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ICAIA 2015
INTERNATIONAL CONFERENCE ON ADAPTIVE & INTELLIGENT AGROINDUSTRY

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2015 3rd INTERNATIONAL CONFERENCE ON ADAPTIVE AND INTELLIGENT AGROINDUSTRY (ICAIA)

on August 3 - 4, 2015
IPB International Convention Center
Bogor, Indonesia

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INTERNATIONAL CONFERENCE ON ADAPTIVE AND INTELLIGENT AGROINDUSTRY ★ ICAIA

PROCEEDINGS

2015 3rd International Conference on Adaptive and Intelligent Agroindustry (ICAIA)

ICAIA 2015

August 3rd - 4th, 2015
IPB International Convention Center
Bogor, Indonesia

ISBN : 978-1-4673-7404-0
IEEE Catalog Number : CFP15C67-CDR

IEEE INDONESIA SECTION

Proceedings of

2015 3rd International Conference on Adaptive and Intelligent Agroindustry (ICAIA)

IPB International Convention Center, Bogor, Indonesia

August 3rd – 4th, 2015

Published by :

Department of Agroindustrial Technology

Bogor Agricultural University

Bogor, Indonesia

Welcome Message from The General Chairs of ICAIA 2015

On behalf of the organizing committee, it is our pleasure to welcome you to International Conference on Adaptive and Intelligent Agroindustry, Bogor, Indonesia. This is the 3rd conference on the topic that is held by the Department of Agroindustrial Technology, Bogor Agricultural University, Indonesia.

The conference is expected to provide excellent opportunity to meet experts, to exchange information, and to strengthen the collaboration among researchers, engineers, and scholars from academia, government, and industry. In addition, the conference committee invited five renowned keynote speakers, i.e. Prof Irawadi from Bogor Agricultural University; Prof Kenneth De Jong from George Mason University, USA; Dr Yandra Arkeman from Bogor Agricultural University; and Dr Guillermo Baigorria from University of Nebraska-Lincoln, USA.

The conference committee also invited Prof Noel Lindsay from University of Adelaide, Australia; Kiyotada Hayashi from National Agricultural Research Center-Tsukuba, Japan; Prof Margareth Gfrerer from Islamic State University of Jakarta, Indonesia; Dr Barry Elsey from University of Adelaide, Australia; Dr Gajendran Kandasamy from Melbourne University, Autralia; and Imperial College London-British, Prof Allan O'Connor from University of Adelaide, Australia; Dr Wisnu Ananta Kusuma from Bogor Agricultural University ,Indonesia; and Dr Frank Neumann from University of Adelaide, Australia, as invited speakers.

This conference was organized by Department of Agroindustrial Technology, Bogor Agricultural University and Asosiasi Agroindustri Indonesia, and technically sponsored by IEEE Indonesia Section. Furthermore, it was supported by Departement of Computer Science, Bogor Agricultural University; Surfactant amd Bionegergy Research Center; PT Bogor Life Science and Technology; Indonesian Ministry of Industry; PT Pachira Distrinusa; and PT Kelola Mina Laut.

I would like to take this opportunity to express my deep appreciation to the conference’s committee members for their hard work and contribution throughout this conference. I would like to thank authors, reviewers, speakers, and session chairs for their support to participate in the Conference. Lastly, I would like to welcome you to join ICAIA 2015 and wish you all an enjoyable stay in Bogor.

Sincerely,
Dr Yandra Arkeman
General Chairs, ICAIA 2015

WELCOMING ADDRESS

Prof. Dr. Ir. Nastiti Siswi Indrasti
Head of Agroindustrial Technology Department
Faculty of Agricultural Engineering and Technology
Bogor Agricultural University
on
3rdInternational Conference on Adaptive and Intelligence Agroindustry (3rd ICAIA)
Bogor, August, 3 – 4, 2015

Assalamu'alaikum Warohmatullahi Wabarokatuh
In the name of Allah, the beneficent and the merciful,

Distinguish Guest, Ladies and Gentlemen
Let me first thank you all for accepting the invitation to participate in this 3rd International Conference on Adaptive and Intelligence Agroindustry (ICAIA). In particular I would like to thank Rector of IPB (Institut Pertanian Bogor/Bogor Agricultural University) Prof. Herry Suhardiyanto for supporting this event as part of the series academic event in celebrating the 52nd Anniversary of Bogor Agricultural University.

We are certainly proud to have been able to assemble this event in IPB, Bogor. The range of participants and audience at this conference is precisely something I would like to stress. Participants who followed the event more than 150 people, coming from various countries including the USA, Australia, Japan, Vietnam, Philippine, Germany and Indonesia. The main goal of the conference is to provide an effective forum for distinguished speakers, academicians, professional and practitioners coming from universities, research institutions, government agencies and industries to share or exchange their ideas, experience and recent progress in Adaptive and Intelligent Agroindustry.

The 2015 3rd International Conference on Adaptive and Intelligent Agro-industry (ICAIA) is the third forum for the presentation of new advances and research results on various topics in all aspects of innovative agro-industry that highlights the development and improvement for today and tomorrow's global need for food, energy, water and medicine. The aim of the conference is to stimulate interaction and cohesiveness among researchers in the vast areas of innovative agro-industry. Innovative Agro-industry has the ability to adapt intelligently to future global challenges, i.e. food, energy, water, and medical. Global challenges needs a new breed of Agroindustry which could produce innovative products to fulfill the needs through advanced processing technology, production systems and business strategy supported by cutting-edge information and communication technology.

The topic for this event is "Empowering Innovative Agroindustry for Natural Resources, Bioenergy and Food Sovereignty". The topics clustered into four main parts:
Track 1 : Innovative Agroindustrial and Business System Engineering

Track 2 : Frontier Approaches in Process and Bioprocess Engineering
Track 3 : Frontier Approaches in Industrial Environmental Engineering
Track 4 : Intelligent Information and Communication Technology for Adaptive Agroindustry of the Future

This event also hosts four (4) workshops: (1) Strategies for Agroindustry Development (2) LCA for Agroindustry (3) Innovation and Technopreneurship for Agroindustry and (4) Agroindustry Informatics.

Distinguish Guest, Ladies and Gentlement,
Agroindustry transforms agricultural commodities into high value-added products. Agroindustry is industry that process agricultural products to increase their value added significantly by using technology and by considering environmental aspect and sustainability. However, with changing global demand and technology advancement, innovative agroindustry is needed in order to be competitive as well as sustainable. The challenge of future agroindustry is not merely efficiency and productivity anymore, but also the challenge to appropriately apply frontier technology as well as meeting future global demands.

Agroindustry needs to deal with the application of advance technologies and cope future global issues. Current global issues which arise and expected to exist in the future are food sovereignty, renewable energy, sustainable water management and pharmacy. The ability of agro-industry to respond the future global issues and the undoubtedly substantial increase in demand in future decades will be highly dependent on the increased application of existing technologies as well as the exploitation of new and innovative technologies.

The emergence of high technology could be applied in the agro-industry are: nanotechnology, biotechnology, bioinformatics, food processing, food packaging-waste, state-of-the-art computation and many others. The aforementioned high-technology along with computation technology could greatly advance agro-industry from a traditional system into a smart-intelligent and innovative technology. Therefore, in the new millennia, adaptive-intelligent and innovative agro-industry will contribute to solutions to global problems and brings agriculture into perfection.

Hope this conference will also discuss this issue in more detail as it is an important matter for all of us. We should no more think just how to produce high value product but it is also necessarily important how to keep our live in good quality by understanding following old saying… “You do not live at once. You only die once and live every day”.

I do not to take up any more of your time with these opening remarks. Let me simply thank you once again for sharing your thoughts with us. Here’s wishing every success for the conference. May Allah bless all of us.

Thank you for your kind attention,
Wassalamu’alaikum Warohmatullahi Wabarokatuh

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AGENDA

Time	Activities
Monday, August 3rd 2015	
08.00 - 09.00	Registration
09.00 - 10.00	Opening Ceremony • Welcoming Address: Prof. Nastiti Siswi Indrasti (Head of DAT, Fateta, IPB) • Welcoming Speech Head of Bogor Regency • Conference Opening: Prof. Herry Suhardiyanto (Rector of IPB) • Opening Speech and Conference Opening : Minister of Industry Indonesia * • Launching Expose International program DAT
10.00 – 10.05	*Photo Session*
10.05 - 10.15	*Coffee break*
	Keynote Speech :
10.15 - 10.45	1. Prof Irawadi (Bogor Agricultural University, Indonesia) 2. Prof. Kenneth De Jong (George Mason University, USA)
10. 45 - 11.30	3. Dr. Yandra Arkeman (Bogor Agricultural University, Indonesia)
11.30 – 12.00	4. Dr. Guillermo Baigorria (University of Nebraska, Lincoln, USA)
12.00 – 12.30	
12.30 – 13.30	Lunch break
	Plenary Session 1 :
13.30 – 13.50	Prof. Noel Lindsay (University of Adelaide, Australia)
13.50 – 14.10	Dr. Kiyotada Hayashi (National Agricultural Research Center, Tsukuba, Japan)
14.10 – 14.30	Prof. Margareth Gfrerer (Islamic State University of Jakarta, Indonesia)
14.30 – 14.50	Dr. Barry Elsey (University of Adelaide, Australia)
14.50 – 15.10	Ir. M. Novi Saputra (Marketing Director KML Food Group)
15.10 – 15.45	*Discussion*
15.30 – 15.45	*Coffee break*
15.45 – 18.00	Parallel session A, B and C
18.00 – 21.00	Welcome Dinner

Time	Activities
Tuesday, August 4rd 2015	
08.30 – 09.00	Registration
	Plenary Session 2 :
09.00 – 09.20	Dr. Gajendran Kandasamy (PhD in Physic, Melbourne University ; PhD in Innovation Imperial Collage, London)
09.20 – 09.40	Prof. Allan O'Connor (University of Adelaide, Australia)
09.40 – 10.00	Dr. Eng. Wisnu Ananta Kusuma, ST, MT (Bogor Agricultural University, Indonesia)
10.00 – 10.20	Dr. Frank Neumann (University of Adelaide, Australia)
10.20 – 10.45	*Discussion*
10.45 – 13.00	Parallel Session A, B and C
13.00 – 14.00	Lunch break
14.00 – 15.30	Parallel Workshop • Strategies for Agroindustry Development • LCA for Agroindustry • Innovation and Technopreneurship for Agroindustry • Agroindustrial Informatics
15.30 – 15.45	Coffee Break
15.45 – 16.15	Closing remark

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Intelligent Information & Communication Technology for Adaptive Agroindustry of the Future

ABSTRACTS OF INVITED SPEAKERS

ISBN : 978-1-4673-7404-0

AN EMPIRICAL INVESTIGATION OF THE BARRIERS TO GREEN PRACTICES IN YOGYAKARTA LEATHER TANNING SMES

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ABSTRACT

This study identifies factors that inhibit green practice implementation in the leather tanning SME industry in Yogyakarta, Indonesia. These external and internal barriers were identified during interview with representatives from a number of leather tanning SMEs and industry experts. The results show that SMEs in this sector adopt only a limited level of environmental practices. Internal barriers to green adoption included insufficient resources and infrastructure, low-skilled human resources, poor financial capability, low awareness, and poor organizational strategies. The external barriers are significant; however, inadequate law enforcement and government support, a small and limited market segment, and the lack of green chemicals contribute also toward these poor practices. To deal with these problems, this research proposes eight strategies to tackle the obstacles that prevent the implementation of leather tanning green practices.

 ISBN : 978-1-4673-7404-0

DECISION ANALYTIC PERSPECTIVES ON LIFE CYCLE ASSESSMENT: HOW TO USE PREFERENCES

Kiyotada Hayashi

ABSTRACT

Multiplicity of assessment criteria has recently attract much attention in life cycle assessment (LCA). For example, the French initiative on LCA-based environmental information and the environmental footprint project conducted by European Commission introduced plural environmental indicators (categories). However, there are still confusions about the possibility of establishing integrated single indicators. This presentation illustrates impossibility of the integration of many environmental indicators using universal weighting factors based on preferences and possibility of decision support based on preference construction, which is based on the understanding that people do not have stable articulated preferences especially about unfamiliar objects such as environmental issues and emerging agro-industrial technologies and that they instead construct preferences through interactive learning processes.

ISBN : 978-1-4673-7404-0

CONFERENCE PRESENTATION

Barry Elsey

ABSTRACT

The conference presentation focus is on the learning experiences of the IPB students doing the second part of a double-degree Master's program. The research examined their pre-departure expectations, the actual learning during the various programs and their post-course reflections. Using an eLearning Diary the personal reflections of the students are used to report on their significant learning experiences in another country and a leading Australian university. The presentation reports the highlights of their learning experiences and considers the innovative aspects of the program at Adelaide University.

ISBN : 978-1-4673-7404-0

EFFICIENT OPTIMIZATION OF MANY OBJECTIVES BY APPROXIMATION-GUIDED EVOLUTION

Frank Neumann

ABSTRACT

Multi-objective optimization problems arise frequently in applications, but can often only be solved approximately by heuristic approaches. Evolutionary algorithms have been widely used to tackle multi-objective problems. These algorithms use different measures to ensure diversity in the objective space but are not guided by a formal notion of approximation. We present a framework for evolutionary multi-objective optimization that allows to work with a formal notion of approximation. This approximation-guided evolutionary algorithm (AGE) has a worst-case runtime linear in the number of objectives and works with an archive that is an approximation of the non-dominated objective vectors seen during the run of the algorithm. Our experimental results show that AGE finds competitive or better solutions not only regarding the achieved approximation, but also regarding the total hypervolume. For all considered test problems, even for many (i.e., more than ten) dimensions, AGE discovers a good approximation of the Pareto front. This is not the case for established algorithms such as NSGA-II, SPEA2, and SMS-EMOA. In this paper we compare AGE with two additional algorithms that use very fast hypervolume-approximations to guide their search. This significantly speeds up the runtime of the hypervolume-based algorithms, which now allows a comparison of the underlying selection schemes.

 ISBN : 978-1-4673-7404-0

AN INTEGRATED AND INTELLIGENT SYSTEM FOR ADAPTIVE AGROINDUSTRY

Yandra Arkeman

ABSTRACT

This research discusses about the most recent research results in the area of adaptive and intelligent agroindustry. The agroindustry covered in this research are food, bioenergy,natural medicine and biofiber industry. The computational intelligence techniques usedin this research are neural networks, fuzzy logic, genetic algorithms, parallel computingand multi-objective optimization.The other tools used are system dynamic, agent-basedmodeling, LCA (Life Cycle Analysis) modeling as well as global climate mideking. Theultimate goal is to develop an integrated and intelligent system that can be used todesign an innovative and sustainable agroindustrial system for today's and tomorrow'seconomy.

ISBN : 978-1-4673-7404-0

HIGH-PERFORMANCE COMPUTING FOR BIOINFORMATICS APPLICATIONS

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Bioinformatics is a growing field of science, which applies the power of contemporary computing systems and algorithm to the analysis of biological data. This data is too complex and too large. Over the past decade there has been a dramatic increase in the number of biological data. There are two additional factors which have contributed to this increasing volume of data. The first factors can be attributed to some larger bioinfomatics research facilities generating more than several hundred gigabytes of data per day. The second factor is concerned with the development of high-throughput techniques for DNA sequencing and analysis.

Activity in Bioinformatics such as DNA sequence analysis, drug discovery, etc are computationally intensive. If large amounts of data are processed, a single computer often runs for many hours or even days. This limitation led to the development of large scale distributed platform and high-performance computing (HPC).

These studies aim to highlight the potential and effectiveness of HPC as viable option to perform some bioinformatics tasks. We introduced the implementation of shared memory computing using OpenMP, distributed memory computing using Massage Passage Interface (MPI), Graphics Processing Unit (GPU) Computing using CUDA, and Map Reduce programming model to solve the problem in bioinformatics such as pairwise alignment, multiple sequence alignment, DNA sequencing error correction, and DNA sequence clustering.

Innovative Agroindustrial and Business System Engineering

 ISBN : 978-1-4673-7404-0

The Feasibility Study of Establishment of Biodiesel and Paving Block Industry from Spent Bleaching Earth

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***Abstract*—Spent Bleaching Earth (SBE) is a solid waste material generated as a part of the refining process in refinery and palm cooking oil industry. The purpose of this research was to analyze the feasibility based on financial and non-financial aspects of the establishing of biodiesel and paving block industry, which were divided into three plans. In addition, the analysis was also performed on the level of sensitivity as a result of a change in a variable effort. The calculation of costs and benefits were arranged in the form of cash flow. Based on the analysis of financially (NPV, IRR, Net B/C, Payback Period) and non-financially aspects, all plans are worth to be established .**

I. INTRODUCTION

Spent Bleaching Earth (SBE) is one of the biggest wastes produced by refinery and cooking oil industry. SBE produced in refinery process using bleaching earth (BE) to remove pigment in crude palm oil (CPO) to produce clearer oil. Young (1987) said that used about 0.5% up to 2.0% BE from every mass of purified CPO.

Indonesian CPO production from year to year increase significantly, it can be seen from the CPO export value that increase every year. Indonesian CPO export in the last decade increase 7-8% per year. Increasing of CPO production is directly proportional to the increase of CPO consumption in Indonesia that growth about 24.55% in 2013. Cooking oil industry is one of the industries that absorb the CPO. In 2012 about 89% CPO used to produce cooking oil (Kemenperin 2014). This value is equivalent with 6.988 ton CPO. It also gives impact in the increasing of SBE waste. It estimates that in 2012 produced about 69.8 ton SBE. According to Taylor (1999) SBE still contains residual oil by 20% - 40%. The high oil content in SBE is potential to be recovered and used as raw material for methyl esters (biodiesel), in addition SBE can also be used as sand substitute in paving block production.

Research on the use of SBE is already done. Mubarok (2014) has conducted research in biodiesel production from SBE thru in situ and the results showed that the best conditions for esterification-transesterification in situ are 230 rpm and 90 minutes for transesterification. The characteristic of biodiesel is also accordance with SNI. Mardiko (2014) also has conducted research in the utilization of SBE to produce paving block. Utilization of SBE into paving block can be derived from byproduct of refinery CPO and byproduct of biodiesel production thru in situ by using SBE from the refinery CPO as raw material.

Currently refinery and cooking oil industry dispose their SBE in an open land (Permana 2009) whereas according to PP No 18 Year 1992 and Environment Agency Guidance (2006), SBE classified as hazardous and toxic waste (B3) which can cause environmental pollution problems such as stink odor and according to Pollard (1990) SBE classified into fire hazard materials (flammable). Therefore, CPO refinery industry is required to handle SBE seriously. SBE utilization into value added product is one of the options that can be done by refinery industry. To do that SBE utilization industry can be integrated with CPO refinery industry. So that SBE produced by CPO refinery industry can be use as raw material to produce biodiesel and or paving block in SBE utilization industry.

To know about the feasibility of the industry establishment, special analysis is required. SBE can be used directly as raw material to produce paving block or used as raw material to produce biodiesel first and then used to produce paving block. So there will be 3 plans of the establishing of the industry. Plan 1 is the establishment of integrated biodiesel and paving block plant with refinery plant, Plan 2 is the establishment of integrated paving block plant with refinery plant, and Plant 3 is the establishment of integrated biodiesel plant with refinery plant. There are several aspects that analyzed; they are marketing aspect, technical and

 ISBN : 978-1-4673-7404-0

technology aspect, management and operational aspect, environmental aspect, legality aspect, and financial aspect. All the aspects can determine the feasibility of the establishment of SBE utilization industry.

II. METHOD

A. Data Collection

Data that collected were primary data and secondary data. Primary data was obtained from interview with experts in the related sector. Secondary data was obtained from report; article; journal; statistic data from government institutions, private sector and research institution; and others.

B. Data Analysis

Marketing data Analysis

Analysis that done on these aspects were market potential according to market development and product marketing of biodiesel and paving block; and marketing strategic that consist of segmentation, targeting, positioning, and marketing mix.

C. Technical and Technology Analysis

Technical and technology analysis cover determine production capacity and location, selection of process technology and equipment, determine machine lay out and space requirement, mass balance and energy balance that produce during production. Determining of production capacity was suited with the available raw materials. Machine and equipment utilizing were suited with selected process technology.

D. Management and Operational Analysis

Analysis for management and operational were selection of organization formed and suitable organization structure, labor requirement and the job desk.

E. Environment and Legality Analysis

Legality analyses determine the suitable form of the organization according to the government law. Environment analysis covers environment effect and the way to overcome.

F. Financial Analysis

Financial analysis was conducted to determine the investment cost, and production cost. In addition it was analyzed the revenue plan that will be earned if the industry run and then the financing structure with prevailing interest rate. Evaluation of the investment criteria are Net Present Value (NPV), Internal Rate of Return (IRR), Net Benefit Cost Ratio (Net B/C), Pay Back Period (PBP), Break Even Point (BEP) and sensitivity analysis.

III. RESULT AND DISCUSSION

A. Marketing Aspect

Biodiesel is one of biofuel which have increased on production and consumption in Indonesia. Increased consumption of biodiesel is affected by: the increase in consumption of biodiesel (a mixture of biodiesel and diesel oil) that are increasing every year, increase in the price of world oil, the desire of stakeholder to implement renewable fuels which is more friendly and sustainable. This is reflected in the Regulation of Minister of Energy and Mineral Resource No. 25 year 2013, which obligates enterprises who holds a commercial license for fuel oil and direct fuel users, such as industry, to use biofuel gradually. It is predicted that the demand for biodiesel until 20125 is still quite large that allegedly opportunity to establish biodiesel industry is quite prospective.

Market segmentation for biodiesel is industries that use diesel fuel. This segment had been selected because they are very potential to substitute diesel fuel with biodiesel. The main targeting for marketing is CPO refinery industry which integrated with Plan 1, 2 and 3. After the need of CPO refinery industry fulfilled, then marketing to industry in area where the factory is located. Positioning for biodiesel are the price is cheaper than industrial diesel fuel that is Rp10200 per liter while the price of industrial diesel fuel is Rp11900 per liter, have low emission level, environmentally friendly, and meet the specification of Indonesian National Standard (SNI).

Paving block is building material used in outdoor (exterior) such as sidewalks, play area, garden, pavement in light road, and surface covering. The property sector is one of the largest users of paving block. According to Bank of Indonesia (2011), Indonesian property industry in 2011 showed positive trend and will continue in the next 3 years. The growth in this sector is an opportunity to gain greater turnover for the material building business that includes the production and distribution. Adji (2012) has conducted research on forecasting the needs of paving block in one of industries and has conducted interviews with 17 contractors who are users of the paving block. The result showed that the demand for paving block will still be increased. Market segmentation for paving block is property industries with target on contractors in Jabodetabek (Jakarta, Bogor Depok, Tangerang and Bekasi). This was chosen because the company is located in the Greater Jakarta area, so it easier to distribute products to consumers. Positioning of the paving block are good quality (perfect shape, no cracks or defects), meet the SNI, and can meet demand in large numbers.

B. Technical and Technology Aspect

Biodiesel production capacity and the paving block

 ISBN : 978-1-4673-7404-0

on Plan 1 is 3950 liters per day and 30625 pieces per day. Capacity for Plan 2 is 32380 pieces per day, and capacity for Plan 3 is 33950 liters per day. The capacity is based on the amount of SBE that produced in CPO refinery unit. Biodiesel production process is based on Mubarok's research (2014) and the paving blocks production is based on Mardiko's research (2014). Machinery and equipment used in the biodiesel and paving block production consists of several tanks and reactors. Machinery and equipment is operated semi-automatic with control in the operator room. Determination of engine capacity is based on mass balance calculations.

C. Management Aspect

Organization type for the third plan is the industry line, because in this system there is unity in the leadership and command, so that the work discipline can be assured, every worker has the duty and responsibility which is limited to the firm, the decision was taken quickly, and costs can be saved. Employment which is needed for the third plan consists of plant manager, responsible to supervising the implementation of production activity, quality control, and maintenance of production facilities. Production supervisor is responsible for managing and supervise the production process, procurement and logistics supervisor is responsible for managing procurement and manage raw materials and product distribution. Operator in charge of running and controlling processes and machinery/equipment, laboratory assistant for quality is responsible to supervise and to check the quality of raw materials, production processes, and products; and driver is responsible for transporting and distributing raw materials and products.

D. Environment and Legality Aspect

To establish an enterprise is needed some kind of licensing such as: *Izin Usaha Industri* (IUI), *Izin Mendirikan Bangunan* (IMB) and *Undang-Undang Gangguan* (UUG). Analysis of environmental aspects are required to determine the impact that caused by the industry on the environment in surrounding. Based on the Regulation of the Minister of Environment No. 11 of 2006 on type of planned business and/or activities that must be equipped with the Environmental Impact Assessment (AMDAL), Plan 1 and Plan 3 shall have the AMDAL, while Plan 2 is not. AMDAL consists of 5 documents, are Presentation of Environmental Information (PIL), the Terms of Reference (KA), Environmental Impact Assessment (ANDAL), Environmental Management Plan (RKL). Activities that potentially cause negative impact to environment are pre-construction stage, construction, operation, and post-operation. For the preparation of AMDAL, companies use consultants who have a AMDAL A certificate (basics AMDAL) or B (composer) and companies using experts in biodiesel. During production industry will generate liquid waste, solid waste and gas waste. Waste that will be disposed of in environment must be completely clean from hazardous materials so not cause damage to environment.

E. Financial Aspect

Investment cost consists of fixed capital investment and working capital. Capital investment required in the construction of biodiesel production facilities and paving blocks are different but the cost of the investment required for the construction of public facilities such as office, road and parking and cost of office supplies are the same. Summary of investment costs is presented in Table 4. The cost of investment needed in the establishment of plan 1 is greater than Plan 2 and 3. This is because the Plan 1 produced two types of product while on Plan 2 and 3 only one type. Therefore, it needs a greater cost on machinery, construction and working capital.

The third Plan is assumed to be established in the area of CPO refinery plant and is part of the plant, so that the land is being used belong to the plant, thus cost of land is zero. Working capital is the cost that spent in a period of time to run production at the beginning. Defined time period is one month. This was chosen in order to reduce the risk of limited capital funds at the time when the industry has operated.

The establishment of Plan 1 and 2 is financed with its own capital and loan from Bank with ratio of 65:35. This refers to the policy of Bank Mandiri that the maximum portion of bank financing either for capital investment or working capital is maximum only 65 %. Long-term fixed capital investment credit is 5 years, while for working capital credit is 3 years. Interest rate for credit interest fixed capital investment and working capital is 13.5%. It is referring to the interest imposed by Bank Mandiri. Interest payments are set by using the sliding rate method.

F. Investment Criteria for Plan 1

The results of investment calculation criteria in Plan 1, which is biodiesel industry and paving blocks that integrated with CPO refinery plant, is presented in Table 1. NPV on biodiesel production and paving blocks on Plan 1 is greater than zero. This means that Plan 1 is feasible. NPV is also state the number of net benefits received from industrial establishment during the life of the project to the interest rate, which is 13.5 %. IRR value obtained by 30% stated that Plan 1 is feasible, because it has an internal rate of return greater than applicable discount rate, which is 13.5%. Net value B/C is greater than tone, that is 1.89, means that for every dollar spent during the life of the project, will generate net benefits for 1.89 dollars.

Calculation of PBP investment for Plan 1 occurs in

ISBN : 978-1-4673-7404-0

between the fifth and sixth year. Investment payback time is faster than industrial age. Based on four criteria used in investment (NPV, IRR, B/C ratio, and PBP) showed that the biodiesel and paving block industry which is integrated with CPO refinery plant (Plan 1) is feasible.

