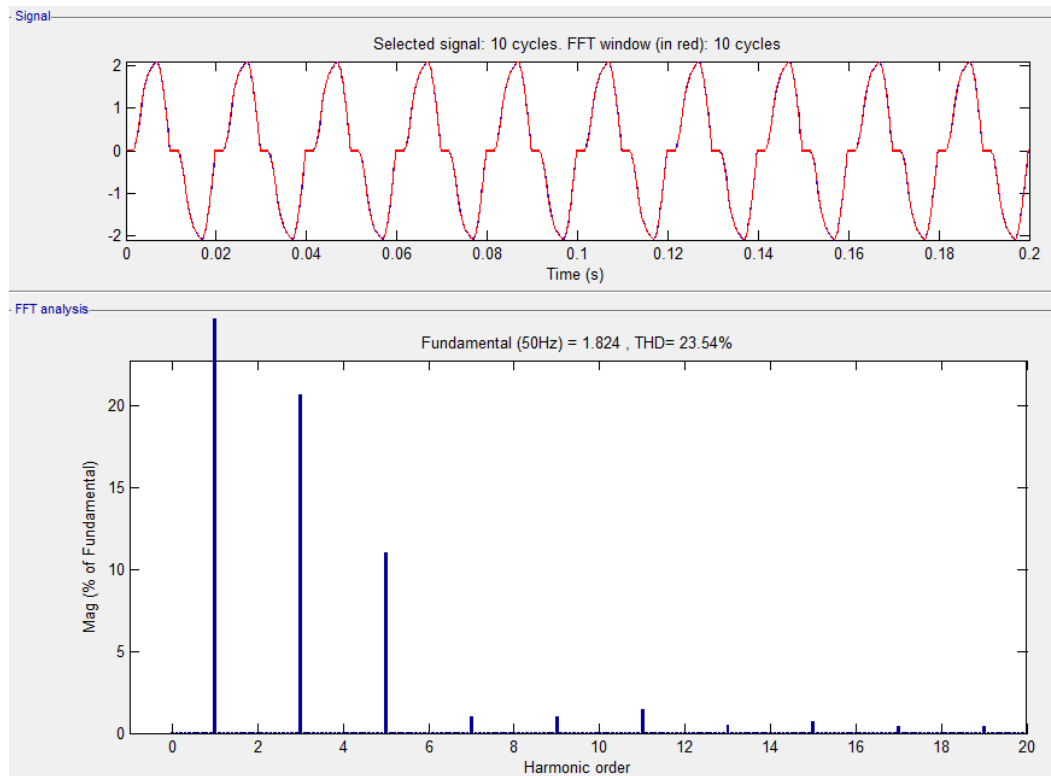


Figure 21 THDi Multilevel Inverter 7 Stage Expenses R 100 Ohm and L 147mH

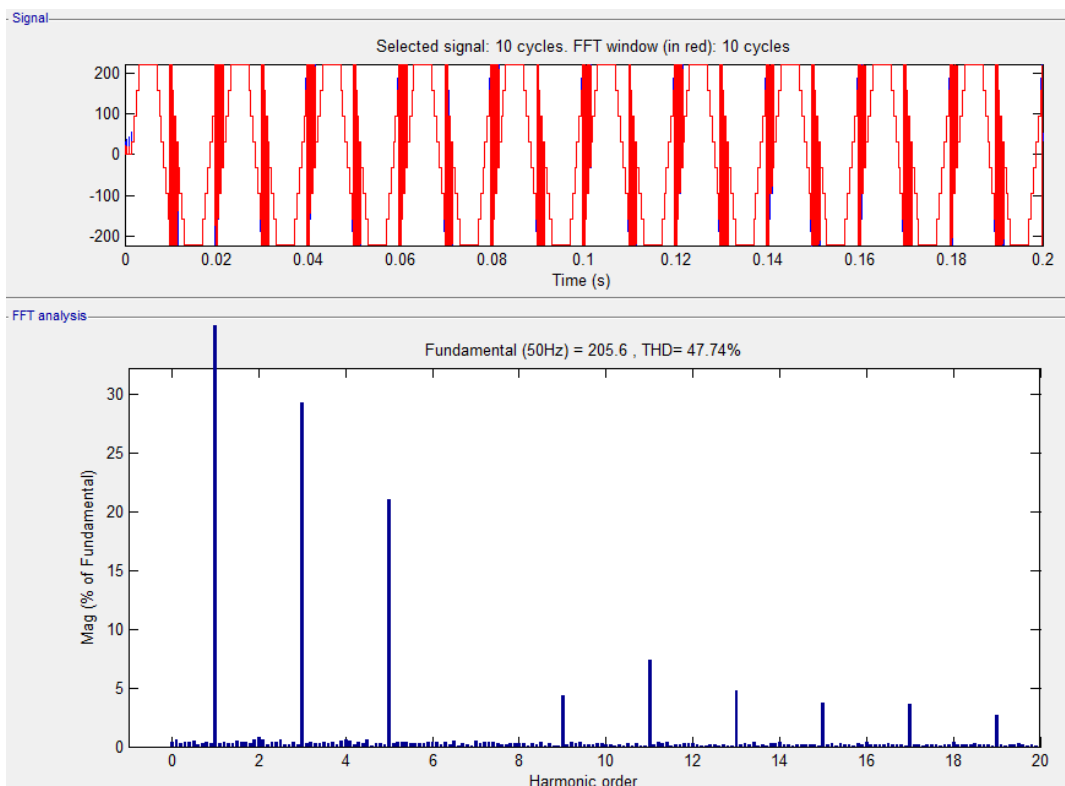


Figure 22 THDv Multilevel Inverter 7 Stage Expenses R 100 Ohm and L 147mH

From Table 2 it can be seen the effects of loading on the load RL of the results generated THD. With the addition of inductive load is seen that the value generated THDv

great with a value above 47%. This is caused because the inductive load can not reduce the ripple voltage at the output waveform of the multilevel inverter. In the third stage, multilevel inverter harmonics generated waves up to 19th harmonic sequence (H19). Similarly, in the multilevel inverter circuit, 5 and multilevel inverter stage 7 stage resulted in a wave harmonics up to the 19th order harmonics (H19).

With the addition of the level of the multilevel inverter 3 stage into 5 stages impaired THDv although the level of harmonics equal to H19, but the percentage of each order of harmonics is smaller. In the multilevel inverter circuit 7 stage THDv the resulting value becomes smaller than the multilevel inverter 5 stages and 3 stages. From the data that has been obtained, it can be seen that with the addition of the level inverter used in the multilevel inverter can degrade and improve THD value generated in the multilevel inverter output.

In addition, inductive load has resulted in THDi resulting smaller than the value THDv. This is because the inductive load characteristics that stores electric current flowing to the load into a magnetic field and improve the value of the current generated by cutting the current ripple.

On the results of FFT Analysis MATLAB Simulink seen that in multilevel inverter stage 3 and stage 5 generates harmonic waves up to 17th harmonic (H17). In multilevel inverter, 7 stages generate harmonic waves up to 15th harmonic (H11). From the results of these THDi can be seen that more and more switching components are used it will result in more harmonic sequences. But more and more switching components are used then the percentage of each order of harmonics is smaller so that the resulting THD will be smaller.

The addition of the value of the resistive load used affects THDv and THDi value generated in this multilevel inverter. However, the addition amount of the rate constant multilevel inverter can reduce THDv and THDi value with the decrease is not too large percentage is around 3% -8%.

V. Conclusion

In this study, the multilevel inverter single phase H-bridge type can reduce the value of Total Harmonic Distortion (THD) at the loading RL. Effect of resistive load (R) in the multilevel inverter output waveform that dampens wave level for R load characteristics that consume electrical energy. Wherein R load change waveform but does not cause a phase shift of current or voltage. The influence of the inductive load (L) on the harmonic wave that is far THDi value at the inverter output wave. But not far THDv value for the load L only cut not with the current wave ripple voltage waveform generated.

Use of the method of the multilevel inverter with single phase inverter type H-bridge may be one way of reducing the value of THD without using filters. However, an arrangement of Duty Cycle and Phase Delay precise as wave input on switching gate (mosfet). With the right settings on the switching component, it will produce sinusoidal wave approaching the storey. So the larger the inverter output waveform close to sinusoidal then the resulting THD value would be diminished.

The setting value Duty Cycle and Time Phase Delay in this study still needs further investigation to obtain better results in the use of the method Multilevel Inverter Phase One's H-Bridge mode.

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Simulation and Control of Clean Water Supply on Campus Toilets Using Passive Infrared Receiver Sensor Technology and Flow Liquid Meter (#630)

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Abstract - *The use of tap water on campus toilets is often problematic due to careless user. The water faucet on campus toilets is often left open, and this leads to wasteful and inefficient use of water. For that, we need a solution to save and control water usage on campus toilets with automatic faucet so that water usage can be used only when they are necessary or needed. Control of water usage on campus toilets using fluid mechanics and physics kinematics method by using solenoid valve as a valve to open and close the flow of water and flow liquid meter to calculate the water discharge data through it. While, PIR sensor that serve to detect the presence of humans in the toilets so that the solenoid valve can open and let the water flows. While Arduino UNO as microcontroller and Wi-Fi shield used to deliver the water discharge data to application that had been built. The test results show that the method used is able to work with stable to control water supply on campus toilets.*

Keywords: *flow liquid, fluid mechanics, physics kinematics, solenoid valve, Arduino, Wi-Fi shield, and PIR sensor.*

I. Introduction

Water is the source of life for every living being. Also, water is one of the main needs in our live. The high level of human needs of water is not proportional to the availability of water on earth, because of all the water that is in the earth, 97% is sea water, while the remaining 3% is fresh water and only 1% is available for human use.

The amount of wasteful use of water causes wasteful use of water. Until now the level of water demand is increasing along with the increasing rate of world population growth. So it is not exaggeration if UNESCO predicts by 2020 the world will experience a global water crisis.

Monitoring of water usage in toilets is expected to reduce excessive water use. This monitoring is supported by Passive Infrared Receiver (PIR) sensor. Passive Infrared Receiver is an infrared-based sensor. However, it is not as common as most infrared sensors that consist of an IR LED and a phototransistor. PIR does not emit anything like IR LEDs. As the name implies 'passive', this sensor only responds to the energy of the passive infrared beam held by every object detected by it. Objects that can be detected by these sensors are usually the human body.

This is due to an IR filter that filters the wavelength of passive infrared light. IR Filter in a PIR sensor module is capable of filtering the wavelength of passive infrared light between 8 to

14 micrometers, so the wavelength produced from the human body ranging between 9 to 10 micrometers can be detected by the sensor.

So when someone walks through the sensor, the sensor captures the emission of a passive infrared beam emitted by the human body which has a different temperature from the environment causing the pyroelectric material to react and generate an electric current due to the heat energy carried by the passive infrared beam. Then an amplifier circuit amplifies the current which is then compared by the comparator to produce the output.

Based on previous research this series of automatic water faucet is manufactured using microcontroller and the motion sensor is used to activate the automatic switch circuits which serve as input to the washer pump to control the valve to close or open. This will open automatically when the sensor is blocked. When the sensor is obstructed then the series will be active.

II. Problem Identification

Water is one of the main needs in everyday life. The amount of water used in the bathrooms become one of the main causes of waste water consumption, when someone opens the water faucet in the bathroom, then often forgets to close it. This is one of the main causes of wasteful use of water consumption. Therefore, we need an approach to control the water flow needed so the efficiency of water usage in the bathroom can be achieved.

III. Previous Research

Several studies have been done to conserve water usage in toilets. In 2010, Gabriel conducted research for automatic faucet control in male toilets using PIR sensors. In his research, Gabriel utilized the PIR sensor as its control center and object detection in the form of human body. The PIR sensor will give instructions to the relay to move the solenoid that acts as a valve. The results of analysis showed that the PIR sensor in this tool can detect the object within a maximum distance of 1.5 meters [1].

A second study in 2011, Alfarobi undertook research for the manufacture of an automatic faucet system for water savings in ablution using motion sensors. In his research, he made a system of automatic ablution faucet by placing the sensor at a certain point, so that when someone finishes, the faucet will automatically close [2].

In 2014, Subandi conducted a research for automation on water faucet to save water consumption. He used an ultrasonic sensor to detect the presence of a limb that is directed to the faucet and stop the flow of water if no limb is directed to the sensor. Ultrasonic sensor will convert physical quantities into mechanical quantities. He used an Atmega16 microcontroller as the system controller. Test results indicated that there was a difference in the amount of volume of water released using automatic faucet and ordinary faucet [3].

In 2014, Yano et al. conducted a research to measure water consumption and compare savings from tap water usage using Wireless Sensor Network. This research used RFbee Sensor to collect, send, and receive data. Data retrieved by RFbee sensors will be collected and then sent wirelessly to a computer connected directly to the RFbee sensor [4].

In 2017, Rahmat et al conducted a research showed that computation of science, especially fluid mechanics and kinematics physics is implemented on microcontroller. Arduino chip-based ATmega328P can be used to detect the location of leaks in pipes by using a data rate of water flow and the system is able to work stably to determining the location of the leak with a maximum distance of 2 meters and it can determine the location of the leak closest to the actual location of the leak with an average flow rate of 10 liters per minute [5].

IV. Methodology

This research consists of several steps begins from data collection which is retrieved automatically through the sensor. For more information about the input and output process of the built system can be seen in Figure 1.

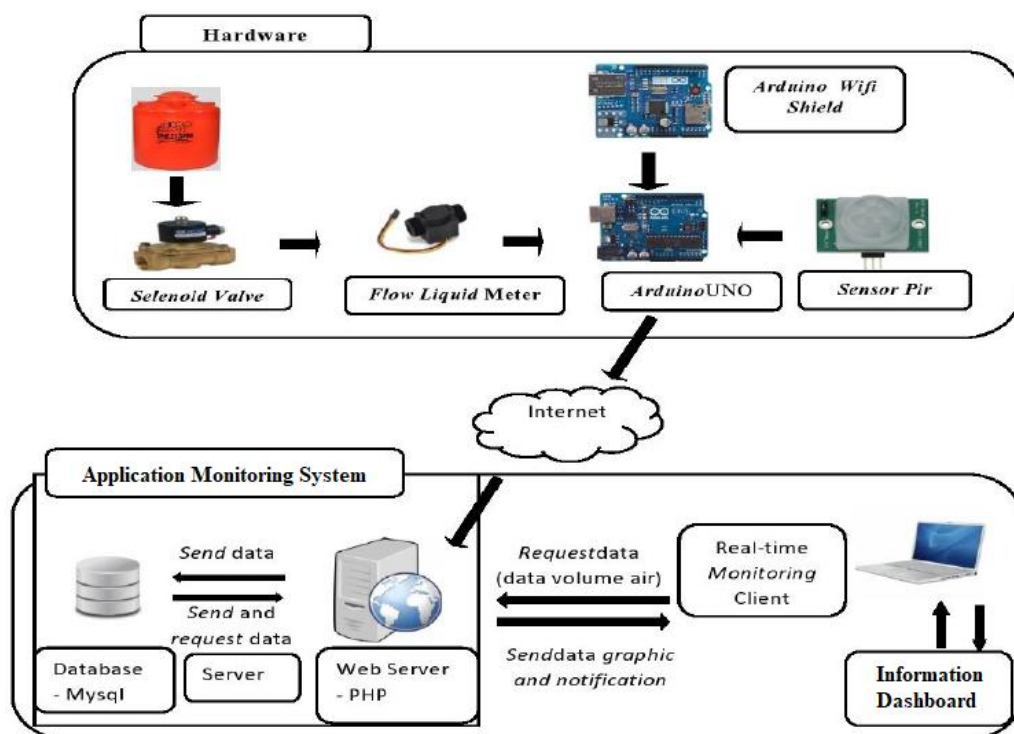


Figure 1. General architecture

A. Hardware and Sensor Monitoring Application System

1) Hardware Sensor

This section shows the process of data retrieval by the sensor to then be sent to Arduino as well as data transmission by Arduino to the monitoring application system assisted by Wi-Fi shield.

This process starts from the water that flows on the pipe and goes through the solenoid valve. Then, it flows through the flow liquid meter sensor that previously installed in the pipe. The sensor will collect data from the water passing through it, and will be sent to the Arduino. Flow liquid meter sensor will transmit data to Arduino via digital pin 2.

Then, Arduino calculates how much water discharge per second that passes through a flow liquid meter sensor. The water discharge per second that had been obtained is first stored in the server where the water discharge data is collected. Server will then directly send the data to the monitoring application system in real time. Collection of data from Arduino to server

using Wi-Fi shield, to connect server with Arduino, Arduino will access the IP address of the server. After it is connected, Arduino will send water discharge data using POST method by accessing web page on server. Wi-Fi shield is mounted with stackable method on Arduino and will connect Arduino with server directly using RJ-45.

2) *Application Monitoring System*

Monitoring application system that will be built is a web-based application system using PHP.

3) *Web Server*

Web server used is a standalone web server. This web server will serve as a place of service and data processing between Arduino, database, and client.

Web server will receive the water discharge data sent by the server where the data is collected. This water discharge data will then be stored into the database and ready to be processed and be represented back to the client in the form of graphs. These graphs will be displayed within a certain time interval and will always be updated automatically every second as long as the Arduino sends the water discharge data to the system. The water discharge data will be processed and ready to be represented back to the client either when they access the web server or not.

4) *Client*

The client will access a web page on the web server to perform monitoring and only the specific client who has permission will be able to access this page. This page will display the amount of water discharge used per day or the amount of water discharge that flows on the flow liquid meter. Water discharge will be displayed in the form of graphs and tables. Water usage graphs will be changed when the water flows through the flow liquid meter and updated automatically in the form of graphs and tables.

B. Data Used

The data used in this research is data which is obtained directly from the sensor. Then the Arduino will receive data from the sensor. The data is number of turns of the mill inside the sensor caused by the flow of water through the liquid meter flow sensor. The number of turns of the mill is further processed using the equation 2.1 so that water discharge data is obtained through the sensor every second. Then Arduino will send the data assisted by Wi-Fi shield into the server that had been provided. The data transmitted is in the form of volume water discharge data that had been used.

C. Hardware Design

1) *Design of Solenoid valve Sensor, Relay, PIR Sensor with Arduino*

Arduino has several pins that serve as a place of data processing and power. On this system, pins are used for processing data sent from the sensor. The solenoid valve sensor will be connected to the digital pin 6 to receive data from the sensor. To open and close the flow of water, adaptor is used to assist by connecting the relay as a current limiter.

PIR is an infrared-based sensor. However, it is not as common as most infrared sensors that consist of an IR LED and a phototransistor. PIR does not emit anything like IR LEDs. As the name implies 'passive', this sensor only responds to the energy of the passive infrared beam held by every object detected by it. Objects that can be detected by these sensors are usually the human body. PIR sensor detects infrared waves that come from the body heat of

living creatures including humans (Agung, et al., 2013). These waves are emitted as humans move. The PIR sensor will connect to the Arduino via digital pin 8 can be seen in Figure 2.

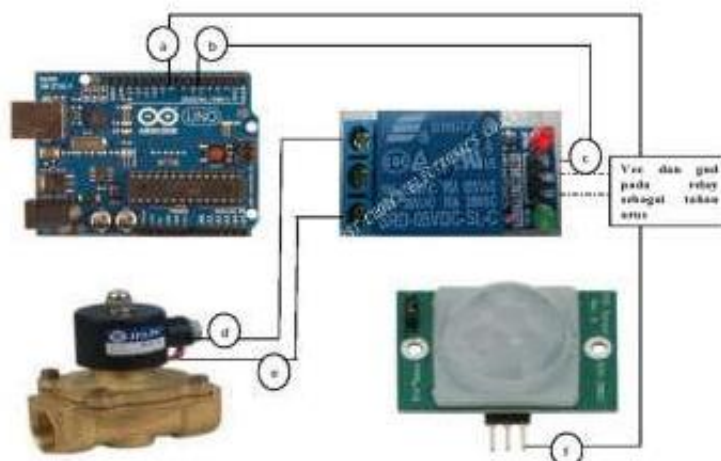


Figure 2. Design of solenoid valve Sensor, PIR sensor with Arduino

2) Design of flow liquid meter with Arduino

Arduino has several pins that serve as a place of data processing and power. On this system, pins are used for processing data sent from the sensor. The flow liquid meter sensor will be connected to the digital pin 2 to receive data from the sensor, GND pin and 5V pin as power for the sensor. To design flow liquid meter with Arduino can be seen in Figure 3.

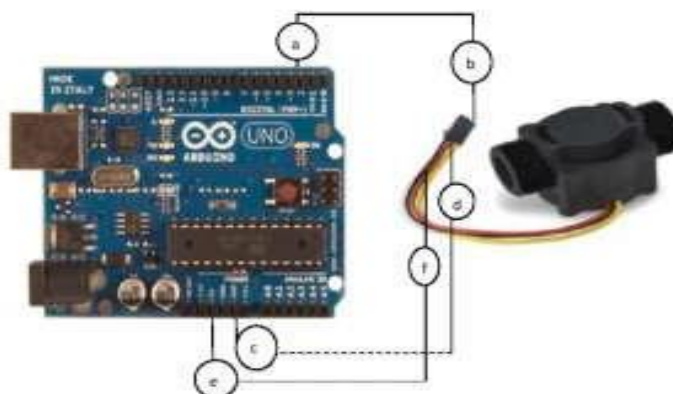


Figure 3. Flow liquid meter design with Arduino

3) Design of Wi-Fi Shield and Arduino

Wi-Fi shield is an additional module used on the Arduino to connect to a server using a Wi-Fi network connection. This module will be mounted with stackable method on the Arduino as shown in Figure 4.



Figure 4. Design of Wi-Fi shield and Arduino

V. Study and Result

System performance test is performed to determine the performance of the system in monitoring whether the system is running well or not.

1) The test performed will display the graph of the amount of water used only when the tool works. The display of the graph will drop because of the interaction of the PIR sensor detects the presence of humans in the room, this will cause the water in the tube to be reduced. Graph can be seen in Figure 5.