TABLE 1
FEASIBILITY INVESTMENT CRITERIA FOR PLAN 1

Criteria	Value	Unit
NPV	9370	Million rupiah
IRR	30	%
B/C Ratio	1.83	
PBP	5.1	Year

G. *Investment Criteria for Plan 2*

The result of investment calculation criteria in Plan 2, which is paving block industry integrated with CPO refinery plant, is presented in Table 2. Table 2 shows that the establishment of paving block industrial integrated with CPO refinery plant (Plan 2) is feasible. Investment feasibility calculation meets the requirements of all four investment criteria. NPV value obtained Rp3,020,274,000 means that the industry provides a positive benefit during the life of the business to the interest rate. Besides, the IRR is greater than the applicable discount rate, which is 28 %. This value states that Plan 2 has an internal rate of return on capital by 89 %. Net value B/C is 1.83 greater than one, stated that every single rupiah used will produce a net benefit of 1.83 rupiah. Time required returning all the investment cost occurs between the fifth and sixth year.

TABLE 2
FEASIBILITY INVESTMENT CRITERIA FOR PLAN 2

Criteria	Value	Unit
NPV	3020	Million rupiah
IRR	28	%
B/C Ratio	1.83	
PBP	5.1	Year

H. *Investment Criteria for Plan 3*

Investment calculation in Plan 3 (Table 3) shows that Plan 3 is feasible to established because able to give Rp6,724,688 million NPV, 28 % IRR, 1.80 Net B/C ratio and 5.32 years to return capital investment.

TABLE 3
FEASIBILITY INVESTMENT CRITERIA FOR PLAN 2

Criteria	Value	Unit
NPV	6724	Million rupiah
IRR	28	%
B/C Ratio	1.80	
PBP	5.32	Year

I. *Sensitivity Analysis*

Sensitivity analysis on Plan 1 carried out on three parameters, which are the increase in the price of auxiliary materials (methanol and cement), the increase in loan interest rates and a decrease in selling prices. If the price of methanol and cement has increased by 20 % and 5 %, as well as higher loan interest rates to 15 %, the Plan 1 is still feasible to set up. However, if there is an increase of 25% in methanol prices and the rise in cement prices by 10 %, then Plan 1 is not feasible to establish. Decrease 15% in selling prices of biodiesel and decrease 5% in selling prices of paving blocks also makes Plan 1 is not feasible. Decrease in the selling price is very sensitive because the selling price already set below the current market price. Details of sensitivity analysis are presented in Table 5.

Sensitivity analysis on Plan 2 conducted to see the effect of changes in raw materials (cement) prices, product prices, and changes in loan interest rate. If the cement price is increase of 5% Plan 2 is still feasible. Increase in loan interest rate of 15% also still makes Plan 2 feasible. However, if there is an increase in cement prices by 10 %, the industry is not feasible. Decrease in the selling price of 5% also makes Plan 2 not feasible. Details of sensitivity analysis are presented in Table 6.

Sensitivity analysis on Plan 3 carried out on three parameters, which are the increase in raw materials (methanol) price, the decrease in the selling price, and the increase in loan interest rate. From Table 7 known that changes in methanol prices and the decrease in the selling price is sensitive to the feasibility of Plan 3. The increase in the price of methanol at 20% and the decrease of the selling price at 12 % make Plan 3 not feasible.

TABLE 4
COMPONENTS OF CAPITAL INVESTMENT FOR PLAN 1.2 AND 3 (IN MILLION RUPIAH)

No	Component	Plan 1	Plan 2	Plan 3
A	Fixed capital investment			
1	Purchasing equipment and machine cost	3532	249	3283
2	Piping cost	2233	-	2233
3	Electrical installation cost	363	3	361
4	Building cost	1132	1686	391
5	Land	-	-	-
6	office supplies cost	131	84	131
7	Vehicle cost	200	200	-
8	Pra-investment cost	42	13	42
9	Contigency cost	763	223	644
10	Interest during construction	737	216	622
B	Working capital			
	Subtotal	1408	970	731
Total		10540	3643	8437

TABLE 5
SENSITIVITY ANALYSIS ON PLAN 1

Change	Investment criteria			
	NPV (million rupiah)	IRR (%)	B/C Ratio	PBP (year)
Methanol price increase 20%, Cement 5%	1505	16	1.14	8.8
Methanol price increase 25%, cement 10%	(1641)	11	0.85	>10
Biodiesel selling price decrease 10%, paving block 2%	2038	17	1.19	8.4
Biodiesel selling price decrease 15%, paving block 5%	(2596)	9	0.75	>10
Loan interest rate increase 15%	9012	29	1.85	5.2

TABLE 6
SENSITIVITY ANALYSIS ON PLAN 2

Change	Investment criteria			
	NPV (million rupiah)	IRR (%)	B/C Ratio	PBP (year)
Cement price 5%	1318	20	1.36	7.5
Cement price 10%	(417)	11	0.89	>10
Paving block selling price decrease 2%	1 633	22	1.45	6.9
Paving block selling price decrease 5%	(447)	11	0.88	>10
Loan interest rate increase 15%	2 907	27	1.79	5.5

TABLE 7
SENSITIVITY ANALYSIS ON PLAN 3

Change	Investment criteria			
	NPV (million rupiah)	IRR (%)	B/C Ratio	PBP (year)
Methanol price increase 10%	2 185	18	1.26	7.85
Methanol price increase 20%	(980)	11	0.89	>10
Biodiesel selling price decrease 10%	358	14	1.04	9.63
Biodiesel selling price decrease 12%	(915)	11	0.89	>10
Loan interest rate increase 15%	6 429	27	1.76	5.48

IV. CONCLUSION

Based on feasibility study of establishment of biodiesel and paving block industry from spent bleaching earth, it can be concluded as follows:

1. The biodiesel industry and paving block are integrated with CPO refinery plant (Plan 1) is feasible with the analysis of investment criteria: NPV Rp9,369,844,000, IRR 30 % , B/C ratio 1.89, and PBP 5.1 years. Based on the results of the sensitivity analysis, the industry is still feasible if the increase in methanol price 20%, cement price 10%, loan interest 15%, and decrease in selling price of biodiesel 10%, paving block 2%. However, if the methanol price increase 25% and cement price 10% as well as a decrease in selling prices of biodiesel 15% and a decrease in selling prices of cement 5 %, the industry became not feasible.
2. Paving block industry which integrated with the CPO refinery plant (Plan 2) is feasible with the analysis of investment criteria NPV Rp3,020,274, IRR 28 % , B/C ratio 1.83, and PBP 5.4 years. Based on the results of the sensitivity analysis, the industry is still feasible if the increase in the cement price 5 %, increase in loan interest 15 %, and decrease in the selling price of paving blocks 2 %. However, if the increase in cement price 10 % and the decrease in the selling price of paving blocks 5%, the industry became not feasible.
3. Biodiesel industry which integrated with CPO refinery plant (Plan 3) is feasible with the analysis of investment criteria NPV Rp6,724,688,000, IRR 28 %, B/C ratio 1.80, and PBP 5.32 year . Based on the results of the sensitivity analysis, the industry is still feasible if the increase in the methanol price 10%, increase in loan interest 15 %, and decrease in selling prices of biodiesel 10%. However, if the increase in methanol price 20% and the reduction in the selling price of biodiesel 12%, the industry became not feasible.
4. From the third Plan that had be done, the most profitable plan is Plan 1 because its criteria for feasibility study is higher than Plan 2 and 3 and the sensitivity values are lower than Plan 2 and 3.

V. RECOMMENDATION

In the biodiesel production process, glycerol is generated. For the next research glycerol can be purified so that the value is higher and could give greater benefit to the biodiesel industry

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Green Supply Chain Management Innovation Diffusion in Indonesian Crumb Rubber Factories: Designing Strategies towards Implementation

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***Abstract*— Green supply chain management (GSCM) is a new technical innovation that has been touted to improve supply chain performance as well as minimize the environmental impacts. Unfortunately, this concept has not been entirely implemented in Indonesian rubber industries. The primary objectives of this research were to suggest the model that is relevant with the crumb rubber supply chain and formulate green approach as well as prioritize strategies to accelerate GSCM implementation in Indonesia's crumb rubber factories (CRFs). The case studies were conducted in two private CRFs. The data were collected through semi-structure interviews, field observation, and examination of QMS documents. The GSCM model for CRFs was constructed and the rooms for improvement were judged through comparing the current condition with the model. In addition, the Analytical Hierarchy Process was employed to prioritize the strategies. The results showed that green procurement which emphasizes on educating farmers and increasing the quality of raw material are the prioritized green approaches. The practical results of this research provide valuable insights and guidelines for CRFs to integrate the green concepts into operational business strategy.**

I. INTRODUCTION

Crumb rubber industry (CR) is a featured export rubber product in Indonesia which has a significant role in national economic development and poverty alleviation. These industry supplies about 28% of CR demand in the world (IRSG, 2014). Recently, the negative environmental impacts have become a highlighted issue in the growth of CRFs. Based on the last annual assessment conducted by Ministry of Environment, about 200 of 218 CRFs are categorized as "*red label performance*". This means that the waste management including hazard and toxic material, water, solid, gas emission generated from the CR production processing has not fulfilled the government regulation standards.

The issue of environmental pollution accompanying industrial development ought to be addressed by the supply chain management which considers the material, and information flows as well as the networking of certain industries to be environmentally friendly [1-3]. Some manufacturing companies in Taiwan, India, China, and Brazil have initiated proactively adopt the GSCM such as electronic, pharmaceutical, logistic, textile industries [4]. However, the adoption in agricultural industries has not been explored widely because the supply chain mechanism of agro-industry being complex and highly uncertain. In this case, the Indonesian CR supply chain is unique and has different dynamic behavior as a result of perishable characteristics of latex, seasonal for harvesting and voluminous [5, 6].

The previous studies related to environmental issues in CRFs only focus on the upstream activities of the supply chain, rubber block and RSS [7]. Research on innovation adoption of GSCM is not broadly developed and the implications regarding diffusion the various GSCM practices are not well understood [3].

II. LITERATURE STUDY

A. Green Supply Chain Management

Green issues that have risen from pressures of regulations, markets, NGOs, and suppliers become a crucial part of the business strategy. Therefore, the integration of green approach into business activities is urgent to sustain the competitiveness in the market[3, 8]. Compared to the traditional supply chain, the GSCM allows collaboration among the members non-linearly to share information and materials [3]. This

Manuscript received April 30, 2015. This work was supported in part by the Ministry of Industry of Indonesia.

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ISBN : 978-1-4673-7404-0

collaboration leads supply chain members to works effectively to achieve higher level of green practice.

The urgency of GSCM implementation has many considerations. However, Diabat and Govindan [12] reported that the decisive reason is the ambition of gaining a sustainable competitive advantage. The advantages include enumerates cost reduction, enhanced value to customers, increased sales, positive media attention, greater operational efficiencies and positive ratings from investment firm [1, 3, 13].

Various models of GSCM, which based on the industry type exist in the literature [3, 14, 15]. To illustrate, Ho, Shalishali [2] define GSCM as a range from purchasing, production, inventory, distribution, marketing, and reverse logistic. While, Srivastava [3] suggested the green product design should be in that model. In this study, the GSCM model has been constructed specifically for CRFs, the model is justified as shown in Figure 2.

B. Innovation Diffusion Theory

Innovation includes practices that are new to organizations, such as equipment, products, services, processes, policies, and projects. While, diffusion is the *"process by which innovation is communicated through certain channels overs time among the members of social system"* [17]. He emphasizes the essential stage is between knowledge and implementation, in which the decision to adopt or reject occurs.

Adopting green practices involves implementing new or modified process, techniques and systems to be more environmentally friendly[18], this adoption behavior can be categorized as a technical innovation process [14]. The green adoption changes fundamentally not only in the internal business operation but also other areas, such as suppliers, customers, business partners, even government as the regulators and policy makers [2]. Based on Rogers's model of innovation decision process, the existence of practice or operation is one of the crucial factors to implement the innovation successfully [17]. Since the GSCM is relatively new to the rubber industries, evidence of alternatives and approaches on how to accelerate this adoption is considerably limited.

C. Analytical Hierarchy Process

AHP is one of the techniques to solve the multi-criteria decision-making problem [19]. The principle is decomposing the complex and unstructured problem into a hierarchical structure. The structure consists of focus or objective, criteria or dimensions and the alternatives [5, 19, 20]. The primary operational technique in the AHP is the pair wise comparisons. This derives the relative importance of the variable in each level and appraises the alternatives in the lowest level in order to make the best decision among alternatives [5, 20].

The using of AHP as a selection method to formulate strategy has been widely used, particularly in agro-industry supply chain [6]. It has been used effectively to investigate GSCM practices such as selecting the green supplier and formulating strategy to adopt GSCM.. AHP has a supplemental power of being able to mix quantitative and qualitative factors into a decision. However, Vaidya and Kumar [20] reported some limitation such as strict hierarchical structure, interdependent relationship within a cluster of factors, and also comparison in a wide range number that tend to produce inconsistency. Thus, in this research, the semi-structure interview, and thematic analysis was conducted to get the better understanding and give veracity of the result of AHP.

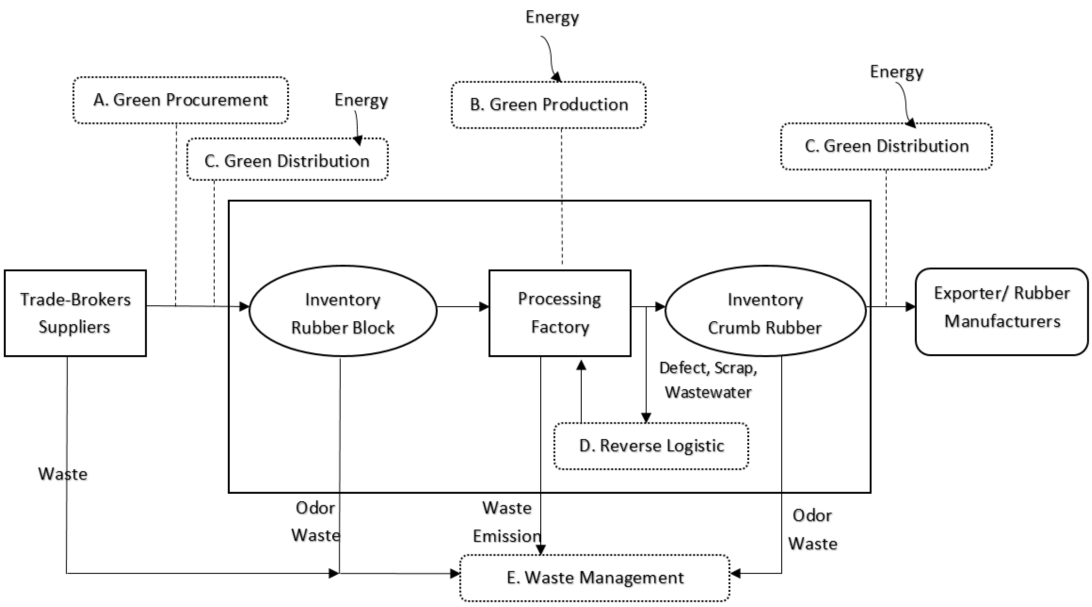

Figure 1 Suggested GSCM Model for Crumb Rubber Factories (Adopted from [1, 3, 7, 10, 21-23])

ISBN : 978-1-4673-7404-0

III. RESEARCH METHOD

A. Data Collection

The research was conducted through a case study methodology with the qualitative approach, case of CRFs in South Sumatera, the highest crumb rubber producer province in Indonesia.

Purposive samples which are company A and B were selected. The companies have been operated for almost 35 years and produced approximately 400-ton crumb rubber monthly. They are classed in "*red level performance*".

An interview script that had open-ended questions was used. The semi-structured interviews were conducted and recorded, mostly about 30-60 minutes for each respondent; a series of notes was made during the interviews. The respondents were the head of divisions and directors of each company. Data of field observation were also collected. This data were beneficial for comparing and matching between the result of the interview & examination of QMS document.

B. Data Analysis

Thematic analysis was used to analyze the result of the interviews. Firstly, all interviews were audio recorded on tape, then listen repeatedly, transcript and coded as proposed by Creswell [24]. After the coding of the material, some nodes were created and categorized following the already established framework from the literature reviews [25].

The AHP was employed by using Expert Choice Software. The hierarchy structure was constructed through study most cited journals, analyze the current system of CRFs, and discuss with experts. The experts are two doctors who are the senior researcher in rubber technology, head of rubber Research Centre, secretary rubber association in Palembang, and two directors CRF. The pair-wise comparison matrix was judged by six experts. Consistency index (CI) which is embedded in the software was calculated to control the consistency of experts' opinion.

IV. RESULTS AND DISCUSSION

A. Current Green Practices in CRFs

To give a better understanding of the dimensions of the environmental endeavors in each company, Table 1 shows the main efforts in terms of executed and continuous practices in order to be green. None of the examined firms used the term "GSCM" for their strategies. The data have been categorized based on the proposed GSCM model implementation in CRF (As shown in Figure 2). Some specific phrases from respondents are in quotation marks, and these give veracity to the research results.

TABLE 1
CURRENT GREEN PRACTICES IN CRFs

Activities	Company A	Company B
Environmental Management	- Integrating the environmental vision into the Quality Management System. "Passionately, We drive possibilities to be the Green Rubber Company."	- Appointing a person who is responsible to monitor and control the environmental performance in the company.
Green Procurement	NA	
Green Production	- Use renewable fuel "palm oil shell as a substitute for coal and gas."	- Redesign the process "modify the dryer to transfer the excess heat to the hanging chamber."
Green Distribution	- Consider the route and energy consumption by using "barge". - Reuse pallets. - Make to order system.	- The location for unloading raw material from the supplier is nearby the processing plant. - Reuse pallets - Make to order system.
Reverse Logistic	– Reuse the wastewater	- Reuse the wastewater
Waste Management	- Compost the waste to be fertilizer instead of discharge. - Adopt new technology in wastewater treatment "huge money to install the active sludge system". - Using non-hazardous chemicals "*deorub*" to minimize the odour." - Control and monitoring pollution	- Recycle by-products - Sell the rubber scrap - Control of pollution - Using non-hazardous chemicals "*deorub*" to minimize the odour."

B. The Hierarchy of GSCM Implementation

The hierarchy was constructed on three levels. The first level is the focus "Green practices selection for GSCM Implementation in CRFs". The second level is the dimension or activity which consists of Green Procurement, Green Production, Green Distribution, Reverse Logistic, and Waste Management. The last level are alternatives or green approached and finally, level 3 alternatives are the green approaches, these were formulated based on analysis of current system and the GSCM model.

As shown in Table 2, the results of local and global weights determined the relative importance of green activities and approaches respectively. In addition, ranking indicates the priority of practices on which organizations should commit and work throughout the process of GSCM implementation. The local weight is derived from judgment with respect to single criterion while the global weight is derived from multiplication by the weight of the criteria. The consistency index for

ISBN : 978-1-4673-7404-0

each pair-wise comparison matrix ranges between 0.0034 – 0.0104 which can be used as reliability indicator for decisions maker.

Based on the AHP result, it is evident that green procurement (0.347), green production (0.266), and waste management (0.183) are the three most important activities to start implementing GSCM. Considering the global weights in Table 2, it is evident that the three prioritized approaches, namely 1) establish the higher standard of rubber block, 2) educate supplier and farmer and 3) reuse wastewater. The findings affirmed the procurement activities in the crucial role, particularly in supplier management relationships like supplier selection and raw material quality. The interpretation of interviews through thematic analysis was used to elucidate the AHP results.

C. Strategies for Greening the Supply Chain

1) Green Procurement

In accordance with the prioritized approaches based on AHP, it is likely consistent with the responses of the respondents. They noticed that the rubber block (raw materials) that purchased from farmers and collectors was the source of waste problems. The lower grade of rubber block cause the higher water and electricity consumption during the production process in CRFs, this leads to generate more wastewater and solid waste. Accordingly, Wibawa, Hendratno [11] reported that about 90% of production cost is raw material procurement. In fact, the production process of rubber block type D, which is the worst grade, causes the increasing of operational cost. It is calculated that the production cost is about as twice as type A, and the waste discharge is approximately as four times as the good grade [10].

The companies have established strict criteria for raw materials standards which is based on quality, delivery and consistency. However, the low grade is still being accepted. This is because the companies experience a lack of raw materials in some seasons, and they may also drop the prize when the quality is too bad and farmers agree without any argument. The rubber block quality is determined by the coagulant used and the amount of impurities[7]. It is found that farmers tend to add impurities such as sand, soil, crumb or other materials to increase the weight [10, 11]. These findings support the AHP results for improve the quality of rubber block, through educate the farmers about the disadvantage of add some impurities in rubber block. Therefore, external factors like the government may support this program.

TABLE 2
THE AHP RESULT OF STRATEGY SELECTION FOR GSCM IMPLEMENTATION IN CRFs.

Activities	Local Weight *	Green Approaches/ Practices	Local Weights	Global Weights **	Ranking
A. Green Procurement	0.347	A1. Substitute hazardous material	0.082	0.028454	14
		A2. Educate suppliers and farmer	0.354	0.122838	2
		A3. Establish higher standard for rubber block	0.564	0.195708	1
B. Green Production	0.266	B1. Adopt new technology	0.147	0.039102	10
		B2. Use alternative energy	0.151	0.040166	9
		B3.Recover excess energy	0.253	0.067298	4
		B4. Redesign process	0.165	0.04389	8
		B5. Improve efficiency machine	0.076	0.020216	16
		B6. Reduce the time of pre-drying process	0.208	0.055328	6
C. Green Distribution	0.106	C1. Use reusable packaging/ pallet	0.085	0.00901	21
		C2. Reduce stock rubber block	0.234	0.024804	15
		C3. Reduce time storage of rubber block	0.348	0.036888	13
		C4. Choose the best transportation mode	0.158	0.016748	19
		C5. Manage the route of truck	0.175	0.01855	18
D. Reverse Logistic	0.098	D1. Recycle the scrap	0.205	0.02009	17
		D2. Reuse the wastewater	0.687	0.067326	3
		D3. Remanufacture the defect product	0.108	0.010584	20
E. Waste Management	0.183	E1. Control of toxic & hazardous chemical	0.204	0.037332	11
		E2. Control emission	0.202	0.036966	12
		E3. Install active sludge wastewater treatment	0.308	0.056364	5
		E4. Use *deorub* to control odor	0.286	0.052338	7

2) Green Production

Initially, it is predicted that green production was the significant activities due to the current efforts in technology process is not working well. However, the result of AHP calculation revealed that the green approaches in production activities have lower priority than the purchasing area. According to the respondents, approaches like install active sludge for wastewater treatment, adopt new technology process and redesign process need an amount of capital investment and skillful human resources. They acknowledged that as emerged barriers to adopting some green approaches. Apart from that, it is found that the source problem of environmental problems in CRFs is in the low quality of rubber block [10, 11]. Surprisingly, the production activities are the significant area to initiate GSCM implementation in manufacturing and assembling [1, 13], not agricultural based industries like CRFs that has a highly dynamic raw material supply chain.

The evidence of the AHP results implies that the green approaches are interrelated within the CRFs. The application of these best practices should be multifaceted, not limited only to highly prioritized practices but also considering the significant factors on GSCM adoption. In addition, the green approaches to greening the waste management, distribution, and reverse logistic should be organized and synchronized with the current production system. The multiple greening approaches along with the high organization commitment results more beneficial for improving efficiency supply chain cost and enhance the environmental performance [12, 13, 26, 27].

3) Waste Management

The results of AHP show that the practices in the waste management are the third main activities in succeeding GSCM adoption. The recommended best practices are mostly the strategy of end of pipe system. CRFs were suggested to treat the wastewater and solid waste rather than implement source-reduction or pollution-prevention strategy. The green practices in AHP results do not emphasize on designing the zero-waste process and optimize the consumption of raw materials and energy because their resistance to change the processing system. Nevertheless, the waste treatment and disposal have been compelling problems like CRFs need to invest in technology and machinery [3, 28]. The other finding suggests controlling the amount of toxic and hazardous chemicals in the production process so that CRFs should have a different warehouse to store it. As a common waste management system, the green practices also include the pollution control from stack emission and the odor from rubber block during storage.

4) Green Distribution

The suggested green practices in GSCM adoption are improvement for logistics system of rubber block and packaging of crumb rubber. Based on the field observation and interviews, it could be said that he current logistic system is intricate from the plantation area to processing plant, particularly the delivery route is less integrated along the rubber block supply chain. This is because the complexity of the rubber block supply chain [9]. The results recommend some practical guidance such as using of alternative transportation modes, minimize travel distances and design the effective routing system. These practices were also suggested in integrating the ecological mindset in either processing or assembling industries [15, 29, 30]. Furthermore, based on experts' opinion, the green warehouse could be achieved by designing an efficient inventory system for both raw materials and crumb rubber product. The design should consider the warehouse capacity, the raw material consumption, the production schedule, and the demand of crumb rubber. Consequently, that design needs to be taken account in production planning.

5) Reverse Logistic

The respondents implies that collecting crumb rubber returns from the rubber manufacturers or exporters is very hardly happened as they mostly accept the product (negotiate for the lowest price if the quality is not as good as the standard). Thus, the experts concluded that internal logistics should be concerned in GSCM adoption. The CRFs have implemented life cycle concept in managing the waste such as consider recycle, reuse, and remanufacture waste as well as the defect product. However, it is found that the implementation of reverse logistics concepts in CRFs is not only for environmental sound but also opportunities financially sound organizational operational. This finding is in accordance with the research results that prioritize profit generation firstly rather than being green consciousness [1, 29]

Surprisingly, reuse the wastewater is the third ranking strategy. This green strategy is proven could minimize the water consumption during the production process and also minimizes wastewater discharge. Furthermore, recycling the scrap and remanufacture the defect product may be less prioritized due to the impact of the strategy is considerably low.

Based on the results and discussion, it implies that the identified green approaches are interrelated within CRFs. The application of these best practices should be multifaceted, not limited only to highly prioritized practices but also considering the significant factors on GSCM adoption. In addition, the green approaches to greening the waste management, distribution, and reverse logistic should be organized and synchronized with the current production system. In order to succeed the GSCM implementation, the company should have a high organization commitment to apply multiple greening approaches. Thus, the advantages of adopting GSCM like increasing efficiency of the supply chain, reducing the production costs, minimizing the waste, and improving the environmental performance could be obtained [12, 13, 26, 27].

V. CONCLUSION AND RECOMMENDATION

The results indicate that CRFs might have been aware of the need to be environmentally friendly but only a few effort and strategies have been integrated into the business strategies. Their commitment, motivation and responsiveness of being green may be oriented in more profitability rather than to be more ecologically. This research may recommend for the CRF managers to use the existing production system as a foundation to synchronize the green awareness with CRFs' operational strategies. Therefore, the adoption of GSCM need not be an experience of radical changes in the organization, but become a part of continual improvement in their quality management system.

The prioritized strategies to accelerate the GSCM implementation are mentioned as follows, a) establish the higher quality of rubber block, b) educate the farmers, and c) reuse the wastewater. The research suggests that CRFs management should be proactively managing the supplier relationship through educating the farmers in order to get higher quality of rubber block.

The sample in this study was limited which leads to result in a typical finding due to it is difficult to be generalized to other industries. However, the result would be valuable not only for practical guidance for CRFs managers but also serve as the base for further research in exploring GSCM implementation for other industries sectors.