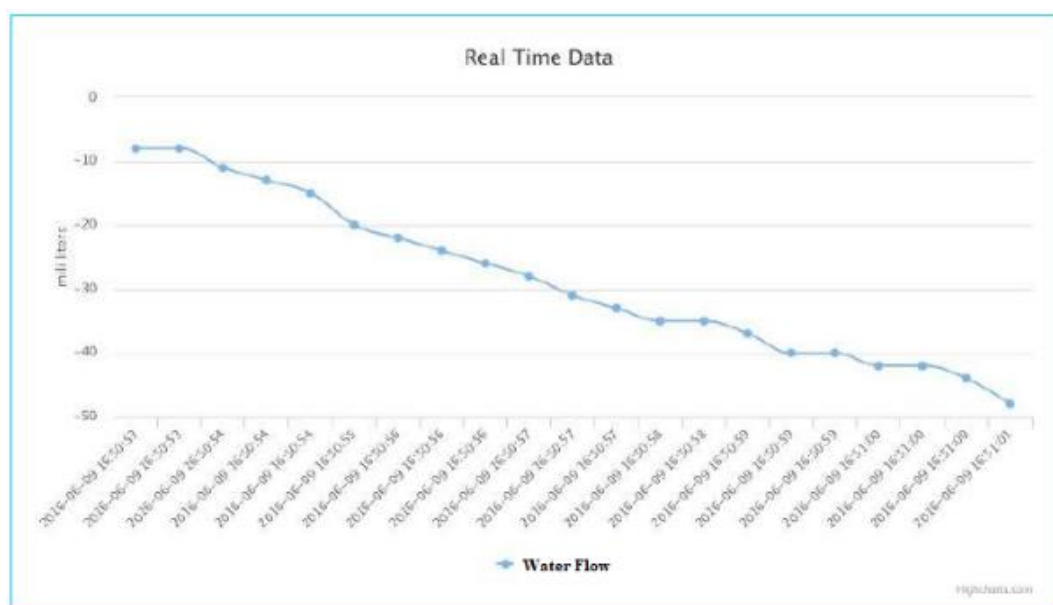


Figure 5. The display of water usage in graph

2) The second phase test will display the test results based on the large number of toilet users. The results of this test will be displayed in tabular form based on testing that have been done. Based on the results of testing the number of toilet users, if there is no toilet users, then the system or tool built will not work. This is due to the PIR sensor does not accept or detect the presence of humans in the toilet. So the water will not flow because the valve on the solenoid valve is not open. When one person enters the toilet, the built-in sensor or system will

work, and that's because the PIR sensor detects the presence of a human in the toilet. Then the valve on the solenoid valve will open so that water can flow when it's needed. What is detected by the PIR sensor is the heat wave generated by the human body. Similarly, when 2, 3, and 4 people enter the toilet, the built system or tool can still work well. From the tests conducted based on the number of toilet users can be concluded that the tool can work well. This study shows that the large number of users will not affect the performance of the sensor or system built. The table can be seen in Table 1.

Table 1. Pir sensor testing based on number of toilet users

No	Number of toilet users	Work	Does Not Work
1	0	-	Does Not Work
2	1	Work	-
3	2	Work	-
4	3	Work	-
5	4	Work	-

3) The next test will display the test results ranging from distance that can still be detected by the sensor. The test results performed will be displayed in tabular form. Based on the tests that have been done, the maximum distance that can be detected by the PIR sensor can only work at a distance of 3 meters, but the PIR sensor test with a distance of 3 meters is not as accurate as a distance of 1 meter or 2 meters. Because the heat wave generated by the human body is too far to reach the PIR sensor. If the toilet user is more than 3 meters away then the PIR sensor will not detect the presence of humans in the toilet and the automatic sensor will not work. Can be seen in Table 2.

Table 2. Pir sensor testing based on distance detectable by sensor

Distance / Meter	Detected	Not Detected
1 m	Detected	-
2 m	Detected	-
3 m	Detected	-
4 m	-	Not Detected

VI. Conclusion

The conclusions can be taken based on Simulation and Control of Clean Water Supply are The built system can reduce the level of human negligence in the use of water on campus toilets. The built system can improve the efficiency of water usage in campus toilets to reduce and anticipate the wasteful use of water. PIR sensor will not operate if blocked by objects or something thick, such as doors and walls of the toilet room.

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Analysis and Simulation of Leakage Current in On-Grid Transformerless Solar Power System (#771)

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Abstract—The increasing of energy demands us to find other sources to solve this problem of energy scarcity. Solar power plants (PV) are often an alternative because of the many advantages of PV systems. PV is a collection of solar panels capable of converting solar energy into electrical energy. The output of a PV is a direct current, therefore, a mechanism is required that converts it into AC power for daily use. PV with a large power, usually using a transformer while the PV with little power, the transformer is not used. Consequently, there is a leakage current due to the parasitic capacitance of the earth. This paper aims to analyze the amount of leakage current that may occur within the system.

Keyword - leakage current, on-grid, PV, simulation, transformerless

I. Introduction

Electricity has become one of the basic needs of society nowadays. Electricity is almost needed in every aspect of our lives, from households to industry. Electrical energy needs increase every year. This growing need is certainly a problem for our country's electricity provider, because most of the electricity supply comes from non-renewable sources. In other words, the fulfillment of the demands are more difficult. To help solve this problem, we need another renewable power source such as solar energy, water, waves, and so on. To convert solar energy into electrical energy, it takes a device called solar cells or commonly known as solar panels or photovoltaic.

Solar cells can convert solar energy into direct current / DC electricity, but most of the electrical equipment we use requires alternating current (AC) power to operate. Therefore, it needs a mechanism that converts DC power into AC or commonly called the inverter. Solar Power Generation or commonly abbreviated with PV can be a solution that can help reduce the scarcity of energy. PV with large power generally use a transformer to raise the voltage according to the working voltage of the grid. But on a small powered PV, the transformer is not used and the PV is directly connected to the grid to reduce losses and minimize costs. This system still has flaws. Galvanic relationship between the grid and the PV can cause a leakage current due to the parasitic capacitance of the earth. This current increase electromagnetic emissions and harmonics injected into the grid ^[1].

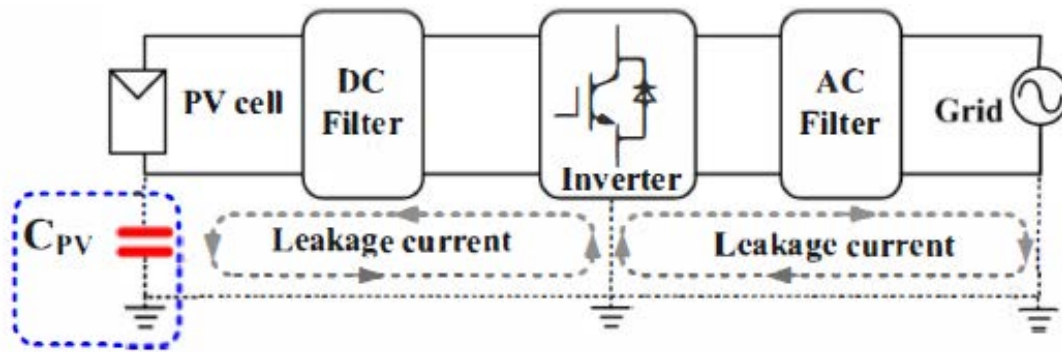


Figure 1 on-grid transformerless solar power system^[3]

II. Simulation Model

This research uses MATLAB Simulink as software to perform simulation. This study evaluates the amount of leakage current with the following series:

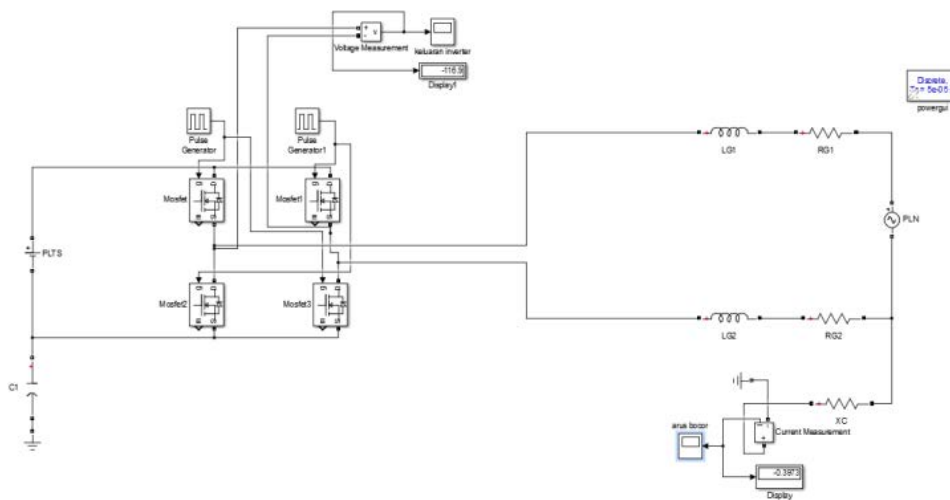


Figure 2 modeling circuit transformerless grid on solar power

The series is created in MATLAB Simulink workspace. The PV component is supplied with a grounded 220V DC voltage source. Then connected with a full-bridge inverter circuit single phase consisting of 4 pieces NPN MOSFET and fueled by two pulse generators. The output of the inverter is connected to the load (fixed load). Load or grid is given by an inductor and a resistor connected to the AC voltage source, as the PLN. The output of the grid is connected to a resistor component as the parasitic capacitive reactance modification which causes a leakage current. The model of Figure 1 was built to study the leakage current . The model includes a capacitor C_p that models the parasitic earth capacitance.

The ground resistor R_p was added for damping the leakage current at the resonant frequency. A value of 100Ω was used to adjust the amplitude of leakage current of the simulation waveforms to the experimental results.

III. Mathematical Modeling

a. Analysis of cell-to-frame Parasitic Capacitance

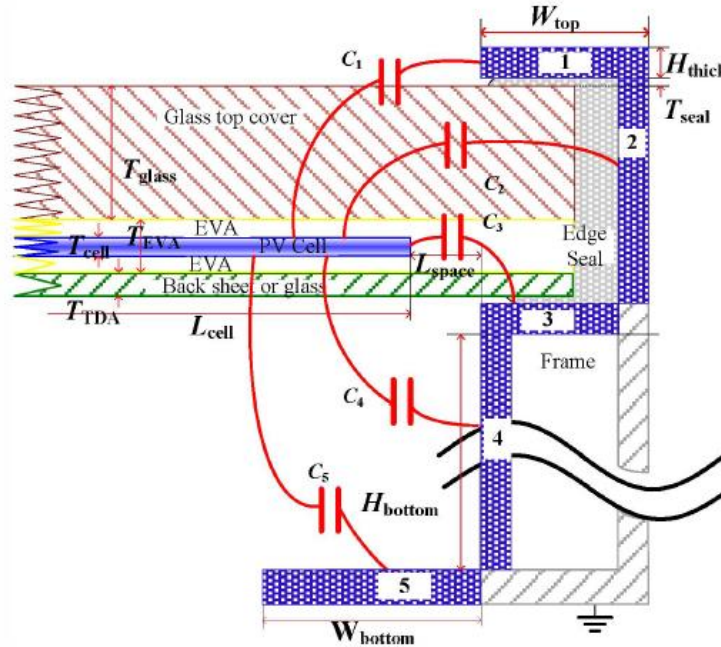


Figure 3 Field line contours are partitioned into five regions with capacitance components defined as C1- C5^[3]

For the computation region separated by C1-C5, each component can be calculated through a fringe capacitance model, in which two conducting plates are not identical to each other. As shown in Fig. 3, the edge capacitance (perunit length) is composed of four components, generally, C_{top} , C_{side} , C_{bottom} and C_{in} . By using Schwarz-Christoffel mapping^[4], these capacitance are derived as:

$$C_{top} = \frac{\epsilon}{\pi} \ln\left(1 + \frac{L}{a+b}\right)$$

$$C_{in} = \frac{\epsilon_0 \epsilon_r L}{a} \tag{1}$$

$$C_{bottom} = \frac{(2 - \ln 4)\epsilon}{\pi} \tag{2}$$

and

$$C_{side} = \frac{\epsilon}{\pi} \ln[2k\sqrt{k^2 - 1} + 2k - 1] \tag{3}$$

where

$$k = 1 + \frac{b}{a} \tag{4}$$

$$C_{side1} = \frac{2\epsilon}{\pi} \ln \left[\frac{a + \eta b + \sqrt{c^2 + (\eta b)^2 + 2a\eta b}}{c + a} \right] \tag{5}$$

$$+ \frac{M\epsilon}{\pi} \ln \frac{\pi}{\sqrt{c^2 + a^2}} \exp\left(-\frac{c-a}{c+a}\right)$$

with

$$\eta = \exp\left(\frac{d+c - \sqrt{c^2 + b^2 + 2ab}}{\tau d}\right) \tag{6}$$

There is another way of analysing the parasitic capacitance, using a simpler method. It could be calculated if the amount of leakage current and ground voltage were known. The equation would be:

$$C_p = \frac{1}{2\pi f} \frac{I_{C_p}}{V_{C_p}} \tag{7}$$

b. Equivalent Circuit

The circuit shown in fig 2 can be simplified into simpler circuit shown in fig 3 :

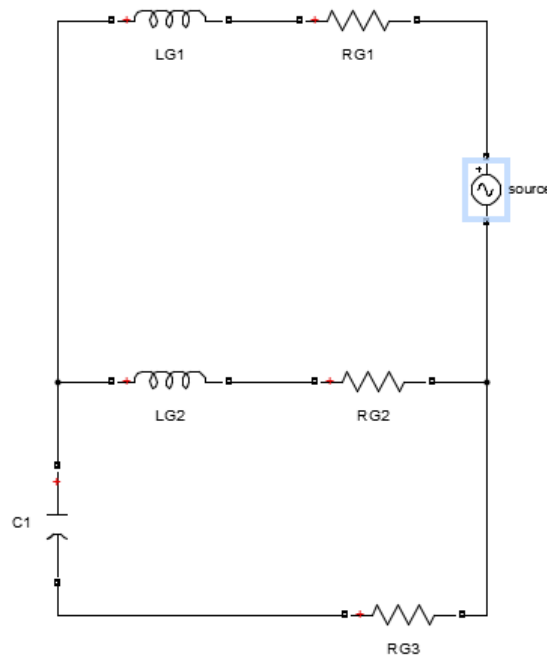


Figure 4 simplified equivalent circuit

Where source is both PLN and PV joined, LG and RG are the grid, and C1 is the parasitic capacitance of the system. The circuit can be analyzed by loop method. From the previous researches, the parameter of the circuit can be found in table I.

TABLE I Components parameter

Parameter	Value
<i>Vac</i>	220V
<i>f</i>	50Hz
<i>Lg</i>	0.04 mH
<i>Rg</i>	0.1Ω
<i>Rground</i>	100 Ω
<i>Cp</i>	13.6 μF

IV. Simulation result

The simulation works in MATLAB Simulink. The PV component is supplied with a grounded 220V DC voltage source. Then connected with a full-bridge inverter circuit single phase consisting of 4 pieces NPN MOSFET and fueled by two pulse generators. The output of the inverter is connected to the load consisted of 0.04 mH inductor and 0.1 Ω resistor. Load or grid is given by an inductor and a resistor connected to the AC voltage source, as the PLN that has 220V peak voltage and 50 Hz of frequency. The output of the grid is connected to 100 Ω resistor component as the ground resistor R_p was added for damping the leakage current at the resonant frequency. The model includes 13.6 μ F capacitor C_p that models the parasitic earth capacitance.

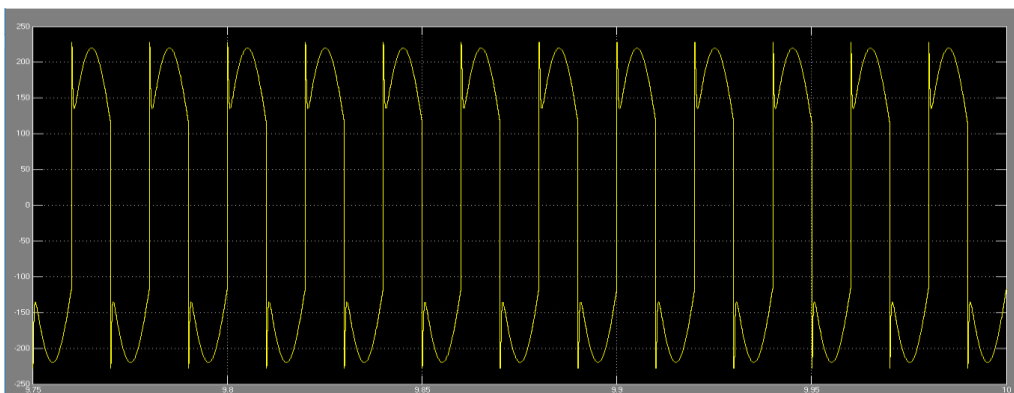


Figure 5 Inverter output after coupled with the grid without transformer

Figure 5 shows the result of inverter output waveform that has been coupled with the grid. The waveform has 33.3% of THD since it has not been connected to any filter. The waveform before connected to the grid would be block-waveform because it was using regular PWM switching technique as it shown in figure 6 below:

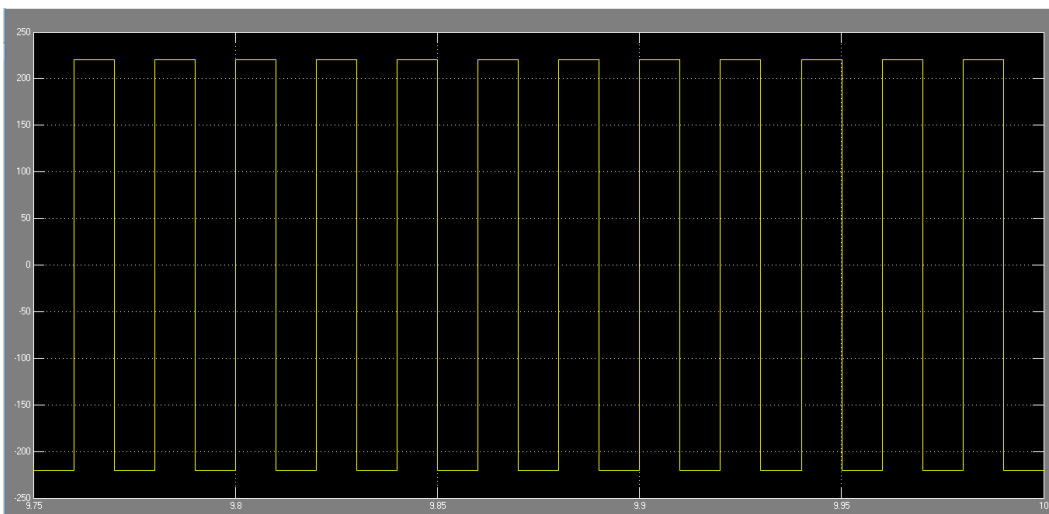


Figure 6 original inverter result

It has 220 V peak. From the simulation concluded that the leakage current is zero when the inverter has not been connected to the grid. After it has been connected, here is the leakage current waveform:

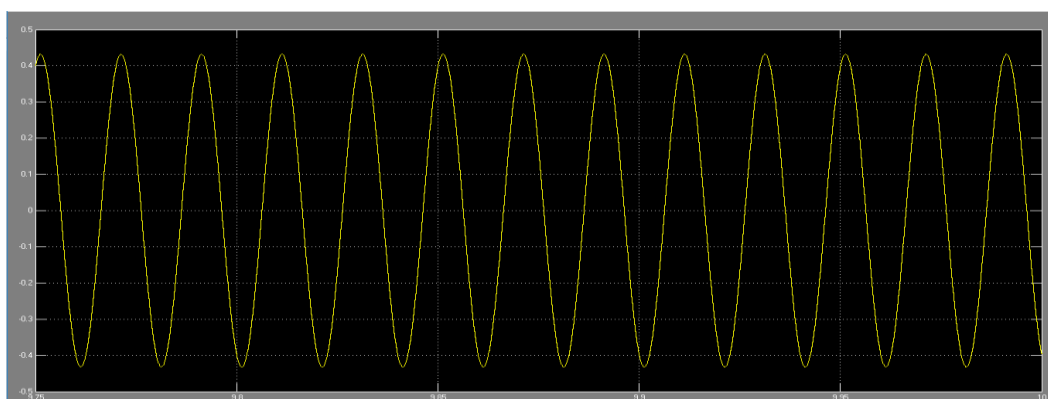


Figure 7 leakage current caused by C_p

As we can see from the diagram, there are some amount of leakage current after the solar power connected to the grid. This was calculated approximately 0,4 A peak.

This leakage current phenomenon of course can be handled by several solution. Without transformer, there is a galvanic connection of the grid and the DC source and thus a leakage current appears. Disadvantages of the appearing leakage current are increased system losses, impairing of electromagnetic compatibility and safety problems [5]. Ground current is limited by standards. In general, the leakage current is superimposed to the line current therefore the harmonic content is increased compared with inverters without transformer. In transformerless grid connected systems a resonant circuit is created if the DC generator is not grounded. This resonant circuit includes the ground capacitance, the filters, the inverter and the impedance of the connected utility grid. Magnitude of the mentioned capacitance depends on the DC source and on the environmental conditions. For fuel cells this ground capacitance is very small so leakage currents with this kind of sources is not a topic. Nevertheless, in photovoltaic applications the panels ground capacitance goes from nanofarads up to microfarads [6], [7] and here leakage current is an important topic. It is important to know the resonance frequency in order to get a properly working system, because the first measure to reduce the ground currents is to decrease the excitation of the resonant circuit. A problem arises due to the great dependence of the ground capacitance with environmental conditions, and hence the resonant frequency of the system. The resonance of the system can be controlled by a damping resistor or the choice of the LCL filter [1].

There are other solution in solving this problem. According to previous research, modulation technique was also giving significant result difference. Bipolar modulation is more recommended than unipolar modulation since the leakage current caused by that technique is lower than the other one [1].

Leakage current can also be reduced by using galvanic isolation technique and common-mode voltage (CMV) damping. The galvanic isolation can be achieved via dc-decoupling or ac-decoupling, for isolation on the dc- or ac- side of the inverter. Nevertheless, leakage current cannot be simply eliminated by galvanic isolation and modulation techniques, due to the presence of switches junction capacitances and resonant circuit effects. Hence, CMV damping is used in some topologies to completely eliminate the leakage current [8].

V. Conclusion

In this paper, the leakage current in a single-phase transformer-less inverter connected to the grid was evaluated. Waveforms of the measured ground voltage and leakage current with different modulation strategies and under different output power conditions are presented. Without the isolation capabilities of the transformer, a resonant circuit arises due to the ground capacitance of the PV panels. The study of the leakage current is needed in order to anticipate any unwanted harm from the current.

Based on the simulation results, the ground capacitance of the PV panels was estimated and a simple model that produces similar results was built. From this, a resonant circuit model should be proposed and an expression to calculate the approximate resonance frequency of the system was derived and in order to be a filter upon noises within the output of inverter wave. Values estimated of ground capacitance change with frequency so further investigation in this topic is needed in order to obtain an improved model that provides accurate results.

Acknowledgement

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Development of Pipe Leak Detection based on Long Wave Infrared Camera for Unmanned Aerial Vehicle Application (#773)

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Abstract-- Oil and gas distribution pipeline require handling in case of leakage. Leaks on the pipeline cause economic losses and have an impact on the environment, so detection must be done in early and rapidly. One method of detecting leakage is through infrared radiation readings. This paper is based on our research to detect the leakage of pipes through infrared image which reading radiation of thermal that emitting from pipe and surrounding area. The detection is processed by a thermal camera with a resolution of 80x60 pixels and a mini computer carried by a multicopter unmanned aerial at varying altitudes. The leakage of the pipe is simulated by flowing water in certain heat into a galvanized pipe that has a leakage point.

Keywords-- pipeline leak detection, infrared camera, thermal vision, remote sensing

I. Introduction

Oil and gas distribution in industries uses pipelines with large construction and long distances. Oil and gas pipelines are spread over underground canals, above ground level, even deep under the sea. Due to its large and very long size, pipeline monitoring every mile for leak detection will be difficult and inefficient. The pipeline in the oil and gas industry is valuable and vulnerable to hazards. Consequently routine monitoring and maintenance are undertaken to reduce both adverse and undesirable incidents and accidents. Zhao and Yang shows that pipeline leakage detection can use infrared radiation reading technology emitted by pipeline leaks [1]. The mapping of infrared energy radiated by the pipe surface makes it possible to recognize leaks even in conditions that are hard to see by the eye.

Leak detection technology is needed in the oil and gas industries today. Therefore further research is required to improve the quality of the heat object measurements through infrared wave radiation. Universitas Lampung in its research center UNILA Robotics and Automation (URO) continues to develop its research in the field of Unmanned Aerial Vehicle (UAV) and its application. This research is part of the achievement of research roadmap in UNILA Robotics and Automation (URO).

II. Literature Review

A. Thermal Radiation

Heat energy can move by three methods which are conduction, convection and radiation. Heat or thermal is the energy produced from the volatility of electrons, atoms, ions, and molecules

in large quantities. If given to the material then some of the energy will be transferred and moved resulting in increased local temperature. The displacement of a solid is heat conduction, in liquid is convection, and no medium is called radiation. Radiation by nature has been introduced by Maxwell as electromagnetic waves, extending from X-rays to microwaves through visible light and infrared.

The thermal radiation seen in the human eye is at the wavelength of 0.4 to 0.8 microns (visible light waves). Every object that emits thermal radiation has a temperature greater than absolute zero (temperature where there is no vibrational motion on the atomic object, temperature -460-deg F). High atomic vibrations exist in objects with hot properties, otherwise cold objects have low vibrations. Positive (proton) and negative (electron) electrical particle reactions create electromagnetic fields and waves that are commensurate with the large emission of thermal radiation. When electromagnetic wave radiation reaches the cold, the electromagnetic field and electric field react to the particles of cold object atoms. In this condition the cold object will absorb the electromagnetic energy of the object hot. Energy is transferred from hot objects to cold objects without physical contact and no medium between them. [2]

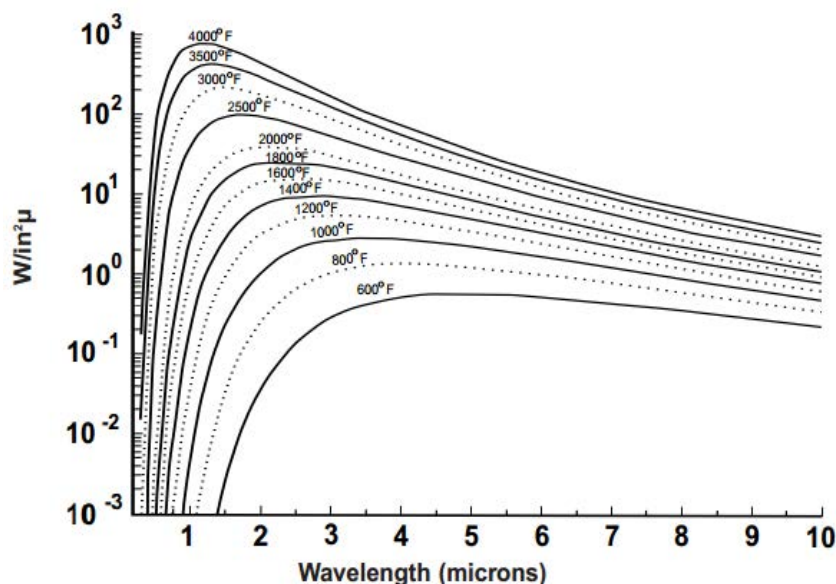


Figure 1. Linear scale graph of Planck curve [3]

Most thermal energy radiation from objects that have heat is in the infrared spectrum, ie from 0.1 to 100 microns (1 microns = 10⁻⁶ m). The amount of energy radiated by heat objects and electromagnetic waves is determined by the temperature of the object. The relationship between radiation energy and electromagnetic waves is shown on a graph called "Planck's Curve" -see figure 1 - found by Max Planck. From the graph we can see that the hot object radiates its energy above the wave spectrum. It can also be seen that the higher the heater temperature the peak wave energy will decrease. Peak energy wavelength and temperature are calculated using Wien transfer law:

$$\text{Peak Energy Wavelength} = \frac{5269 \text{ microns}^{\circ}\text{R}}{\text{Temp.}(\text{°F})+460} \quad (1)$$

There are physical parameters that must be considered when calculating how much heat energy object [3], they are:

Stefan-Boltzman Equation - is used to calculate the amount of radiant power from the surface of the object (blackbody) at a certain temperature, shown in the formula

$$E = \sigma T^4 \quad (2)$$

E = energy per unit area ($W\ m^{-2}$)

σ = cons ($5.67 \times 10^{-8}\ W\ m^{-2}\ K^{-4}$)

T = surface temperature ($^{\circ}K$)

View Factor - explains the percentage of energy that the object emits about the product. The Stefan-Boltzman equation only counts the radiation from a heat source, but does not calculate the radiant energy that is about the object. There is a geometric relationship between the heater size and the receiving object, and the distance between the two. The closer the heater to the receiving object, the more efficient the heat transfer will be.

Emmissivity - explains how radiation energy is absorbed by the product. Not all the energy that reaches the object is absorbed. Some will be reflected and others will be forwarded.

Total Incident Energy = Absorbed + Reflected + Transmitted

It is the physical property of the product that determines how well the object absorbs the radiative energy that it is exposed to. This physical property determines how well a surface radiates radiation energy. Emissivity is a numerical value with a scale between 0 and 1 that shows how well the object's ability to absorb or radiate radiation energy. Objects that perfectly absorb radiation energy are called blackbody (having emissivity = 1).

B. Infrared Spectrum on Electromagnetic Waves

Electromagnetic waves are waves that do not require transmission medium and are described with velocity, frequency, and wavelength (see figure 2). Based on differences in wavelength and frequency of electromagnetic waves consisting of gamma rays ($<0.01\ nm$), X-rays ($0.01-10\ nm$), ultraviolet ($10-400\ nm$), visible light ($390-750\ nm$), infrared ($0.75-1\ mm$), microwave ($1\ mm - 1\ m$), and radio waves ($1\ mm - km$) as shown in figure 3. Infrared waves include all electromagnetic radiation that is more than visible light waves, but shorter than microwaves.

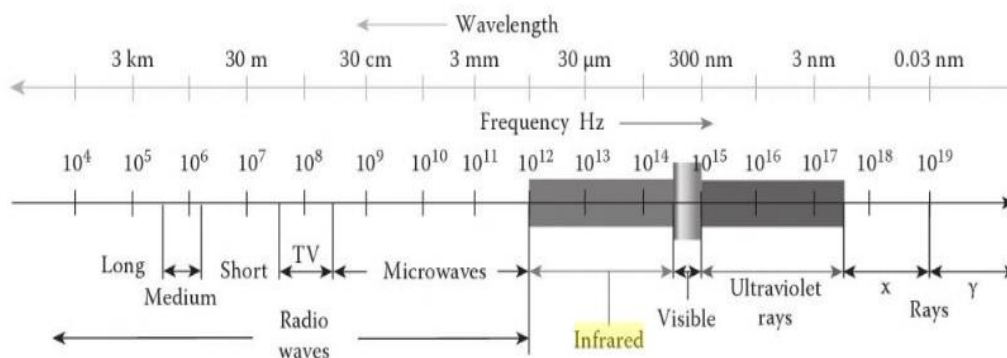


Figure 2. The spectrum of electromagnetic waves [4]

The infrared spectra are divided into several spectra including Near Infrared (NIR), Shortwave Infrared (SWIR), Midwave Infrared (MWIR), and Longwave Infrared (LWIR). NIR wavelengths have a range between 0.7-1.0 μm , SWIR waves with wavelength ranges between 1.0-2.5 μm , MWIR on wavelength ranges between 3.0-5.0 μm , and LWIR wavelengths are in the 8.0-14.0 μm range. The width of the infrared wave spectrum can be seen in figure 4.

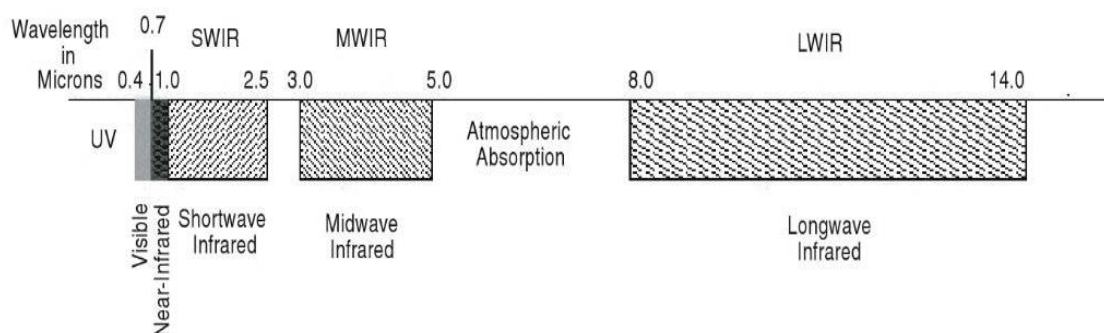


Figure 3. Infrared wave spectrum with its types (NIR, SWIR, MWIR, LWIR) [4]

At a wavelength of 3 μm or higher, the imaged radiation of the objects radiates according to temperature significantly, thereby often referred to as thermal infrared. The thermal infrared spectrum is divided into two main spectrums: MWIR and LWIR. Between these two spectra lie the atmospheric emission with a wavelength of between 5 and 8 μm . On this spectrum, thermal imaging is very difficult to do because it is so fuzzy with thermal air. Spectrum range with wavelength over 14 μm is termed Very Longwave Infrared (VLWIR) with higher application, but in this study only discussed until LWIR spectrum.

The radiation value depends on the temperature and emissivity of the material. For example in the human body with average temperature (37 deg C), through empirical measurement at least emissivity value is 0.91 at MWIR and at least 0.97 in LWIR. Objects with high efficiency reflect light, then less efficiency emits its thermal energy (emissivity) [4]. The maximum emissivity value of 1.0 (usually $e = 0.99$ or greater) means that objects perfectly absorb and emit radiation, the usual maximum emissivity termed with blackbody, and lower emissivity commonly called graybody. In many cases, object detection with thermal infrared is better using LWIR because LWIR emissions are higher than MWIR. Figure 5 shows the comparison of imaging results on different between visible light and infrared spectra.

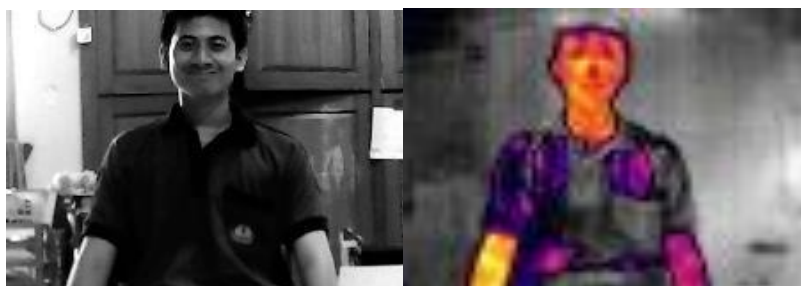


Figure 4. Facial images captured simultaneously in (a) visible light spectrum 0.4-0.7 μm with grayscale results, (b) longwave infrared 8.0-14.0 μm with colormap

C. Infrared Detection with LWIR Camera (Lepton FLIR)

The material used for infrared detection is one type of bolometer, which can measure the strength of electromagnetic radiation based on material heat with a temperature-dependent electrical resistance. More specifically, the microbolometer type of material is used as a detector on a non-cooling thermal camera commonly called an uncooled microbolometer. Research has shown that the microbolometer has a near-ideal performance for room temperature infrared sensors and is intended for infrared imaging construction without low-cost cooling [5]. The microbolometer array is placed on the camera for the detection of heat radiation (infrared) on objects with a wavelength of 7.5-14 μm .

Most thermal cameras used for remote-sensing are cooled systems. Cooled system is very sensitive and accurate in thermal sensing, this system is also big, expensive, and takes a lot of power. Due to its size and large power consumption, the system cooled thermal cameras are not used in small unmanned aerial vehicles. However, thermal camera microbolometers are not as sensitive and as accurate as cooled systems [6].

Lepton FLIR is one of infrared camera system integrated with LWIR microbolometer sensor array, fixed-focus lens assembly, and signal-processing electronics. FLIR Lepton Camera has embedded digital thermal image processing functions including automatic thermal environment compensation, noise filter, non-uniformity correction, and gain control integrated in one system.

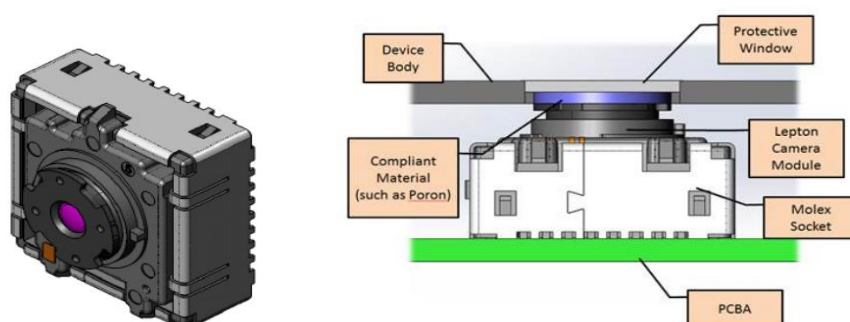


Figure 5. (a) Physical appearance (b) FLIR Lepton camera design structure [7]

Heat detection of objects using Uncooled vanadium-oxide (Vox) microbolometer sensor technology where the temperature will fluctuate according to the incident flux response. Changes in temperature will cause a proportional change in each microbolometer resistance. The Vox microbolometer material on the camera has a high temperature coefficient of resistance (TCR) and low noise, resulting in excellent thermal sensitivity and stable uniformity. The thermal detection sensitivity of this camera is less than <50 mK or 0.050 C. [7]

The shape and physical structure of FLIR Lepton camera can be seen in figure 6. With size 8.5 x 11.7 x 5.6 mm (without socket), 10.6 x 11.7 x 5.9 mm (with socket). Based on the specifications, the lens section has a FOV-horizontal 51-deg, and 63.5-deg diagonal with 80 (h) x 60 (v) active pixels used to capture relatively larger images of thermal cameras in general. The imaging results of the lens segment are sent to the Focal Plane Array (FPA) to be

converted and generate a periodic stream. Serial streams from FPA are received by on chip system devices (SoCs) that provide signal processing and output formatting. A simple architectural diagram of the Lepton camera module is shown in figure 7.

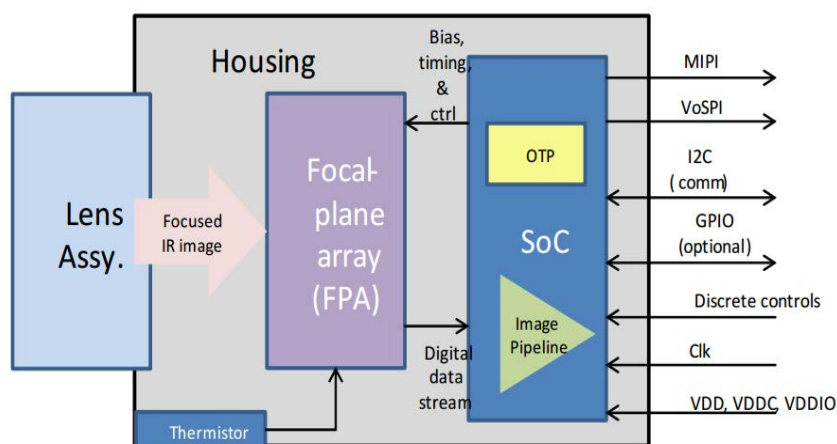


Figure 6. Lepton camera architecture. [7]

Thermal camera is one of the instruments to measure and image the heat of an object through the infrared radiation it emits. The array sensor in the camera will work by mapping the radiation to produce the temperature and thermal distribution information of an object.

D. Unmanned Aerial Vehicle (UAV)

Research on UAVs is increasingly focused on smaller and more reliable embedded hardware, making on-board data processing on UAVs more qualified. Data processing is capable of working even for video processing in real-time and fast algorithms for object detection and tracking [8]. Smaller unmanned aerial vehicles (UAVs) can be efficient devices for low cost thermal imaging [6]. Generally, thermal cameras used in UAVs are cooled systems that have large size, costly, and consume a lot of electrical power. Due to these conditions, thermal cameras with a light, low-cost, low-power uncool system are suitable for small unmanned aerial vehicles. In this study used multicopter type where take off and landing vertically and can maintain a certain altitude and position.

III. Research Methods

Scenario of Pipe Leak Simulation

For leakage simulation scenarios on pipes can be illustrated in Figure 7.

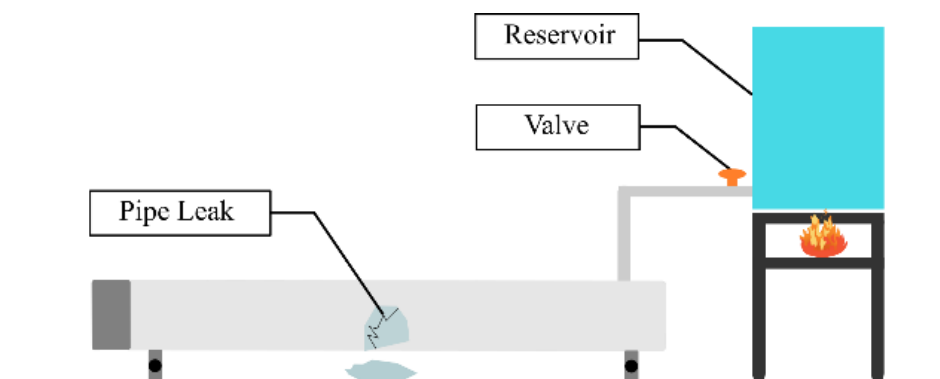


Figure 7. Illustration of leakage simulation scenario in oil and gas pipeline with hot water flow

As a substitute for oil and gas, this research uses water heated to room temperature of oil and gas distribution pipes. The reservoir is heated by fire with water temperature in the reservoir ranging from 130-170 degrees Fahrenheit (pipe room temperature) to obtain a representative result with conditions in the field. The heated water is supplied through a tube whose output is controlled by a tap into a galvanized pipe that has been manually leaked. Spot leakage pipe is made at the center of the pipe with a 5mm leak diameter. Galvanized pipe is placed at a height of 0.5 meters and a reservoir height of 1 meter above ground level.

Designing Tools and Systems

Table 1. Component Use of Justification

No	Component Name	Justification Usage
1	LWIR (Long Wave Infra-Red) FLIR Lepton Camera	Captures heat radiation from the pipeline and digitally imaging it
2	USB Visible Light Camera	Imaging pipe on the visible light spectrum as a comparison
3	Raspberry Pi 3	The main processing computer for processing and storing digital images
4	Raspbian Linux-based Operating System	Operating system used Linux based to facilitate communication between devices
5	Library OpenCV and IDE C++	Software for digital image processing based on coding with C ++ language
6	Laptop Corei3 2,4 Ghz 4GB RAM	Laptop as user interface to program and see infrared image processing
7	Multicopter	Aircraft carrier unmanned thermal camera

Imaging of the object is taken by using an infrared thermal camera to view the scattered heat visualizations on the surface of the pipe. The thermal camera will image the pipe surface and the existence of a pipe leak point at a certain height. In this research will be seen the heat distribution on the surface of the pipe and its effect on leakage.

Figure 8 below shows the design of a heat detection imaging system on objects captured by thermal cameras.