To enhance the robustness of the findings, it is suggested to conduct the research on a larger scale with more various respondents and stakeholders. In addition, evaluation of GSCM performance with objective data, and use the other perspective such as Ecological Modernization Theory [18] or theory of environmental flow would be valuable in exploring the diffusion of innovative environment management practices. Moreover, regarding the limitation of AHP, it would better to utilize analytical networking process in terms of feedback systematic and interdependency property.

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ISBN : 978-1-4673-7404-0

Mobile Business Analytics System for Service Level Analysis of Customer Relationship Decision

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Abstract*-Business Analytics (BA), which is a part of the Business Intelligence (BI), is one form of analysis that can be used on determining the relationship between company and their customers. BA is a concept that also can be used to improve the relationship with customers based on analysis of data. This paper aims to identify services that determine the level of customer satisfaction and the pattern of satisfaction level with the services, which the analysis will be integrated into the mobile application. System analysis must be done first before building the apps. Identification was done by distributing questionnaire against customers using Liker scale and the result was analysed using Relief method. The result of Relief would show the attributes that affect the level of customer satisfaction. Decision Tree is used to recognize the pattern of satisfaction level. Result shows that there are 9 from 18 attributes of service affecting customer satisfaction. There are six pattern for determining customer satisfaction level obtained from DT calculation. In addition, mobile applications containing the model to perform the analysis are built in Java Programming Language.

I. INTRODUCTION

Business Intelligence (BI) can be defined as the process of getting information about the business from data. As a subset of Business Intelligence, Business Analytics (BA) creates capabilities to be competitive with provide procedures that can be used to analyse data in order to improve business performance through fact based decision making [1]. BA is a group of approaches, organizational procedures and tools used in combination with another method to gain and analyse the information and to predict outcomes on how to solve a problem [2]. BA is popularly used in sales, marketing, supply chain optimization, and Customer Relationship Management (CRM) [3].

CRM is a strategy to build relationships with customers and it focuses on efforts to maintain a profitable customer. CRM is defined in the four simple elements: know, target, sell, service [4]. Companies need to find out their customers better (know). Knowledge of customer is used to target the most profitable customers (target). CRM establish a way to offer the product to the customer (sell) and retain customers by providing good service to the customer (service). During past few years, analysing customer data has been recognizing to be an effective strategy of business analytics and CRM. It leads to significant development in business applications. They've been used to reduce customer attrition and improve customer profitability. To reduce customer attrition, company should know more about their customers and their wishes for service that is provided by company to increase loyalty. Nowadays, customers desire more on service, not only good quality of product. Not concerning customer desires, will surely increase the risk of increasing the propensity of consumers to switch to other company [5].

Data mining, as the key of analysis data in BA, is an assistive tool to analyse in CRM. The goal of data mining in the field of CRM as well as this paper, is does to increase the customer relationship by understanding customer's needs. In the term of services, it can be used to determine the customer preference, to suggest recommendations, to identify customer behaviour due to company service, and to recognize the service that affect to customer satisfaction level [6]. Survey about service must be conducted to identify customer needs in company, in which case company would like to take corrective decision and action corresponding to customer's voice. Information of customer satisfaction toward service that obtained by data mining analysis, will support the company in developing business strategies and services.

A service level as part of information processed in data mining is an agreed measure which might include one of the following elements to describe the performance of a service delivery: quantity, quality, timeliness, and cost. Service level is similar to standards, but this term is usually reserved for organisation wide performance and as an aid for public scrutiny. An analysis of the service level should be conducted to determine whether the existing services are met with the customer's satisfaction [7]. One measurement method of determination of service level is by conducting survey. Some advantages in analysing the service-satisfaction level using survey are understand of customer needs and priorities, and growing customer relationships [8]. Customer relationship decision aims to decide whether to maintain or withdraw; rather loyal or churn. Customers who have a long retention are profitable

ISBN : 978-1-4673-7404-0

customer and they should be maintained. In retaining customers, customer satisfaction comprehension must be applied to meet customer expectation.

This paper is focused on customer relationships related with the services provided by the company and discovering which services are critical for customers to improve its performance by using data mining techniques. The challenge of this paper is the use of data mining to find out about the customer, and implementation it to mobile-based applications. Mobile applications that developed will be dynamic, and customer preference will serve as input application, so that the company can know the continuous development of customer desires to services provided by the company. Therefore this study compiled with the following objectives (1) to identify the attributes of services that affect customer satisfaction (2) to analyse pattern using DT from result of previous method (3) to implement the proposed system analysis and design into mobile application.

II. METHODOLOGY

A. Identification Important Attributes

The first step is identify the attributes of service that company provided. Identification attributes of service conducted to determine the parameters used in this study. Attributes of services will be divided into five variables including reliability, assurance, tangible, empathy, and responsiveness. The identification was done by conducting interviews to the company and studying related literature. Result of identification applied into questionnaires which was used to interview customers and to determine customer satisfaction of each service. Overall level of satisfaction which used as a class in Relief and Decision Tree analysis asked in the interview The scale used in the questionnaire is the Liker scale with a range of one to five. The sampling used in this study is judgement sampling which the character of customers that will be the respondent is already determined. A respondent in this study is the customer who always conducts direct transactions with the company within three weeks and only limited to customers in traditional markets. The respondents are the agent and snack retailer in traditional markets.

Reference [9] stated a method to select features of services that necessary to describe the target concept which determine the important service that affect to customer satisfaction. Relief method eliminates the irrelevant features of service, so the result becomes effective. Relief is capable to estimate the quality of service attributes in classification problems with strong dependencies between attributes [10]. Based on reference [9], here is the formulation of Relief that would be used in this paper.

$$\boldsymbol{w_i} = \boldsymbol{w_i} + |\mathbf{x_i} - \text{near-miss}_i(x)| - |\mathbf{x_i} - \text{near-hit}_i(x)| \quad (1)$$

$\boldsymbol{w_i}$ is the weight of attributes-i, near-miss $_i$ is the expected to be different with x_i and near-hit $_i$ is the expected to be very close to x_i. $\mathbf{x_i}$ is the instance of attribute-i. Attributes which has a weight value of the top 10, will be declared the 10 attributes that most affect the level of customer satisfaction with the services. 10 of these attributes will be used to predict or see a pattern of behaviour towards the satisfaction of customers using decision tree. Reference [11] describes Relief method as pre-processing method before learning a model. In this paper, Relief was used before DT model was performed. The positive weight value will be used for DT analysis

B. Service Level Analysis Using Decision Tree

According to reference [12] Decision Tree (DT) is classification techniques of data mining analysis. DT was selected because of its ability to perform exploration on large dataset and find the most meaningful variable towards customers on a dataset [6]. DT provides predictions in the form of patterns and used to understand the target or customers [13]. The results of the decision tree will give answers about customer satisfaction patterns existing today [6]. DT formulations have to be followed to perform the splitting or separation which will form the root node, internal nodes and leaf nodes [12]. The formulations are to be followed is the determination of entropy and information gain, and the following is formulation [14].

$$Info(D) = -\sum_{i=1}^{m} p_i \log_2 p_i \quad (2)$$

$$Info_A(D) = \sum_{j=1}^{v} \frac{|D_j|}{|D|} \times Info(D_j) \quad (3)$$

$$Gain(A) = Info(D) - Info_A(D) \quad (4)$$

$\boldsymbol{D}$ is the entropy of training set, where $\boldsymbol{p_i}$ is nonzero probability that an arbitrary tuple in $\boldsymbol{D}$ belongs to class $\boldsymbol{C_i}$. In this paper it's just have two classes, that is "Quite Satisfy" and "Satisfy", and this class is used to for Relief method. $\boldsymbol{m}$ is the number of partitions in the training set, in this paper the value of $\boldsymbol{m}$ is 20. DT provides a flowchart that resembles a tree structure, where each internal node denotes a test on an attribute, each branch represents a class or class distribution. In this paper the overall customer satisfaction level for the company's customer service performance assigned as class and the data used is the level of customer satisfaction on the performance for each services. As in the formula (5), attributes that have the greatest gain serve as the root node or an internal node and split will perform in according to the attribute values [12]. Attributes that serve as root or internal node, will not be used against for the next calculations. The split and grow procedure of a node stop when: all records in a specific node have the same value for the class field and a significant predictor cannot be found, and the separation cannot

ISBN : 978-1-4673-7404-0

be improved further although the result is not perfect [13]. DT and Relief analysis will be implemented into application.

C. System Analysis and Design into Mobile Phone Application

System analysis is used to determine the user and their need for developed system. Besides, the system analysis is also has the purpose to determine input, process, and output from the system. System entity is one method that can represent input, process and output of system [15]. After system analysis has been done, design system performed furthermore. Purpose of the design system is to construct the system towards functional requirement, arrange implementation, and describe the system. The design system can be describe using BPMN and UML. BPMN and UML will be developed using software Sybase Power Designer 16.5. The result of analysis and design system will be implemented into apps using Java programming language which the software is Android Studio. WEKA library is used for data mining analysis inside the application. SQLite will serve as a database on the application used to store and handle data using Structure Query Language (SQL). Furthermore, we perform verification system by comparing model system with application and result in application with result in manual calculation.

III. RESULT AND DISCUSSION

A. Identification the Important Attributes

The results of interview to the company and literature studies indicate there are 18 attributes where each attribute is derived from the five variables used. Variables used to identify the attributes of the company are: there is no fault caused by the company in carrying out the duties and services (reliability), competent workers and staff, polite and convincing in carrying out their responsibilities (assurance), physical facilities are adequate (tangible), workers and staff care to the customer (empathy), and the responsiveness of workers to the problems experienced by customers which is related with a service that company gives (responsiveness). These variables need to be translated into quality attributes to measure satisfaction or dissatisfaction of customers. Table I is a list of quality attributes for each of variables that have already been identified in company. Variables and attributes that had been identified applied into questionnaire. The questionnaire used to determine customer satisfaction with each service attribute and used as a tool in conducting interviews to customers. Result of the questionnaire used as data in Relief and DT analysis.

The results of Relief calculation show the weight value of each service attribute. Reference [9] describe that the threshold weight value must be determined. The purpose of threshold value determination was to determine which features have an influence to customer satisfaction level. Range of threshold values is from 0 to 1. The threshold value in this paper is 0. So, we decided to take only attributes which have positive weight value. The parameter with positive weight value is considered to be relevant or affect the customer satisfaction level. Table I show the weights value on each attribute.

TABLE I
WEIGHT VALUE OF EACH ATTRIBUTE

No Attribute	Attribute of Customer Service	Weight Value
1	On time in delivery	0,0128
2	The promptness of response to the order	0,0075
3	Product item which delivered according the order	-0,0322
4	No damaged product when it arrive to customer	0,0375
5	Easiness of product returns in case the product mistake	-0,0622
6	Easiness and convenience in transaction	-0,0050
7	Competent staff and good distribution facilities	0,0169
8	Availability of ordered products	0,0061
9	Customer profile documentation	0,0255
10	Minimum threshold for ordering products	-0,0544
11	Hospitality in service	-0,0231
12	Call centre for service complaints	-0,0350
13	Service about product information	0,0111
14	Availability for help in case of errors	-0,0306
15	Easiness in ordering products	-0,0175
16	Quick and appropriate in complaint response	0,0472*
17	Staff provide information about new products	-0,0044
18	Discounts for loyal customers	0,0231

*Attribute with the largest weight value

In Table I shows that the attribute 3, 5, 6, 10, 11, 12, 14, 15, and 17 have negative weights value or is below the specified threshold. This indicates from 20 respondents, these attributes are irrelevant on the level of customer satisfaction with the services. Attributes that affect customer satisfaction levels are ordered beginning with largest value. The attributes are 16, 4, 18, 9, 7, 1, 13, 2, and 8. These attributes will be used as a dataset for DT calculation.

ISBN : 978-1-4673-7404-0

B. Result of Service Level Analysis

The dataset used in the analysis of DT are dataset which the attributes affect to the level of customer satisfaction based on the results of Relief analysis. The DT calculations from the dataset show that attribute 4 which is "No damaged product when it arrives to customer" became the root attribute. In performing splits, DT calculated value in attribute 4 which do not have a homogenous class. The next calculation generated attribute 7 "Competent staff and good distribution facilities" became internal node of value 4 (Satisfy) at attribute 4. DT calculation stopped because of the values that belongs attribute 7 could not be split. This is due to the value of the next gain result does not generate value with a significant difference between one attribute to another, so the split stopped. Fig 1 shows the structure of DT.

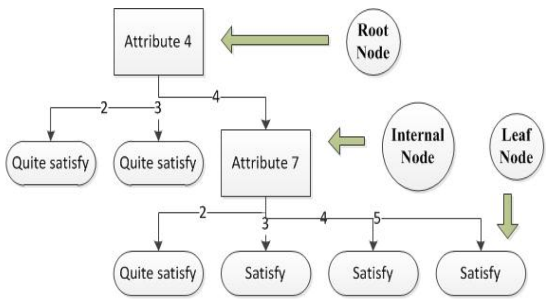

Figure 1. DT structure result

Pattern of customer satisfaction level will be established based on structure shown in Figure 4. The pattern of customer satisfaction divided into two groups, where there are a pattern of customers at a rate "Quite satisfy" with the service and "Satisfy" with the service. Patterns of customers with the "Quite satisfy" level described in Table II and the pattern with a "Satisfy" level in Table III.

TABLE II
PATTERNS OF CUSTOMER WITH "QUITE SATISFY" LEVEL

No	Rule "Quite satisfy"
1	IF Attribute 4 = 2 (Less satisfy) THEN Overall customer satisfaction is "Quite satisfy"
2	IF Attribute 4 = 3 (Quite satisfy) THEN Overall customer satisfaction is "Quite satisfy"
3	IF Attribute 4 = 4 (Satisfy) AND Attribute 7 = 2 (Quite satisfy) THEN Overall customer satisfaction is "Quite satisfy"

TABLE III
PATTERNS OF CUSTOMER WITH "SATISFY" LEVEL

No	Rule "Satisfy"
1	IF Attribute 4 = 4 (Satisfy) AND Attribute 7 = 3 (Quite satisfy) THEN Overall customer satisfaction is "Satisfy"
2	IF Attribute 4 = 4 (Satisfy) AND Attribute 7 = 4 (Satisfy) THEN Overall customer satisfaction is "Satisfy"
3	IF Attribute 4 = 4 (Satisfy) AND Attribute 7 = 5 (Very satisfy) THEN Overall customer satisfaction is "Satisfy"

Tables II and III describe the pattern of customer satisfaction level to existing services today. For example, the first pattern: If customer feel "Less satisfy" about performance of attribute 4, then customer satisfaction level is "Quite satisfy" to the overall performance of services. Depictions like these examples apply to each pattern in the table. In the next step, both analysis will implemented into mobile phone application

C. Analysis System and Design into Mobile Apps

System analysis obtain two stakeholders in the system that will developed, those are customer and sales manager. The customer satisfaction level on each attribute of service serve as a data for the system. Data will be analyse using the Relief and DT on the system. Results of the analysis will be used as a report for the manager to know the condition of its customers regarding the company's services. The following description of the systems analysis representation using entities.

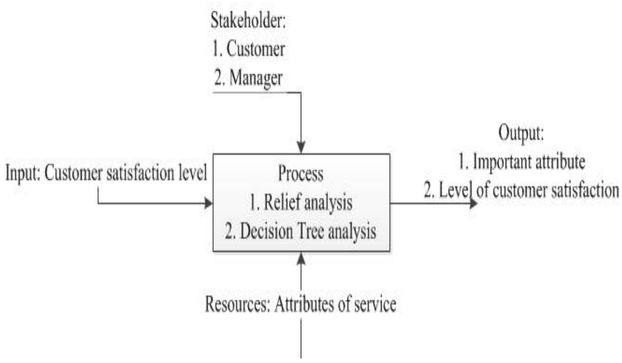

Figure 2. Entity of system

Results of system analysis will be used as basis in perform the system design. The design system that to be developed is described using BPMN and use case. BPMN which was made describes the overview of the applications that would be developed. BPMN explains interaction between customers as a source of data and manager as the person who will see the report of data analysis. Analysis model mounted into the information system based on models calculated before. Use case diagram shows the behaviour of stakeholder which will be accommodated by mobile application. Details of the application interface that is used will be explained using use case. Use case described the customer and manager behaviour on the application made. Fig 3 show the BPMN, Use case and example of apps interface

ISBN : 978-1-4673-7404-0

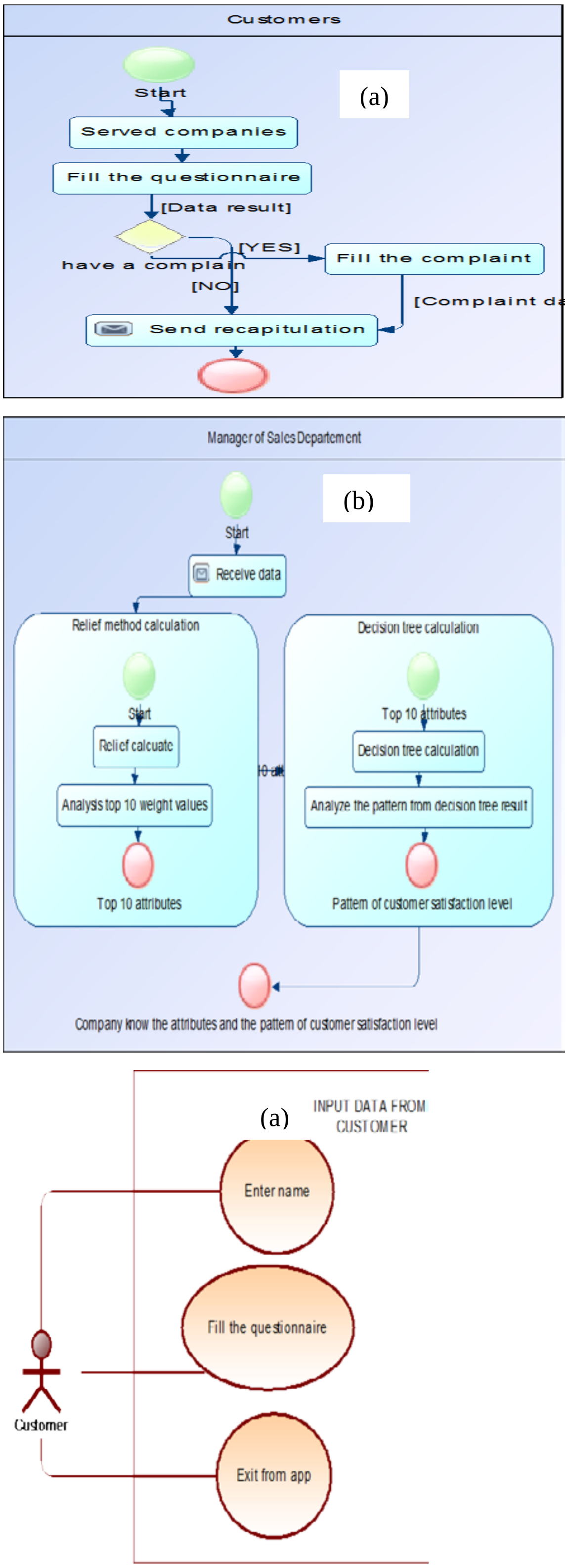

Figure 3. (a) BPMN, use case, and interface for customer (b) BPMN, use case, and interface for manager

Interface shown in the Fig 3 is the result of the coding in the Android Studio that using java language. Library WEKA used for relief and decision tree analysis, and SQLite as a internal database on the application. Interface that intended for customers is an interface that serves as a data input. While the manager interface used are the result of the analysis of input data, so that the manager can immediately find out the attributes of service that determine customer satisfaction and the pattern of customer satisfaction toward to the important attributes from the result of previous analysis. Verification was done by comparing the applications that have been actualize with the targets described in BPMN. The following table illustrates the comparison

TABLE IV
COMPARISON BETWEEN MODEL AND APPLICATION

No	BPMN Model	Actualization in Application	Status
1	Questionnaire as a media for satisfaction level measurement	Actualization by providing an interface for customer and the radio buttons for input data	Done
2	Relief calculation	Actualization by using WEKA library to conduct the calculation	Done
3	Decision tree calculation	Actualization by using WEKA library to conduct the calculation	Done
4	Report for manager	Actualization by provide a graphic to find out the attribute that affect customer satisfaction and tree diagram to find out the satisfaction level	Done

Table IV shows that BPMN models already actualized on the application that made. With the same data, comparison result of calculation from the application with the manual calculation show no difference in the results. So, the application is verified.

The advantage of the application that developed in this paper is provide information to company about the services that impact on customer satisfaction and the pattern of customer level satisfaction. The disadvantage of this application is it only can be applied in specific company which is the object of this paper. Another disadvantages of this application is real time analysis. Real time analysis becomes issue due to this application uses internal database provided by android operating system that cannot be simply shared to other device.

IV. CONCLUSION

There are nine attributes affect the level of customer satisfaction identified by using Relief. From the nine attributes, DT analysis generates six patterns of customer satisfaction with the services provided. System analysis and design has been done by using system entity, BPMN and UML. Based on result of system analysis, there are two application that must be developed, that two application are application for manager and customers.

V. RECOMMENDATION

Applications can be developed with the addition of features changer customer service. Furthermore, the application can developed using HTML 5 and connect the database in internet. So, the application can perform real time analysis by connecting two different devices.

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 ISBN : 978-1-4673-7404-0

Exploring an Innovative Approach to Address Non-Tariff Barriers Experienced by Small to Medium Enterprises in Downstream Coffee Production in Indonesia

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Agricultural products have becoming the main commodity to be exported by developing countries. As a one part of them, Indonesia produces several coffee products both upstream like green beans as well as the downstream like processed instant coffee. However, Indonesia's coffee exports on processed products have facing some Non-Tariff Barriers. This situation made Indonesia losing added value from processed coffee products trade. This study explores the adaptability of innovation system approach to support Indonesian processed coffee producer in facing NTBs.

I. Introduction

INDONESIA is a one of the biggest coffee producers in the world. Based on a Ministry of Industry of the Republic of Indonesia (MoI) in 2013, Indonesia was the 3rd largest coffee producer in the world with amounting to the production of 748 thousand tonnes of coffee production. There are totally 1.3 million hectares of coffee plantation in Indonesia, being composed of 1 million hectare Robusta variety coffee plantation and 0.3 million hectare Arabica variety coffee plantation that spreads almost in all continents.

However, export performance of coffee downstream products is still low. This is only 20% of total coffee export. Consequently, Indonesian coffee producers are losing their added value from processed product exports. For several years some of Indonesian coffee producers tried to enter world market. However, they faced several barriers other than import tariffs from importer countries. These barriers are defined as Non-Tariff Barriers (NTBs).

Recent studies show that tariff Escalation is not the main barrier to export; rather it is prevalence of non-tariff barriers that limits the ability of developing countries to increase their agricultural processed exports [1, 2]. Furthermore, Intracen surveys on November 2013 found that exporters of agricultural goods are the most affected by NTBs (51% of surveyed companies), with 66% reported burdensome by regulations that applied by partner countries.

A lack of networking information sharing and coordination between parties on developing countries have made the NTBS problem more complex [2]. It is found that problems caused by the application of NTBs more derived from the exporting country rather than the importing country, although the requirements of NTBs are derived from the importing country. Therefore, there is a need to create a systematic approach that will guide pattern of coordination based on ability and responsibility of each party on exporting countries.

This study examined adaptability of innovation system approach to explore communication and knowledge sharing gap when seeking innovative solution to solve NTBs on exporting coffee processed product. Communication and information sharing among actors; business (based on preference of small medium enterprise), academic and government in Indonesia are examined by National Innovation System perspective. Those three actors are interviewed due to their role as an essential part on innovation process in solving NTBs problem of coffee processed product. Interview result is mapped by soft system methodology to explore gaps on relation between actors. For planning innovation system recommendation purpose, findings about current situation are mapped into a strategic plan based on triple helix emergence steps.

The rest of this paper is consisting of four sections. The next chapter briefly reviews NTBs as a barrier of export, while, Section 3 reviews innovation system approach foundation on resolving complex problem. Result of system approach to examine current situation and adaptability for further system

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ISBN : 978-1-4673-7404-0

development to build better knowledge sharing on solving NTBs problem are explored on Section 4. The last section presents some conclusions, further research and limitation.

II. NTBS AS A BARRIER TO EXPORT

A. *NTBs impact on agriculture's export*

NTBs are regulations or policies that can impact trade flows [3]. Every country creates NTBs based on its government policy and strategy. In creating NTBs, the reciprocal nature requires a country to consider not only interest of consumer but also producer. Domestic producer capability in conform to the NTBs regulation is important since it will be the standard of making NTBs. However, not all country can conform to that regulation due to differentiation of conditions. Several researchers found that NTBs made international trade becomes more difficult and less efficient between countries [4, 5]. Consequently, NTBs become a barrier on flow of international trade.

Several researchers found that export barriers from NTBs are more stringent in agriculture products [2, 6, 7]. This is because agriculture products usually have more regulations and standards than other goods. Developing countries that typically depend on agriculture export are suffering because of these barriers [1, 8]. An agriculture product like coffee is regulated with several rules since it is consumed directly to human body.

Healthy issue becomes a major concern for government to protect their domestic peoples. Sanitary standard, residue level of specific chemical, and quality standard are some of regulations that categorized as NTBs. Undoubtedly; NTBs are needed for safety and quality reasons that protect the consumer. It is found that quality standard certification on food product has successfully increase quality of imported food [9, 10]. However, it is become unnecessary if government or policy maker set a standard beyond necessity and increase it by the time [11]. Agriculture standards practise that ultimately aim to protect the consumer have deviated and become a trade protection instruments. High level standard that set by developed country has becomes a barrier for developing country to export their agriculture product.

Another type of NTBs in agriculture products are fairness regulations. Fairness issues on agriculture products such as coffee product emerge in early 2000's [12]. Market on the developed country became aware about the importance of equal profit sharing between producers, manufacturers and traders. This is lead to establishment of fair trade regulation. Nevertheless, fair trade regulation is very complicated. It is hard for small company in developing country to understand and comply with the regulation. For developing country cases, researchers found that only major exporter can comply with fair trade regulation [13]. Farmers and small manufactures are suffers more because the regulation that actually intend to raise their welfare.

From discussion as above, it is clear that NTBs are a regulations or policies that creates by a country that can disrupt trade flow with other countries. NTBs that created by developed country has negative effect to the developing country export. Agriculture product is faced more stringent barrier as result of NTBs. This is happen because of nature of agriculture product that directly consumed by consumer. Health and safety regulation that practised by developed country is above necessary and has a propensity to escalate by period. Developed country policy that intended to give equality for agriculture product producer becomes an additional barrier for small producer in developing country since information, technology and institutional limitation. NTBs become barrier for export of agriculture product from developing country to developed country.

III. INNOVATION SYSTEM APPROACH IN ASYMMETRIC INFORMATION AND COORDINATION BETWEEN PARTIES

A. *Innovation on system perspective*

Innovation system is an approach to view and explore innovation process based on system perspective [14]. This approach is a developed concept of innovation process that put innovation as an arrangement of national production system, home-market economic position in international trade, interactive process based on research, and institutional approach in innovative activities [15]. System approach may explain dynamic problem that involving information network, communication between actors and creation of innovation concerning NTBs problem in developing countries.