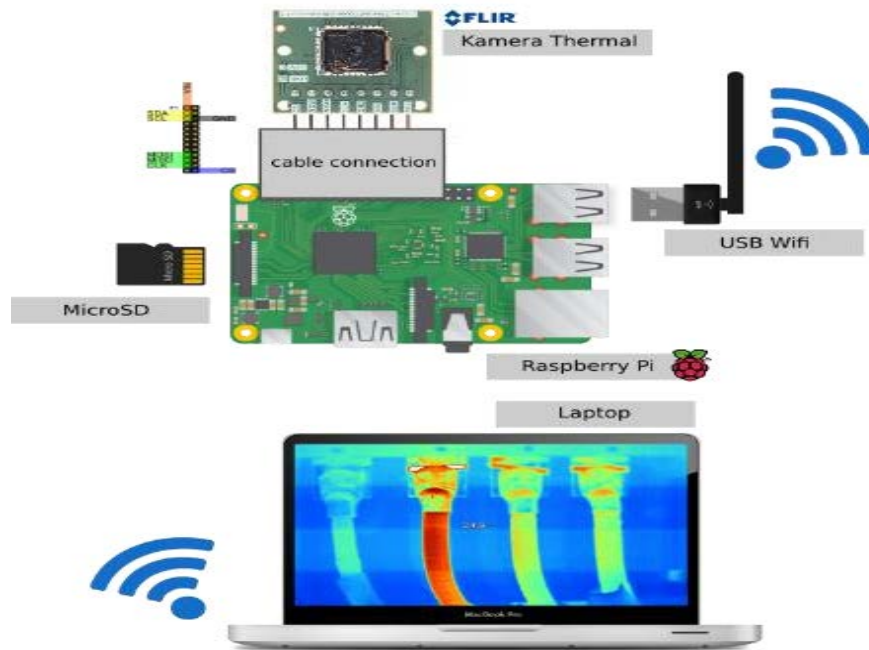


Figure 8. (a) Sketch of the main components of Raspberry Pi, (b) Raspberry Pi internal hardware diagram

Data retrieval

The data is taken by imaging the pipe that has a leak point with the air rides. However, in this research, data collection is not performed in real field, but still pay attention to the character and rule of pipe leak detection so that this research representative with detection in field.

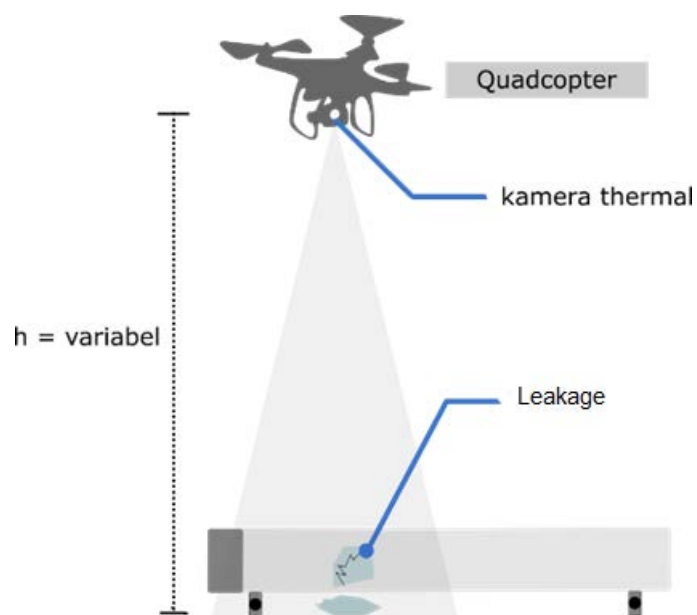


Figure 9. Illustration of pipeline imaging works on unmanned aerial rides

Data retrieval is done by simulating imaging of leak line. The pipe is spread over a certain length, and is imaged through the air at a certain height. The height of the shooting is determined not far from the pipe to maintain the quality and detail of the pipe image. With a certain length and a small camera resolution (80x60 pixels) at a certain height there will be some separate pipe images. Raising the distance of the shoot will indeed produce an image that reveals a wider pipe viewing angle, but will reduce the quality and detail of the pipe image. So it needs to maintain certain heights, to improve detection details.

Pipe imaging is done by flying a multirotor carrying an infrared camera along with a mini-computer. Multirotor flown at a predetermined distance and captures the pipe under conditions multirotor is steady-state. The altitude variable used is at a height of 1-10 meters. Pipe leakage will cause the liquid to come out of the pipe and give effect to the surrounding area. Data retrieval undertaken by flying multirotor will only imaged the top surface only. Detection properties in this research is to detect the presence or absence of leakage in certain area and not detect the location of point/hole leak.

Prior to the pipe leakage imaging, some temperature data retrieval was conducted for reference. Temperature data that is the temperature of the pipe surface temperature before and after the hot water, the ambient temperature, the temperature of the ground surface, and the temperature of the hot water coming out of the pipe leak hole.

IV. Data Result and Discussion

Initial stage in this research is assembling component at multicopter. As in design, FLIR lepton cameras are connected with raspberry pi as the main processor. Raspberries and cameras mounted on the lower body of multicopter. Both the thermal camera and the visual camera are positioned facing down. The power supply from the battery is connected to UBEC 5V 3A to keep current and voltage stable for raspberry pi. From the software side, the raspberry boot is set to connect automatically to the access point created by the user's computer. Remote connection settings are always enabled to easily connect raspberries with laptops.

After the assembly process, the thermal camera is tested whether it works properly. Thermal camera reading program uses source code in C++ programming language. In addition to camera readings and displays, programs are also added to store images and print the maximum value the camera generates. The value read on the thermal camera represents the heat on the monitored object. Figure 2 shows the varieties of values of camera reading values to reality temperatures that are not so linear in their changes. If the value range is not too large then the graph of change is quite linear.

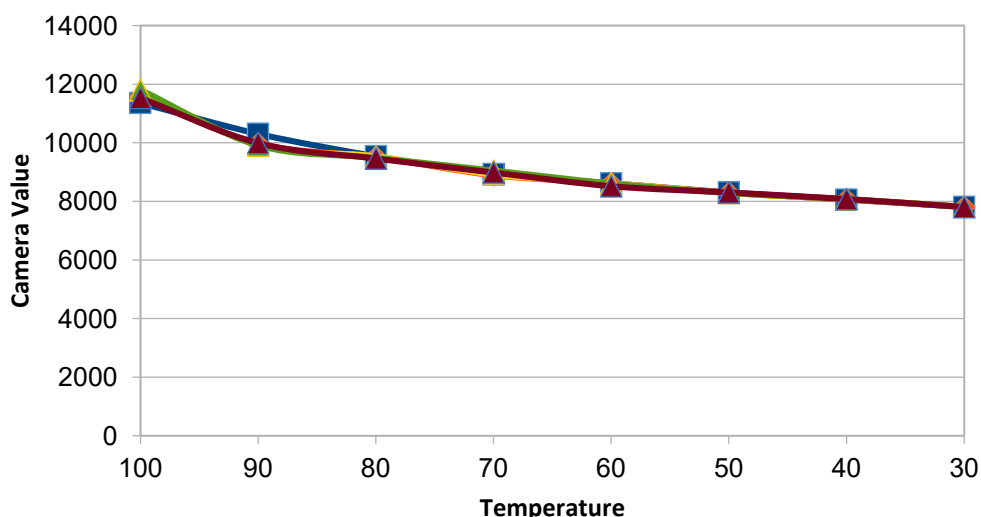


Figure 10. Graph of reality temperature relation with value of lepton camera

Pipe leakage is done by simulating the flow of hot water into the galvanized pipe. The first simulation is the flow of water with a temperature of 76 degrees Celsius. Imagery is divided into two, they are pipe imaging that has leak point and imaging without a leak point. The results of pipe imaging can be seen in the figure 11. There is a difference between the image of the pipe that has leaks with no leakage. The pipe with the leak point has significantly different heat with the other pipe surfaces and there is another heat on the soil affected by the leak. Otherwise image without leakage, the heat on surface has no significant difference and there is no heat emission from the ground around the pipe.

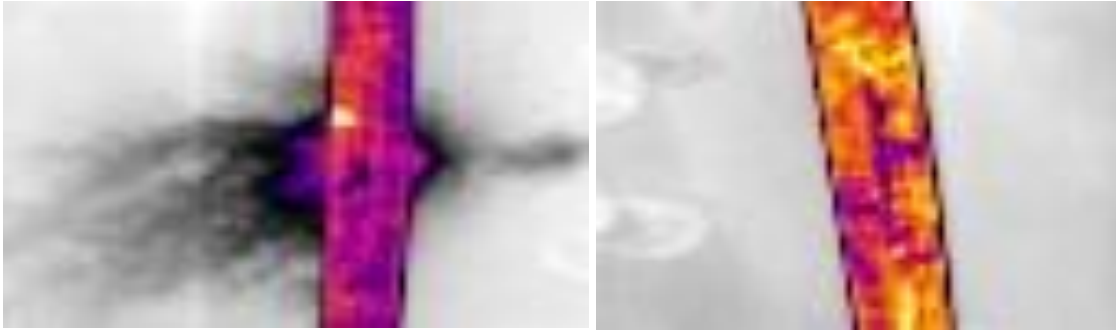


Figure 11. The infrared camera image results in the area (a) the pipe having a leakage point (b) of the pipe without a leak point

Taking images at different altitudes will also produce different detection results. Taking next data done with imaging at a height of 1 to 10 meters. Imaging is executed ten times at 1 meter intervals. The temperature of the water that flowed into the pipe was 58 degrees, the surface temperature of the pipe measured 37 degrees, and the water leak temperature was 39 degrees.

Table 2. Value thermal camera in the leakage image of the pipe with different heights

Lepton Value		Altitude (meter)
Peak Value	Bottom Value	
8140	7407	10
8331	7412	9
8379	7373	8
8315	7424	7
7810	7435	6
7964	7389	5
7970	7428	4
8094	7408	3
8137	7475	2
8335	7461	1

At different altitudes, the value of thermal camera readings against pipeline leaks has vary values. The resulting image is different to the altitude of the image, as shown in the figure 12.

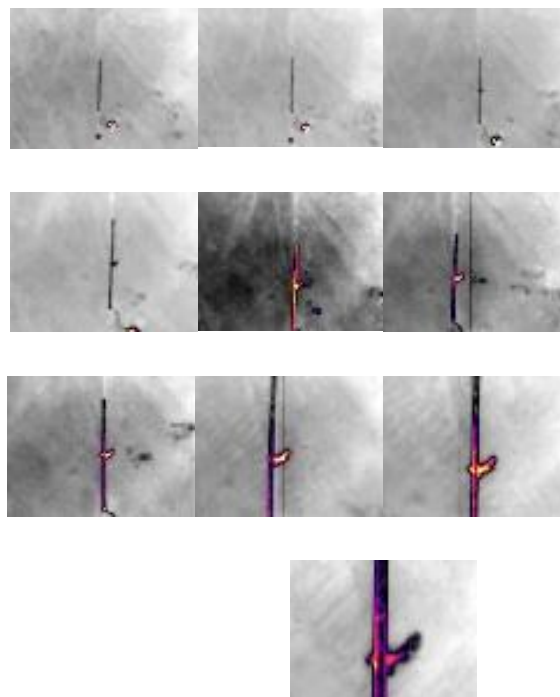


Figure 12. Thermal camera imaging results against pipeline leaks at altitude (a) 10 meters, (b) 9 meters, (c) 8 meters, (d) 7 meters, (e) 6 meters, (f) 5 meters, (g) 4 meters, (h) 3 meters, (i) 2 meters, (j) 1 meter

With a 80x60 pixels spatial resolution camera, the images above 6 meters altitude have poor detection quality where only the visible pipe form but not with its leakage point. At this altitude, what are shown hot is a reservoir that contains hot water. At an altitude of 1 to 6 meters, there is a well-visible leak in the infrared image. There is a dispersion of heat around the pipe indicating there is a leak in the area. The lower the altitude so the leak detection becomes more obvious.

V. Conclusion

Thermal camera can be applied on pipeline leak detection. Using microbolometer Long Wave Infrared (LWIR) placed on a multicopter unmanned aerial vehicle, it is able to detect leakage on pipeline well. But with 80x60 pixel thermal camera, small spatial resolution only detect leakage less than 7 meter.

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Section 2

Life and Applied Sciences

**Integrated Sci-Tech :
Interdisciplinary Research Approach
Volume 3**

Case Study of Converter Performance Evaluation on Sulfuric Acid Production (Department III PT B) (#573)

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Abstract—Converter was one tool unit that consisting 4 beds in the production process of sulfuric acid. The performance of this converter was supported by the addition of a vanadium pentaoxide (V₂O₅) catalyst. The process that occurring in the converter was double contacts – double absorbers. The purpose of this case was converter performance evaluation that using by SO₂ conversion parameter to SO₃. Primary data was the dry air flow rate that entering the burner, the SO₂ gas content that be into the converter, the catalyst temperature of each converter bed, and the catalyst pressure in each bed converter. Data on the field showed that activity on bed I was 72,96%, and theoretical was 60%. Then, bed II gave 91,22%; 87%; on bed III was 96,85%; 94%; and bed IV was 99,9%; 99,73% as respectively. From these experiments could be concluded that result data was greater than the theoretical. The difference of this conversion indicated that the performance of the converter did not increase.

Keywords—absorber, bed, converter, SO₂ conversion, performance.

I. Introduction

Converter is unit used to produce sulfuric acid in PT B production department III which consists of 4 beds. The catalyst used Vanadium Pentaoxide (V₂O₅)[1]. The eprocess used is double contact double adsorber. Converter consists of 4 bed, and three bed is the first level conversion and the fourth bed is a second level conversion. Gas process containing SO₂ wit temperature of 430°C goes to converter bed I. About 60% of SO₂ gas is converted to SO₃ [2] wit the following reaction :



Reaction (1) is reversible exothermic reaction with her release of 23,49 x 10³ Kcal/kg.mol. The gas output of bed I using SO₃ gas with temperature 610°C goes into heat exchanger I where the heat is given to going into bed IV, then gas from bed I goes to bed II with temperature 440°C and will happen subequent conversions. The output gas II with temperature 520°C goes into heat exchanger II then gas with temperature 430°C goes to bed III, in converted heat exchanger gas giving its heat to the gas entering bed IV. The output from bed III containing SO₃ gas with temperature 450°C goes into economizer I where it is cooled to 220°C before entering the absorber tower I. After SO₃ gas absorber with H₂SO₄ in the absorber tower, the remaining gas at 80°C through the demister is separated in parallel and then into piping heat exchanger I dan II, then become one before going into bed IV. Before gas to entering bed IV is heated in di heat exchanger I becomes 420°C. The output gas bed IV with a temperature 440°C goes into economizer II, where the gas is cooled to

190°C before entering the absorber tower II. To prevent the possibility of condensation from the absorber tower output gas I the equipped with tracking mounted on the gas line between the absorber tower I and heat exchanger II [3],[4].

Controlling temperature of each bed and maintaining the desired SO₂ gas concentration in the gas to be generated in the converter is most important operating process. This temperature rise should not exceed 62°C for bed output 1, its purpose is to avoid catalyst damage and other equipment in the converter. It can be controlled by closing or opening the heat regulator. Hot gas temperature drop inside heat exchanger.

The balance of the reaction depends on the temperature, total pressure, and reactant concentration. The equilibrium constants for this reaction are calculated from the respective gas parallel trace as follow :

$$K_p = \frac{p(SO_3)}{p(SO_2) \cdot p(O_2)^{0.5}} \quad (2)$$

The relationship between K_p and temperature according to bodenstein and pohl is as follows:

$$\text{Log } K_p = 5186,5/T + 0,611 \log T - 6,75 \quad (3)$$

The conversion achieved in double contact double absorber process is better than single contact process. In a single contact process the maximum conversion achieved with 4 bed catalysts is 99.5-98% depending on the composition of the incoming gas. While in double contact double absorber process can each more than 99,7%.

Converter on PT B using array 3+1. The reactant gases first enter the bed reactor 1, the output gas from bed 1 goes into bed 2 and so on until bed 3, between the bed is always cooled and before entering bed, the gas from bed 3 is passed by absorber 1 for SO₃ absorption. This is used H₂SO₄ 98,5% as an absorbent. It is expected that SO₃ will be bound by the water contained in sulfuric acid. In this case no pure H₂O is used as an absorbent because the SO₃ dissolving heat in H₂O is higher so that a portion of H₂O is evaporated and carries the H₂SO₄ molecule and creates a haze that is difficult to remove so that the absorption is not perfect. SO₂ gas output from absorber 1 is fed to bed 4 to convert SO₂ to SO₃ leftover. From bed 4 gas enters absorber 2 for SO₃ gas absorption. With this process is expected to exhaust gas free gas SO₃ gas.

In process of making H₂SO₄ especially in the process that occurs in the converter unit is indispensable heat exchangers, because the process of SO₂ conversion to SO₃ an exothermic reaction. This exothermic reaction will cause the temperature of the output on each bed to be increased so that a heat exchanger is required to cool the bed temperature so that it is equal to the operating conditions on the next bed.

Basically the heat exchanger used is heat exchanger used is HE and economizer. HE (heat exchanger) is used to cool SO₂ and SO₃ outputs of bed 1 and 2, while the economizer is used cool the SO₃ outputs of bed 3 and 4. The type of heat trapper is shell and tube type, where the SO₃ gas will be cooled through the shell side, while the coolant which is used through the tube side. HE shell and tube usually use steel pipe containing Fe metal element so it can cause corrosion if react with SO₂ gas and SO₃, although this process happened slowly but will still degrade the performance of the heat exchanger.

II. Procedure Method

A. How to obtain Data

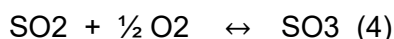
Primary data obtained from central control room of production acid sulfate II Departemenr III PT B, among others:

- 1) Dry air flow rate enter burner
- 2) SO₂ Gas into converter
- 3) Temperature of catalyst in each bed of converter
- 4) Catalyst pressure in each bed of converter

B. Data Processing

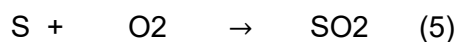
From the data obtained is done data processing as follows:

- 1) Calculating the incoming gas composition on each converter bed based on reaction stoichiometry and mass balance is converted.



Initial	a	b	c	
Reaction	ax	$\frac{1}{2} ax$	ax	
Balanced	$a(1-x)$	$b - \frac{1}{2} ax$	$c + ax$	

For SO₂ converter coming from bed 1 already known percentage of data contained in laboratory, then from the data we can calculate the number of moles of SO₂ with the following formula :



Initial	L	F		-
Reaction	L	L		L
Balanced	-	F-L		L
SO ₂ Gas inlet converter				= L kmol
O ₂ Gas reaction in furnace (burner)				= L mol
O ₂ Gas left out in furnace				= M kmol
				= F-L kmol

N₂ in which are included in th air burner = N kmol

Then :

$$\begin{aligned} \% \text{SO}_2 \text{ inlet converter} &= \frac{n\text{SO}_2}{n\text{SO}_2 + n\text{O}_2 + n\text{N}_2} \\ &= \frac{L}{L + M + N} \end{aligned}$$

Calculate the conversion of each bed by trial and error method with the formula used Bodenstein dan Pohl (3) :

$$\text{Log } K_p = 5186,5/T + 0,611 \log T - 6,7497 = f(x)$$

f(x) is prepared based on the respective concentrations of the reactants in equilibrium. The balance state of K_p is structured as follows :



Awal	a	b	c	
Reaksi	ax	$\frac{1}{2} ax$	ax	
Setimbang	$a(1-x)$	$b - \frac{1}{2} ax$	$c + ax$	

$$\begin{aligned}
 \text{SO}_2 &= a - ax && = A \\
 \text{O}_2 &= b - \frac{1}{2} ax && = B \\
 \text{SO}_3 &= c + ax && = C \\
 \text{N}_2 &= d && = D \\
 \text{Total} &= a - ax + b - \frac{1}{2} ax + c + ax + d = E \\
 &= a + b + c + d - \frac{1}{2} ax && = E
 \end{aligned}$$

$$Kp = \frac{\left(\frac{C}{E} xPabs\right)}{\left(\frac{A}{E} xPabs\right)\left(\frac{B}{E} xPabs\right)^{1/2}}$$

$$Kp = \frac{\left(\frac{C}{A}\right)}{\left(\frac{B}{E} xPabs\right)^{1/2}}$$

of the temperature of each bed obtained the value of Kp each bed by the method of trial and error by counting the conversion (x).

2) Calculate the conversion of each bed by trial and error method :

$$\text{Bed I} = \frac{\text{SO}_2 \text{ inlet} - \text{SO}_2 \text{ Outlet I}}{\text{SO}_2 \text{ inlet}} \times 100\% = xI\% \quad (2)$$

$$\text{Bed II} = \frac{\text{SO}_2 \text{ inlet} - \text{SO}_2 \text{ Outlet II}}{\text{SO}_2 \text{ inlet}} \times 100\% = xII\% \quad (3)$$

$$\text{Bed III} = \frac{\text{SO}_2 \text{ inlet} - \text{SO}_2 \text{ Outlet III}}{\text{SO}_2 \text{ inlet}} \times 100\% = xIII\% \quad (4)$$

$$\text{Bed IV} = \frac{\text{SO}_2 \text{ inlet} - \text{SO}_2 \text{ Outlet IV}}{\text{SO}_2 \text{ inlet}} \times 100\% = xIV\% \quad (5)$$

III. Result and Discussion

The conversion calculation from data processing in appliance resulting bed converter temperature parameter in Table 1.

TABLE I The conversion calculation on the converter appliance using the resulting bed convert temperature parameter

Bed	Calculation of converter (%)	Converter teoritis
I	72,96	60
II	91,22	87
III	96, 85	94
IV	99,9	99,73

IV. Conclusion

The conclusion of the formation of SO₃ design tool amount to 99,7% of the calculation of actual data obtained conversion of 99,93%. From the data can be seen that the conversion calculation is greater than the theoretical conversion. This conversion difference indicates that the performance of the converter is not suffering.