As a system, innovation has several dimensions that important to be explored. They are: components, relationships and attributes [16]. Components define as the operating parts of the system of innovation, such as: actors, organisations, research institutes, policy maker and other institutions. Relationships as a second dimension are defined as links between components.

Attributes as the last dimension of system are characteristic that belong to components and relationships among them. This issue is connected to the functions of the system of innovation. Each sector or nation has it is own characteristic of innovation system. For that reason, it is become significant to explore what kind applicable innovation system based components and relationship condition.

B. Approaches on innovation system

There are several system approaches that have developed related to innovation process in order to map innovation process. Several main approaches are input/output analysis, sectoral innovation system, and national innovation system [16]. Every approach is focusing on different system analysis. Utilisation of appropriate approaches is important to get the precise analysis and recommendation based on factual data on the field.

National Innovation System (NIS) approach is the widest framework that covering not only business but also scientific or research institution and government as policy maker [17]. Role that played by research institution, business and policy maker are considered as a single system on national level. This concept views that interactions between actors can determine development of innovation process. This approach may appropriate to this research since NTBs problem that faced by Indonesian coffee producer is involving not only regional or sectoral actors but also in national scale. Coffee producer in Indonesia is not concentrate in one area but they are scattered around the country. Policy that supports coffee production and manufacturing process still comes from central government as a national policy. Therefore the innovation system approach may cover the problem on national scope.

NIS views that knowledge as an important factor of innovational growth is cannot become scarce like other resources [18]. It will be continuously expand by the interaction among actors in the system. Communication and behavior pattern are important to be examined in searching for the most effective way for embedding knowledge on the system. On developing country case, researcher founds communication and sharing information infrastructure become a weak point that result slow economic development [17]. This is similar with this research background which Indonesia as a developing country has communication network problem. Problem solving on NTBs become less efficient since the related parties have weak system of information and innovation network.

As the consequence of wide scope that covered by NIS, this approach may lead the analysis into complexity analysis. Large numbers of actors that related and contribute to the innovation process are making the analysis of relationship among actors also become numerous. It is crucial to determine the right actors on NIS since every case tend to be different. This approach also becomes less specific as a consequence of simplification process of complex system. Aggregation approach or analytical model is needed to determine the actors that include in the system.

C. Comprehensive Plan on Innovation System Adaptation

NIS has a goal to enhance economic development of a country and develop technology capability. However, adaptability result of NIS on a country is vary depend on the situation on the country [19, 20]. Based on the research, it is suggests that government need to plan and implement policies to successfully adapt NIS. The suggestion may appropriate to this research since NIS that try to adapt to solve NTBs problem in export of coffee product need to be support by a comprehensive plan.

The framework of NIS implementation can be adapted from the four stages of developing THM [21]. The first stage is internal transformation of each helix. On this stage, academia actors such as research institution, university, and other training institution are facilitated to do a knowledge sharing and technology transfer. The second stage is influence of one helix to another. Third, creation of new overlay based on trilateral networks. New organisation or institution may be establish to provide broader knowledge sharing and coordination process. Knowledge sharing organisation as a center of knowledge sharing becomes a key of successful NIS adaptation [22]. On the last stage, triple helix network has developed into a larger society. Information and knowledge sharing become freely distributed and stable [23]. Knowledge sharing become expanding by the time since spiraling effect between actors within the system.

All the stages is may be suitable for emerge innovation system on a country. However, it will need some period to implement each of stages. Therefore, there will be no sudden progress in innovation system condition along the process. On the other hand, this process is required a political and planning stability so can be worked sustainably.

IV. Findings and Results

A. Effectiveness of collaboration between parties figures and tables

Theming processed based on interviews process with all participants was categorised and structured on a rich picture (Figure 1.). In general, there are some connections between SME business, government and academics. Moreover, there is pattern of collaboration between parties to solve

ISBN : 978-1-4673-7404-0

NTBs problem. However, pattern of communication is not two ways communication. As an example between academics and business, communication pattern only one way from academic. Furthermore, coordination and communication are less planned; they are based on yearly basis. Rich picture was accustomed to simplify and draw complex connection between parties.

SMEs that produce coffee processed product tried to export their product to international market. However, they found that there are several NTBs become barriers to entry. Information about NTBs in form of regulations or standards are partially accepted by business. Furthermore, they founds that information about regulations or standards that required by importing country are not easy to access. They obtain knowledge about NTBs based on experience and other informal sharing such as forum between businesses.

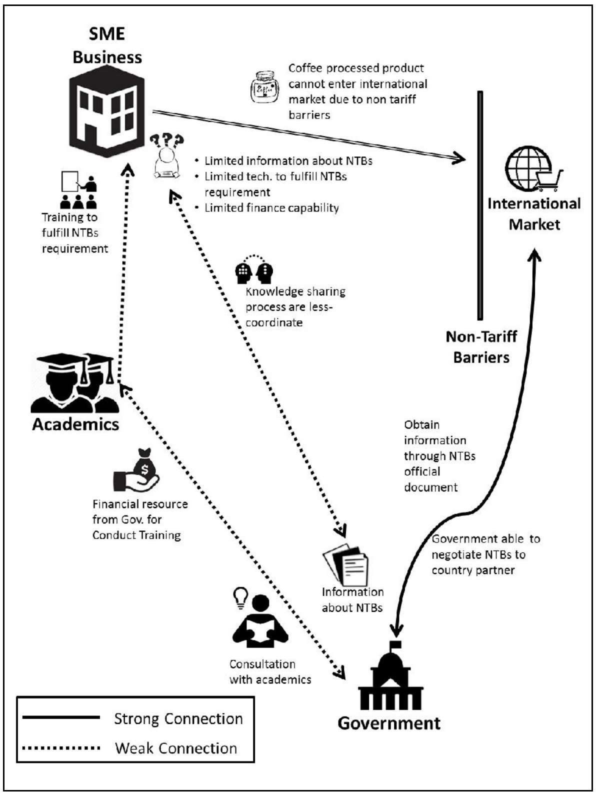

Figure 1 Communication Network Rich Picture

SMEs shares their information and knowledge with government and academics infrequently. Meeting that focusing on export of coffee product issue and involving parties is rarely conducted. Knowledge sharing between government and SMEs are unplanned and unsustain. SMEs only consult with government when they facing problems concerning exporting their product. Furthermore, there is also hesitation and distrust business to the government in solving NTBs problem. However, business is still hoping more solution from government about NTBs problem. They thought that support from government especially on information; technology and financial access would help them very much. This situation may happen since communication process is not well performed.

SMEs business views that government is cannot completely help them in solving NTBs problem. They realise that government has many business company to support in several problems. However, they asking government to create an action plan to support export of coffee processed product. They hope that with this kind of plan there will be a sustain arrangement of information and knowledge sharing with government and academic.

Communication and information sharing between SMEs and academic are rarely happen. Information and knowledge sharing between both of them usually unscheduled. Seminars that conducted by academic, become one of event that gathering business and academic to discuss some matters. Government also occasionally creates some trainings or seminars for SME Business that recruit academic as a trainer or speaker. On this event, Academics can transfer their knowledge to solve NTBs problems. Information and knowledge sharing process between Academics, SME Business and Government is not conducted in planned and sustain matter.

In term of NTBs problem in coffee processed product, Government has some resources of information. Moreover, Government also is able to open a discussion for NTBs elimination with other countries. However, as discussed before, knowledge sharing process between Government, Academic and SME Business is not well conduct. Based on the interview, business felt that Government support in solving NTBs problem is not matched with current condition of the business. As an example, there is an event that government with some of SME businesses are going to Europe for examining coffee NTBs on several countries. SMEs view this event was cannot help them much since SME business has no capability in technology and financial to fulfill those requirements. This kind of information is not well known by government since poor communication with the business. Low effectiveness on solving NTBs problem might happen because of lack of coordination and communication between parties.

B. Barriers of knowledge and information sharing

Barriers of knowledge and information sharing between parties for solving NTBs problem on coffee processed product was explored by analysing the root cause analysis using CATWOE tool. This tool used to view information and knowledge sharing interaction that involving three parties SME business, academics

ISBN : 978-1-4673-7404-0

and government in a single system.

More structured form on knowledge sharing for solving NTBs problem of coffee processed product is the transformation that needed by SME. Information about NTBs that obtained by SMEs based on their daily experience is not enough to solve the problem. Information that gathered by SME concerning about NTBs is unstructured. SMEs tend to export their product as much market as they can. This sporadic effort was facing various barriers in form of NTBs requirement. Furthermore, SMEs have limited financial resource, knowledge and technology to fulfill these requirements by them self.

Academic's knowledge and technology support obviously may support SMEs to fulfill NTBs requirement. However, information and knowledge sharing between academics and SME was not well performed. It was happened since Academics and SMEs have different objectives. Helping SMEs to solve NTBs problem is not academics priority. Therefore, it is requiring kind of scheme for bridging knowledge sharing process between both parties.

Government already helps some of SMEs by accelerating their technology and knowledge ability in processing coffee product. They also had information concerning regulations and variety kind of NTBs on coffee processed product. Trainings, seminars and machinery grants are some of endeavors that government done to share knowledge and upscale SMEs abilities. Moreover, some of those activities are involving academics as a source of knowledge. However, this kind of government support for SMEs is not conducted in well planned process. Government had not created a long term plan in supporting SME of coffee processed product. There is no detail of objectives and steps to develop SMEs in coffee product that involving all parties.

This situation shown that information, knowledge and solution regarding NTBs on coffee processed product are available. However, SMEs that facing this problem did not have access to those kind of information. There are several barriers that may cause that problem. First, business, academics and government are institutions that naturally have different objective. Second, there is no long term planning to solve NTBs problem in each parties. Third, communication network between parties might weak and less structured. Those facts might become the root cause of inefficiency in solving NTBs problem on coffee processed product.

Customer, actor and owner analysis conducted based on interpretation of interview process. Customer is defined as the parties that will gained the end result of transformation process as previous sub chapter. Actors are defined as parties that will doing the transformation process. Furthermore, owner is defined as party that will become the real owner of this transformation process.

Based on the interview it was obvious that SMEs as a SME business on coffee processed product is the party who has problem with application of NTBs by target exported countries. Sustainable plan in coordination and knowledge sharing between parties will support them on solving this problem. They are the customer that will enjoy the end result of transformation process.

Building a kind of well establish knowledge network to solve NTBs problem may requiring participation and commitment from all three parties. Business and academics need to be supported by Government on very basic part which is political will. They said that government statement in form of government law to support export activity of coffee processed product is needed by both business and academics. Moreover, academic's technological support and willingness to share in supporting the transformation process is also important for business and government. Consequently, transformation process to create a better knowledge network may demanding involvement from all of three parties as the actors.

Government may become the owner of this transformation process. Both SME and academics said that government is the party that can lead coordination process between parties. SME hoping for Government action to settled a policy and planning for coordinating knowledge sharing in solving NTBs. Meanwhile, Academics said that they confidently can fulfill some of technology requirement on NTBs fulfillment process. This is depending on the Government who can make policy and plan.

Transformation process that aim to structuring knowledge network in solving NTBs problem may be limited on several constraint. Based on the interview, SME business said that planning process might be created on national context. They thought that export supporting process may be efficient if planned in national framework. Moreover, any kind of scheme of supporting for any beverages commodity from government will be follow by KMM as a business. Consequently, transformation process might be applied in national framework.

From a broader perspective, transformation process is believed by all parties might support SME business on coffee processed product to solve NTBs problem. This part also concludes that unstructured communication process may result inefficiency on NTBs solving activities. Access of all parties to information and knowledge is unbalance between

ISBN : 978-1-4673-7404-0

parties. There is a need for gathering and manage information and knowledge in more structure system.

V. Conclusion

This paper is aim to explore adaptability of system approach on supporting coffee processed business that facing NTBs as a barrier to export their product. NTBs as an export barrier was losing added value that might receive by coffee processed business. From the preferences of SME business, NTBs become a problem because of inadequacy of information about NTBs and solution to fulfill the requirement. On the other hand, other parties such as academics and government have some information and solutions to this problem. However information network and knowledge sharing process between them are less structured and unplanned. System approach is used to view this problem from broaden perspective.

This study found that coordination and communication between parties to solve NTBs parties may be less efficient. This situation happen since there is no formal communication pattern between parties. Furthermore, there is no proper schedule of meeting between parties. This fact is similar with B. Å. Lundvall (2007) and Mohan et al. (2013), which low connectivity between parties is happen on developing countries and causing low rapidity of economic development.

Transformation process for structuring coordination and knowledge sharing process is the main process that might support enhancement of NTBs solving. However, there are some barriers that might exist on that process. Based on root cause analysis, there are three causes that might result on low coordination of NTBs solving process. First, business, academics and government are having different objective. Second, there is no long term planning to solve NTBs problem in each parties. Third, communication network between parties might weak and less structured.

Government role to transforming coordination process in knowledge sharing, still needed by business and academics. Both business and academics still view that this process should be start from government plan. Some countries like China and ex-Soviet Union was successful to create Triple Helix System that led by government (Liu & White, 2001). Therefore, Government might take a lead on coordinating the transformation by make a policy in form of government law that can be a fundamental support of coordinating process.

Based on the system approach perspective, coordination between parties is important to reach the target. Communication between components might be stronger by intermediary institutions (Lee, Park, Yoon, & Park, 2010; Zeng, Xie, & Tam, 2010). This study found that both business and government interesting in the idea of intermediary institution to bridging the gap of communication between parties. However, academic is less interest about this idea and suggest to optimising the current institution. This is align with Massa and Testa (2008) have found. Intermediary institution might be faster the collaborative network process. However, it must also be anticipated that additional party on the system will result more complex problem if without guidance about role and function.

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 ISBN : 978-1-4673-7404-0

Innovation on Guardrail Press Tool with Simple Technology for Highway Road Business

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Abstract - The road toll is a freeway for 4-wheel and other vehicles. When the median guardrail is damaged due to the negligence of motorists, it takes up to 48 hours to be repaired. Each replacement of guardrail that has been hit by a vehicle, is typically y replaced with a new one. For the replacement, the contractor company uses new beam reserves. If there is no backup/stock, they order a new one from the steel factory with five tons minimum order or equivalent to 100 beams.

In order to save time and cost, we have designed a guardrail press tool that can be operated immediately following a damaged barrier. Beam guardrail stamping tools has a dimension of 150 cm long, 150 cm wide and 50 cm high. It is made of steel pipe with a diameter of 140 cm and 0.5 cm thick. To straighten a bent guardrail, it is placed in the middle of a press tool that has the same curvature form as the shape of the guardrail. Then, the guardrail beam is pressed by two jacks each with the power of 20 tons. It takes ten minutes and three workers to repair a bent guardrail. So, in seven hours it resulted 42 rods.

ISBN : 978-1-4673-7404-0

An Analysis of Innovation Network Performance on the Palm Oil Industry in North Sumatera

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Abstract**—**Indonesian government set North Sumatera as a center of palm oil industry and encourage the growth of innovation in this region. Advances in technological innovation are considered as the main factor that affect the competitiveness of firms, industries and become the key factor for increasing national economic growth. In order to develop innovation, the collaboration between government, research institutions and firms is essential. This paper assess the effectiveness of network among actors on the palm oil industry in North Sumatera. A Social Network Analysis (SNA) was carried out to determine the structure and performance of this network. The result show that the network among actors in the palm oil industry is not effective. Surprisingly, the government play insignificant role in distributing information and knowledge within the network, while research institutions have more influence. This study also identify the barriers in establishing collaboration, namely trust issues, similarities of research, limited coordination, funds, overlapping roles, convoluted bureaucracy and risk of innovation. Finally, this paper use interpretive analysis based on the interviews to recommend some action plan, which are tax incentives, transfer knowledge in turn-key project, improve the capabilities of research institutes, regular meeting and shift from academic based research to industrial need research.

I. INTRODUCTION

At current time, Indonesia is the world's largest producers of palm oil, namely around 29,3 million tons in 2014 and the industry has been the economy's most valuable agricultural export sector for the last century. Although Indonesia became the leading country in the production of palm oil, most of this commodity are exported as Crude Palm Oil (CPO) and Crude Palm Kernel Oil (CKPO), which are categorised as semi-products with low added value. This condition encouraged the government to develop downstream products of palm oil in order to increase the value added of palm oil. Therefore, the government set the North Sumatera as a center of downstream palm oil industry.

In an effort to increase the value added of palm oil products, innovation plays important roles. Schumpeter [1] define innovation as new products, new methods, new sources of raw material, new markets or new organizations. For palm oil industry, innovation is required to produce various new downstream products, and then bring these products to domestic or global market. This effort will bring an opportunity for the industry to increase the value added of palm oil products.

However, many invention failed to enter economic system because of several different factors, such as lack of collaboration, stagnation on government policy [2], limited funding and failed to identify market demand [3]. This condition applies on palm oil industry in North Sumatera. Many research's conducted only to meet the academic interests without considering the needs of the company. The government itself, do not provide essential policy support to foster innovation in the palm oil industry. It indicates that the collaboration between research institution, government and firms is not managed properly.

This study analyze the innovation network performance on the palm oil industry in North Sumatera. There are four research question to be answered, among them:

1. How effective is the network among actors of the palm oil industry in North Sumatera?.
2. What are the barriers for establishing collaboration between actors of the palm oil industry in North Sumatera?.
3. What pathway could be developed in the future to improve the network among actors of the palm oil industry in North Sumatera?.

II. LITERATURE REVIEW

A. The government policy in developing innovations

The government through the Ministry of Industry plans to develop palm oil downstream products with the hope of increasing the value added of CPO and CKPO. The price of CPO and CKPO in 2014 was USD 818,4 per ton, very low compared to the price of its downstream products. In fact, CPO and CKPO can be used as raw material for several derivative product, namely food products (including cooking oil, margarine and

Manuscript received July 15, 2015. This work was supported in part by the Ministry of Industry of Indonesia.
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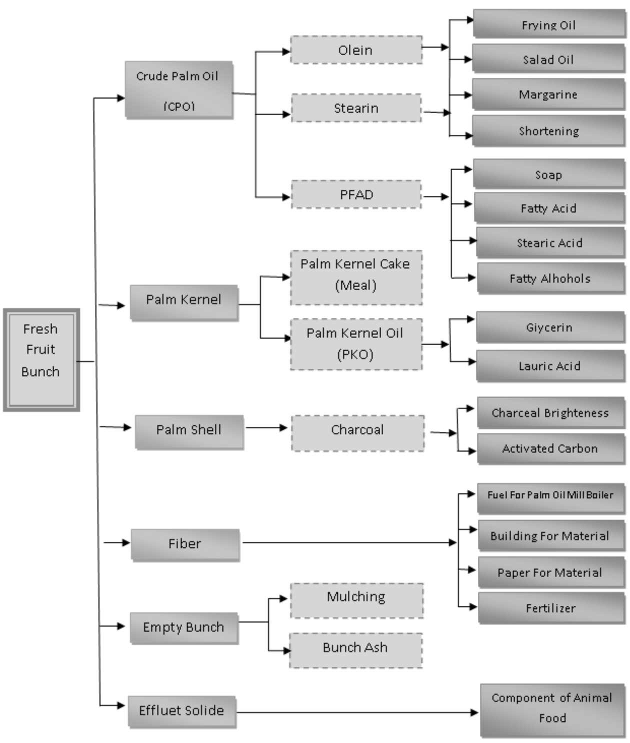
 ISBN : 978-1-4673-7404-0

shortening) and oleochemicals (fatty acids, fatty alcohol and glycerin). Moreover, palm oil is the major raw material for biodiesel industry and become more important for the sustainability of energy in Indonesia. In figure 1, it illustrates twenty three downstream products that will be developed by the Indonesian government.

Figure 1. Palm Oil Industrial Tree



In order to support the development of downstream palm oil industry, the government issued two main policies. The first policy listed on Ministry of Industry Decree No. 13 Year 2010 which includes the palm oil industry roadmap and long term strategy 2011-2025. In this regulation, the government set North Sumatera as a center for the downstream palm oil industry, along with Riau and East Kalimantan. Moreover, the government also established palm oil industrial cluster in North Sumatera as a special economic zone with various facilities and incentive to the industry. The other policy declared by government is joint regulation between Ministry of Research and Technology and Ministry of State Affairs No. 36 Year 2012 about regional innovation system. The policy focuses on developing a leading commodity for each province, for example palm oil for North Sumatera province. It indicates that North Sumatera is important region for the development of downstream palm oil industry.

However, these policies have not been able to accelerate the development of downstream palm oil industry in Indonesia. Pratama [4] define three major problems, namely infrastructure development, low performance of innovation and ineffective network among actors.

B. Assessing innovation network performance using Social Network Analysis (SNA)

A network is a set of nodes connected by a set of ties (see table 1). The nodes can be anything whether it is a persons/individuals, teams, organizations, concepts, patents, etc [5]. In social terminology, a network could become a capital for a person/organization. Burt [6] define 4 attributes on social network in his study which are roles, emotional closeness, duration and frequency. Based on his findings, people who has more contact in his/her "pocket" will eventually get benefits, for example early promotion. It is quite reasonable, considering the people who have extensive networks will easily get the information and knowledge, so that they can adapt well in any conditions. In organization level, company which has wider network, either with government or research institutions, will gain more access to innovation/technology or incentives.

Table 1. Network Analysis

Network Analysis Terms	Definitions
Node	The basic elements of a network
Tie/Edge	A set of two nodes. Ties can be dichotomous (unweighted) or weighted/valued, directed or not (undirected)
Directed Tie	An ordered set of two nodes, i.e., with an initial/sources and a terminal/destination node
Network	A set of nodes connected by a set of ties
Valued Network	A network whose ties/edges are associated with a measure of magnitude or strength
Ego	A node which receives particular focus
Alters	The set of nodes that has ties with the ego but not including the ego itself
Network Size	The total number of nodes of a network
Relational Data	The set of ties of a network

In the case of palm oil industry, the nodes are organizations, consist of government, research institution and business. The network connect all actors and relay the information and knowledge which is important in the creation of innovation. Furthermore, Rodgers [7] emphasize the importance of network in technology diffusion. The new technology will be spread quickly among actors through the existing network. More importantly, the existing network will help a new technology to be accepted by the community (lowering the resistance of new technology). That's why, it is essential to manage the effective network among actors in the palm oil industry.

A network could be analyzed using Social Network Analysis (SNA). This framework views social relationship in terms of network theory, consisting of nodes, representing individual actors within the network, and ties which represent relationships between the individuals actors [8]. Network analysis is not done individually, but with an entity consisting of individuals and relationships that exist between them [9]. According to Hanneman and Riddle [10], social network analysis is a technique for studying the relationships or social relations among members in a group. Meanwhile, other theories stated that social network analysis is a process of learning and understanding of the network (formal and informal) in certain fields [11].

Overall, SNA calculate the tie strength which is important in assessing the overall degree of connectivity of members in an environment and the likelihood that information will flow from one member to another [12]. It means, this analysis will reveal whether the technology and information distribute and spread quickly among members. This attribute is very important to assess the effectiveness of network in the palm oil industry.

The network analysis could be done using a software which was developed by Lin Freeman, Martin Everett and Steve Borgatti [13]. Some measurements that can be done using this software are [10]:

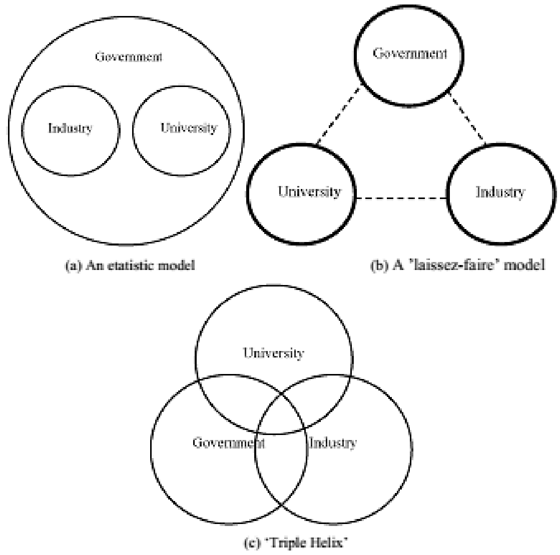
1. Degree of centrality, the degree of the presence and position of an actor in a social networking. This can be categorised into two types, which are: 1) In degree is the ability of actors to relate to an actor; and 2) Out Degree is an actor's ability to relate to other actors in the network.
2. Closeness centrality, shows the extent to which the information can be spread in the network and measures the distance between the actors in the network. Dissemination of information easily demonstrate with high proximity value
3. Betweeness centrality, shows how strong an actor can become a facilitator between other actors in the network. An actor with a high betweeness value has the ability to convey information to actors who are not directly connected with them.

C. Triple Helix as a model of collaboration

Innovation activities has been divided into three major categorise which are internal, external and cooperation [14]. The internal innovation is an activity that conducted using internal resources and capabilities of a company, while external innovation can be interpreted as an access to knowledge and technology through licensing, hiring external researchers or outsourcing [15]. However, many companies realize that the process to produce a knowledge or technology is very complex and it would be costly for them to conduct it by themselves. Therefore, companies tend to build cooperation with external parties, such as universities, research institutes, government and other companies.

Lenger [16] stated that university and research institution play big role, especially for providing qualified researcher and produced locally adopted research. Meanwhile, the government can support the industry by providing substancial resources or infrastructure, namely incentive and energy sources. On the other hand, the readiness of business actors to adopt research results is very important. Many big oil palm enterprise such as SMART, Unilever, Lonsum and Sampoerna Agro have established their own R&D stations in order to enhance technology development, strengthen the competitiveness and build cooperation with SME's [17].
One of the models which are developed based on the interaction between actors is a Triple Helix Model. This model provides an illustration of the cooperation between universities, industry and government in the creation of innovation or technology. The technology is expected to encourage national and regional development [18]. In further discussion, has been studied about how the ideal interaction between university, industry and government. In the beginning, the government considered a central figure in innovation activities with its policy and budget (Figure 2(a)). But over time, [19] argued that the most appropriate model is that each actor has equal status and have close interaction/ intersect (Figure 2(c)) . Moreover, Brannback, Carsrud, Krueger Jr, and Elfving [20] adapted the theory and illustrates the the configuration of academic, business and government in figure 2.

Figure 2. Triple Helix Model



III. RESEARCH METHOD

This study conducted in the palm oil industry which is located in North Sumatera. In this research, interview became the main sources of data while observation and legal documents provide some additional information. The participants were interviewed for 30-60 minutes to answer all the research questions. All interviews were recorded and transcribed for analysis. This study used purposive sampling since it is focused on the actors who have experience and expertise on downstream palm oil industry.

Table 2. Profile of participants

No	Participants	Institution
1	Respondent 1	Research Center A
2	M. Ansori Nasution, ST, M.Sc	Indonesian Oil Palm Research Institution (IOPRI)
3	Ir. Dahlius	Sei Mangkei Center of Innovation
4	Ir. Deny Mulyawan, MT	PT. Perkebunan Nusantara III
5	Respondent 2	Enterprise B
6	Fadhil Hasan	Indonesian Palm Oil Association
7	Ir. Dhiah Nuraini, M.Si	Ministry of Industry
8	Ir. Ida Yani Pane, MT	Local Government of North Sumatera
9	Dr. Listyani Wijayanti	Agency of the Assessment and Application of Technology

The study utilised two measurement methods, namely: 1) SNA approach to determine the network performance; 2) coding and themes based on interview. For quantitative analysis, this research used UCINET as analytical tools to assess the network performance.