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Alginate Addition on Geblek (#640)

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Abstract- *The objective of this research was to obtain the appropriate alginate addition to the best physical, chemical, and sensory characteristics of Geblek. The experiment was arranged in a non-factorial Random Complete Block Design (RCBD) in four replications. The treatment given on each replication was the alginate addition that consisted of six different levels, they were 0% (A0), 1% (A1), 2% (A2), 3% (A3), 4% (A4), dan 5% (A5) (w/w). The data were evaluated by using The Smallest Real Difference Test (SRD) of 5%. The results showed that the appropriate concentration of alginate addition was 1% with the following criteria texture was not tough; preferred by panelists based on texture, colour, and taste attributes; has a hardness value of 0.475 mm/g/dt; water content of 39.864%;oil absorption of 5.567%, fat content of 3.905% protein of 5.849%, ash of 2.039%, and carbohydrate of 40.776%.*

Keywords: *Alginate, Geblek, and quality of Geblek*

I. Introduction

Cassava was one of agricultural commodities in Indonesia which has a important role in fulfilling the national food needs because of its abundant availability. Fresh cassava tuber has a very low economic value at the big harvest time. Therefore, it requires effort to increase the added value of cassava tuber . One of cassava tuber diversification process was geblek.

Geblek was one kind of traditional food from Kulonprogo, Yogyakarta. Raw materials of geblek were wet starch, cassava dregs, coconut slices or grated coconut and spices (Koesoemawardani, et al., 2016). The colour of geblek was cloudy white, printed in small ball or can be formed in another custom, when it was bitten likes a sluggish cracker, its taste was savory and most tasty was consumed a few minute after fried in while warm (Sije, 2013; Koesoemawardani, et al., 2016). One of the problem of geblek was its texture become hard in cold condition. Therefore, the innovation to improve its texture was dobe by using a binder material that can synergize with cassava tuber , especially in making geblek.

Ji-Sheng et al. (2011) states that alginate has groups of hydroxyl and numerous carboxyl, which determine the physicochemical and biological characteristics of alginates, even affecting their reactive functional groups. Thus, alginate was very flexible to be used in many potential applications of foodstuffs (Abd El-baki, 1982; Sim, 2011; Santana et al., 2013; Khoury et al., 2014; Fransiska et al., 2014; Rockower, et al, 1983 ; Ahmed et al., 1983) and non-foodstuffs (Davies et al., 1994; Mandal, 2006; Liew, et al., 2006). Therefore, this research uses alginate to improve the texture of geblek. The purpose of this research was to

obtain appropriate addition amount of alginate in the making of geblek, in order to produce the best physical, chemical, and sensory characteristics of geblek.

II. Materials and Methods

The materials for making geblek were cassava tubers, sodium alginate, water, garlic, salt, coconut pulp, and grated coconut, while the other materials are materials for analyst. The tools were geblek processing tools, glass and instrument tools for analysis.

III. Research Methods

This research was arranged in nonfactorial within Randomized Complete Block Design (RCBD) consisting of 6 levels of alginate addition, ie 0%, 1%, 2%, 3%, 4%, and 5% (w / w). Results were expressed by means of values. Comparison of means performed by ANOVA and followed by LSD ($p < 0,05$) (Steel and Torrie, 1995). Fried geblek were evaluated on physical, chemistry, and sensory properties. Evaluation on sensory characteristic covers attributes of texture (hedonic and scoring methods), colour, flavor, and taste with hedonic methods (Meilgaard et al., 2006). Evaluation of physical and chemical properties on geblek product were test of product hardness (Sumarmono, 2012), colour with Digital Image (Eko, 2012), water content (AOAC, 1984), and Oil Holding Capacity (AOAC, 1995). The best product from physical and sensory properties test result then will be tested on protein (AOAC, 2007) and carbohydrate content (by difference).

IV. Results and discussion

A. Texture (Scoring test) and Hardness Level

The result of analysis of texture by scoring test and hardness level showed that the addition of alginate concentration has significant effect on geblek texture. This is in line with Santana et al (2013) study which stated that the addition of alginate has an effect on hardness, springiness, and cooking yield on soy sauce fish; Abd El-Baki et al (1982) states that alginate can increase water holding capacity (WHC), increased considerably the cooking yield of sausage and plasticity on fresh buffalo sausage. Sim et al (2011) states that sodium alginate can improve the texture of the wheat dough and the Chinese steamed bread to be softer for a long time during storage. The score of texture value of geblek product with the addition of alginate concentration of 0-5% is 2,65-4,02 which means hard, rather hard, and no hard texture (Table 1).

Based on the LSD test (Table 1) it is known that the value of geblek texture score with the addition of alginate concentration of 1% is significantly different with the texture value of geblek in the addition of alginate concentration of 0%, 2%, 3%, 4%, and 5%, while geblek texture with alginate concentration addition of 3%, 4%, and 5% were not significantly different. The highest score of geblek texture score was in addition of alginate concentration of 1% with a score of 4.02 (no hard), whereas the lowest score of texture scoring at Alginate concentration addition of 3%, 4%, and 5% with score 2.65-2,86 (rather hard)

Table 1. Scoring test score on geblek texture with addition of alginate at various concentrations

Treatment	Middle Score
A1 (Alginates addition of 1%)	4,02 ^a
A0 (Alginates addition of 0%)	3,55 ^b
A2 (Alginates addition of 2%)	3,38 ^b
A3 (Alginates addition of 3%)	2,86 ^c
A4 (Alginates addition of 4%)	2,73 ^c
A5 (Alginates addition of 5%)	2,65 ^c
BNT0,05 = 0,416	

Note: Different numbers mean each treatment is significantly different in test on Least Significance Different (LSD) of 5% level

Table 2. Hardness level of geblek with addition of alginate at various concentrations

Treatment	Middle Score
A1 (Alginates addition of 1%)	0,48 ^a
A0 (Alginates addition of 0%)	0,46 ^b
A2 (Alginates addition of 2%)	0,46 ^b
A3 (Alginates addition of 3%)	0,44 ^c
A4 (Alginates addition of 4%)	0,44 ^c
A5 (Alginates addition of 5%)	0,43 ^d
BNT0,05 = 0,008	

Note : Different numbers mean each treatment is significantly different in test on Least Significance Different (LSD) of 5% level

Based on LSD test (Table 2) it is known that the value of geblek texture score with the addition of alginate concentration of 1% is significantly different with the value of geblek texture in the addition of alginate concentration of 0%, 2%, 3%, 4%, and 5%. The highest hardness value was obtained at geblek with the addition of alginate concentration of 1% i.e. 0.48 mm / g / dt, while the lowest hardness was obtained at geblek with 5% alginate concentration treatment i.e. 0.43 mm / g / dt . In the frying process found expansion which determined by the water content of the material. According to Muliawan's (1991) research, this expansion is the result of a large number of explosions of chained water that evaporate rapidly during the frying process and simultaneously form air cavities that are spread evenly throughout the product structure. If the starch gelatinization process runs perfectly then will find more empty cavity and leave little space between the cavities. When product become cool, the empty cavity will shrink and make the texture geblek without the addition of alginate become hard.

The hardness level of geblek is influenced by the amount of water trapped by alginate in forming gel. Natrium alginate can bind water very strongly because it contains a large number of carboxylic anions (COO-) trapped in the three-dimensional structure (Marseno 1988, Ji-Sheng et al., 2011). If given alginate concentration is too high, geblek texture

produced will get harder. This is directly proportional to research on the parameter of water content value, i.e. geblek with large addition of alginate concentration has low moisture value, if it's fried the amount of evaporated water will be less, thus the water content of the product will decrease. Low water content geblek has a high hardness level, and vice versa (Koesoemawardani et al., 2012). The influence of alginate addition to water content also found in Prawira research (2008), i.e. the alginate addition with high concentration, can produce low water content in kamaboko. Based on hedonic test on geblek, it was found that geblek with alginate addition of 1% yielded the most preferred texture with score 4.14 (very favorable).

B. Colour

The analysis of variance result showed that the addition of alginate concentration had significant effect on panelist's hedonic score on geblek colour (Prawira, 2008; Syafarini, 2009; Santana et al. 2013). Colour score of hedonic test of geblek product with the addition of alginate concentration of 0 -5 % is 2.25-4.29 which means the resulting texture is rather un-favorable, neutral, and very favorable.

Table 3. Hedonic score on the colour of geblek with the addition of alginate at various concentrations

Treatment	Median
A0 (Alginate addition of 0%)	4,29a
A1 (Alginate addition of 1%)	4,03ab
A2 (Alginate addition of 2%)	3,75b
A3 (Alginate addition of 3%)	3,30c
A4 (Alginate addition of 4%)	2,68d
A5 (Alginate addition of 5%)	2,25e
BNT _{0,05} = 0,318	

Note: Different numbers mean each treatment is significantly different in the Least Significance Different Test (LSD) of 5%

Table 3 shown that the hedonic value of geblek color with the addition of alginate concentration of 0% is not significantly different with the value of geblek color in the addition of alginate concentration of 1%, but significantly different with the color of geblek in the addition of alginate concentration of 2%, 3%, 4 %, And 5%. The highest hedonic value on colour is obtained in geblek with the addition of alginate, 1%, and 2% concentration with a score of 3.75-4.29 (favorable). Geblek with the addition of alginate at high concentration, making the geblek colour darker than Geblek with alginate addition at low concentrations. The addition of alginate in geblek of 0%, 1%, and 2% has a white to slightly brownish white appearances, while the addition of alginate 3%, 4% and 5% has a slightly brownish up to brownish appearance. Therefore geblek with the addition of alginate at high concentrations was less favorable to the panelists than geblek with the addition of alginate at low concentrations.

The result of the hedonic test on geblek colour is directly proportional to this research on color parameters analyzed by using digital image. Samples of geblek that categorized in the white threshold value is geblek with alginate addition treatment of 0%, while geblek with the

addition of alginate of 1% to 5% not categorized in the white threshold value. Produced geblek with the addition of alginate 1% to 5% has a white brownish, slightly brownish up to brownish appearance. The effect of alginate addition to geblek color in line with Prawira research (2008), that is more alginate concentration added resulting in more lesswhite level in kamaboko, and it guessed related to the water holding capacity possessed by alginate. Kamaboko with high water binding capability has a lower brightness level compare to low one. Kamaboko with high water binding yield produced lower free water content in the product, causing the product becomes less bright, whereas kamaboko with low water binding capability produced high free water content causing the product becomes more brighter.

C. Colour Using Digital Image Test

The process of capturing light by cones cell of human eye basically divided into three main groups, namely red (red), green (Green), and blue (Blue). Then they converted into HSI colour modeling (Hue, Saturation, Intensity) to simplify the process of color clarification. Based on the results of color analysis using digital images of MATLAB applications obtained data as follows.

Table 4. HSI values in geblek colour with addition of alginate at various concentrations

Treatment	H	S	I
A0 (Alginate addition of 0%)	0,2038	0,2205	0,1658
A1 (Alginate addition of 1%)	0,1539	0,2852	0,1521
A2 (Alginate addition of 2%)	0,1527	0,2848	0,1520
A3 (Alginate addition of 3%)	0,1491	0,2822	0,1568
A4 (Alginate addition of 4%)	0,1487	0,2641	0,1535
A5 (Alginate addition of 5%)	0,1485	0,2621	0,1512

Hue (H) is an attribute or property of light used to distinguish colours and determine redness, greenness, and so on. The weakness and strength of this hue are described in saturation. Saturation (S) is a component used to describe the strength and fade of a colour received by the eye. Intensity (I) is an attribute that expresses the representation of the number, much of a light reflected or transmitted by an object (Kiswanto, 2012). According to Sije (2013), Geblek has a cloudy white physical appearance. An object can be said to be white if it has a threshold value of Hue between 0.2 to 0.7; Saturation value is between 0.01 to 0.3; And the Intensity value is between 0.1 and 1. Based on the MATLAB results, the samples which categorized in the white threshold value are geblek with 0% alginate addition treatment, while the geblek with the addition of alginate of 1% to 5% are not in the white threshold value. Produced Geblek with the addition of alginate 1% to 5% has appearance of a slightly brownish white, slightly brownish up to brownish.

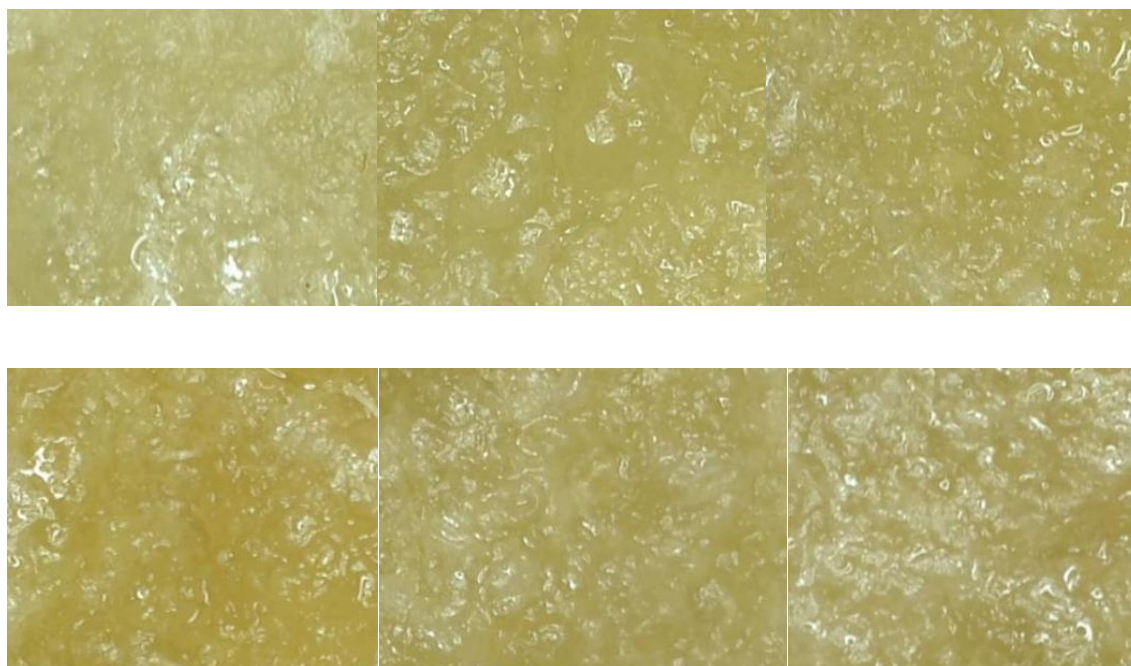


Figure 1. Geblek colour with addition of alginate at various concentrations

D. Flavors

The results of analysis of variance showed that the addition of alginate concentration significantly affected the panelist's preference on the geblek taste. This is in line with Wanstedt et al's (1981) study; Ahmed et al. (1983). The score of hedonic on flavor of geblek products with the addition of alginate concentration of 0-5% was 2.35-4.12 (slightly favorable to very favorable).

Table 5. Hedonic score on the taste of geblek with the addition of alginate at various concentrations

Treatment	Mean
A1 (Alginate addition of 0%)	4,12a
A0 (Alginate addition of 1%)	3,93a
A2 (Alginate addition of 2%)	3,68b
A3 (Alginate addition of 3%)	3,06c
A4 (Alginate addition of 4%)	2,74d
A5 (Alginate addition of 5%)	2,35e
BNT _{0,05} = 0,229	

Note : Different numbers mean each treatment is significantly different in the Least Significance Different Test (LSD) of 5%

Table 5 shows the hedonic value of geblek flavor with the addition of alginate concentration of 1% is not significantly different with the hedonic value of geblek at the addition of alginate concentration of 0%, but significantly different with the flavor of geblek in the addition of alginate concentration of 2%, 3%, 4 %, And 5%. The highest hedonic value of

taste was obtained at geblek with the addition of alginate concentration of 1% and 0% with score 3,93-4,12 (favorable), whereas the hedonic value on the lowest flavor was the addition of 5% alginate concentration with score 2,35 (un-favorable). Addition of alginate with higher concentration causes geblek has a bitter taste compared with the addition of alginate with lower concentrations. This results in products with high alginate concentration not favored by the panelists.

E. Water content

The analysis of variance result showed that the addition of alginate concentration significantly affected the water content of geblek product. The value of water content of geblek products with the addition of alginate concentration of 0 - 5% is 41,532-31,554%.

Table 6. Value of geblek water content with the addition of alginate at various concentrations

Treatment	Mean
A1 (Alginate addition of 0%)	42,53 ^a
A0 (Alginate addition of 1%)	39,86 ^b
A2 (Alginate addition of 2%)	37,91 ^c
A3 (Alginate addition of 3%)	35,86 ^d
A4 (Alginate addition of 4%)	34,55 ^d
A5 (Alginate addition of 5%)	31,55 ^e
BNT0,05 = 1,922	

Note: Different numbers mean each treatment is significantly different in the Least Significance Different Test (LSD) of 5%

Table 6 shows that the water content of geblek with the addition of alginate concentration of 0% is significantly different with the water content of geblek on the addition of alginate concentration of 1%, 2%, 3%, 4%, and 5%. The highest water content value was obtained in geblek with the addition of 0% alginate concentration that is 42.53%, while the lowest geblek hardness value was at the addition of 5% alginate concentration that is 31.55%. The ability of alginate in water binding was very high, more alginate concentration given to geblek, then it shows the tendency of more lower water content produced, and vice versa, less alginate concentration given to geblek, more higher the water content (Prawira, 2008; Mastuti, 2008; Koesoemawardani, et al 2012). Sodium alginate can bind water very strongly because it contains large amounts of carboxylic anion (COO⁻). The water binding able to form gel because the large amount of water trapped in the three-dimensional structure). When dissolved in water, sodium alginate will form a mesh-like grid that can bind strongly many water molecules and hold water-soluble well (Marseno, 1988; Ji-Sheng et al., 2011). The increased concentration of Na-alginate allows more chemical reaction of gel formation. Gel formation causes free water in tendon to be used for forming complex bonds of gel matrix consisting of water-protein-polysaccharides, so less free water in the meat system (Prawira, 2008).

F. Oil Absorption Strength

Oil absorption strength is the amount of oil absorbed in the product during the frying process. Oil absorption is obtained from the reduction of fat content value after fried with water content value before frying. Analysis of Variance result (Table 43) showed that the addition of alginate concentration had significant effect on the absorption of oil of geblek products. The absorption capacity of geblek oil with the addition of alginate concentration of 0-5% was 5,58-15,62%.

Table 7. Absorption value of geblek oil with the addition of alginate at various concentrations

Treatment	Mean
A0 (Alginate addition of 0%)	15,62 ^a
A1 (Alginate addition of 1%)	10,41 ^b
A2 (Alginate addition of 2%)	9,83 ^c
A3 (Alginate addition of 3%)	9,23 ^d
A4 (Alginate addition of 4%)	7,19 ^e
A5 (Alginate addition of 5%)	5,58 ^f
BNT0,05 = 0,098	

Note: Different numbers mean each treatment is significantly different in the Least Significance Different Test (LSD) of 5%

Table 7 shows that the absorption of oil in geblek among all treatments of alginate concentration addition is different. The highest oil absorption is obtained in geblek with the addition of 0% alginate concentration, while the lowest oil absorption is obtained in geblek with the addition of alginate concentration of 5% . If more alginate concentration is given, then the less absorption of oil in geblek happens.

According to Dalimunthe's (2014) study, the strength reduction of oil absorption is due to decreased water content and fat content, so in the frying process will create less water-filled cavities, then the water will out and fill by oil. This is in line with the value of moisture content in this study, ie higher moisture content results in higher product oil absorption, whereas low moisture content results in low oil product absorption. High temperatures cause more dehydration on the surface of the material so that there is more empty space filled with oil (Ketaren, 1986). The fried foods have the same structure, they are outer zone surface, crust and core. The absorbed oil used for soften food crust, match with the amount of water that evaporates during frying.

G. Best Treatment

The best product selection is based on the results of geblek products testing with organoleptic, physical, and chemical parameters. Geblek with the addition of 1% alginate treatment is the best product which has a texture that is no hard criteria; favored by panelists based on texture, color, and taste attributes; Has a hardness value of 0.475 mm / g / dt; water content of 39,864%; and oil absorption of 5,567%.

V. Conclusion

Based on the results of research that has been done, it can be concluded that the appropriate concentration of alginate addition to the best physical, chemical, and organoleptic characteristics of geblek, is geblek with the addition of alginate of 1% which has a texture that is not hard; Favored by panelists based on texture, color, and taste attributes; Has a hardness value of 0.475 mm/g / dt; Water content of 39,864%; Oil absorption of 5,567%, fat content of 3,905%, protein of 5,849%, ash content of 2,039%, and carbohydrate level of 40,776%.

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Using GNU Octave and Modification of Prim's Algorithm to Solve the Multi Periods Degree Constrained Minimum Spanning Tree (#734)

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Abstract. *The Minimum Spanning Tree (MST) is a wellknown problem and used as the backbone problem in many network design problem. Given a graph $G(V,E)$, where V is the set of vertices and E is the set of edges connecting vertices in V , and for every edge e_{ij} there is an associated weight $c_{ij} \geq 0$, The Multi Period Degree Constrained Minimum Spanning Tree (MPDCMST) is a problem of finding an MST while also considering the degree constrained on every vertex, and satisfying vertices installation on every period. We developed two algorithms for solving this problem (MPDCMST_early and MPDCMST_later) and used GNU OCTAVE for coding and visualization. We implement those algorithms using 300 generated random problems. Moreover, we compare our algorithms using those that already in the literature and show that our proposed algorithms are competitive.*

Keywords: *multi periods, degree constrained, Prims' algorithms, GNU OCTAVE*

I. Introduction

Most in network design problems, The Minimum Spanning Tree (MST) is usually used as the backbone. If we add degree restriction on its vertices (can represent cities, stations, etc) of the graph (represents the network), the problem becomes the Degree Constrained Minimum Spanning Tree (DCMST) problem. Moreover, if we restrict and divide the stages or periods of the network's instalation, the problem emerges as The Multi Period Degree Constrained Minimum Spanning Tree (MPDCMST) problem. The later constraint occurs usually because of the fund limitation for installing (connecting) the network. This problem arises when we want to design a network which requires that every vertex (node) restricts the number of connections/interfaces whilst also must to consider a set of vertices that have to be connected/ installed in a certain period due to the fund restriction, weather, etc.

In this paper we organize the discussion as follows: In Section 2 we give the history of the problem; In Section 3 we discuss how to apply the algorithms developed using GNU Octave and implement them; in Section 4 we discuss the results, followed by conclusion.

II. The Constrained Minimum Spanning Tree Problem

Because of its specific structure and used in many network design problems, the Minimum spanning tree problem have been studied extensively and a variety of fast algorithms have been developed. An efficient and fast minimum spanning tree algorithm that requires computational time nearly linear in the number of edges had been developed [1]. The MST problem is one of the classical problems where the objective is to construct a minimum cost/weight network. This problem usually arises in many network design applications that must satisfy other graph parameters such as: degree, distance, diameter, connectivity, flow, etc. For instance, in a transportation network a distance restriction on the flow commodities could represent the maximum distance allowed for delivery.

The Degree Constrained Minimum Spanning Tree (DCMST) problem is a Minimum Spanning Tree with degree restriction on every vertex. This problem arises on designing

network where the degree restriction represents the number of allowable links on that vertex, i.e. the handling capacity of each of the vertices imposes a restriction on the number of edges (or wires/roads) that can be connected to a vertex. For example, the application of The DCMST is in designing the road system, where the set of roads must connect a collection of suburbs/towns, but there is a restriction that no more than certain number of roads (example: four roads) are allowed to meet at an intersection.

There are lots of investigations regarding the DCMST problem. Because of its NP-Completeness [2], heuristic methods have been dominated such as: greedy algorithm based on Prim's and Kruskal's algorithm [3], Genetic Algorithm [4], Iterative Refinement [5], Simulated Annealing [6], Modified Penalty [7], and Tabu Search [8-10].

In real situation, to connect all components in a network need certain time and process in order to be completed. The time of completion can vary depends on the need and priority of the network itself. The Multi Period Degree Constrained Minimum Spanning Tree (MPDCMST) problem was introduced and the proposed method to solved it by using branch exchange and Lagrangean relaxation [11] with assumption 10 years planning horizon. WADR1 and WADR2 algorithms developed by doing some modifications in Kruskal's algorithm [12], WADR3 and WADR4 are the algorithms developed as variants of WADR1 and WADR2 [13-14]. Motivated by the connectivity property on the process of finding MST by Prim's algorithm, the WADR5 was developed [14]. WADR3 and WADR4 are similar algorithms developed by modifying WADR1 and WADR2. The information and illustration why the solutions of WADR3 and WADR4 are different are given in [15].

III. GNU Octave, MPDCMST and Implementation

GNU Octave is a free software that runs on GNU/Linux, macOS, BSD, and windows. This software originally was intended as a companion to a chemical reactor design course, but the one who first developed it is John W. Eaton [17]. Since this is free software, the users are encouraged to modified and developed this software and free to distribute it.

The different of using GNU Octave and other language programming (such as Java) is in GNU Octave more rigid, we have to follow certain rules (such as we have to convert to matrix form or others), not as Java where we are more flexible to developed the program. For example, the data used for implementation represent the edges of complete graph for certain vertex order. For vertex order 10, the number of edges is 45, which is got from the formula $n(E) = \frac{n(n-1)}{2}$, $n=10$. Before putting in GNU Octave, we have to modify this equation to be $2n(E) = n^2 - n$. This is quadratic equation and to find n is $n = \frac{1 + \sqrt{1 + 8n(E)}}{2}$. Thus, to read the data, the source code for reading the data (vertex order) is as following (let $n(E) = Un$):

```
function vertex = check_vertex(matrix)
    bykisi=length(matrix);%bykisi=Un
    c=2*bykisi;
    n=(1+sqrt(1+(4*c)))/2;
    vertex=n;
end
```

WWM1 AND WWM2 ALGORITHMS

We develop two algorithms to solve the MPDCMST based on Prim's Algorithms and modified it to satisfy the constrained given and implement them using the same data used in [12 -14], the HVT_i , number of periods, and $MAXVT_i$ is the same as [15]. The reason of using Prim's algorithm because Prim's algorithm maintain the connectivity during the process of finding the MST. Both WWM1 and WWM2 use vertex 1 as central vertex.

WWM1 Algorithm

WWM1 algorithms starts by setting vertex 1 as root and then check the nearest vertices in HVT_i to be connected/installed in the network (T), and continue connecting those vertices in HVT_i as long is not violate the degree restriction. If there degree violation occurs,

do edge exchange while also maintaining the connectivity of vertices in HVT_i . Next, check the $MAXVT_i$. Connect the edges whose smallest edge weight to T as long as the connection not violate the degree constrained. If the number of vertices connected on that period already the same as $MAXVT_i$, then continue to the next period, and continue the process as the previous period until all vertices are connected/installed. The following figures illustrate the process in every period:

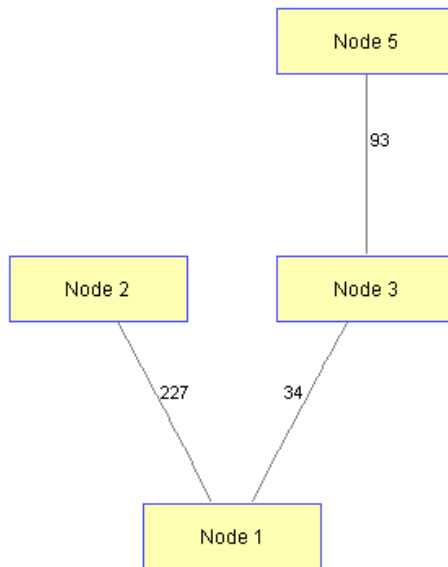


Figure-1. The first period of WWM1 algorithm

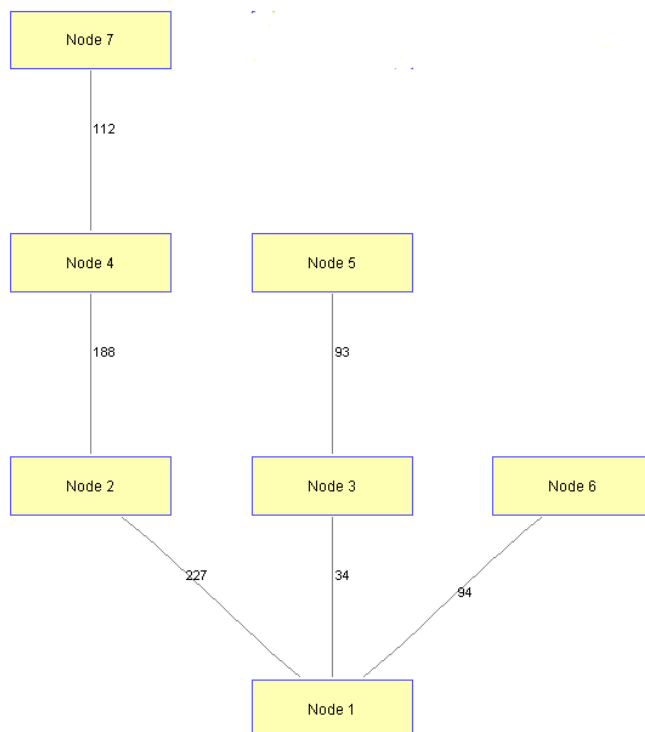


Figure-2. The second period of WWM1 algorithm

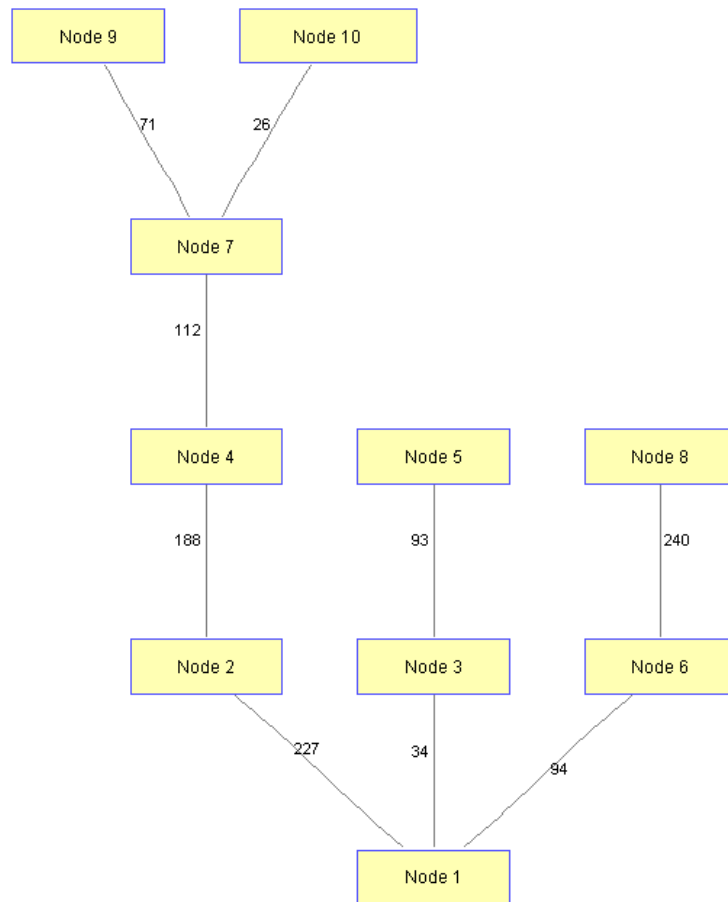


Figure-3. The third period of WWM1 algorithm

WWM2 Algorithm

The WWM2 algorithm is similar with WWM1 algorithm, except in the WWM2 the process of connecting the vertices in HVT_i is more flexible. Those vertices in HVT_i can be installed in the beginning of the period or at the end, as long as the installation/connection process still at that period. The following figures show the process of installation in every period of WWM2 algorithm.

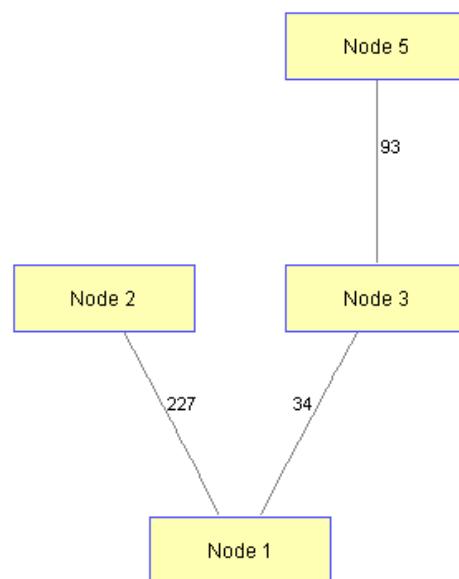


Figure-4. The first period of WWM2 algorithm

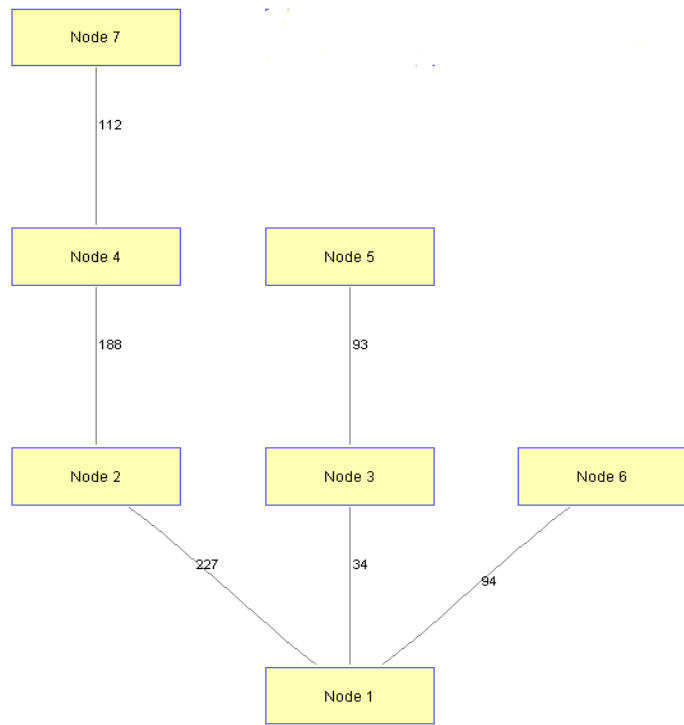


Figure-5. The second period of WWM2 algorithm

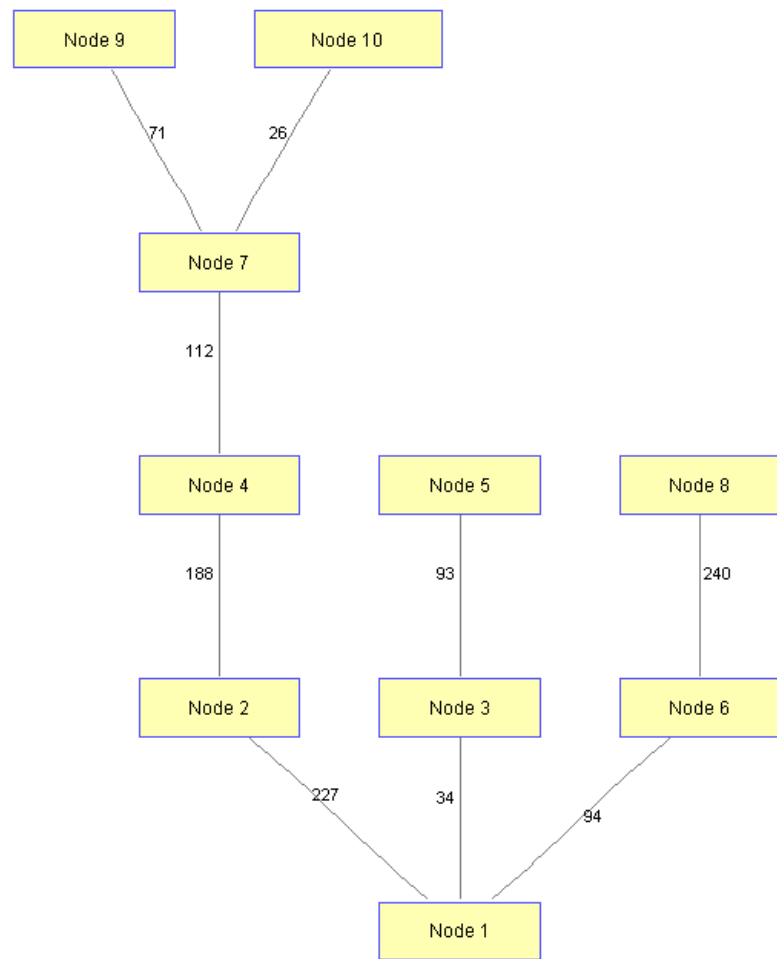


Figure-6. The third period of WWM2 algorithm

IV. Results and Discussions

We compare WW1 and WW2 algorithms against WADR5 algorithm because those three algorithms are developed based on the same algorithms which is Prim's algorithms. Moreover, we use the same data for implementation, same set of HVT_i , $MAXVT_i$ and the number of periods. The data used for implementation is the random problems generated using uniformly distribution with weight range from 1 – 1000 (integer). For every vertex order there are 30 problems generated and the vertex order used are 10 to 100 with increment of 10. Therefore there are total 300 problems implemented. The solution taken is the average solution from 30 problems for every vertex order. The following table show the result:

Table-1. The comparative solutions of the methods

Vertex order	The average solution				
	MST	DCMST	WADR5	WWM1	WWM2
10	1129,43	1178,8	1341,933	1498,6	1286,6
20	1196,1	1299	1557,63	1804,97	1428,57
30	1177,43	1319,53	1755,4	2039,97	1490,03
40	1151,23	1286,3	1719,27	2117,1	1440,03
50	1223,43	1356,47	1844,1	2427,27	1566,6
60	1175,57	1320,73	1851,2	2389,87	1573,57
70	1242,1	1410,03	1963,83	2558,5	1612,27
80	1236,83	1410,23	1942,4	2579,4	1675,2
90	1248	1404,93	1941,3	2618,43	1613,23
100	1234,1	1370,8	1992,4	2564,07	1567,53

V. Conclusions

From the result and discussion we can see that among the three algorithms, WWM2 performs the best. The flexibility in the process of connecting/installing the vertices but not violate the rules gives better solution than if the vertices must be connected in a certain order.

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Section 3

Medical Sciences and Biomedical Engineering

**Integrated Sci-Tech :
Interdisciplinary Research Approach
Volume 3**

The Experience Of The Husband Who Accompanied The Wife With Cervical Cancer Who Are Undergoing Treatment (#671)

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Abstract. *Cervical cancer was a cancer that is highly feared by women because it does not caused symptoms at the beginning of this development. The purposed of this research is to know the description of the experience of the husband who accompanied the wife with cervical cancer who are undergoing treatment. The typed of the study is qualitative research with descriptive phenomenology design. The number of participants in this study is four participants, with purposive sampling technique. Analysis data technique used is with engineering analysis colaizzi. Result : The results of this research identifies five themes, that knowledge of disease of cervical cancer, psychological response, the source of motivation to cervical cancer patients, treatment efforts and the hope of healing. The husband who accompanied the wife with cervical cancer felt sad when she saw the condition of his wife at this time and keep trying for healing his wife. The researcher suggested to health care personnel so that paying attention to the psychological state of the patient's cervical cancer in addition to paying attention to its physical state.*

Keywords : *the experience of the husband, wife, cervical cancer*

I. Preliminary

Cervical cancer is a cancer that is feared by women, because cervical cancer does not cause symptoms in the early stages of cancer development. Based on the phenomenon that researchers have found for a cervical cancer patients need the support of his family. Such support can increase the motivation itself to recover. Family support is also a very important factor for someone who is facing a problem to improve his mental and spirited life.

One cervical cancer patient reveals "I really need the support of the family that makes me more comfortable". The patient also said "I am grateful for the full support of my family to get well soon". This suggests that support from the family can improve the psychological state that is being felt by cervical cancer patients.

The person closest to cervical cancer patients is the patient's husband. Based on a preliminary study that researchers conducted on February 23, 2107, the patient's husband felt sad when he saw the condition of his wife, As one of the patient's husband said "I must be sad to see the condition of my wife at this time". But there is also one of the patient's husband who said "I feel mediocre when I see the circumstances of my wife". Although there are differences of opinion from the patient's husband, but all give the same hope that hope that his wife quickly heal and get the best treatment in order to perform their daily activities. In addition, the patient's husband said not so know with cervical cancer. This makes husbands feel sad when they know the situation and make them want to quickly check the situation experienced by his wife.

Data in Indonesia cervical cancer is the most common cancer in women causing death, an estimated 40,000 new cases of cervical cancer each year, each day found 41 new cases and 20 deaths at once (Widiantara, 2016). Based on the data Riset Kesehatan Dasar (Riskesdas)

In 2013 the prevalence of tumors or cancer in Indonesia is about 1.4 per 1000 population or 330,000 people. Cervical cancer is a cancer with the highest prevalence in Indonesia in 2013, namely cervical cancer as much as 0.8% or about 98,692 people (Depkes, 2014). Cervical cancer ranks first cancer in women in Bali with a prevalence of 0.7% or about 1438 people. The incidence of cervical cancer in Bali is 43 / 100,000 people (0.89%) (Dinas Kesehatan Provinsi Bali, 2013).

One of the research conducted by Rahayu in 2011 about the phenomenological study of husband experience with wife who had cervical cancer in Jakarta area, States that couples who have wives diagnosed with cervical cancer cause psychological reactions in couples and require adaptation before accepting the conditions that occur in the wife. Changes in life are also experienced by couples including physical, psychosocial and sexual life changes in their marriages (Rahayu, 2011).

From the experience experienced by cervical cancer patients themselves ie research from Negari in 2015. The study, conducted by Negari, on the experience of cervical cancer patients undergoing chemotherapy, states that patients with cervical cancer experience various effects in chemotherapy such as hair loss, abdominal pain and fatigue, support from the family is also needed by patients to face the problems it faces (Negari, 2015).

The general purpose of this study is to know the description of the experience of the husband who accompanied the wife with cervical cancer who are undergoing treatment.

II. Materials and Methods

In this research using qualitative research method with descriptive phenomenology approach. Qualitative research is a study that generally explains and provides an understanding of various human behaviors and experiences (individuals) in various forms (Rachmawati, 2014). Descriptive phenomenology requires the researcher to process the bracketing (to confine the assumptions and knowledge about the phenomenon that occurs) to be able to give a complete picture of what kind and how the participants experience the situation and phenomena experienced in the reality of social life based on the point of view of the participants (Rachmawati, 2014).

This research was conducted at Ruang Poly Kebidanan RSUP Sanglah Denpasar. The time of this study was conducted on 1 April to 31 May 2017. The selection of participants is done by purposive sampling that is selected with certain considerations and objectives.

The selection of participants in this study was selected with consideration of inclusion criteria of the husband who accompanied the wife with cervical cancer who are undergoing outpatient treatment in Poly Kebidanan RSUP Sanglah Denpasar. The husband who accompanied the wife with cervical cancer who underwent chemotherapy. The husband who accompanies the wife with cervical cancer is willing to become a participant.

In this study the main instrument is the researchers themselves. Which serves to establish the focus of research, selecting informants as data sources, collecting data, assessing data quality, analyzing data, interpreting data and making conclusions on findings. Analysis of data used in this study using analysis according to Colaizzi where there are seven stages of data analysis process with phenomenology method that Each transcript should be read and re-read to get a general sense of the whole content. For each transcript, significant statements relating to the phenomena under study should be extracted. Meaning must be formulated from this significant statement. The formulated meaning should be sorted into categories, groups and themes. The researcher's findings should be integrated into the full description of the phenomenon under study. The structure of the phenomenon must be explained. Finally the

validation of the findings should be sought from the study participants to compare the descriptive results of the researcher with their experience (Shosha, 2012).

III. Results and Discussion

Participants involved in this research is the husband who accompanied the wife with cervical cancer who are undergoing treatment as many as 4 people with varying age that is 58, 55, 42, 72 years. All participants had a wife who was diagnosed with cervical cancer who was undergoing treatment at the Police Room Kebidanan Sanglah Denpasar Hospital.