ISBN : 978-1-4673-7404-0

IV. FINDINGS AND DISCUSSION

Based on the literature review, palm oil enterprises has the tendency to build cooperation with other actors in order to create innovation. It is encouraged by the fact that they cannot generate innovation by themselves, or in other words the cost is very high. In research collaboration, they can share information, knowledge, infrastructure, human skill, and capitals [21].

In building a collaboration for the development of downstream palm oil products, each actor have their own role and activities, as follows:

Research instutions- Universities or research institutes are responsible for the creation of knowledge and technology through a series of research activities. It is possible because research institutions has the resources to support those activities, such as laboratory equipment and human resources.

Government- The government has a role in providing research funding. The other main roles is to design policies that support the development of innovation in the downstream palm oil industry.

Business- In the collaboration activities, the company propose research topics which are relevant to their problems, and then the study will be carried out by the research institutions.

A. Innovation Network Performance

The effectiveness of the network data analysis can be done using social network analysis. This method is used to determine the segmentation, connectedness and distribution of a network. This study assess the network among nine institution, namely:

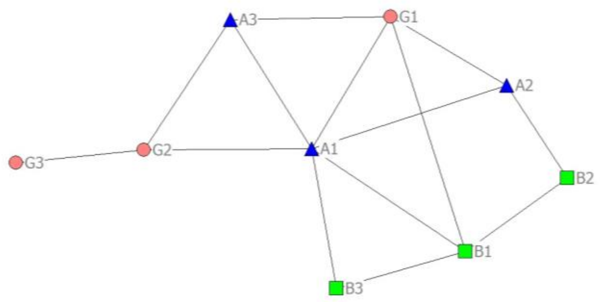
1. Indonesian Oil Palm Research Institution (A1);
2. Sei Mangkei Center of Innovation (A2);
3. Research Center A (A3);
4. PT. Perkebunan Nusantara III (B1);
5. Enterprise B (B2);
6. Indonesian Palm Oil Association (B3);
7. Ministry of Industry (G1);
8. Agency of the Assessment and Application of Technology (G2);
9. Local Government of North Sumatera (G3).

Based on the calculation, the overall tie strength (connectivity) of the network is 0.271 while the overall density (distribution) is 0.389. It means that both the tie strength and the density of this network are weak. Tie strength represent frequency, reciprocity, emotional intensity and intimacy of a relationship, as stated by Granovetter [22]. A strong network requires high frequency of contacts [23], confirmation from both sides/ reciprocity [24] and trust among two parties. The low score of tie strength indicates that the actors did not establish extensive contact and the network is not well structured. The more connected an actor with other actors means that the information and knowledge can be delivered faster

Degree of Centrality (Key Actors)

Furthermore, Pow et al [25] explain about the importance of centrality for determining the effectiveness of a network. This calculation aims to quantify the influence of an actor in a network and draw a complete picture of the problem (see figure 3).

Figure 3. Network Visualization



Based on the diagram above, we can clearly see that IOPRI (A1) remain the center of the network and it has a close relationship with either the government or businesses. In addition, IOPRI assist the development of Sei Mangkei Center of Innovation, as a part of Memorandum of Understanding (MoU) between Ministry of Industry and PT. RPN. Anshori who is a researcher from IOPRI provides the following statement:

"IOPRI as the oldest palm oil research institution assisted PIKS since 2009. This is part of the cooperation between Ministry of Industry and PT. RPN, in order to increase the innovation on downstream palm oil industry. IOPRI helps us to formulate the Standard Operational Procedure (SOP), calibrate our research equipment and train our human resource. It is important to improve the capabilities of our institution".

On the other hand, the government has a minimal role in the network. Neither the Ministry of Industry, BPPT and local governments have a considerable influence on the growth of innovation in the palm oil industry. In fact, the local government of North Sumatra have absolutely no contact with the business and research institutions. This is less than ideal conditions for government, who actually has the biggest power as policy maker and the providers of research funding.

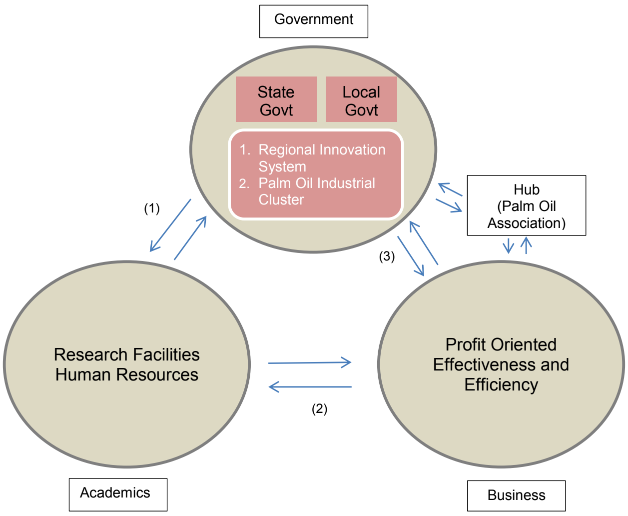
B. Barriers

To improve the effectiveness of the network in the palm oil industry , it needs to be explored the factors that hinder collaboration. Brunel [26] identify two types of barriers in research institutes-industry collaboration, which are barriers related to orientation/goal and conflicts of intellectual property (IP). Meanwhile, Belkhodja and Landry [27] define the impediments of collaboration as (1) lack of partnerships that link researchers and users; (2) lack of rewards; and (3) lack of funds.

This section analyse the main obstacles which inhibit the collaboration between actors on palm oil industry in North Sumatera. In the figure 4, it can be seen that there are three types of relationships between actors, namely (1) The relationship between the government and research institutions; (2) The relationship between research institutions and businesses; and (3) The relationship between government and businesses. Each of these relationships has its own characters and challenges.

ISBN : 978-1-4673-7404-0

Figure 4. Model of Collaboration



(1) Linkage 1 (Government-Academics)
(2) Linkage 2 (Academics-Business)
(3) Linkage 3 (Government-Business)

In order to explore the obstacles in the relationship between government and research institutions, the researcher conducted interviews with the palm oil industry. There are several things that act as barriers of collaboration in linkage 1, namely:

a. Limited coordination among actors

One of the facts that appear in the interview is the lack of coordination between the government and research institutions, as if they were waiting for each other to be the main actor of collaboration. Dhiah from Ministry of Industry stated that:

"There is no single actor who willingly initiates cooperation between various institutions in the palm oil industry. This condition create inefficiency of the network. The government should take this role and become facilitator for the meetings".

b. Funds

One of the obstacles aggravating the relationship between the actors is limited funding from the government. Currently, research institutions rely heavily on government funding, but unfortunately the government only gives a limited amount of budget to support the growth of innovation in the palm oil industry.

However, to increase innovation in a region, does not necessarily mean to increase the budget for research and development. Koch et al [28] give an argument that investment in research institutions are not automatically going to help the industry, if there is no attempt to integrate those research results into practical action.

In the second linkage, which is the relationship between the academic and business (linkage 2), there are some factors that hinder the creation of collaboration, among others:

a. Trust from business/user

It is caused by the low capabilities of research institution and lack of qualified researchers. At Sei Mangkei Center of Innovation, the government has helped the procurement of laboratory equipment to support research activities, but lack of experts lead to low innovation produced by this institution. Another thing that creates the weakness in the research institute in Indonesia is the lack of international recognition. This is caused by limited infrastructure and lack of publication of research results. Dahlius raise this issue:

"Lack of qualified researchers and research facilities become the barriers of our institution. Many palm oil enterprise do not recognize our capabilities because of this factor. It is important for us to improve our facilities and recruit more qualified researchers in order to gain the trust from the businesses".

b. Similarities of research (IP conflicts)

Another factors that become obstacles in establishing collaboration is the issue of patents. Innovators have experience where their technology/ innovation emulated by other institution. This resulted in trust issues among institution and reluctance to cooperate with other parties.

c. Risk of innovation

Companies have concerns about the potential failure of R&D activities. In general, the company is the party which suffers the biggest loss from the failure of a technology. There are no guarantees of the success of innovation and this makes the businesses more reluctant to cooperate with others. The government itself understands these issues and incorporate these things in Act No. 3 Year 2014 about National Industrial Policy.

In these regulations , the government provides coverage for the risk of the use of technology which was developed domestically by research institutions, companies, and / or college. This Guarantee shall apply to technologies which have not been developed in Indonesia and does not apply to the risks arising from mismanagement. In Government Regulation No.41 Year 2015, the government offers two schemes in underwriting the risk which are insurance and reimbursement.

However, the implementation of this policy remains unclear. This is caused by the absence of technical guideline, mainly related to an insurance claim or reimbursement. The government itself has not appointed an insurance agency that will deal with this matter.

Meanwhile, some of the factors that create obstacles in the collaboration between government and business (linkage 3), are listed below:

a. Convoluted bureaucracy

Companies regard the government as an institution which has convoluted bureaucracy and lengthy procedures. This affects the willingness of businesses to cooperate with the government. Furthermore, companies are very concerned about the efficiency and effectiveness of its business. If the collaboration with the government does not provide benefits, then they will not do it. The absence of government incentives for collaborative research/ innovation becomes a factor that weakens the industry's willingness to cooperate with other actors. Deny (PTPN III) advise that:

"Common barriers that occur in building cooperation between companies and the government is funding,

bureaucracy and risk. Long bureaucratic process makes companies reluctant to establish a relationship with the government so it needs special attention. Meanwhile, we should make a discussion about the risk of failure of a research. The risk should distributed fairly among government, research institutions and companies. This is because the leader of the company is considering the cost of innovation. If the innovation activities had no impact on sales or productivity of the company, then it would be difficult to provide support"

C. Policy Strategy and Action Plan

The issue that arises during the interviews is the importance of appropriate government policies to foster research collaboration in the palm oil industry. Lei et al [29] advise the government to provide encouragement and inducement for other actors. In addition, most of the participants expressed the need for action plan as a concrete step to improve the network among actors in the palm oil industry.

Table 4. Policy Strategy and Action Plan

Policy Strategy 1 *Implementation of tax incentives*: Many participants believe that tax incentives will enhance the collaboration among actors in the palm oil industry. Industry tends to be resistant to top-down policies such as industrial cluster, and more amenable to supportive policy [30].
Policy Strategy 2 *Transfer knowledge obligation*: In fact , most of downstream palm oil industry is a multinational company and they prefers doing research in the country of origin. The government can offer a turn-key project to some multinational company, with the obligations to carry aout technology transfer to local industries or research center.
Policy Strategy 3 *Encourage international collaboration*: Indonesia has the experience on national scale research which enable big funds and encourage international collaboration.
Action Plan 1 Improve the research facilities and qualified researchers: The government can provide the funds for research institution to buy machinery or equipment. Moreover, training and certification should become the priority agenda in this action plan.
Action plan 2 Shift from academic based into industrial need: Many research's conducted only to meet the academic interests without considering the needs of the company. This condition causes low successful innovations implemented by the business. The actors should begin to reconsider their focus on research collaboration.
Action Plan 3 Regular coordination meeting: Coordination and monitoring is important to ensure that the research collaboration stay on track. In this meeting, the actors can discuss about the purpose and detailed information of the research.

D. Limitations and future research directions

This research has limitation on the data collected from interview. This data may not cover and represent all of the population which means it cannot be generalized for all palm oil industry. However, this research focus more on the barriers of collaboration in palm oil industry. For future studies, it can be explored about the different types or backgrounds of a firm, for example private firms appear to be more reluctant to establish collaboration with government, compared to stated owned companies. In addition, a research can be done in another region, for example Riau or East Kalimantan, because every region has specific characteristic.

E. Summary

Collaboration among academics, government and businessess is important in creating innovation for downstream palm oil industry. The network in the palm oil industry in North Sumatera is not effective and the barriers of collaboration should be addressed in order to improve the network performance.

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ISBN : 978-1-4673-7404-0

Application of Nanotechnology to Improve Physical Properties of Red Fruit Oil Emulsion in order to Increase Its Industrial Use

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Abstract— **An emulsion is defined as a dispersion of two immiscible liquids that is homogenized by addition of stabilizer or emulsifier in the system. The emulsion system is generally unstable. This condition can be solved by reducing the droplet size to 20-200 nm in order to convert the system to nanoemulsion system. The smaller droplet size results in increasing its kinetic stability, optical transparency, solubility and decreasing its viscosity. Based on previous research, it has been reported that red fruit oil emulsion was formulated in oil and water within ratio of 7:3 by combining 0.2% of CMC and 0.5% of tween 80 as emulsifiers. It resulted a oil red fruit emulsion with red orange in color, 20.5 dPa.s of viscosity, and 100% of stability in 30 days storage at room temperature. The appearance of emulsion was opaque, because the light could not be penetrated by the system. Furthermore, the oil globules were separated from the system after 30 days storage. This paper will describe nanotechnology methods to improve the physical properties of red fruit nanoemulsion, so that it will be more potential to be applied in a wide range of industries such as food and pharmaceuticals.**

I. Introduction

In the twenty-first century, industry based agriculture which is well-known as agroindustry (an industry processing agricultural products) will enter the obvious era of globalization. In the era, there are several certain characteristics such as increasing mobility of information, investment, technology, resources and industrial operations compared to the previous era [1]. Consumers will be the determinant of market and products so that producers are necessary to find ways which are able to win the competition, and meet consumer desires or demands. Product innovation is a key aspect in the process of developing new products according to customer desires, and how important creating a competitive advantage is. Innovation can contribute to achieve competitive advantage through its contribution to the consumer such as the creation of value added and value in use. Innovation in the basic understanding is a developing process of new ideas and findings (invention) to ready stage to be benefited in commercial or public interests, aimed to create new technologies [2].

The improvement of innovation through technology is able to support new product development process which is qualified, varied and sustained in a fast changing environment and reaching global markets. Technology plays an important role in encouraging changes on industrial structures, and encourages the creation of new industries. Technology advancement creates a processing which can develop new products because the technology will meet the demands of consumers on products value and benefit. Changes and rapid technological developments have a considerably fast influence of the process of creating new products and improving the competitiveness of industry.

Adoption and technological innovation have an imperative role in responding to the needs and desires of consumers. To meet fast dynamical market demand changed, products must be developed and improved continuously because of only the products which are flexible, have good quality and good taste in accordance with the needs and desires of consumers that can compete in global business competition [1]. Yet a technological innovation which has been well-developed for the improvement and advancement in the field of food products, cosmetics and pharmaceuticals is nanotechnology. By this technology, it will produce nanometer-sized material with a number of chemical and physical properties that are superior over large-sized material (bulk). Nanoparticles have a very large surface area so that it generates more active nano-sized particles. Furthermore, this technology is the potential for the delivery of active ingredients of drugs or bioactive food ingredients such as nutraceuticals or functional components [3].

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 ISBN : 978-1-4673-7404-0

Nanotechnology can be applied to produce droplets with a nano-sized emulsion system. The emulsion is a system, containing two phases which are not mixable in which a liquid dispersed into small droplets in other liquids [4]. Common emulsion system is a mixture of oil and water, where oil and water are mechanically mixed it will initially form oil or water droplets. However, if left for a few minutes it will rejoin with homogenous droplets so that it is necessary to add an emulsifying ingredient which can prevent the re-unification of the droplet [4]. Furthermore, if there are ancillary of energies as well along with long time spent the emulsion will be still easily damaged. By nanotechnology these problems can be overcome, via reducing the sizes of the droplet, through nanoemulsion manufacturing. Nanoemulsion is transparent, translucent, water-oil dispersion stabilized by surfactants or film layer of surfactant molecules with a droplet size of 20-200 nm [5]. Small droplet size of nanoemulsion makes kinetically stable nanoemulsion in order to prevent sedimentation and creaming during storage.

Vegetable oil sources are abundant and inexhaustible in Indonesia such as coconut oil and palm oil which are used as a medium for emulsion system. Another source of vegetable oil which can be the potential to be developed into a product is oil emulsion of red fruit (Pandanus conoideus) [6]-[7]. References [8] reveals that red fruit oil content ranging from 26.88 to 30.72%, can act as a dispersing medium or medium dispersed while mixed with water. This paper will enumerate the research of red fruit oil emulsion conducted and nanotechnology innovation used to improve physical properties of red fruit oil emulsion into products nanoemulsion. It also will describe usefulness of the opportunities for being applied in the food industry and pharmaceuticals.

II. RED FRUIT OIL EMULSION

A. Emulsification of Red Fruit Oil

The study of product diversification of red fruit oil converted into oil emulsion has been reported. Red fruit oil emulsification is done by dispersing emulsifier in water, and then stirred until homogenously distributed. Afterwards, the mixture is inserted in red fruit oil, and homogenized for ± 7 minutes [6]. The study examines several aspects: 1) emulsifier tested in the emulsification of red fruit which is CMC (carboxyl methyl cellulose), tween 20 (polyoxyethylene sorbitan monolaurate), tween 80 (polyoxyethylene sorbitan monooleate), gelatin, GMS (glycerol monostearate), lecithin, SPAN 60 (sorbitan monostearate), Arabic gum, pectin and dextrin, 2) maximum concentration of CMC, gum arabic, tween 20 and tween 80, GMS and lecithin which is 0.5%, while maximum concentration of pectin, gelatin, dextrin and SPAN 60 is 1%, 3) the ratio of oil and water tested is 3: 7, 4: 6, 5: 5, 6: 4 and 7: 3 consecutively.

The results of the research reported: First, the use of tween 20, tween 80 and CMC could form red fruit oil emulsion of being stable for five days. Second, the concentration of emulsifying effect influenced on ratio between oil and water to produce good emulsion viscosity and flowability of red fruit oil. Finally, the formation of emulsions with using tween 20 and tween 80 occurred on oil and water ratio 7: 3 at an emulsifier concentration of 0.375%, while the use of CMC occurred on ratio of oil and water 6: 4 with an emulsifier concentration of 0.375%.

The formation of red fruit oil emulsion is marked with discoloration mixture of oil and water. At the beginning the color is red and then changed to orange turbid. Emulsion formed still includes categories macroemulsion because of their opaque appearances and low stabilities.

The differences between macroemulsion and nanoemulsion can be seen visually by their appearances. Macroemulsion looks opaque (white turbid, milk-like) whereas nanoemulsion is obviously transparent (clear). It is related to the size of droplets and the wavelength of visible light. Small droplet sizes can be passed by visible light. Nanoemulsion appears visibly different from microscale emulsion since the droplets can be much smaller than optical wavelengths of the visible spectrum [9]. It can be concluded that nanoemulsion is visibly transparent because the light can pass through the emulsion, while macroemulsion looks opaque because the light can not come through.

The difference of stability between macroemulsion and nanoemulsion is also affected by the size of droplets. Because of their small droplet sizes of nanoemulsion, it causes a large reduction in gravity force, and Brownian motion may be sufficient to possess a higher stability against sedimentation or creaming over an emulsion [10]. Nanoemulsion is very stable due to the effects of Brownian motion, dominating the force of gravity, and a wide range of attractive forces which are acted between the droplet decreases with a decrease in droplet size [9].

B. Physical Properties and Active Components Red Fruit Oil Emulsion

The study of physical properties and active components of fruit oil emulsions has also been reported. Red fruit emulsion is physically orange red, orange citrus-scented, sweet taste, creamy texture, pH 6.4 and 100% stable after 30 days of storage at room temperature emulsion [7]. Formula emulsion with CMC tends to have a higher viscosity (25.5 dPa.s), compared with emulsion formula with the use of tween 20 and CMC (21.5 dPa.s) and the use tween 80 and CMC (20.5 dPa.s) [7]. Cellulose gum (CMC) is able to form a solution containing water in which water molecules are trapped in gel structure formed CMC, and to produce a high viscosity; so that it can serve as a thickener CMC [11]-[12].

The content of β-carotene and α-tocopherol emulsion of red fruit with the use of an emulsifier mixture between Tween 80 0.5% and 0.2% CMC is respectively 14 mg/kg and 229.4 mg / kg [7]. Red fruit emulsion has lower β-carotene levels than red palm oil emulsion (99-192 mg/kg), but the levels of α-tocopherol emulsions of red fruit oil is higher than red palm oil emulsion is 29-55 mg/kg [13]. The content of β-carotene and α-tocopherol om red fruit oil emulsion showed that the product diversification red fruit could be used as a alternative source of vitamin A and vitamin E that have been previously gained from palm oil [14]-[15].

III. PREPARATION OF NANOEMULSION

A. *Major Components of Nanoemulsion*

The main components of nanoemulsion are equivalent to the major components of macroemulsion, comprising of water, oil, surfactant, and sometimes along with co-surfactant and co-solvent [16].

1) Oils: selecting an appropriate oily phase is very indispensable as it influences the selection of other ingredients of nanoemulsions, mainly in case of O/W nanoemulsions . Naturally occurring oils and fats are comprised of mixtures of triglycerides which contain fatty acid with varying chain lengths and degrees of unsaturation. Triglycerides are classified as short (<5 carbons), medium (6-12 carbons), or long chain (>12 carbons); and may be synthetically hydrogenated to decrease the degree of unsaturation thereby it confers a resistance to oxidative degradation [16]

2) Surfactants: The choice of surfactant is critical for nanoemulsion formulation. The production of nanoemulsion is more costly than that requires producing macroemulsions. Presence of surfactants helps lower surface tensions between oil and water. During emulsification an increase in the interfacial area takes place, and this brings about a reduction in surface excess [17]. Equilibrium point of the process is restored by adsorption of surfactant from the bulk but this undertakes time (shorter times ensuing at higher surfactant activity) [17]

In practice, surfactant mixtures are utilized and these have resulted in effects on surface tension and dilatational modulus [17]. The utilization of surfactant can be combined and mixed with a surfactant having low, medium and high HLB (hydrophilic/lipophilic balance). Low surfactant helps solubilize oil compound and high surfactant will help solubilize water components whereas medium surfactant has moderate porosity expected to be able to interact with these above surfactants. Medium surfactant has lower surface area, and is able to form new smaller droplets in order to be obtained stable emulsion [18].

3) Cosurfactants : Most of the times, surfactant alone cannot lower the oil-water interfacial tension sufficiently to yield a nanoemulsion which necessitates the addition of an amphiphillic short chain molecule or cosurfactant to bring about the surface tension close to zero [16]. The cosurfactant has the effect of further reducing the interfacial tension, whilst increasing the fluidty of the interface, theraby increasing the entropy of the`system [19]

3) Cosolvents: Organic solvents such as ethanol, glyserol, propylene glycol (PG) and polyethylene glycol (PEG) are suitable for oral delivery, and they enable dissolution of large quantity of either hydrophilic surfactant or drug in lipid base by co-solvency and by making the environment more hydrophobic through reducing the dielectric content of water [16]

B. *Methods of Preparation of Nanoemulsion*

Nanoemulsion can be produced using a variety of methods, which are classified as either high-energy or low energy approaches. High-energy approaches use mechanical devices capable of generating intense disruptive forces that breakup the oil and water phases and lead to the formation of oil droplets [20]. Low-energy approaches rely on the spontaneous formation of oil droplets within mixed oil-water-emulsifier systems when the solution or environmental conditions are altered [20].

High-energy emulsification methods include high shear homogenization, high-pressure homogenization, microfluidization, ultrasonic homogenization and electrified coaxial [20]. High-energy methods are effective in reducing droplet sizes, but may not be suitable for some unstable molecules, such as proteins or peptides [21]. Alternatively, low-energy emulsification methods, such as membrane emulsification, spontaneous emulsification, solvent displacement, emulsion inversion point and phase inversion point, can also be used to prepare nanoemulsions [20].

C. *Techniques for the Identification and Characterization of Nanoemulsion*

The analytical techniques that can be used for the identification and characterization of nanoemulsions are subdivided into three groups separation, characterization and imaging techniques [20]. The techniques that are used to characterize nanoemulsions from a physical perspective such as size, size distribution, zeta potential, and crystallinity of the nanoemulsions. Some of the imaging methods that are used for the characterization of nanoemulsions system are transmission electron miscroscopy (TEM), scanning electron microscopy (SEM) and atomic force microscopy [20].

IV. OPPORTUNITIES AND PROBLEMS OF DEVELOPMENT OF THE RED FRUIT OIL NANOEMULSION

Red fruit oil contains a variety of bioactive components such α-cryptoxanthin 5.4-138.5 ng/mg, β-cryptoxanthin 3.9-29.4 ng/mg, α-carotene 3.5-80.0 ng/mg, β-carotene 10.8-118.0, α-tocopherol 2618 ng/mg, oleic acid 59.35-60.55 g/100g, linoleic acid 4.27-5.96 g/100g, linolenic acid 0.87-1.14 g/100g and palmitic acid 0.6 to 1.3% [22]-[23]-[24]. The content of the red fruit oil carotene component is lower than palm oil but has content tocopherol higher than palm oil. Palm oil contains β-carotene 542 ppm and α-tocopherol 171 ppm, whereas coconut oil does not contain both the active compound [15].

Studies on the test diet red fruit extracts in vivo and testing of antioxidant activity in vitro has been widely reported. Red fruit provide beneficial physiological effect on the body a certain dose that is anti-inflammatory [25], at a dose of 0.21 mL / 200 g is able to inhibit the growth of lung cancer in mice induction results 7,12- Dimetilbenz (a) antrasen (DMBA) [26], increases the immune cells [27], increasing the cellular immune response in mice [28], and antihiperkolestrolemia [29]. Ethyl acetate extract of red fruit is able to inhibit 50% of DPPH free radical activity at concentrations 5,25-53,47μg / ml [30].

At present, red fruit oil used as herbal presentation consumed directly in the form of oil or in capsule form. It is presented in a way that does not provide convenience to those who consume. In addition, if they are in the form of oils active components are not easily absorbed by the body.

Majority of phytochemicals, such as polyphenols and carotenoids, are`either poorly soluble or lipopholic compounds [21]. Active components that poorly dissolve in oil or water pose a problem as to route for their administration, transport and reaching their targets, resuling in a poor oral bioavailability. To evercome instability, poor water solubility, and to enhance the bioavailability of nutraceuticals, one option to entrap the compound of interest into a food matrix is to use nanoemulsion.

Nanoemulsions become increasingly important in food industry as an innovative approach in carrying functional agents like fatty acids, polyphenols, vitamins, natural colorants, antimicrobials, some micronutrients and flavours [31]. The size and composition of the droplets in nanoemulsions influences the rate and extent of lipid digestion, as well as the bioavailability of lipophilic active compounds [32]. The most significant reseach studies focused on describing the benefits of incorporative bioactive compounds in nanoemulsion.

Research by [33] has managed to prepare formulations of beta carotene nanoemulsion with medium chain triglycerides with emulsifying tween 20. Other research by [34] briefly 0.03% (w/w) b-carotene was dissolved at 40ºC in n-hexane, then this organic solution was then added to an aqueous solution containing 0.5% (w/w) Tween 20. The emulsions were homogenized using an Ultra-Turrax homogenizer. Those nanoemulsions showed a good physical stability during 21 days storage.

Bioavailability of the active component in nanoemulsion can be influenced by the size of the droplet, nanoemulsion constituent components, and also the method used. For high-fat nanoemulsions, the bioaccessibility decreased and then increased with increasing long-chain triglyceride content, which was attributed to changes in the amount of non-digested oil present, as well as in the solubilisation capacity of the micelle phase [35]. The rate and extent of lipid digestion increased with decreasing mean droplet diameter (small~ medium>large), which was attributed to the increase in lipid surface area exposed to pancreatic lipase with decreasing droplet size [36]. The droplet size also depended on the amount of surfactant (TWEEN-80) used: the mean particle diameter decreased and then increased with increasing surfactant concentration with an optimum value around Surfactant-to-emulsion ratio 10%. It said further that by optimizing system composition and homogenization conditions able to form Vitamin E acetate-loaded nanoemulsions with small mean droplet diameters (d < 50 nm) and low polydispersity indexes (PDI< 0.13), moreover the spontaneous emulsification method therefore has great potential for forming nanoemulsion-based delivery systems for food, personal care, and pharmaceutical applications [37].