Researchers conducted interviews to participants and continued by analyzing the results of interviews with the Colaizzi method, about the experience of the husband who accompanied the wife with cervical cancer who are undergoing treatment.

Based on the results of interviews with participants, in get 5 themes of knowledge about cervical cancer disease where sub theme on this theme is the signs and symptoms of cervical cancer. The second theme is the psychological response where the sub themes in this theme are sad. The third theme is the source of motivation to cervical cancer patients, the theme is sub theme of emotional support from the husband and emotional support from the family. The fourth theme is the treatment effort, the theme is obtained sub theme is following doctor's instructions. The fifth theme is the hope of healing, obtained sub theme of spiritual hope. The 5 themes are:

Knowledge of cervical cancer

Signs and symptoms of cervical cancer

"If cervical cancer is first whitish, after whiteness ... After using KB is whitish, there are little spots like blood"

(P2,L4-7)

"At first my wife complained his stomach ache, keep coming whitish lot and smell, continue 10 days bleeding"

(P3,L4-7)

The first theme obtained in this study is the knowledge of the husband about cervical cancer is needed to be able to make decisions about what action will be done if his wife experienced signs and symptoms of cervical cancer that generally occur. In this research, the sub theme is the husband's patient explain the signs and symptoms of cervical cancer. Signs and symptoms that usually appear in patients with cervical cancer, among others, as follows: When the woman has an advanced stage will experience pain in the thigh or one of the thighs experience swelling, appetite becomes greatly reduced, unstable weight, difficult to urinate, and experience spontaneous bleeding. The results of this study are in line with research conducted by Rahayu, 2011. According Rahayu before the husband learned that his wife suffered from cervical cancer have found some signs and symptoms that appear related to cervical cancer, such as: bleeding outside sexual and also whiteness (Rahayu, 2011). According to the opinion of the researcher in this study obtained that the husband's knowledge about the signs and symptoms complained of by his wife caused different perceptions on each participant. In participants who have a good knowledge of signs and symptoms are complained will make a better reaction to check his wife to the nearest medical services otherwise if the husband's knowledge of the signs and symptoms complained of by his wife less will cause slow efforts to check his wife to the health care Thus resulting when it is known the results of the examination is known his wife is already in an advanced stage.

Psychological response

Sad

"Sad too that I feel seeing my wife's circumstances"

(P1,L275-276)

"My feeling is obviously sad to see the state of my wife at this time"

(P4,L32-34)

The second theme is the result of psychological response. Psychological response is the reaction of human behavior related to the environment, where here the environment in question is the relationship with the wife. On this theme sub theme obtained sadly expressed by the husband of cervical cancer patients. The sadness that arises in people who have the same problems can cause different reactions because the sadness is individual or personal. Sorrow is a natural thing experienced by someone who experiences an unpleasant event or event (Trisnantari, 2015). In addition, this study is also similar to research conducted by Wardani, 2014. According to Wardani the sadness experienced is influenced by several factors that is, because the disease suffered relapse again and never healed, felt the inconvenience of the family, separation with husband and child due to death (Wardani, 2014). According to the opinion of researchers in this study expressed the sad feeling experienced by the husband who was accompanying his wife with cervical cancer undergoing treatment that arises because the husbands do not bear to see the condition of his current wife.

Sources of motivation to cervical cancer patients

Emotional support from husband

"It's a problem so we must continue to support by giving spirit and we always damping"

(P1,L361-363)

"Keep providing support for the spirit of life, motivation, keep accompanying "

(P3,L76-78)

The third theme obtained results motivation sources to patients with cervical cancer. In this study obtained sub themes of emotional support from the husband and emotional support from the family. Participants in this study mentioned the motivation given by himself to the wife who suffered from cervical cancer in the form of emotional support. Motivation is a desire that is in an individual individual who encourages to perform actions, actions, behavior or behavior. Motivation is also interpreted as a stimulus of desire and the force of the will which causes a person to act or behave (Kusumantari, 2015). Research by Erfina, 2010 is similar to the research that researchers do is get the results of participants get support from people around like husband, child, family, neighbors and colleagues. Support obtained is in the form of emotional support (Erfina, 2010). In the opinion of the researcher the emotional support provided by the husband to the wife is very important because the husband is the person closest to the wife so that moral support or spirit given to his wife can grow his wife's spirit to heal.

Emotional support from family

"Yes all support, encourage and children also help what is told by mama, so all family very support mama in treatment"

(P1,L452-455)

"All participate in providing motivation, from children and also all of you participate in encouraging my wife"

(P4,L51-54)

In addition to this study participants also said his wife received emotional support from family and also the people closest. Support is in the form of encouragement and also motivation

provided by the family so as to grow the spirit of his wife in undergoing treatment performed. The family is the smallest unit of society that consists of the head of the family and some who are gathered and live somewhere under a roof in a state of interdependence. Family support is the attitude, action, and acceptance of the family to someone who is ill, in the form of information support, assessment support, instrumental support and emotional support (Murdiana, 2016). The results of this study are in line with research conducted by Sumetriani, 2015. According Sumetriani cervical cancer patients get good emotional support from their families, whether it's a big family of husband and extended family of the patient itself, so the growing spirit to heal (Sumetriani, 2015). In the opinion of the researchers in this study, the support of the family or the closest people is needed by the patient's husband and especially to the wife who suffered from cervical cancer that is useful to foster his spirit to undergo treatment and get healing.

Treatment efforts

Follow the doctor's advice

"The effort trying to find a drug, undergoing a doctor's order because what the doctor's order would be the best, whatever the doctor ordered for treatment undertaken, chemo yes chemo, finished chemo want what this ray yaa rays live"

(P3,L142-148)

"Efforts continue to seek to medicines continue to pray also ... the important thing pokonya my wife quickly recovered live whatever the doctor orders I do not know anything"

(P4,L91-92,L95-97)

The fourth theme is the treatment effort, in this theme obtained sub theme is following doctor's advice. The participant's statement in this study describes the efforts made by the husband accompanying the wife to undergo treatment. His current efforts are to follow the advice given by doctors in undergoing treatment. Health efforts are an effort to realize optimal health status for society, health efforts are carried out with maintenance approach, health promotion (promotif), prevention of disease (preventive), curative disease (curative), and health restoration (rehabilitative) (Hanafiah, 2008). The results of this study are in line with research conducted by Rahayu, 2011. According Rahayu participants prefer treatment with doctors, such as surgery, chemotherapy and radiotherapy or irradiation (Rahayu, 2011). According to the opinion of the researcher in this research explains that the effort done by husband is to follow all the instructions of doctor for treatment which is lived by his wife, the instruction in the form of drug delivery, surgery action and also chemotherapy.

Hope for healing

Spiritual hope

"Hope we will soon recover by trying as hard as possible that we can just, I try as much as possible for healing"

(P1,L565-568)

"Pingin my wife healed, quickly healed can be the best treatment, just what is instructed by my doctor to live "

(P3,L151-154)

The final theme is the hope of healing. Hope is a desire to achieve certain goals and coupled with the motivation. In this research, the sub theme is spiritual hope. Participants in this study expressed the wish they wanted to the wife who was undergoing treatment. Hope is a spiritual hope that his wife will recover quickly. Hope is known to help the individual in finding the meaning of the illness that is when individuals with cancer feel uncomfortable with symptoms of the disease he felt, the increased inability and fear of facing death. Hope can help the

individual to cope with discomfort, live life with illness and live life with power. Expectations relate to spiritual problems, if there are spiritual obstacles causing individuals to have low expectations and cause despair (Negari, 2015). The results of this study are also in line with research conducted by Sumetriani, 2015. According Sumetriani cervical cancer patients expect recovery after undergoing chemotherapy in order to reunite with his family at home. According to the opinion of researchers in this study explained that the husband expects his wife to recover quickly and get the best treatment. Hope is also supported by the husband's efforts to always accompany his wife to undergo treatment.

IV. Conclusions and Recommendations

Conclusion

The results of this study found 5 themes of knowledge about cervical cancer disease where sub theme on this theme is the signs and symptoms of cervical cancer. The second theme is the psychological response where the sub themes in this theme are sad. The third theme is the source of motivation to cervical cancer patients, the theme is sub theme of emotional support from the husband and emotional support from the family. The fourth theme is the treatment effort, the theme is obtained sub theme that is following the doctor's advice. The fifth theme is the hope of healing, obtained sub theme of spiritual hope.

Recommendations

Based on the results of research that has been done is expected to increase nursing care to patients and also expected health workers can provide emotional support and also information to increase hope and spirit of cervical cancer patients who are undergoing treatment.

The phenomenon of the experience of a husband accompanying a wife with cervical cancer who is undergoing treatment provides knowledge and also a different understanding of the experience he experienced. It is encouraging to develop nursing care in patients with cervical cancer who are undergoing treatment.

In this study researchers have difficulty in developing questions when conducting interviews with participants, so for further research is expected to develop this research with a wider coverage and use better interview techniques to get more accurate and interesting results.

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Section 4

Agricultural Engineering and Food Science

**Integrated Sci-Tech :
Interdisciplinary Research Approach
Volume 3**

The Development of Agropolitan Lingsar to Support Economy & Tourism in the West Lombok Regency (#733)

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Abstract. *The development of agropolitan in the agriculture sector needed to improve farmer's welfare. The Lingsar Agropolitan area is one of the areas of agro tourism potential in West Nusatenggara Regency with the various potential of agricultural commodities and good agricultural land management system. Agrotourism is a series of tourism activities utilizing agriculture potential as a tourist attraction, in the form of agricultural areas, the uniqueness and diversity of agricultural production activities and agricultural technology and culture of farmers. This study aims to identify the potential and problems of Lingsar agropolitan area, to support the agro tourism and economy of West Lombok Regency. Analytical methods used include agribusiness subsystem analysis, circle system analysis, land capability and suitability analysis and force field analysis (FFA). The result of this research shows that "ragamadu" commodities could support agro tourism in Lingsar district.*

Keywords: *agro tourism, force field analysis and ragamadu.*

I. Introduction

The concept of agropolitan develop by Friedman in 1975 [1]. He stated that the agropolitan model has room for rural development and is built on the idea of accelerated development that is oriented to human needs with more equitable economic benefits. The agropolitan concept is an approach to planning development from below that promises real economic empowerment for the rural poor [2]. To empower economic of the poor in rural area, in the concept of agropolitan we should identified the potential commodities to support agricultural development in rural area.

The development of potential commodities could support agro tourism development. Agro tourism is a series of tourism activities utilizing agriculture potential as a tourist attraction, in the form of agricultural areas natural landscape and the uniqueness and diversity of agricultural production activities and agricultural technology and culture of farmers. The agro tourism activity aims to broaden knowledge insight, recreational experience and business relationship in agriculture that includes food crops, horticulture, plantation, fishery and livestock [3]. The Lingsar District, West Lombok Regency, is one of the subdistricts in West Lombok with agropolitan diversity activities that have agrotourism potential, from upstream, on the farm to downstream. This sector includes food crops, plantations, forestry, and livestock. Food crops include rice, corn, crops besides rice, vegetables and fruits. As a rice center, rice production in West Lombok Regency becomes an indicator of the success of agricultural programs.

In the Regional Mid Term Development Plan (RPJMD) West Nusatenggara Province (NTB) 2013-2018 [4], one of the goal is to improve the welfare of the community, accelerate poverty reduction and develop regional excellence. Indicators of successful implementation of the program and policy are one of them depends on the condition of food security and nutrition in all region. The indicators of food security are closely related to the agricultural sector. So the development of agricultural sector could improve the economic welfare of the farmer's.

The food crops subsector and the plantation sub-sector in West Lombok Regency also contributed significantly to the West Lombok Regency economy. Coconut and Cashew is a superior product of plantation. With good management of plantation, products in West Lombok are expected to compete with other regions.

Livestock cannot be separated from agriculture, so in line with the agricultural production, West Lombok Regency also develops livestock products as well. Some of the main products of the farm are cows, buffalo, goats, sheep, horses, chickens and pigs. Although it has not been able to contribute significantly to West Lombok's economy, the potential of this livestock sector needs to be explored and developed. West Lombok district has agricultural potentials that are still not utilized to the fullest. The agricultural potentials of West Lombok district if produced, processed and marketed with good planning is believed to improve the economy of the farmers and the district of West Lombok.

The aims of this study are to identify the potential and problem related to the development of agropolitan lingsar, and identified the potential products of agriculture that will develop. While the Scope of Research Area is located in District Lingsar West Lombok Regency.

II. Method

A. Data Collection and Processing Stages

Sampling technique or data collecting used in this study is in the form of interviews with selected key person associated with agriculture, plantation, animal husbandry and agroindustry. Interviews are conducted on the topic of subsystems and their potentials and problems. Also, researchers collect secondary data as needed.

B. Stage Analysis and Data Interpretation

These stages analyze and interpret data from the collected and processed. This will be used as an input for the region to apply the agropolitan commodity rating to be developed. A comprehensive analysis will be presented related to the selection of superior priorities supported by quantitative and qualitative data. Analytical methods used include land suitability and capability analysis, subsystem analysis, linkage system analysis, FFA analysis. These analysis results in the management strategy of Lingsar agropolitan area.

1. Analysis of Land Capability and Suitability

An analysis of the capability and suitability of the land is used to determine the suitability of land use for existing soil types. This suitability is correlated with the variable weighting analysis. Grouping of soil is into units of ability, sub class, and evaluation based class.

2. Subsystem Analysis

According to Rustiadi and Dardak (2007), agropolitan subsystem analysis includes upstream agribusiness analysis, farming subsystem analysis, downstream agropolitan analysis, agro-output subsystem analysis and marketing subsystem, and subsystem analysis of support services.

3. Linkage Analysis System

Linkage system analysis is an analysis used to analyze the macro and comprehensive relationship of a tourist object as a system. The things that will be examined is the relationship between sectors, integrity, and relationships among superior commodities in an area.

4. Force Field Analysis

Force Field Analysis is a simple tool to analyze the factors found in complex problems. This analysis is divided into two factors that can affect the problem regarding factors or pressures that support the status quo (holding strength) and the pressures that support the change in the desired direction (mover). (Lewin K, 1951)

III. Result and Discussion

A. West Lombok District Land Use

Tabel 1 shows land use in West Lombok Regency, detailing courtyard, building and garden, moor/field, farm land, meadow, community forest and plantation.

Table 1. Land Use Type Of West Lombok Regency

Districts	Court Yard Building & Garden	Moor/Field	Farm land	Meadow	Community Forest	State Forest	Plantation
1. Sekotong	14 720	4 317	4 071	577	3 689	468	632
2. Lembar	886	1 270	546	-	-	761	978
3. Gerung	2 348	4	6	-	323	142	369
4. Labuapi	872	230	-	-	15	20	15
5. Kediri	449	126	-	-	-	156	-
6. Kuripan	689	-	-	-	208	6	-
7. Narmada	2 073	2 272	368	-	61	3956	-
8. Lingsar	856	3 320	-	-	-	4003	-
9. Gunungsari	4 052	3 668	116	-	-	115	268
10. Batu Layar	639	1 799	-	-	652	110	-
Amount /Total	27 579	17 006	5 107	577	4 948	9777	2262

Source: Agriculture, Plantation & Forestry Agency, West Lombok District in West Lombok Regency Data, 2016

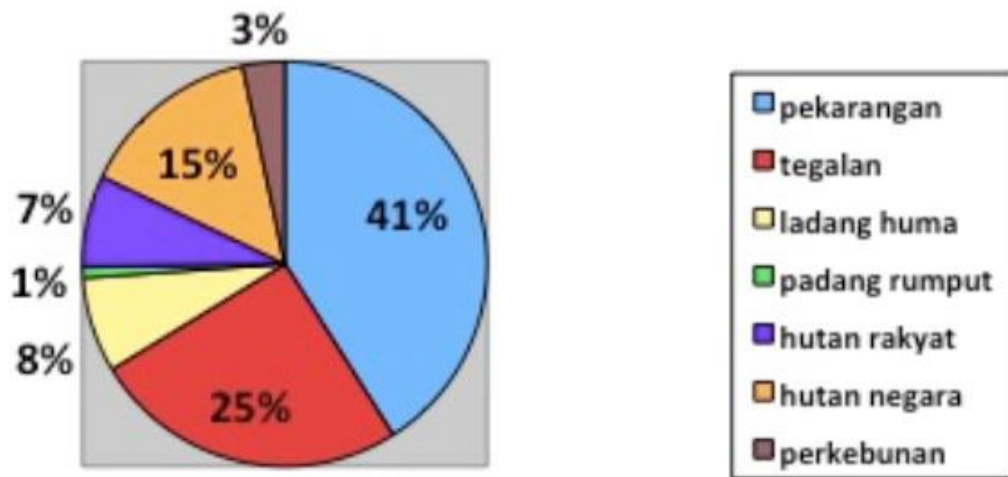


Figure 1. Land Use Diagram in West Lombok Regency.

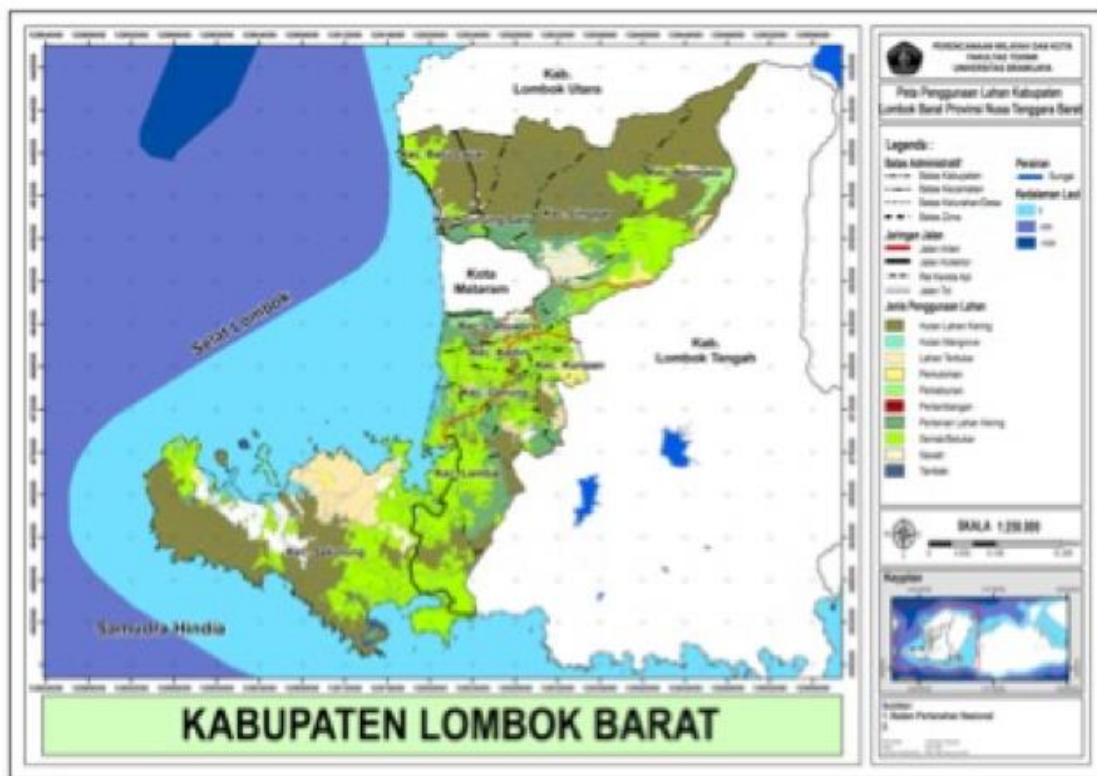


Figure 2. Land Use Diagram in West Lombok Regency.

B. Analysis of Land capability and suitability

Results from the analysis of the land ability and suitability, the Lingsar sub-district is located in the cultivation area and is in accordance to be used as in the agropolitan management. From the land ability and suitability analysis in the agropolitan area, the concept of agrotourism development can be done in Lingsar sub-district.

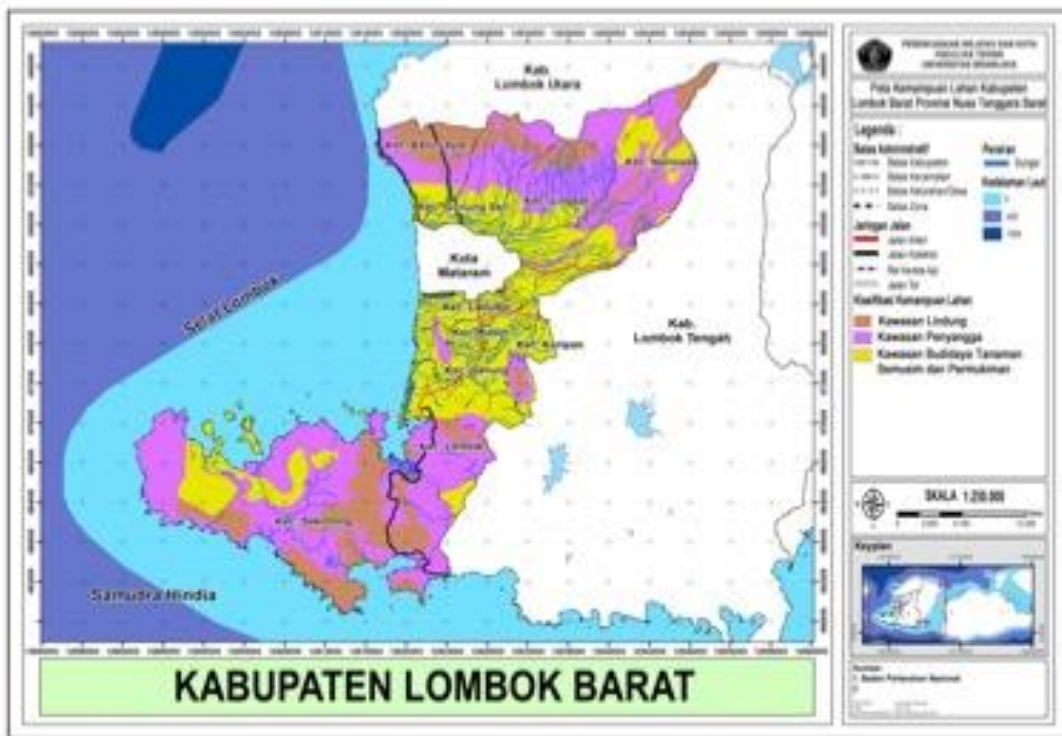


Figure 3. Land Suitability in West Lombok Regency.

C. Subsystem Analysis

Ragamadu is one of the commodities in West Lombok Regency with further development potential. Ragamadu is a combination of Rambutan-Palm Sugar-Mangosteen-Durian which the community intends to develop.

1. Analysis of Upstream Sub System

Analysis of the upstream subsystem of Ragamadu commodities consists of raw materials and seeds, machinery and equipment, agricultural technology, and human resources. Ragamadu is a land located in the district Gunungsari, Lingsar and Narmada. Commodity developers do not incur expenses for nurseries at the start of the business. Since it grows naturally, palm trees do not require fertilizer or pesticides for treatment.



Figure 4. Commodities Ragamadu in Lingsar Subdistrict (Source: Survey Results, 2017.)

2. Analysis of Farm Subsystem

Ragamadu plants (rambutan, palm sugar, mangosteen, durian) grown in the garden do not have a special care for production. Plant owners allow the plants to grow without interference and special care.

3. Analysis of downstream subsystems

Analysis of Ragamadu Downstream Subsystems consists of labor and technical production. In the management of Ragamadu are made into palm sugar and dodol.



Figure 5. Ragamadu Processing Result in Lingsar Subdistrict (Source: Survey Results, 2017.)

4. Analysis of Marketing Subsystem

The Ragamadu processing products in this agro industry are developed into several ready-to-sell products such as sugar, briquette sugar, ant sugar, sugar sherbet, and liquid sugar. As for mangosteen, rambutan and durian, they are processed into dodol. Marketing is done at local market of NTB province level. Some palm sugar has been exported to japan in small quantities.

5. Analysis of support services subsystem

The Ragamadu Supporting sub-system analysis discusses the things that help the process from upstream to marketing in the form of counselling and cooperation forms. Bukit Tuan agroindustry business receives assistance in the form of counselling and training. Also it also has a partnership with the brownie cake business for providing raw materials of sugar.

D. Analysis of Inter sector Linkage System

Based on the linkage system between commodity diagram in Figure 5, there is a correlation or relationship between commodities; the relationship between Ragamadu commodities is associated with cattle for using a type of organic fertilizer from cattle dung. The relationship between agriculture and livestock sector is cattle waste used by farmers are made into

manure. The use of manure is beneficial for farmers and cattle ranchers in West Lombok Regency.

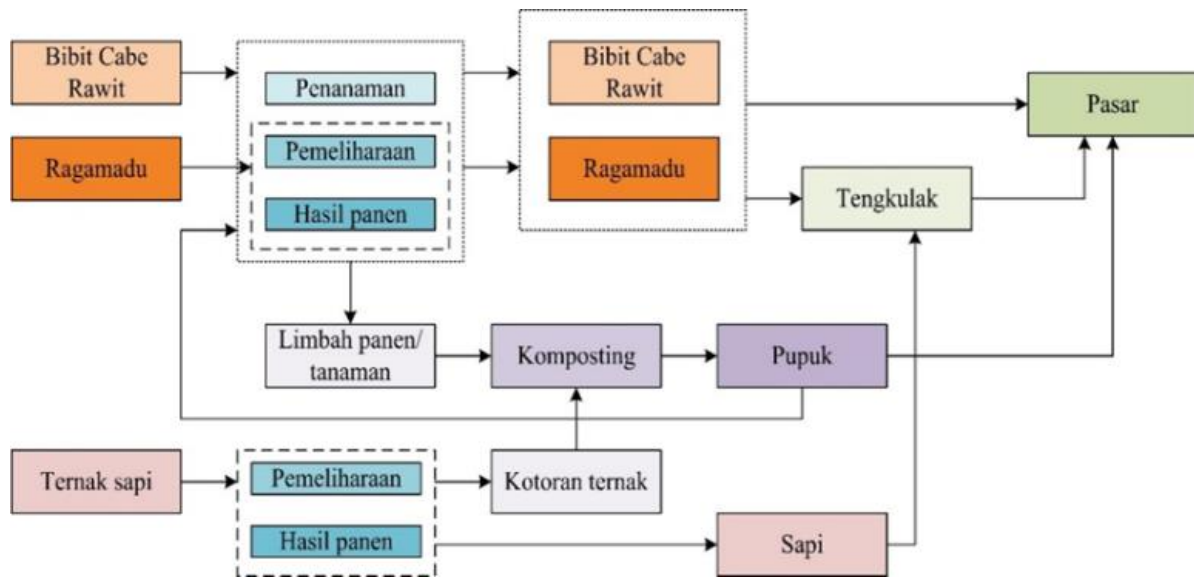


Figure 6. Inter Commodity Linkage System (Source: Survey Results, 2017.)

E. Subsystem Analysis

Force field analysis (FFA) is an analytical tool used in planning changes by identifying the factors supporting and constraining the goals. The supporting factors of force field analysis result are as follows:

Table 2. Table Force Field Analysis

No	Supporting factors	Constraining factor
1	HR, agriculture is relatively large	Narrow land area and limited access to capital resources
2	The agricultural sector has a high multiplier effect	Low quality of human resources
3	Available agricultural areas and potential land that has not been utilized optimally	Limited supporting facilities and infrastructure
4	A great diversity of biological resources that have not been utilized and developed maximally	Low level of productivity
5	The high level of public awareness of the importance of nutritional value of food	Production and quality of agricultural products
6	Demand for agricultural products is increasing	The unfavourable pattern of business partnerships
7	-	The existing agricultural institutions have not functioned optimally.

Based on Table 2. The Force field analysis concludes that there is less supporting factors than constraining factors. It is, therefore, necessary to formulate a strategy in the form of referral processing of commodities results in Lingsar agropolitan area based on the supporting and constraining factors.

F. Management Strategy

Management strategies based on the referral of Lingsar agropolitan area management based on FFA analysis to support the economy and tourism are as follows:

1. Develop the processing industry of ragamadu commodity based on educational tourism
2. Ragamadu processing is fully supported by the government to provide the help needed by farmers.
3. Training for innovations of diverse crops.
4. Training for innovations of diverse crops.
5. Application of minimum selling price so that farmers remain profitable
6. Promotion and marketing of the crop as well as ragamadu processed products

IV. Conclusion

Based on the analysis, the constraining factors in the Agropolitan management to agrotourism is the quality of human resources, unsupporting facilities and infrastructure, suboptimal institution, and insufficient marketing of results. The strategy used as the direction of agropolitan Lingsar area management are:

- Making lingsar sub-district become the center of agropolitan activity in downstream subsystem and marketing activities
- Lingsar Subdistrict is directed into education-based tourism in the agroindustrial sector as branding of west Lombok district in terms of tourism and improving the local economy.

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Feeding Behaviour of Sumatran Rhinoceros (*Dicerorhinus sumatrensis*) in Sumatran Rhino Sanctuary Way Kambas National Park (#762)

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Abstract— Sumatran Rhinoceros (*Dicerorhinus sumatrensis*) is nocturnal wildlife with complex behaviour. Sumatran Rhinoceros feeding time usually occurs at midnight before morning and in the morning as well. The feeding behavior of Sumatran Rhinoceros will be different in natural habitat and sanctuary. The information about Sumatran Rhinoceros behaviour can support the conservation effort that undertaken. This research aims to analyze the feeding behavior of Sumatran Rhinoceros in Sumatran Rhino Sanctuary. This research was conducted on July 2017 at Sumatran Rhino Sanctuary Way Kambas National Park and the object was one female Sumatran rhinoceros named "Ratu". The Focal Animal Sampling was used to observe Sumatran Rhinoceros feeding behavior. The results showed that the dynamics of feeding activity with the highest percentage occurs in the morning (07.00-10.00 WIB) that is equal to 70% and the proportion of feeding time in a day is 35% of total daily time. The percentage was comparison of total drop-in feeding activity time at amount 1792 minute and total drop-in feeding activity time at amount 419 minute with Ratu's total daily activity started from 07.00 WIB until 18.00 WIB, in amount of 6359 minute. Drop-in feeding was given twice a day. The drop-in feeding behavior of the Sumatran Rhinoceros is made as natural as possible by minimizing handfeeding like spesificallty put the feed inside the cage and let the rhino eat independently to maintain its natural behavior. Naturally the Sumatran Rhinceros feeding behavior begins by walking to the feed source and sniffing the feed then the Sumatran Rhinoceros will push the trees with their heads or bodies then stepped on with their feet until it fell down, and then they pulling roots, twisting the branches, or breaking branches with mouth.

Keywords— Behaviour, Sumatran Rhinoceros, Feeding, Sumatran Rhino Sanctuary, Way Kambas National Park.

I. Introduction

SUMATRAN Rhinoceros was the only rhino species that had two horns and also known as the smallest rhino in the world^[1]. This species was critically endangered with the lowest number of population among the other rhino^[2]. Its population in natural habitat was estimated approximately 200-300 individual spread in South East Asia^[3]. Reliable population estimates for Sumatran rhinoceros have always been difficult to obtain^[4]. This uncertain number of Sumatran Rhinoceros population needs to get more concern^[5]. The declining of population was caused by lose of habitat because the land forest over function, encroachment, illegal logging and poaching^[6].

The Sumatran rhinoceros is a good example to illustrate the challenges in the conservation of a highly endangered species^[7]. Sumatran Rhinoceros was in category critically endangered species^[8] and include as Appendice 1 species^[9]. Yayasan Badak Indonesia (YABI) was a partner of Forestry Department in order to conserve rhino in Indonesia. YABI had one program named Sumatran Rhino Sanctuary (SRS) that located in Way Kambas National Park^[10]. SRS is a rhino sanctuary which managed with semi in-situ program^[11] and its made as natural as possible with a little human intervention but still in a intensive supervision. This breeding centre for Sumatran Rhinoceros was established in 1998 as a last-ditch attempt to save the population from extinction^[12]. Sanctuary rhinoceroses in Indonesia also browse freely in 10-hectare enclosures and select additional browse items on their own^[13].

The knowledge about Sumatran Rhinoceros feeding behaviour was an information about its natural behaviour and how to apply it for supporting the conservation effort that will conducted. The success of Sumatran Rhinoceros protection and conservation was determined by manager's capability that has adequate education about Sumatran Rhinoceros behaviour in order to know what the obstacle in its management^[14]. Fewer research about Sumatran Rhinoceros feeding behaviour whether drop-in or in natural habitat made this research necessary. This research aims to analyze how Sumatran Rhinoceros drop-in and natural feeding behaviour in SRS.

II. Procedure

A. Time and Location

This research was conducted in July 2017 at Sumatran Rhino Sumatran Way Kambas National Park, Lampung Province, Indonesia. The only site of which we are aware suitable for such a large rainforest enclosure would be Way Kambas National Park^[15]. SRS has a lowland rainforest ecosystem type. The topography was at altitude of 0-50 m above sea level with a wet tropical climate. Geographically located between 4°59'- 5°05' LS and 105°42'- 105°48' BT^[16].

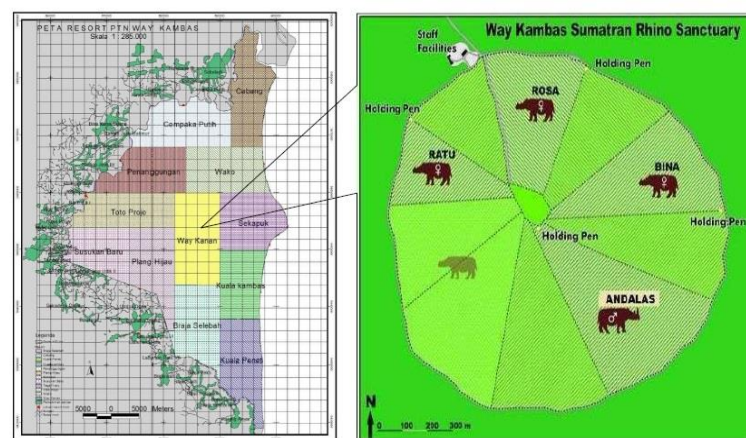


Figure 1. Research Location at Sumatran Rhino Sanctuary, Way Kambas National Park with Scale 1:285.000^[17]

B. Tools and Object

The tools that used in this research were camera, binocular, watch, stationary, laptop and tallysheets, while the object was one female Sumatran Rhino in SRS named “Ratu”.

C. Methods

Data about Sumatran Rhino feeding behaviour was obtained by using Focal Animal Sampling method^{[18][19]}. The collected data were primary and secondary data. Primary data was the Sumatran Rhino feeding behaviour and secondary data were books, journals and other literature which could more amplify the results.

D. Data Analyzing

This research was used the quantitative descriptive techniques. The activity dynamics and time proportion of feeding behaviour was obtained by Focal Animal Sampling equation^{[18][19]} then analyzed quantitatively. The feeding behaviour was analyzed descriptively.

$$\text{Activity Analysis} = \frac{\text{Number of Activity}}{\sum \text{Total Activity}} \times 100 \%$$

$$\text{Time Analysis} = \frac{\text{Time for each Activity (minutes)}}{\sum \text{Total Time (minutes)}} \times 100 \%$$

III. Results and Discussion

The object was “Ratu” and she was chosen because she can easily adjust stranger presence and she was in parenting period therefore it is not too dangerous to observe. Feeding behaviour is include chewing, swallowing, or inserting any material into the mouth^{[20][21]}. The observation was performed for 105 hours observation within 14 days (\pm 7 hours/ day) and it was separated into two sections which is drop-in feeding behaviour when the rhino inside the cage and natural feeding behaviour when the rhino was released into the forest. Sumatran Rhinoceros behaviour was very complex both in activity dynamics and time proportion. This could be affected by the surrounding enviromental conditions. Ratu’s daily behaviour has different frequency. The activity dynamics was used to know the pattern of activity changes to get the highest frequency of activity in certain hours to represent the trend of Sumatran Rhino activity in general the it is presented in graphic form (Fig 2) as follows.

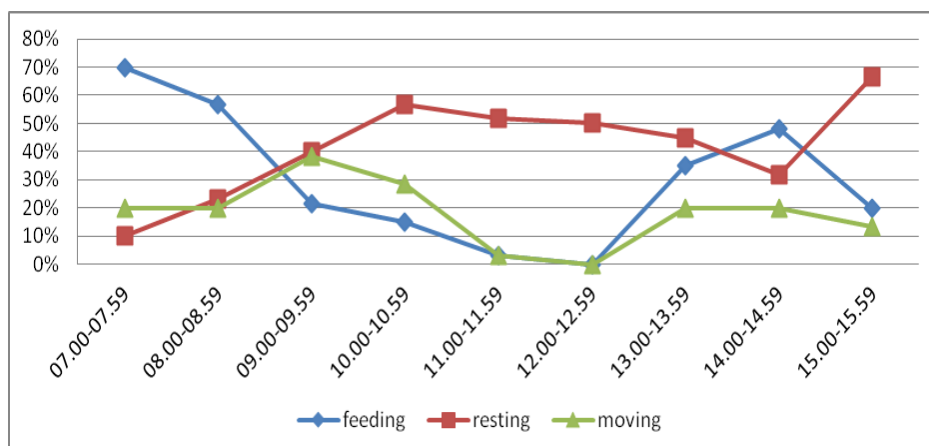


Figure 2. Ratu’s activity dynamics per hours.

Based on Figure 1 it could be seen that the activity with the highest percentage in the morning (07.00-10.00 am) was feeding that is 70% at 07.00-07.59 AM and the lowest percentage was moving which is 10% at 07.00-07.59 AM. This happens because it was the time for rhino to get drop-in feed therefore the most dominant behaviour was feeding. Based on other research Sumatran Rhinoceros feeding behaviour in the cage mostly occurs between 07.00-09.00 AM with the average percentage of feeding time 57,5% [22]. During the day (10.00 AM - 14.00 PM), the behaviour with the highest percentage in the day was resting that is 56,7% at 10.00-10.59 AM and the lowest percentage was moving and feeding at the same amount of 0% at 12.00 AM -12.59 PM. This happens because Sumatran Rhinoceros likes to wallowing during the day to stabilize their body temprature. Usually when the weather is hot, rhino will find the nearest wallow from the cage. During the day, rhino spend more time for wallowing than looking for an extra food in order to keep their body temprature in right. Other research states that at the certain times among 11.00 AM - 13.00 PM Sumatran Rhinoceros had going for wallowing[22]. Activity with the highest percentage in the afternoon (14.00-16.00 PM) was resting that is 66,7% at 15.00-15.59 PM and the lowest percentage was moving in amount 13,3% at 15.00-15.59 PM. This happens because in the afternoon the rhino was given additional drop-in feed around their wallow area, therefore when they were full then they will immediately return to the wallow.

The proportion time of daily activity was the time allocation for each activity based on the total daily time. This data was compared to its total daily time started from 07.00 AM until 16.00 PM. The results were presented in graphical form as follows (Figure 3)

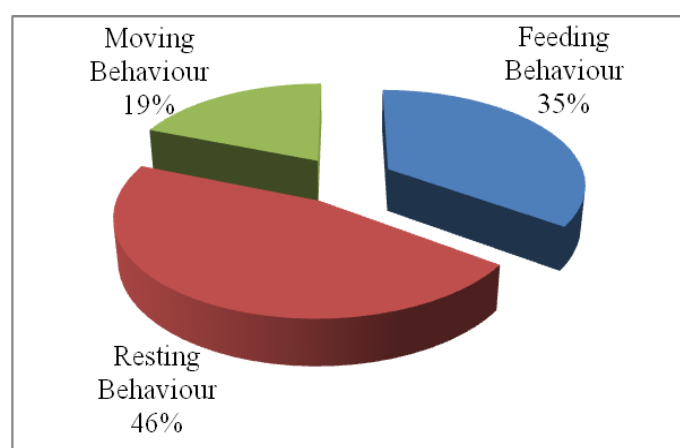


Figure 3. Ratu's time proportion per day

Base on the Fig 3 it could be seen that Ratu spent 35% of her total daily time for feeding behaviour. This number was obtained from the comparison of total drop-in feeding time in amount 1792 minutes summed up total natural feeding time in amount 419 minutes with Ratu's total daily time started from 07.00 AM -16.00 PM in amount 6359 minutes. Rhino spent 49% of their daily time for feeding[23]. This thing was significantly different with this result because the result calculation was obtained based on observation time started at 07.00 AM -16.00 PM while the statement calculation was based on one day observation time. Basically Sumatran Rhinoceros was a nocturnal animal, therefore its feeding behaviour more active at night[24].

Drop-in feeding was made as natural as possible in order to minimize the handfeeding by putting the feed inside the cage and let the rhino eat independently (Fig 4). However, in certain conditions handfeeding can be done, for example when the rhino lacks of appetite

the keeper will separates the preferred feed thus the rhino can eat more voraciously.



Figure 4. Ratu and Delilah had drop-in feeding inside the cage.

Before being fed, the rhino will walk near the feed and stand still while snorting the feed or sometimes rubbing their head or body to the cage. When feeding, the rhino will bite the part of the branch that has lot of leaves and then the rhino will chewing the feed while standing or sometimes with closed eyes. The average of chewing time in a single input was ± 31 seconds with the amount of feed chews as much as ± 35 times per input. When the rhino full they will walk around the cage and stand still at the center of the cage it difficult to be fed again. Because this species is an obligate browser that requires a large percentage of its diet to consist of fresh, diverse browse species ^[25], it is challenging to maintain in zoos and is less likely to receive a higher plane of nutrition than its wild counterparts browsing in their native forests of Sumatra ^[26]. If the feed in the enclosure is incompatible with its natural diet, this might affected the animal behaviour^[27]. The drop-in feeding was also given in the afternoon, but the feeding was not done inside the cage but it was given in the forest (Fig 5) The afternoon drop-in feeding place usually close to the wallow area.



Figure 5. Ratu and Delilah had afternoon drop-in feeding.

Natural feeding behaviour occurs when the rhino was released to the forest at 10.00 AM, but if the feed necessity were already fulfilled from drop-in feeding, usually the rhino will go straight to the wallow area. Natural feeding behaviour begins by walking to the feed source then the rhino will sniffing and snorting the feed source. The rhino will push the trunk of the tree with their body or head (Fig 6) then stepped on it with their legs until it completely fell down. Sumatran Rhinoceros was feeding by push the side of the tree with their chest to lie down the tree then stepped the tree until it fell between their legs^[22]. Rhino got their feed by destroying, biting, and bending the tree with their horn, teeth, and legs^[28].



Figure 6. Ratu pushing the tree with her head.

The rhino also like to eats by stuck out their mouth to reached the hanging roots and then pulling them off (Fig 7). Some literature describe that some plants are being eaten by rhinos by pulled off, especially for the lower plants like lianas and roots^{[29][30]}.



Figure 7. Ratu trying to reach the roots with her mouth.

Sumatran Rhinoceros also likes saplings and eat them by twisting and biting them to pick up the leaves (Fig 8). The saplings was placed behind the anterior horn then rhino will twisted the saplings which is a typical rhino feeding behaviour^[1].

Sumatran Rhinoceros feeding by taken the leaves from its stem, especially in the shoot part ^[16]. In one meal, Sumatran Rhinoceros will have as much as eight times picking up leaves before moving to another place.



Figure 8. Ratu's pushing the tree with her head.

IV. Conclusion

Based on the research, the feeding activity dynamics with the highest percentage occurs in the morning (07.00-10.00 AM) was 70%. Time proportion of Ratu's feeding behaviour in a day was 35 % of her total daily time. The feeding methods of Sumatran Rhinoceros were by pushing the tree by their head or body and then stepped it with their legs until fell down, pulling off the roots, twisting the branch, and breaking the branch with their mouth.

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