To improve the effectiveness and bioavailability of the active components in the red fruit which can be used in herbal oils used for food and pharmaceutical fields, the nano technology innovation will be extremely useful in increasing the value and benefits of red fruit crops. Therefore, it is necessary to conduct a series of intensive studies regarding the red fruit oil preparation and physicochemical characterization of nano-emulsions as well as the bioavailability of the active component with the application of nanotechnologies.

Another issue that also must be a concerned is the security of nanoparticle products. It is due to the fact that there is still much debate about the safety both for humans who consume them and for the environment.

V. CONCLUSION

Red fruit oil has been reported that the oil contains active components sucs as α-cryptoxanthin, β-cryptoxanthin, α-carotene, α-tocopherol, unsaturated fatty acids (oleic acid, linoleic acid, linolenic acid). Red fruit oil could be used as a dispersing medium and dispersed at the nanoscale emulsion system with better physical properties. These systems have been thought to have several advantages over conventional emulsions as colloidal delivery systems due to their smaller particle size. Nanoemulsions have superior properties such as optical transparency, enhanced functionality, and physical stability, which makes them very attractive for food or pharmacy products.

ACKNOWLEDGMENT

Authors thank Dr. Yandra Arkeman, a lecturer of Departement of Agroindustrial Technology, Bogor Agricultural University due to his assistance on reviewing this review paper.

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ISBN : 978-1-4673-7404-0

Exploring the Internationalization Process Model of an Indonesian Product – Case Study: Fruit Chips SMEs

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***Abstract*— The SMEs opportunity to be involved in international markets is wide open, since Government has drawn attention to the access to international market and the upcoming opportunities from globalization. This study explores the internationalization process of fruit chips SMEs. The data were collected during interviews with two owners of banana fruit chips SMEs which one is located in Sidoarjo and the other is located in Lumajang. The data collections were developed with the basis of the Uppsala Internationalization Process Model. The results shows the importance of SMEs social capital to build up network position in the industry as it opens up an access to international market. In addition firm-specific advantage and appropriate strategy are the key success factors to success in international business**.

I. Introduction

The Indonesian government pays high attention to the role of small and medium enterprises (SMEs), as they have made a significant contribution to the Indonesian economy. Small and medium industries dominate the enterprises structure in Indonesia to more than 99% and have become main employment sources, giving livelihood to more than 97% nation's workforce. SMEs are also quick to recover when a crisis comes.

One of the mid-term industry development determined that industry must strengthen the domestic market and to escalate export (Presidential Regulation no 28/2008). Moreover, globalization as an inevitable phenomenon will drive free trade flows. This is the condition where trade between countries, such as flow of goods; services; investments and others, become borderless. An example of this, Indonesia at the end of 2015 will be facing ASEAN Economic Community (AEC) that will lead to the opportunity for a market size of 600 million people. With the support from government and the existence of opportunities, therefore this is the time for SMEs to involve in international trade or to internationalize the businesses.

Manuscript received May 10, 2015. This work was supported in part by the Ministry of Industry of Indonesia.

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However, SMEs in Indonesia are still facing some problems related to international business. Despite the huge numbers of SMEs, the contribution to total industry export was still below 20%. Tambunan, T (2011) explains that most of SMEs in Indonesia are still focused on domestic markets. Most of SMEs face constraints in technology, skilled workers, access to international market knowledge and lack of capital. Thus, studying the internationalization process from SMEs that have been successful in entering international markets is expected could give a better illustration to other SMEs to follow their paths. In other words, learning other firm's internationalization behavior can be done by imitative learning (Haunschild and Miner, 1997 as cited in Petersen, Pedersen and Sharma (2003)). Imitating other firm's internationalization decision will add firm's experiential knowledge and make firm become more familiar with international market (Bonaccorsi (1992) as cited in Hadley and Wilson (2003)).

Despite the above problems there are two fruit chips SMEs that have successfully entered international markets. Mekarsari and Burnosari SMEs are these two success examples. By studying the success of these SMEs, it is expected to be a guide, mapping and motivation for other SMEs that they are also able to enter the international market.

To carry out this research, the Uppsala Internationalization process model (Uppsala model) is offered. Given that background, this research aims to explore fruit chips SMEs internationalization process based on the Uppsala model which is specific in Banana fruit chips SMEs.

II. Literature Review

A. *SMEs Development*

Given the data in 2012, SMEs dominated the industry structure to more than 99%, of which 98% of them are micro enterprises. Table 3 shows that during period 2011 – 2012, micro enterprises rose 2.38%, consecutively small enterprises rose 4.52% and medium enterprises rose 10.65%. Unfortunately, there was no further information whether the increase trend from these

ISBN : 978-1-4673-7404-0

enterprises was the indication of transformation process or size upgrading from micro to small or from small to medium sized enterprises. This size upgrading process might give better explanation to the SMEs development in Indonesial.

Table 1. The number of SMEs period 2011 – 2012
Source: www.depkop.go.id

Indicator	2011 Unit	2011 Market Share (%)	2012 Unit	2012 Market Share (%)
Les	4952	0.01	4968	0.01
MSMEs	55.206.444	99.99	56.534.591	99.99
Enterprises	55.211.396		56.539.559	

Meanwhile, if viewed from the export contribution of SMEs during a period 2009 - 2011 SMEs export showed increased trend although the value in 2012 is still temporary. From export value Rp162 trillion in 2009 to Rp187 trillion in 2011, the export value rose 16%. However, the SMEs export contribution still much smaller than the Large Enterprises (LEs). Despite the number of LEs that are not more than 2% of the total enterprises in Indonesia but the export contribution reached to more than 80%. With export value Rp790 trillion in 2009 to Rp1, 185 trillion in 2012. The following table 2 presents Indonesian industry exports based on enterprises structure and national value:

Table 2. Export value period 2009-2011
Source: www.depkop.go.id

Export value (billion Rp)	**2009**	**2010**	**2011**
SMEs	162,254.5	175,894.9	187,441.8
Les	790,835.3	936,825.0	953,009.3
Total	953,089.8	1,112,719.9	1,140,451.1
SME's contribution	17.02 %	15.81 %	16.44 %
LE's contribution	82.98 %	84.19 %	83.56 %

B. *SMEs Characteristics and Export Limitations*

According to Tambunan (2008b) there are several SMEs characteristics that important to the Indonesian economy. First, SMEs counted to more than 99% of all enterprises and big source of employment (>97% of workforce). Second, mostly the locations are rural based and agriculturally based activities. Therefor it might be important for rural economic development Third, SMEs are labour intensive, thus provide livelihood to many people. Fourth, source of capital is from personal savings. Fifth, their production is less dependent on imported raw material and mainly targets domestic markets and low income consumers. Sixth, mostly both the entrepreneur and workers are low educated.

Based on characteristics above, there might be correlations with low SMEs export contributions. First, rural based location might influence SMEs access to formal financial institution such as banks. As most SMEs finance their activities from personal saving and exports is considered as expensive, SMEs need other financial source to fund the export activity. Sometimes, this situation make SMEs turned to informal institution and must bear with high rate of return (Irjayanti & Azis 2012). Moreover, although government has provided such a scheme to funding SMEs activities, most of SMEs do not aware of this facility. Thus, export expensive costs and lack of capital become one of main constraints for SMEs in doing export activities ((Tambunan 2008a, 2008b, 2009, 2011)). Another reason is rural based area might also limit SMEs access to international market knowledge. This situation make difficult for export-oriented SMEs to seek opportunities in international market. Moreover Irjayanti and Azis (2012) emphasize the importance of market knowledge although SMEs has made good product but lack of market knowledge will inhibit SMEs in international market transactions. As a result of this, most of export-oriented SMEs decided to use intermediaries' services such as traders, exporting companies to export their product, or through cooperation with large enterprises (Les), where SMEs produce the semi-final product and then finalized by LEs (Tambunan 2008a, 2009).

Second, SMEs domestic target market orientation and low income consumer might give an indication those SMEs products mostly are still in low quality. Tambunan (2011) explains most of Indonesian SMEs focus on domestic market due to lack of technology and skilled workers in which these aspect might influence the SMEs products quality and cost efficiency. The product's quality in domestic market needs to correspond with the international market's quality required. Ernawati (2013) in her research found that Indonesian processed food product in Vietnam has problem to compete with competitors due to less attractive packaging which affect to consumer interest.

C. *Internationalization*

Rundh (2006) as cited in Sari, Alam and Beaumont (2008a) give definition of internationalization as the process of increasing the operational activities into international markets. In addition to this, Calof and Beamish (1995) as cited in Masum and Fernandez (2008) explains that internationalization involve firm's operational adjustment, in strategy, structure and resources to an international market. Meanwhile Bandi and Bhatt (2008) explains internationalization as the firm's process to enter foreign market and developing international operations. Moreover, Shirani (2009) explains internationalization as the action of firms to export their products and services and the process to have international business activities.

This research use the internationalization definition from Bandi and Bhatt (2008), as this research purpose is to gain better understanding on the fruit chips SMEs process to internationalize their products into international markets

ISBN : 978-1-4673-7404-0

D. The Uppsala Internationalization Process Model

The original Uppsala model was developed in 1977 which the model was developed by observing four Swedish firms on how the firms internationalize the businesses. However due to the development on business network research or the Network view, the Uppsala model was revisited in 2009. Network view sees firms are embedded in the environment as part of networks.

There are several assumptions underlying on Uppsala model. First, market knowledge is essential to have as it is the initiator of internationalization. Second, such knowledge can be obtained primarily through experience in international operations. Third, the firm objective is to increase the business long-term profit. Fourth, the firm tries to keep the risk-taking at a low (Hansson, Sundell & Öhman 2004). Fifth, the model assumes that internationalization is pursued within networks.

The original model was developed in 1977 and revisited in 2009. The model consist of state and change aspect. Each aspect consist of two elemets. The state aspect consists of “Knowledge Opportunities and Network position”. Meanwhile the change aspect consists of “Relationship commitment decision” and “Learning, creating and trust building” (Johanson & Vahlne 2009). The model explains the importance of market knowledge that will influence a firm’s commitment decisions and the activities that follow them. This commitment will lead to learning and creating new knowledge. An increased level of knowledge may be either positive, which manifested in form of increase level of commitment, or negative in impacts on commitment decisions. Hence the model is dynamic (Johanson & Vahlne 2009). The following figure shows the contemporary of Uppsala model:

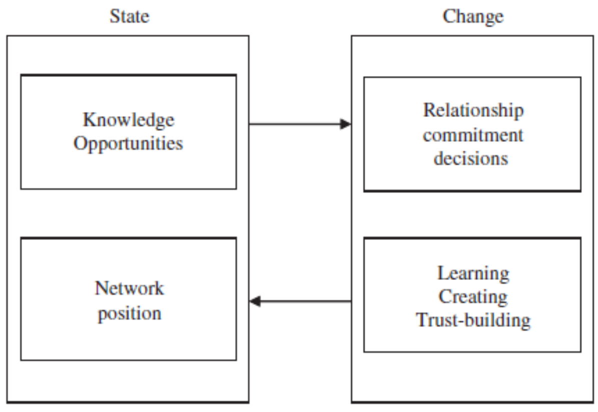

Figure 1 The Uppsala Model (2009)

The Uppsala model categorized knowledge into two types, which are objective and experiential knowledge. Objective knowledge can be acquired and shared easily to organization through a standardized method such as market research. On the other hand, Johanson and Vahlne (2009) argue that experiential knowledge can only acquire through firm’s operational activities or in other words experiential knowledge gathered by learning by doing. And it is become the basic mechanism in the internationalization process. This argument has been criticized that firms can get the experiential learning of different firms without experiencing the same encounters as these organizations. Firms could observe the other organization’s behavior, in particular the internationalization behavior, to learn as the same experiences that organization have (Haunschild and Miner, 1997 as cited in Petersen, Pedersen and Sharma (2003)). In addition, the network view explains that knowledge does not accrue just from firm’s current activities but rather additionally from activities of its networks (relationships). Therefore such relationships develop firm’s knowledge (Kogut (2000) as cited in (Johanson & Vahlne 2009)).

After firms confirm the opportunities and required knowledge, firms could decide whether to abide by commitments. But, before the commitment decisions there is an important factor which becomes the lubricant so that commitment could run well, and that is trust. It can be said after firms has sufficient knowledge of foreign market, firms will establish a relationship with a company / local partner, which requires mutual trust prior to business commitments being made. Trust building comes first before establishing a commitment. When trust and commitment exist it would guarantee efficient, productive and effective outcomes.

Firms interactions within its relationship (partner), will allow both parties to learn about and from each other. There is a knowledge sharing between them. As a result, this interaction may also create new knowledge and create new opportunities as well. In addition, if the partner also is committed to other relationship, the firm will also have indirect relationship to a wider network which may also make has the probability to benefit the knowledge that possessed among them. Thus, the firm will benefit from its indirect relationship as well.

But, on the other hand new knowledge will also have negative effect, when one of the parties perceive the current performance and in the future are not sufficiently promising (Johanson & Vahlne 2009). As a result, these aspects will influence the level of trust and commitments as well. The level of trust and commitment can either goes up or down. The Uppsala model underlines that the speed, intensity and efficiency of these processes depend on the existing body of knowledge, trust and commitment.

The Uppsala model emphasizes that internationalization depends on a firm’s existing relationship and network. The actors of business networks consist of customers, distributors, suppliers, competitors and government (Johanson & Mattsson (1988) as cited in Chetty and Holm (2000)). There are two ways that a firm’s relationship affects internationalization. First, firms find business opportunities in an international market. This opportunity recognition depends on the level of knowledge which produced together by firms and its related relationship. In the way it is, knowledge is developed by unilateral, bilateral or multilateral processes. Second, firms internationalize when a relationship partner who is going to internationalize the business or has already enter an international market, wants the focal firm to follow. It happens when firm’s partner need services or products from focal firm.

ISBN : 978-1-4673-7404-0

III. RESEARCH METHOD

Both primary and secondary data were used to collect data. In collecting primary data, semi-structured interviews were conducted with two banana fruit chips SMEs owners which is located in East Java Province. The participants were selected using purposive sampling based on the following criteria:

1. Banana fruit chips SMEs that has already internationalized the business (export)
2. Hold different process of internationalization, i.e. one case by direct export and another case using agents

The participants for this study were two owners of Banana fruit chips SMEs which are:

a. Mrs Ida Widyastuti: The owner of Mekarsari SME in Sidoarjo
b. Mrs Kasri Andayani: The owner of Burnosari SME in Lumajang

The open-ended questions were prepared based on theoretical propositions (The Uppsala model) to guide data collection and analysis. Interview durations ranged between 45-60 minutes Afterwards the narrative data were transcribed, coded and analysed using descriptive and interpretive approach analysis.

IV. FINDINGS AND DISCUSSION

A. *SMEs Profiles*

Burnosari SME established in 1997. The business started when Mrs Kasri Andayani (Ani), the owner, saw the opportunity of the abundance of banana production in Lumajang. Burnosari processed banana into a product called banana sale and banana chips.

Recently, Burnosari marketing area covers several cities in East Java Province, Indonesia. After positive response from domestic market, in 2004 an Exportir agent from Mojokerto interested to be a buyer and market Burnosari banana chips to international market. The cooperation term between these two parties, Burnosari SME produce and sell banana chips without packing and brand as much as 1 ton weekly, henceforward the product being repackaged and given brand by the agent to be sold into Singapore.

Burnosari SME also get several bids to export its product into international market from foreign buyer, namely to Dubai, UAE and Seoul, South Korea. But, because of limited production capacity Mrs. Ani had to reject the bids.

Meanwhile, Mekarsari SME established by Mrs. Ida Widyastuti in 2002 and it was started in Trenggalek. Mrs. Ida also saw the potential from the abundance of banana production. Therefore Mrs. Ida had an idea to develop partnership with the farmer where from this partnership farmers sell the harvest to Mekarsari and Mekarsari also empowering the local people to process the banana into banana chips.

Recently Mekarsari marketing area covers almost all big cities in Java Island. The Mekarsari success in domestic market has put government attention and eventually facilitates them to attend international exhibition. Currently Mekarsari SME has two factories, one is located in Trenggalek where the production is specialized for domestic market and another is located in Sidoarjo where the production is specialized for international market.

B. *Internationalization Process*

Network Position

Both Mekarsari and Burnosari SME started their business in domestic market. Their domestic market activities have enabled Mekarsari and Burnosari SME acquire knowledge and experience in banana chips industry. In extent they both also develop domestic business networks. This finding is supported by research from Masum and Fernandez (2008) which found the importance of domestic market position prior internationalization. They explain domestic market position will affect market commitment and significantly affects position in international market.

As the knowledge and experience from Mekarsari and Burnosari is growing, at the same time their social capital is developing, such as reputation (achievements), networks and trust. In example of Mekarsari reputations (achievements) are “Inspirative Woman of the Year” in 2011 by Nova Tabloid, “1st Winner of entrepreneurial Woman” in 2012 by Femina magazine and “1st of Ernest and Young Enterpreneurs Winning Women” in 2012.

At this point both Mekarsari and Burnosari SME still at the “early starter” network position as described by the network model. This is indicated from both SMEs that do not have international activities as well as international business networks. As a result of this, both SMEs have low level of international market knowledge).

Mekarsari Subsequent Internationalization Process

Knowledge and Opportunities

Afterward, both SMEs have different subsequent internationalization process. Mekarsari’s achievements from various media have attracted the Government attention and invited Mekarsari to attend international exhibition in Malaysia. This was first time Mekarsari involvement in international activity.

As a result, Mekarsari begin to acquire both the institutional and market-specific business knowledge in Malaysia. Mekarsari has used its social capital to acquire, and interpret international market knowledge. This finding confirmed what has been explained by Arenius (2005) that the use of social capital can gain firms to the access of information.

In addition, Mekarsari recognize the opportunity within international market as the potential buyer shows its interest and strong willingness to market Mekarsari’s product in their home market. Mekarsari also have to bear cost of travel, accommodation and cost of coordination which is confirmed the term of liability of foreignness in the Uppsala model.

Relationship Commitment Decision

Before committed to establish cooperation between the two parties, both Mekarsari and potential buyers exploring the mutual business prospects in the future (probing). This assessment will have two side effects. First, trust was built among them and lead to relationship commitment. Second, on the contrary they decided not to

 ISBN : 978-1-4673-7404-0

commit each other, in this case Mekarsari face the failure of relationship building.

In an example of this relationship building failure was when Mekarsari probe the Japan market in which the potential buyer offered lower price than Mekarsari expectation. In addition to the complexity of technical requirements, Mekarsari decided not to probe Japan market. This finding confirmed that building relationship is time consuming, costly and uncertain process (Johanson & Vahlne 2006). On the other hand, if both parties perceived they will have good business prospects in the future, the trust was built and they will establish a relationship commitment together.

Mekarsari's commitment to enter international market was visible in several things. First, Mekarsari build new factory in Sidoarjo, with bigger capacity and automated machine, to produce Banana chips that to be exported. Second, Mekarsari make an improvement in production process to increase product's quality. Third, Mekarsari in sending their products to a particular international market based on an order made by the buyer. Thus, this cooperation establishment will also increase the Mekarsari's level of dependence to buyer.

Learning, Creating and Trust-Building

In order to determine the packaging designs, flavour of banana chips to meet local preferences, certification to be included as the technical requirement both Mekarsari and buyer establish intensively communication. Through this communication, also allow them to discover new opportunities.

For instance the relationship with buyer from Philippines discovers the potential opportunity in Indonesian rambak crackers. Having known this, the buyer requested Mekarsari to produce Rambak crackers and to be exported to Qatar. In addition, this relationship also leads Mekarsari to expand their exporting are to Middle-east through "LULU" supermarket chain. The cooperation is established in private label strategy.

As the Uppsala internationalization process model is dynamic and the aspect is affecting one another, those above processes will lead Mekarsari to a new "Network Position". As an example, Mekarsari started their internationalization process from "early starter" and as Mekarsari has established the relationship with a foreign partner, Mekarsari might possess an "International among other" position.

Burnosari Subsequent Internationalization Process

On the other hand, it is a different process for Burnosari. As Burnosari does not have access and knowledge to a particular market in addition problem in raw material continuity supply, Burnosari decided to make a cooperation (relationship commitment decision) to use a middleman service. Therefore through this service, the use of agent has overcome the problems of Burnosari in accessing market knowledge. This finding confirmed the the use of agents to acquire market knowledge along with it reduce costs and uncertainty (Chetty & Holm 2000). Thus, the network position of Burnosari remains stand still.

C. Limitations Regarding Data Collections

By interviewing only two fruit chips SMEs, care must be taken before generalizing the findings of internationalization process to all fruit chips SMEs, or other industries. In addition, there are so many factors that affect internationalization such as economic factors, non-tariff barriers, and infrastructure and so on which are not addressed in this research. However, considering all of these limitations, this research is believed could give some insights of SMEs success in entering international market. Therefore it is expected other SMEs could learn from it. Moreover, this research could be basis for further extensive research on this relevant topic.

V. CONCLUSIONS

This research shows the importance of Government promotion assistance program for SMEs to access the international market knowledge. Assistance such as international exhibition participation will enable these SMEs to have international market knowledge that is needed and to discover opportunities within. Nevertheless, market knowledge prior the international exhibition attendance is considered important as well. This knowledge will help SMEs to analyse whether the market is potentially developed or not. This will help SMEs to avoid the unnecessary costs and lead to costs effectiveness.

In addition, this research also shows the importance of social capital, firm-specific advantage and the appropriate strategy as the key success in international business. The use of middleman service can also be used to link into international market.

The internationalization processes of both SMEs are considered to follow The Uppsala model. The existing relationship and its networks has become the basis point to enter international market. This research shows different path for both SMEs internationalization process. Mekarsari SME might have better network position since its first internationalization. On contrast, the dependence Burnosari SME to middleman service might have prevented them to obtain international market knowledge as a result the network position possessed might remain stand still.

A. Implications

In long term objective, Building partnership between SMEs and farmers or SMEs and state owned enterprises is important in order to ensure the availability raw material supply. This is the fundamental requirement for SMEs to ensure its production capacity and sustainability so that SMEs will gain its credibility to international customers.

In addition, The government promotion assistance program is important for SMEs to access market knowledge. Thus, SMEs opportunity to participate in the international exhibition should be expanded. However, there are several things need to be concerned by the Government. First, the Government needs to provide sufficient information for SMEs of particular market knowledge prior the attendance. This will help SMEs to mapping the existing potential. Second, the Government need to consider giving funding to finance SMEs accommodation and travel costs. As this international exhibition participation will make SMEs face financial risks.

Moreover, Governments can also assist SMEs in finding solutions to provide continuous supply of raw material. The Government could facilitate the partnership between SMEs and farmers or SMEs and State owned enterprises.

B. Further Research

This research is limited to only two successful fruit chips SMEs in internationalization. Suggestions that can be used for further research are:

1. Sample size. It is interesting to conduct this research using bigger sample. With bigger sample size of SMEs that have successful entered international market, it is expected to obtain a better understanding of SMEs internationalization process.

2. Different case. It is interesting if the further research involve SMEs that fail to enter international market. As a result it is expected to gain better understanding in SMEs internationalization problem and can be as comparison with the successful SMEs.

3. Participants. This research in only limited from business participant. It is better to conduct this research in the future to involve Government and Academics to have different perspectives and be part of triangulation.

4. SMEs readiness evaluation. The further research will be richer in analysis if it involves an analysis to evaluate SMEs readiness prior internationalization. Such analysis could be a SWOT analysis. This would be helpful for the Government if they would like to assess which SMEs that potentially go international.

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ISBN : 978-1-4673-7404-0

Innovation Management in Indonesian Palm Oil Industry

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***Abstract*- Indonesia is the biggest producer of palm oil in the world with 31.5 million tons of Crude Palm Oil (CPO) in 2014 and had export value almost 21 million USD. On the other hand, the economic value of Indonesian palm oil is lower than Malaysia. It happened because the palm oil Industry is less developed and depend on the large area of plantation. However, the development of palm oil industry is not only increasing the economic value but also creating new jobs for Indonesian. But, many problems happen in the developing process, one of them is the lack of Innovation. Therefore, the aim of the study is formulating innovation management for the palm oil industry. The research is using a case study strategy, with an inductive approach and interpretive philosophy. Data collection is using in-depth interviews with an expert from Industry, a researcher from University, and a researcher from research institution. The data is analyzed by a triangulation method. The result showed that the innovation management in upstream industry and downstream industry has different stage. The development of innovation in downstream area needs more stage called as a demonstration plant stage. Furthermore, the availability of the market becomes the main factor for enterprises to develop innovation. There are two types of market internal and external. Moreover, before conducting research, the industry categorizes their problems into four sections urgent-direct, urgent-indirect, less urgent-direct, and less urgent-indirect. Based on that, they can prepare a short-term and a long-term strategy. Finally, the industry can develop innovation by their own resources, but the government, research institution and university can help the industry to accelerate the process, by conducting collaboration among them**.

Key Words : Innovation Management, Palm oil, Industry, Indonesia

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I. Introduction

A. Background

Palm oil (*Elaeis guineensis Jacq*) is one kind of hard plant that comes from Africa. It grows inland location 500 meters above the sea surface. The plant produces a first fruit after three years that can be harvested for 25 until 30 years (Pahan 2011). The palm oil fruit, called fresh fruit bunch (FFB), produces crude palm oil (CPO) with yield between 20 and 24 % and palm kernel oil (PKO) with yield from 3 to 4% [1]

Moreover, the production cost of CPO is approximately 300 USD/ton, much lower than compared with the cost to produce one ton of soybean and rapeseed oil which are 400-800 USD and 500-700 USD respectively [2]. Furthermore, palm oil is the most economic commodity compared to other oil and fat resources. It is not only because of the price competitiveness but also the techno-economic superior attributes (both physical and chemical) of the palm oil. The superior attributes mean palm oil can be processed into different types of products on a wider area [3].

Palm Oil is the biggest and most important commodity in global trade, and it contributes more than 32% of the total volume of oil and fat produced in the worldwide [4, 5] [6].

CPO can be processed into several kind of product that can be categorized into two groups: edible products and non-edible products. There are several edible products such as margarine, vegetable oil, shortening, cocoa butter substitute, and coffee whitener. There are also many non-edible products like soap, detergent, plasticizer, and biodiesel [7]. So, the significant function of the commodity leads to the demand of palm oil in the world market rising significantly every year [5].

The palm oil is also one of the most important commodities for the Indonesian economy because it contributes high income and can empower many workers both in the upstream and the downstream industry [8]. Furthermore, the production cost of Indonesian's palm oil is the lowest when compared with other palm oil producers in the world [9].

In the last three decades, Indonesian palm oil industry has been growing rapidly supported by a large area of suitable land, good weather and availability of labor [10]. They make Indonesia become the world largest producer of crude palm oil

 ISBN : 978-1-4673-7404-0

(CPO) in 2014, with total productions of approximately 31.5 million tons. For the coming years, CPO production in Indonesia is expected to increase gradually affected by the opening of new plantations in several areas [11, 12].

Furthermore, innovation is one of the key factors for developing the palm oil industry. It can help enterprises to expand their market segment, increase the quality of product and decrease the production cost [13]. Developing innovation is not easy for enterprises because they should have a good management to reach their goal.

B. Research Question

Q1: What kind of innovation management uses by enterprises in developing innovation in Indonesian Palm Oil Industry?

Q2: What kind of strategy can be used to accelerate the development of innovation in palm oil downstream industry?

C. Limitation

The research has been conducted in Indonesia and Australia from June 2014 until March 2015. The innovation management is based on the best practice in PT SMART Tbk, one of the biggest palm oil enterprises in Indonesia. Moreover, the Innovation management is also based on the researcher's interpretation of expert's opinion. The result of the research cannot be generalized for other palm oil enterprises in Indonesia because the sample was just only one. But the result can be used as a base for further research to create a new model to develop innovation in the palm oil downstream industry.

II. Managing Innovation

There are three types of innovation which contribute to business development market innovation, product innovation, and process innovation. Market innovation focuses identifying new markets and how to provide a best service. Product innovation is concerned with the identification of new products and how these are best developed. Process innovation is tried to identify new internal operations and how these are best performed [14]. However, the term of innovation used in this thesis is concerned with two types of innovation which are product and process innovation.

Furthermore, Rothwel [15] Suggested five generations of the innovation process, and the characters of each generation can be seen in Table 1

Moreover, innovation is very important for a firm to survive in their business, both by creating new products or by improving the existing products. With innovation, they can maintain or increase market share of products or drive new markets [13]. Furthermore, Innovation also can give impact to the social and economic Change [16]. In addition, innovation can increase economic growth and decrease a poverty rate. It will involve complex inter-linkages among industry, academician, and government within multiple overlapping "innovation ecosystems". The innovation can create new ways for the production process, more, better or previously unavailable products can be produced at prices that people can afford

TABLE 1
Five Generations of Innovation

Generation	Period	Characteristics
First- The Technology push	1950s – 1960s	Innovation to develop new products and production technique
Second - the market pull	1960s – Early 1970s	Providing new products based on market and customers needed.
Third - the coupling model	Early 1970s – mid-1980s	The process of innovation represents the confluence of technological capabilities and market needs within the framework of the innovating firm
Fourth – The integrated model	Early 1980s – Early 1990s	Integrating suppliers into the new product development process at an early stage while at the same time integrating the activities of the different in-house departments involved, who work on the project simultaneously (in parallel) rather than sequentially (in series)
The fifth – The System integration and network Model	Early 1990s - now	Integration among strategic partner, supplier and customers with the strong system and has collaboration between marketing and R&D. Emphasis on flexibility and speed, and also focus on the quality

In the beginning, innovation development used a closed innovation paradigm, it means every activity to develop innovation in the firm just uses their own resource and do not involve an external party. However, there is a new paradigm for developing innovation in the firms, called an open innovation paradigm. The new paradigm suggests a firm should collaborate with other parties to develop their innovation. The principles of the paradigms are not all smart people work for us, but the firms need to work with smart people inside and outside the company; we do not have to develop new research to profit from it, a better business model is better than entering to

ISBN : 978-1-4673-7404-0

market first and we should gain profit from others who use our IP and we can gain profit by buying other IP [17].

Based on this open innovation paradigm, when a firm wants to develop innovation they should collaborate with other institutions. It can help them to optimize the process, reduce the cost and gain more benefit. Moreover, this study aims to formulate innovation management that including collaboration among companies, government and research institution in terms of developing innovation.

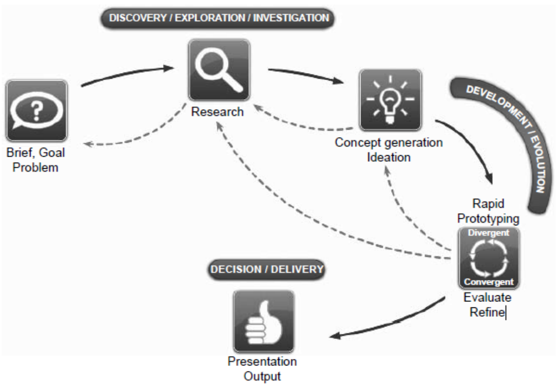

Figure 1. A Model of the Design Process (Carlopio 2010)

Moreover, to explain every stage in developing innovation, the paper is using an approach from Carlopio (2010). It is called as a model of design process. The model is developed from traditional strategic planning. The model of design process has five steps, the first is briefing; followed with research, after that is concept generation ideation, continued with developing a prototype, and the last is delivering the output. The model can be showed in figure 1.

III. Research Methodology

A. Introduction

The study is using a case study strategy because the research aims to find a phenomenon occurring in a Palm Oil Industry. Furthermore, PT SMART Tbk is chosen as a sample for the study, we will learn from them how the company manages their strategy in order to develop innovation. Moreover, the respondents of the research also include researchers from university and research center, who will explain the innovation climate in palm oil industry based on their expertise. The results of the interview will be analyzed by a triangulation method to see the innovation condition in palm oil industry comprehensively [18]. Furthermore, the research will formulate a strategy to develop innovation in the palm oil industry based on the best practice in PT SMART Tbk (one of the biggest palm oil company). Finally, the research will suggest a collaboration management among stakeholders to accelerate the process of developing innovation in the palm oil Industry

B. Case Study

A case study research is a study to understand a phenomenon in its real world context. Robson defines case study as a strategy for doing research that involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence [18]). The case is based on best practice in PT SMART Tbk, a one of the biggest palm oil companies in Indonesia.

C. Validity

In qualitative study, researcher effects and bias are well acknowledged and become part of the study itself. As a consequence, the concept of validity within qualitative studies cannot be seen as fixed but is dependent on how the research process itself unfolds [19]. A qualitative approach may be considered valid if it retains a level of integrity and quality and is an accurate and truthful account of an individual's experience

Furthermore Maxwell [20] offers seven techniques to validate the result of qualitative research, there are: Intensive long-term [field] involvement; Rich data; Respondent validation; Search for discrepant evidence and negative case; Triangulation; Quasi- statistics; and Comparison. In this research, I validate my findings using two technique; Respondent validation and Triangulation method.

Triangulation is a method to see a point from the different point of views. The principle of the method is seeking at least three ways of verifying or corroborating a particular event, description, or fact being reported by a study. Such corroboration serves as another way of strengthening the validity of a study. The ideal triangulation would not only seek confirmation from three sources but would try to find three different kinds of sources. [21]

D. Participant

There are three respondents for the research, one from Industry, one from Research Institution and one from University. All of them are experts in developing innovation in palm oil industry

IV. Result and Discussion

Research Question 1: *What kind of innovation management uses by enterprises in developing innovation in Indonesian Palm Oil Industry?*

The model of the design process from Carlopio (2010) is suitable to describe innovation management in the palm oil industry. Even though, the research also made several adjustments to the model especially about the name of steps.

A. Idea Generation

The first step of developing innovation is idea generation, which defining the problem and questioning the basic assumptions which surround it [22]. The Company generates ideas to solve problems

ISBN : 978-1-4673-7404-0

or to improve their system or products. In this study, ideas are generated from problems in the market. Moreover, there are two types of market; Internal and external market. Innovation for Internal market includes reducing production cost and improving product quality. Innovation for external market usually provides new products that have high demand in the market. Liwang [23] Says that he already identified the problems in their company, and he knows what kind of research needed to solve the problems. For example is how to us fertilizer as low as possible with productivity as high as possible. So there are several solutions for the problem (a) Change the plant, (b) Change the application, and (C) Change the time."

Liwang [23] also says about the External market: before develop innovation, we should know where we will sell the product. Because a company always calculates the profit aspect before develop a new product, has it profit or not? If it gives profit, the company will try to provide that product.

After that, the research team will make a list of problem and also solution possibility based on their discussion. It will be used as a basis for the second step of innovation management.

B. Idea Selection

There are many problems collected in idea generation stage, but they also have many ideas to solve it. So, to make it more manageable, they divide the problems into four categorize based on priority, urgent-less urgent and direct - indirect. It can be seen in figure 1

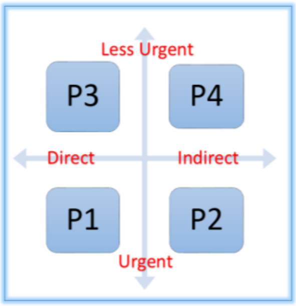

Figure 1. Research Priority Matrix (Based on the interview)
P1: Direct and Urgent,
P2: Indirect but urgent
P3: Direct but Less Urgent
P4: Indirect and less Urgent

The ideas in group P1 are a high priority research because the solution will give direct impact to the problems in the short term. The example of this type of research is a fertilizing scheme such as timing for giving the fertilizer, how much the dosage, and type of fertilizer

Furthermore, in Group P2 the solution has not direct interaction with the problem but it can solve the problem in different way. An example of this case is a research about microbe that has effect to the absorption of fertilizer in the plant.

And in group P3 and P4, that research needs more time to gain a result, cannot finish just in a year. Even the research takes long time, but it is important for the company because it can solve the fundamental problems. For example is a research to develop a new seed which resists to fungus.

The research priority is used as a base for the R&D department to conduct their research. Which problems must be solved in the short term and which one for the long term. What kind of resources needed for the research, are they already having it? Or they need to make collaboration with other parties to solve the problems. So, the matrix priority is very important for the company to optimize their resources.

C. Research and Development

The research and development activities are conducted in laboratory and plantation. The company also can make research collaboration with other parties such as universities and research institutions, it depends on the situations. Nowadays, the company already collaborates with University, and University student does a part of research. However, the focus of research is selected by the company, and it is usually a part of research that contained in P3 or P4 group of Research Priority. With this strategy, the result of research can be used by company to develop their innovation.

However, the collaboration with other parties is very important especially to develop innovation in downstream industry. Because it needs a lot money to be conducted

D. Prototype Creation

There are two types of research based on the industrial area: upstream and downstream. There are several example of research in upstream area such as efficiency in fertilizer, pesticide, and human resource. The palm oil industry is already established in this area of research because they already have a site to develop prototype from their research. However, the industry is still struggling in developing innovation for the downstream industry, such as developing equipment to process CPO become oleochemical or other downstream products. The problems happen because creating that kind of equipment need a lot of money.

Hambali [25] from IPB says about the problem in creating a demonstration plant for palm oil downstream industry:

> "Biodiesel, we are starting from industrial scale, but it must be observed. For example, we want to make 100.000 ton a year. It is big, isn't it? Who want to finance it? Industry does not want to do that, so government should finance it.

ISBN : 978-1-4673-7404-0

Finally, Liwang [23] from PT SMART Tbk argues about the innovation in the palm oil downstream industry

> "After produces CPO and other downstream product; we just buy the technology because the technology does not change a lot of. If we want to change it, which research institution can do that? If we want to make a prototype, how much the budget needed? It is impossible."

.

Both respondents have similar think about developing innovation in the palm oil downstream industry. The main problem is lack of budget to scale up the research.

E. Implementation

The research result in upstream area can be implemented directly in the company especially in their plantation. For example research in developing a new seed. They will use the new seed for re-planting their old tree; so it can reduce the cost of planting. When they already fulfill the internal market, they will start to sell their seed to other companies or to farmers by creating a subsidiary company.

Furthermore, combining a short and long term research is a good strategy for the enterprises. It will produce innovation to solve their urgent and less urgent problem. Based on Rothwel [15], their research strategy is already in the third generation of Innovation.

However, even their strategy is already success implemented in upstream area, but the strategy does not work well in downstream area. There are many challenges in developing innovation in the downstream area, such as financial aspect, market demand, human resource and regulation.

Furthermore, research in the downstream industry needs a different strategy with research in upstream industry. Because, research in the downstream industry cannot just use a small scale capacity but needs to use a demonstration plant that has the similar capacity with the real plant. It means the research not only needs a lot of money but also has a high risk.

The development of innovation in the palm oil downstream industry needs one more step compare with the innovation management in the upstream industry, the additional stage is called as demonstration plant stage. In that stage, the industry should optimize their collaboration with other parties, the University and Research Institutions. The collaboration can help the company reduces the research cost and also divides the risk to other stakeholders.

Research Question 2: What kind of strategy can be used to accelerate the development of innovation in palm oil downstream industry?

There are many strategies to develop innovation for the palm oil industry. The most important thing is the government should use their power to support the development process. Hambali [25] Suggests several strategies to accelerate the development process:

a. Government should provide sufficient fund for university to buy new equipment. So the university can help companies to develop their innovation in downstream industry
b. Government should reduce the tax for a company who has a research in downstream industry. .

In other hand, Susetyo [24], a researcher from BPPT, suggests government should implement a regulation that Private Company should participate in the research activity; venture and insurance also should enter the process. Moreover, government should reduce a tax for companies who do a research in developing innovation.

Liwang [23], Director of Research and Development of PT SMART Tbk, argues that the research depends on the availability of industry (market demand) and industry will grow up when the money (Incentive) is available, because it can reduce their cost so will increase their profit. However, the incentive is depend on the government regulation.

Based on the opinions from three points of views, the development of innovation in downstream industry depends on incentive from government to research institutions, university and Industry. The government can give incentive to research institutions and university in forms of additional budget to upgrade the research facilities such as machinery and laboratory equipment. For the Industry who has research to develop innovation in the palm oil downstream industry, the government can give incentive for them such as reducing tax.

However, the government also has a role to provide a wider market for the palm oil downstream industry. So the investor will interest to invest their money to develop innovation. Moreover, there are two types of market based on the location, local and export market. In Local market, government should stimulate Indonesian people to increase consumption of palm oil product, so it will increase the palm oil demand. For overseas market, Indonesian government should promote about the palm oil products to the market in other countries, so the demand of the palm oil products can increase.

Furthermore, Liwang [23] also suggests the government to lead the process of innovation development in downstream industry by creating an institution which deals with the activity.

> "But if we are reckless, there should be an institution that deal with the development of palm oil downstream industry. I saw Malaysia, and it is simple. The important thing is working together. For example, there is a budget, 10 trillion, for five years. So we use students. Developing from University, LIPI and BPPT is also support. [23]

Furthermore, collaboration among government, research institution and industry can accelerate the process of developing innovation in the palm oil downstream industry.

V. Conclusion:

Based on the research, the model of design process from Carlopio is suitable to describe the innovation management in the palm oil upstream industry. However, the development of innovation in the palm oil downstream industry has a different stage; it needs one more step after the prototype creation stage which called as the demonstration plant stage.

The research also shows the industry generates ideas based on market demand both internal and external, and they also tries to provide a new technology for their customer. It shows that the industry already in the third generation of innovation. Moreover the industry categories their ideas into four groups: direct-urgent, direct- less urgent, indirect-urgent and indirect-less urgent. This strategy can optimize their resources, which one the priority and which one for the long term research.

In the research and development stage, industry can do the research with their resources or make collaboration with other parties, it depends on the situation such as the availability of human resources, machinery or laboratory instruments. Furthermore, the research in upstream area is easy to be implemented by company because the company already has their own market. In contrast, research in downstream area needs more support from the government and other research institution because the development of innovation in that area has a high risk and also needs more budgets.

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INNOVATION DESIGN PROCESS FOR

ISBN : 978-1-4673-7404-0

GAYO'S COFFEE QUALITY IMPROVEMENT

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***Abstract*— Gayo Coffee has been known as the source of living for citizens in Aceh Tengah and Bener Meriah, Indonesia for almost a century ago. The research focuses on two goals, there are constructing related diagram of primary production of gayo coffee bean and analysing technical quality problems. Based on the technical problems in yield reduction and post harvesting and processing, BPMN model describes the stages of cultivation management, the elements involved and the interactions that occur. The main problem in the area is the number of varieties of arabica coffee grown in AT and BM. The high range of varieties affects the complexity of management activities on land cultivation. BPMN model clarifies activities that influence inconsistent coffee flavours dan coffee moulding. Based on FMEA measurement, results recommended activities to improvement of the quality of Gayo coffee.**

Keywords : Gayo Coffee, Quality Improvemnet, BPMN, FMEA.

I. INTRODUCTION

Coffee, cultivated in more than 80 countries in Central and South America, Africa and Asia, ranks among the world's most valuable agricultural commodities. Coffee cultivation provides liveli-hoods for 20-25 million farming families; and engages over 100 million people in its producing and processing. Smallholder coffee farmers, together with their families and rural workers produce over 70 per cent of this labour intensive crop. This phenomenon was supported by total production in crop years 2013/2014, which reached approximately 120.6 million bags (1 bag = 60 kg). Meanwhile the world coffee consumption in 2013 reached roughly 132 million bags [1]. Total coffee production in 2013/14 was estimated at 146.8 million 60 kg bags, very slightly down on the 147.5 million bags produced in 2012/13. The drought in Brazil came after its 2013/14 harvest had ended, but will have a signiicant impact on production in 2014/15 and 2015/16 [2].

For the time being, Indonesia produces 25% of Arabica coffee with the remaining 75% of Robusta variety production [3]. Most of Arabica coffees are planted in Aceh, one of Indonesian province, mainly in two governmental districts; namely Aceh Tengah and Bener Meriah [4]. Then clever enough, since 2005 Aceh Province (AP) has been seen this as the opportunity with a clear awareness of the potential Arabica coffee, named as Gayo Coffee. Due to this, AP has shifted its goal from bulk-commodity coffee into specialty coffee, in order to earn substantial premium price and promote it as a promising opportunity for farmers.

There are still several problems needed to be firstly solved, such as misconduct farm management practices, ensuring coffee quality and reliability of processing steps, efficient supply chain and providing market accessibility channels [5,6].

Based on methodology of business process model, the research utilizes system approach to describe and mapping the gayo coffee quality problem. Business process models are an important part of enterprise and supply chain architectures [7]. Therefore this article focuses on two goals, there are constructing related diagram of primary production of gayo coffee bean and analysing technical quality problems.

Quality management is a system which increasingly attains more focus from agribusiness and food industry to deal with problems entering international market and other changing situations which are needed to be adapted [8,9]. Beside that, quality management as a system principally based on procedures and control circles as ways to control and assure quality, with concerns to suitable condition of food technology and human interferences with management of decision making [10].

II. RECENT SITUATION

Aceh coffee industry is referred to small holder coffee producers in Gayo Highland, located in AT and BM. It covers 77,000 farming families and mostly produces Arabica varieties in ± 96,401 ha with total production ± 47,784 ton in 2012, with a rough estimation of a good farm producing ± 500 kg/ha. In fact, after conflict in 2005, from total area 84,000 ha, ± 13,000 ha area became abandoned land. Then, in 2009 the coffee plantation area expanded, and the number of abandoned land decreased roughly to ± 10,000 ha [4,11]. In these regions, coffee is cultivated at medium density of 1,000-1,500 trees per ha with shade grown system, whereas the large areas are planted on steep slopes. Due to the highland's climate, which has long wet season and short dry season, this coffee has long harvest season, approximately around 8 months. It starts from September to June [11].

A. Gayo Coffee Processing

The processing of Gayo Coffee is generally classified into propagation stage and field processing. Propagation stage begins with pre germination of dried seed up to 1 month in nursery

ISBN : 978-1-4673-7404-0

beds. Then farmers select the fine seeds and continue to germinate the seeds in poly bags up to 3 months, and finally plant it in soil with a range 1.5 m within seed. During soil plantation, farm management practices needed to be done. Therefore, during 1.5 years up to 2 years before first harvest, farmers regularly do weeding, pruning and irrigation.

Moreover, first harvesting is done by manual picking, continued with cleaning and sorting from the stone and unwanted materials. Farmers consider that by doing manual picking, the ripening level of picking cherries is same, which makes cherries pulping comes to place and directly continues with fermentation and mucilage removing up to 24 hours. The next day, wet parchment coffee is produced and dried up to 2-4 days. The first drying process produces ―Kopi Gabah. Then wet hulling comes to place and produces so called ―Kopi Labu that be dried manually up to 2-3 days to achieve moisture content of 11-13%. Furthermore, when drying, packaged, stored are done, coffee is further processed and or marketed [11,12,13].

B. Aceh Coffee Industry Players

In order to know how the supply and value chain of Aceh coffee industry is formed, it seems important to discuss the players who are involved directly and bring about significant changes in the supply chains.

Farmers and Producers

Farmers and producers in AT and BM are the families who hold small coffee plantations with size around 1-1.5 ha. Being a coffee farmer is a pride for citizens in AT and BM, therefore almost 85% of citizens of these districts make coffee as a part of their living, either intensively or part-time. Many training reports added that those farmers are very active, adaptive and have high willingness to implement the knowledge or other techniques, if the advantages are demonstrated. However, mostly of those farmers have lack of knowledge about pest and coffee diseases, as well as supply chain and access to the market [13].

Aceh Coffee Forum (FKA)

Aceh Coffee Forum was established as public-private partnership for coffee industry after the condense research of problem identification of Gayo's coffee supply chain was conducted in 2005. FKA comprises each representative of the supply chain actors and relevant stakeholders, namely the business community, small scale farmers or producers, cooperatives, exporters, research bodies, local government and NGOs. This forum was set up to identify the problems and opportunities to propose initiatives for strengthening the local industry as well as to act as mobile resources and implantation [13].

Suppliers and Marketing Channel

The coffee supply chain is still applied in the traditional way, which means that it is mostly ran by private sectors and centralised in Port Belawan - North Sumatera Province as a gate for export. The supply chain varies and involves many parties and transportation methods, but it is simplified in the model below. Moreover, two international coffee producers have invested in BM region as well, namely PT. Holland Coffee Beverages from Netherlands and PT. Indocafco from Switzerland, whereas PD. Geunap Meupakat is the only regional producer which has export quality coffee in BM [14].

Government

Aceh Government, for both AT and BM are totally aware of the benefit of Gayo Coffee towards the development of economic condition. Therefore many attentions are devoted to Aceh coffee industry, for instance the rehabilitation programs since 2005 in abandoned coffee plantation in AT and BM, numerous collaboration projects or partnerships within international NGOs and other coffee associations in Indonesia related to post harvest practices and the achievement of geographical indication for Gayo Coffee [14].

Certification Bodies

As the market opens up and more international buyers enter the Aceh market, these certification programs are being familiarised quickly by the range of exporters. In 2007, there were 10 active exporters who have cooperated with roughly 15,000 farmers in AT and BM. Perhaps those farmers have implemented one of these international certification bodies such as Fair Trade, UTZ Certified, Rain Forest Alliance, Starbucks and Organic certificates [15]. These certifications above are categorized as third party certification that acts as voluntary regulatory systems in coffee industry and be viewed as strategic instruments for contributing the value added distribution along the supply chain. In addition, it can be helpful as export promotion towards some agencies who consider environmental impact [16].

C. The Potential of Aceh Coffee as Specialty Coffee

The terms ―specialty coffee was firstly introduced by Erna Knutsen in 1978, and described as coffee produced in special geographic and being perfectly suitable for producing coffee beans with unique flavour profiles. This concept has been adopted and developed by Specialty Coffee Association which has representative in each continent or country around the globe. Moreover, coffee is a brewed drink which highly dependent on its quality throughout the supply chain that contains a long complex of intermediaries which involve many actors from farmers until barista. And then, the next

ISBN : 978-1-4673-7404-0

contributors of specialty coffee are placed on its preservation and revelation [17].

Coffee preservation refers to suitable climate condition, coffee varieties and farm management practices. In this case, Aceh has the right soil for planting Arabica, contents primarily *Andosols* - highly fertile soil layer from volcanic material blessed with appropriate climatic conditions in Gayo Highland areas. The next thing is well managed farms with good pruning and shade grown system, producing the ripe coffee cherries on a healthy plant with harvesting done manually when the cherries are fully ripe, not before. On the other hand, **coffee revelation** covers the processing steps both in the field area and the transformation process from green to roasted coffee. In Aceh, farmers and producers apply the unique wet hulling system producing coffee with heavy body, less acidity and high level of spicy flavour, as the key feature Aceh Coffee is famous for. Therefore Gayo Coffee has unique characteristics, even though it only covers small quantity of Arabica coffee in the world market compared to Columbian Mild Arabica Coffee [18].

III. Techinal Problems in Aceh Coffee Industry

1. Yield Reduction

Since the end of 2010, research reported that the yields of Gayo Coffee was continuously declining as a result of several conditions in production areas: coffee diseases, unproductive plants and inconsistent farm management and post harvest practices [14,15].

Misconduct Farm Management Practices

In Aceh, there are approximately 20 Arabica varieties have being planted, but only few of them are well known due to their flavour. Meanwhile, none of these varieties has outstanding performances. For instances while some varieties have disease problems, others have physiological problems or produce low cup quality coffee. Moreover, the habit of planting new varieties without any pre-research of plant location in one coffee field or only used it as hedge of their primary plantation makes a random distribution of coffee varieties in Aceh.

Coffee Diseases

There are two common diseases in Aceh coffee, namely Coffee Leaf Rust (CSR) and Root Diseases. CSR is a major disease of Arabica varieties which causes leaf drop, whereas root disease is classified by Aceh farmers as ―white, ―brown and ―black and affects and kills both coffee and shade trees.

Non-ideal Shade Grown System

In terms of farming systems, there are four main areas of coffee shade grown system in Aceh, but none of them has ideal qualities. Shade grown system is good method to reduce fertilizer input due to high bio-mass circulation in the system. However in Aceh, most of the farmers still have dependency upon fertilizers, meanwhile the coffee trees also showed permanent trend of bean size decline, higher incidence of leaf rust which are the visual signs of nutrient deficiency that indicates the decline of soil fertility. Moreover, in Aceh, mostly orange, banana and *Leucaena* trees are often used as intercropping trees in what their called as ―shade grown system.

Unproductive/Old Plants

Research stated that the majority of coffee trees in BM and AT are 25 years old, which is considered as old plants based on Wintgents and Descroix concept who added that the productive coffee trees are the ones younger than 20-30 years [14].

Based on the technical problems in yield reduction, BPMN model (Figure 1) describes the stages of cultivation management, the elements involved and the interactions that occur. The main problem in the area is the number of varieties of arabica coffee grown in AT and BM. The high range of varieties affects the complexity of management activities on land cultivation.

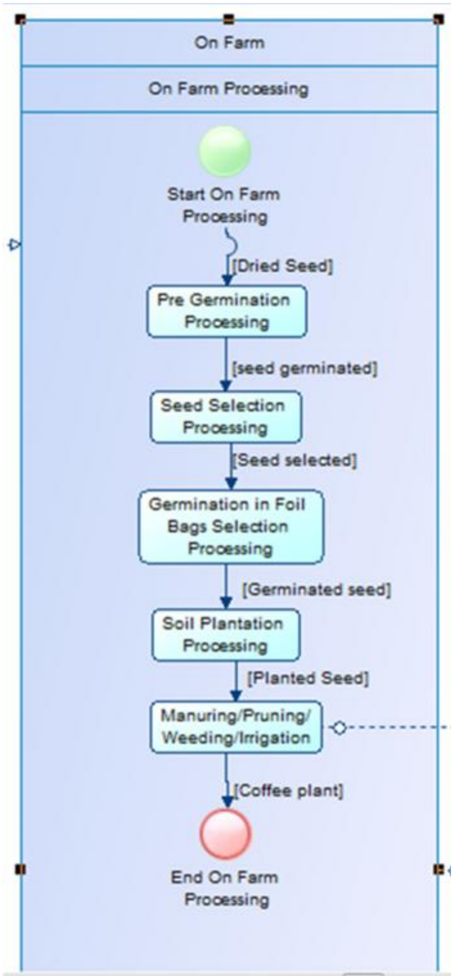

Figure 1. BPMN swin lane : activities on farm

ISBN : 978-1-4673-7404-0

2. Post Harvest and Processing Techniques

Research reported that during post harvest stages and processing steps, the main objective of these steps are to improve coffee quality, produce consistent flavour and establish the character of Gayo coffee which turns in as an attraction for the buyers [13, 14]. In general, in post harvest and processing techniques the main problems are as follows:

Inconsistent Coffee Flavours

Due to the fact that different process techniques, processing sequences and measurement controls that are adopted by cooperatives or single farmer in Aceh, Gayo Coffee has random flavour and still unable to create its own character, which is enhancing the high full-body and its less acidity. Most of Gayo Coffee farmers use semi-dry coffee process, by using half-drying the wet parchment coffee and continuing with wet hulling process, which, as most of Gayo coffee producers believe, are important steps of flavour development in Aceh coffee also lowering its acidity [19]. However, this wet-hulling practice also causes high level of green bean defect. Moreover, unseparation of field processing within green cherries and ripe cherries, and common practices to store wet parchment coffee for up to two weeks and —kopi gabah up to 3 weeks due to inadequate number of machineries and utilities that Gayo coffee producers have, also play significant roles in development of unpleasant harsh taste and unwanted flavours like fruity, fermented and earthy flavours in Gayo coffee cup quality [13,14].

Coffee Moulding

The formation of mould in coffee often occurs in AT and BM due to the hygiene of the water used in processing, inadequate drying infrastructure available during the harvesting time, inefficient drying process and too long storage of wet parchment coffee. In AT and BM, coffee harvesting is held from September to June. Meanwhile, from September until January there is a rainy season in Indonesia, which makes sun-drying unavailable [13,14,15].

Based on the technical problems in post harvesting and processing, BPMN model (Figure 2) clarifies activities that influence inconsistent coffee flavours dan coffee moulding.

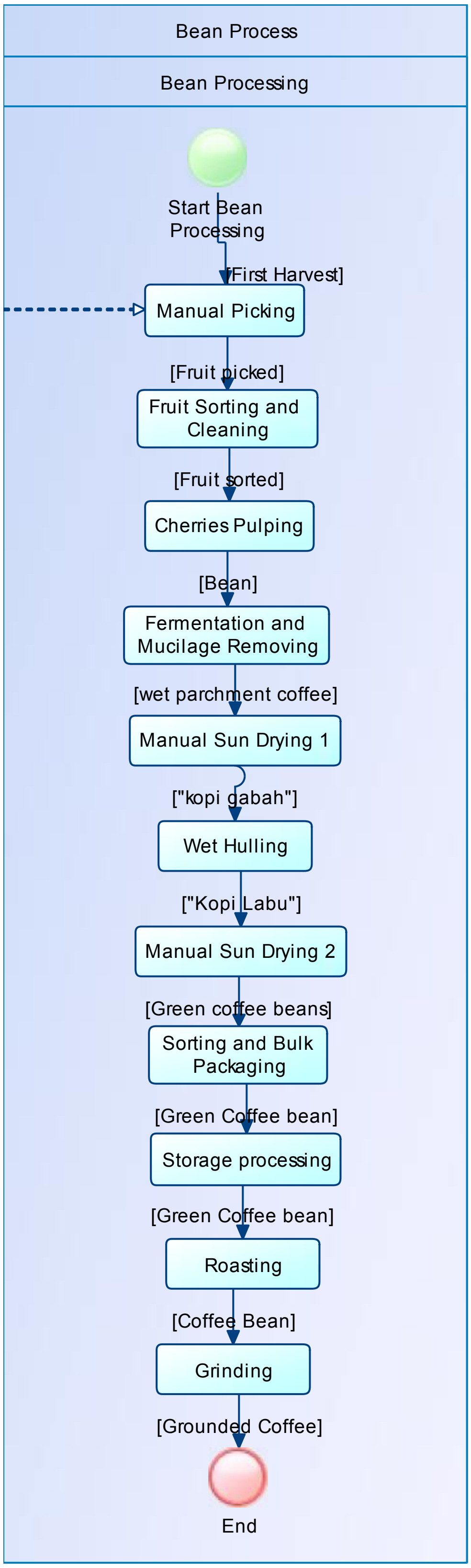

Figure 2. BPMN swin lane : activities on bean process

ISBN : 978-1-4673-7404-0

IV. TECHNICAL QUALITY

The design of quality management framework is done firstly by knowing the causes and solving the problems that are occurring nowadays in Aceh coffee industry (ACI). For this purpore, research use Failure Mode and Effect Analysis (FMEA) tool. FMEA is a systematic analytical model that aims to predict the likelihood of failures that occur at design phase of product in order to prevent problems before they are occurred and to reduce losses in production. FMEA starts from establishment of component process, identification of potential failure of each process, continued by identification of causes of each failure as well as its impact. Then, after identification of existing or proposed control for each failure takes place, the assessment of failure mode measurement based on the severity, occurrence and ability to detect is performed. Finally, when the measurement is done, corrective actions are identified and failure assessment is reviewed [10].

After identification of problems has been conducted and described in BPMN diagram, it is shown that all of these three activities have obstacles that directly influence either quality of Gayo coffee. Therefore the process needs to be reviewed and corrected, due to the problems that it has, which has been presented in Table 1.

Table. 1 Technical problems with FMEA measurement

Technical Problems	Suffering Parties	The Causes & Sub-causes	FMEA			RPN
			O	S	D	
Yield Reduction	Farmers	Misconduct Farm Management Practices	7	5	3	105
		Coffee diseases	5	7	3	105
		Non ideal shade grown system	3	6	3	54
		Unproductive/old plants	2	7	1	14
Inconsistent coffee Flavours	Coffee Processors	Different processing techniques	7	6	3	126
		Un-separation between green and ripe cherries	7	6	2	84
		Long storage for wet parchment coffee	6	6	2	72
Formation of coffee moulding	Coffee Processors	Water condition is used in processing	7	9	4	252
		In-efficient drying process	7	8	4	224
		Long storage for fresh coffee cherries and wet parchment	5	9	4	180
		Inadequate and drying infrastructure	5	8	4	160

Table 1. presents the result of FMEA analysis. Furthermore re-design of the process is done by engagement of recommended actions in new design. These recommended actions are corrective action that should be taken out of control situation to ensure that the process will be under control again.

V. RECOMENDATION

A. Yield Reduction

As for a problem with interconnected causes like presented in Table 1, it is essential for yield reduction to determine which cause has the major effect. As demonstrated by FMEA, misconduct farm management practices and coffee diseases are the major causes, whilst the other two still have lower impact. Moreover, both major causes and non ideal shade grown system need high investment for implementing its recommended action, whilst unproductive plants have lower investment. The problem should be solved in the following sequence: misconduct farm management practices, coffee diseases, unproductive plants, and non-ideal shade management systems.

Establishing code of farm management practices and providing participatory programs for the farmers: To have correct and suitable knowledge of farm management of Gayo Coffee plantation, FKA should establish code of farm management practices, which includes quality control completely with control point in farm site, which should follow the code of hygiene practice for primary production like is explained in Codex RCP 53-2003[20]. This code of practices should be assisted with sufficient knowledge on the farmer's side, which made the training, is essential. The training should be carried on by grouping the farmers in co-operative group and helping them with the relevant participatory program, as a program which assists and provides the farmers with sufficient and required knowledge based on the problems that they faced on. This program joins and involves all parties and stakeholders are required and involved, and usually conducts direct on the field. Then as a suggestion, it might be easy to implement if during the training, it is also included and joined the traditional positive farm management practices or so-called indigenous knowledge of Gayo people. Finally, as final approach, this code of practices should be presented as well in form of manual handbook, which can be used as the guidelines for the farmers. Therefore, this action is not specific measurement control of the problems, but it provides long term solutions in order to cover the missing knowledge, to educate and build up the right quality perception within those farmers. Knowing that building quality understanding requires laborious work, as well as time and experts, the huge commitment is urged to be promoted by those coffee farmers as well as FKA.

Coffee trees rejuvenation and the sequence re-plantation: Most of trees that have low yielding and are prone to diseases are adult plants and still in productive stage, whilst unproductive plants refer to 20-30 years old trees. Therefore the suggestion for coffee diseases problem is doing coffee rejuvenation for trees in productive stage, by implementing suitable grafting techniques in order to improve yield and upgrading the inferior plant. The grafting plants should be a result of fine breeding and have the resistances towards the diseases [21]. On the other hand, the old unproductive plants will be substituted by the new young stock sequentially. Moreover, before conducting coffee rejuvenation and re-plantation, it is desirable to do preliminary research in order to have statistic figures of coffee area (ha) and coffee trees condition, such as amount of old plants per ha (20 30 years), amount of mature plants per ha (<20 years) and productive plants per ha (8-15 years), as well as the percentage of infected and healthy plants. Meanwhile for Gayo Coffee in lower altitude, it might be better to re-plant these areas with Robusta varieties, based on consideration that Arabica coffee that is planted in lower altitude do not have superior quality and are prone to diseases [22].

Shade trees rehabilitation: Having an ideal shade management system means doing optimisation of shade trees management, by knowing the principle factors for deciding whether shade trees is beneficial to adapt or not [21].

B. Inconsistent Coffee Flavours

Based on Table 1., the major cause of inconsistent coffee flavour is different processing techniques or sequences, continued by merging the green and ripe cherries and the habit to store wet parchment coffee for longer time. The recommended actions should be adopted with detail below :

Separation treatment based on ripening level: Even though manual hand picking is implemented during harvesting, the ripening level of cherries is still varied and the green cherries are sometimes picked as well. Merging those cherries all together makes the drying process inefficient, and at the end green and floating cherries which produce unpleasant flavours influence the flavour of ripe cherries.

Providing adequate storage and drying facilities: Storing wet parchment coffee often occurs when over harvesting and over production come to place. Therefore the suggestion is to provide an adequate storage and patio for drying facilities in larger area [23]. Then, arranging the right time span or formulating processing schedule are needed in every processing step in order to prevent overloading wet parchment coffee and postpone the drying process.

Establishing code of processing practices and providing participatory program for coffee producers: As coffee is produced by many farmers, the uniformity of processing techniques is a must, in order to have consistent quality, reach the desired characters, and meet consumer expectations. Therefore the suggestion is that FKA provides code of processing practices, which includes establishment quality control, provides the relevant infrastructures for instance sensory laboratory, and trains the coffee producer the knowledge of coffee cupping. The introducing of code of practices needs a help from an expert such kinds of participatory programs as direct assistances for farmer cooperatives. As a suggestion, the implementation this code of practices should be connected with practices in farm sites as well as the hygiene practices. By doing so, while building up this code of practices, FKA should consider the—Good Hygiene Practices along the coffee chain a training tool from UN-FAO [20]. Moreover, considering the distances between farms and villages, the farmers should be provided with manual handbook as the guidelines that clearly explains and describes the process, the hygiene practices and measurement of quality control and other relevant information

C. Formation of Coffee Moulding

Providing Operational Pre-Requisite Programs for prevention of coffee moulding formation: Coffee moulding could lead to contamination of OTA (Ocrhatoxin A) which is counted as a health risk. Therefore, based on ISO 22000 as food safety standard, the suggestion is implementation of Operational Pre-Requisite Programs (OPRP) as safety program systems to be carried out in all steps of coffee processing. The OPRP is designed based on the guidelines from FAO and ICO Documents [24]. It will be falls into four programs as (a) pre-harvest; (b) harvest; (c) field process and (d) by products.

Pre-harvest: Although usually the development of fungi is not responsible for plant disease, fungi growth could be involved in fruit spoilage as well. Moreover, fungi are capable of surviving in viable, healthy seeds and then transmit to the coffee bean itself. Several actions should be taken into account during pre-harvest practices such as preventing overhead irrigation, cleaning the orchard in off-season, employing farm management practices, and non-disposing un-composted waste that can also be produced on the farm, or animal feed in or around the orchard [21]. This is because the deposition of seed and seed-associated material could encourage proliferation of OTA producers since many are seed-borne fungi.

Harvest: During harvesting, several indications of mould formation could occur when cherries are in contacted with the ground for long time, when ripe cherries remain on the trees for a long time due to late harvesting, or postponing the processing after harvest and storing the harvested cherries in sack, keeping cherries under water for more than one day. Therefore several recommendations are offered such as: remove the brush, fallen cherries

ISBN : 978-1-4673-7404-0

and high weeds; use picking mats beneath the trees where possible, establish clear routines for processing and handling secondary products and assure that harvested coffee can be promptly moved through the processing steps without delay [13].

Field Process: Rapid change and senescence are directly followed when coffee is detached from the tree. Therefore the change phases are important to be known in order to determine the processing control. Post harvest coffee is classified into two distinct phases and joined by a transnational phase [13, 25]. The first is called a high moisture phase, which starts with harvesting and the phase where coffee is in unstable condition and spoilage can only be controlled by encouraging competitor micro-organisms, restricting oxygen and shortening the duration of this phase. The second is a low moisture phase, which begins in the later part of drying and extends up to roasting, where the commodity is in a stable state and control is exerted by preventing the re-introduction or redistribution of water in the coffee bulk. Then, during the transnational phase, spoilage can only be controlled by time reduction because there is enough water for the growth of mesophilic and xerophilic spoilage organisms but not their hydrophilic competitors, and aeration is an indispensable part of drying. By knowing these phases, it is possible to predict the fungi formation that is likely to occur during pulping, mucilage removing, and drying process take place.

By products: In coffee processing, pulp and husk, leaves, over ripe cherries are counted as by products [26]. In order to maintain hygiene condition and not to provide any room for fungi to grow, these by products should obtain a specific treatment, such as: collecting and putting these by products in particular places, if possible set aside from patio or drying area; recycling the used water when it is possible to do, the used water should be collected, processed or at least undergo the purification treatment before it casts off into environment.

VI. CONCLUSIONS

Business process modeling of Gayo coffee quality improvement related to technical problems. Modeling with BPMN depicts the stages and the interaction between the elements. Two technical problems related yield reduction and inconsistent coffee flavor. Stages in BPMN describes activities that contribute to the reduction of technical problems. Furthermore FMEA tools highlighting the main root causes of three section from two technical problems. Based on FMEA measurement, results recommended activities to resolve technical problems on the improvement of the quality of Gayo coffee.

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ISBN : 978-1-4673-7404-0

Technology Innovation Adoption to Improve the Performance of Dairy Small-Medium Enterprises (SME): Case study in Pangalengan-Bandung Regency, West Java, Indonesia

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Abstract— This study explores the conditions and the problems of the production and quality of the product faced by dairy SMEs in Pangalengan-Bandung Regency. This study aims to recommend the technology that might be accepted and adopted to address the problem in the framework of GMP and to identify factors that may influence the adoption of the new technology. Problems related with the quality of the products have been identified and GMP implementation evaluation has been conducted. This research recommends the technology adoption that might be acceptable and adopted to address the problems are: 1. Establishing a process control system. A scheme of standardized production process has been proposed; 2. Mechanization of key processing stage, such as moulding and cutting machines and the use of boiling pans equipped with the thermocouple; 3. Improvement of the product's packaging to enhance protection of the product thus will extend the shelf life. It is suggested to modify the secondary packaging using standing pouch aluminum foil. Factors that may influence the adoption of technology by the SMEs have been identified. The positive factors are: the motivation and efforts to improve the quality and performance of the product; consumers' demand for quality and good manufacturing practices; government or regulatory enforcement; and increasing production volumes. The negative factors are: limited knowledge and educational background of the SMEs' human resources; the reluctance of the SMEs to change their current traditional practices; and financial cost.The SMEs perceived that the relative advantage of GMP implementation is low due to the cost that arise as a results of facilities and equipment improvement. Implementation of GMP and the new technology embodied in it are perceived as complicated by the SMEs. This is caused by their limited knowledge of the concept of GMP and the new technology itself. However, the SMEs perceived that GMP implementation is compatible with their values, needs, consumer's demand, and government regulatory.

Manuscript received July 16, 2015.

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I. INTRODUCTION

Bacground and Need

SMEs have an important role in the economy of Indonesi, they contribute significantly to the GDP, which amounts approximately to 60 percent and the number of workers absorbed by the sector stood at 97 percent of the total workforce available [3]. However, there are several challenges faced by the SMEs in developing countries, such as sourcing financial capital, human resource competency, technology adoption, etc.[24]. The majority of SMEs in Indonesia still apply traditional practices in terms of production processes and marketing, which indicates the low level of technology adopted [3].

Pangalengan is a sub-district of Bandung Regency that serves as the centre of milk production in West Java. There are many establishments of SMEs of dairy products producing milk caramel, milk nougat, milk dodol, and milk crackers [15]. Initially, the smallholder dairy farmers' motivation was to utilize the fresh milk that could not be absorbed by the big dairy processors due to quality issues. Therefore, they were urged to innovate by processing the excess fresh milk to become more valuable dairy products using simple and limited technology. This process is known as the grass-root innovation. Bhaduri and Kumar [7] define grass-root innovation as the innovation that was done by the grass-root people who have grasped the corresponding techniques and skills and usually due to necessity, hardships and challenges.

Pangalengan has a wide range of traditional dairy products that have been known and appreciated by consumers for years. The main product is milk caramel which amounts to 80 % of total products. These SMEs in Pangalengan produce milk caramel with production capacity ranging between 150 – 1000 l of milk per day involving 10 – 65 workers per each SME. These SMEs contribute to the economy of the region by creating the

ISBN : 978-1-4673-7404-0

added value of the fresh milk (increasing income) and absorbing the workforce (reducing unemployment).a provincial region in Indonesia located on Java Island.

Most of dairy SMEs in Pangalengan lack of technology adoption and GMP implementation, with resulting inconsistency in the quality of the product and limited area of product distribution. This has resulted in the product's low marketability when compared with the milk candy found in the national market which consists of mainly imported products.

Research Purpose

The purposes of this research are: 1. To recommend the adoption of technology in implementing GMP in the SMEs of dairy products (esp. milk caramel) that may improve the quality of the product, and; 2. To identify the positive and negative factors that may influence the adoption of this new technology by the SMEs.

Research Questions

The research questions this research are identified as follow:

1. What are the problems of production and quality of the product? (confirmative and exploratory question)
2. What type of technology innovation might be acceptable and adopted to address the problems?
3. What are the positive and negative factors that may influence the adoption of technology by these SMEs?

Research Limitations

This research is conducted on the dairy SMEs in Pangalengan- Bandung Regency, West Java, Indonesia. The study focuses on the product of grass-root innovation, such as: milk caramel. The research adopts a case study research approach conducted in Pangalengan, thus the result may not be generalisable (typical findings) to another region. The theoretical framework used in this study limits the discussion of the findings based on the GMP theory and innovation adoption theory

II. LITERATURE REVIEW

A. *Quality Assurance*

Quality is a diverse concept and may be defined in different ways depending on the interest of the manufacturers or the consumer's point of view. The widely known concept of quality introduced by Juran (1988) defines quality as "fitness for use" which means that the product or services should meet the requirement and expectation of the consumers [26]. Industry defines quality as,

"A measure of purity, strength, flavour, color, size, maturity, workmanship and condition, or any other distinctive attribute or characteristic of the product" [26, p. 12]

Quality assurance describes and manages the activities of control, evaluation, audits, and regulatory aspects of food processing system to assure that the product being produced conforms to the standards. Nowadays the quality assurance systems that can be implemented by the food SMEs are those in the ISO Series (ISO 9001:2008, ISO 22000:2005), Hazard Analysis Critical Control Point (HACCP), and Good Manufacturing Practices (GMP) [18],[26].

There have been numerous studies of factors that influence the implementation and adoption of quality assurance systems by the SMEs. Karipidis *et al* [18] reviewed that the influencing factors can be grouped into four categories, which are:

1. Internal benefits or advantages (e.g. improve company's confidence to produce quality product)
2. External benefits or advantages (e.g. improve market share and competitiveness)
3. Internal barriers or disadvantages (e.g. limited trained human resources and limited financial)
4. External barriers or disadvantages (insufficient quality tools and lack of training or education).

There are four basic factors that may encourage SMEs to adopt QAS, which are: their positioning in the marketplace when compared to the competition, the effect of poor quality, the quality culture, and the effectiveness of activities aiming to achieve quality goals [18].

Reference [16] confirmed that the primary motive for adopting a food safety system (GMP, MeSTI) in Malaysian food industry was to improve product quality, while external factors influencing food safety adoption was consumer awareness of food safety and the intention of industry to increase customer confidence.

Another study on the implementation of the quality control system in dairy SME in Bandung suggest that the problems faced by the SME in relation to milk caramels encompass the raw materials quality, processing quality control, human resources management, as well as the product marketing and distribution [15]. However, this study did not clearly evaluate the implementation of Good Manufacturing Practices (GMP) as a quality assurance system that is more practical and suitable for the food SMEs in Indonesia [20]. Thus, it needs further study about the technology that can be accepted and adopted by the milk caramel SMEs to solve the quality problems and improving the implementation of GMP.

B. *Good Manufacturing Practices (GMP)*

GMP is guidance for food production which is aimed to produce food products with quality, that are safe to be consumed and in accordance with consumers' requirements. Fardiaz (1996) as cited by Herlinawati [17] states that the objectives of GMP application in the food industry are to:

1. Encourage the food processing industry to be responsible for the quality and safety of products produced.
2. Improve the competitiveness of the food processing industry.
3. Improve the productivity and efficiency of the food processing industry.

GMP forms the basis of a foundational platform for a quality assurance program upon which other systems such as food safety system (e.g. ISO 22000, HACCP) could be built to produce consistent quality and safety of the food. GMP provides the basic requirement to assure good practices related to the workers, the facility and environment, the machinery or equipment and also process control [9], [14]. The benefits of GMP

ISBN : 978-1-4673-7404-0

implementation in small dairy factory are related to food safety, longer product shelf life, reduced losses, better working environment, and consumer satisfaction [11].

The GMP standard in this study refers to the Regulation of Head of The National Agency for Food and Drug Control (NADFC) Republic of Indonesia No. HK.03.1.23.04.12.2206 year 2012 about GMP for household and small scale industry [20] and covers the following aspects:

1. Location and production environments
   The location of the food industry should be kept clean, free of litter, odour, smoke, dirt and dust. The environment of the location should be maintained in a clean state.
2. Building and facility
   Building and facility should assure that during the production process, food will not be contaminated by the physical, biological, and chemical hazards, as well as easy to clean and sanitize.
3. Production equipment
   The equipment coming contact with food should be designed and constructed to ensure the quality and the safety of the food produced. Production equipment and containers should be made of materials with no toxic effect, durable, and easy to clean and sanitize in its intended use.
4. Water supply and facility
   An adequate supply of potable water with appropriate facilities for its storage, distribution and temperature control, should be available and meet the requirement of clean water quality or drinking water quality.
5. Hygiene and sanitation facility and activity
   Hygiene and sanitation facility and activity are needed to assure that the building and equipment are in clean condition and to prevent the cross-contamination from the workers. Cleaning facility for washing of food, equipment, supplies and building and employee hygiene facilities (hand washing and toilet) should be available, well maintained, and in a clean state.
6. Personnel health and hygiene
   Food handlers should maintain a high degree of cleanliness, where appropriate, wear suitable protective clothing, head covering, and footwear. Food handlers should avoid the non-hygienic practices that could result in contamination of food, for example: smoking, spitting, chewing or eating, and sneezing or coughing over unprotected food.
7. Maintenance and sanitation hygiene program
   Maintenance and sanitation program for production facilities (buildings, machinery / equipment, pest control, waste handling and other) shall be done periodically to ensure avoiding cross contamination to the processed food.
8. Storage
   Storage of raw materials and finished products should be provided in such a way to avoid the decreasing of quality and safety of the product. The storage of raw materials and finished products must be separated in a clean room.
9. Process control
   The production process shall be controlled properly to produce good quality and safe food product. Process control in food home industry or food SME can be done through the following steps by establishing: a. The raw material specification; b. The raw material composition and formulation; c. The standard operating procedure for the production process; d. The type, size, specification of the packaging; e. The detailed product information, including product's name, production date, expiry date.
10. Food labelling
    The food label should contain the following minimum required information: a. Product's name; b. List of raw materials and ingredients; c. Nett weight; d. Producer's name and address; e. Expiry date; f. Production code; g. Food licence number.
11. Supervision by the person in charge
    A person in charge is required to supervise all stages of the production process and control to assure the food product quality and safety.
12. Product recall
    The owner of the food establishment must recall the product if suspected to cause illness/food poisoning/ and or not meet the requirements of food legislations and regulations.
13. Records and documentation
    Appropriate records and documentation are needed to facilitate traceability of problems related to production and distribution process, to prevent the distribution of products that exceed the expiry date, and to improve the suitability and effectiveness of the food safety and quality management system.
14. Training of employees
    Managers and employees must have basic knowledge and competency regarding the principles and practices of food hygiene, sanitation and food processing in order to produce good quality and safe food.

A study on the implementation of GMP and HACCP plan in a *nata de coco* company shows that it has addressed the issues of physical contamination from equipment, environment, and workers, thus reducing the rejected product from 14.43% to 5.32%. However, there are some issues regarding the implementation of GMP in the developing countries such as: 1. Industry size; 2. Infrastructure; 3. Tradition; 4. Behaviour/attitude; and 5. Financial cost [14].

Applying GMP and HACCP to traditional food processing can effectively manage and control hazards that may be associated with the traditional practices. GMP implementation is an effective system for ensuring the quality and safety in the traditional processing of maize in Ghana [2]. In such traditional operations, GMP can be implemented at minimal cost by relying on simple techniques and instruments such as visual inspections, using pH strips, thermometers, and timing of unit operations.

Yuwono, Zakaria & Panjaitan [28] identified internal and external factors that influence the continuity of GMP application in the fish fillet processing plants. The internal factors are lack of education and lack of experience, whereas the external factors are lack of

ISBN : 978-1-4673-7404-0

government policies in socialisation and training of GMP, lack of potable water and ice supply, lack of law enforcement, and market demand.

C. Technology Innovation Adoption

The introduction of quality assurance concepts to the SMEs that is embodied in the implementation of GMP and the processing technology included can be regarded as a new technology or innovation concept for the SMEs. The implementation of GMP and technology included in it is aimed to improve the product's quality and competitiveness.

The newness of an innovation is measured subjectively by the adopters and more emphasizing in the usefulness and novelty [22]. In the context of a developing country, technological innovation is the process where a company creates and/or applies the new design and/or new production process of goods and services regardless of whether they are new to their competitors, their customers or the world [4].

Accoring to Rogers [22], technology innovation can be classified into hardware technology and software technology. Hardware technology refers to the physical or material objects such as tools, machinery, or equipment, while software technology refers to information base or systems underlying the hardware technology [22]. GMP is the software technology that underlying the usage of hardware technology needed to improve the implementation of the concept.

The rate of technology / innovation adoption is influenced by the perceived attributes of the innovations as explained by Rogers [22] as follow:

1. Relative advantage. This is the degree to which innovation is perceived as better than the existing one. It can be measured by the economic perspective, convenience, and satisfaction.
2. Compatibility. This is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and the needs of the adopters.
3. Complexity. This is the degree to which an innovation is perceived as difficult to be understood and to be applied.
4. Trialability. This is the degree to which an innovation can be trialled prior to full implementation in the real situation.
5. Observability, it is the degree to which the result of an innovation can be observed by others.

This study focuses on the relative advantage, compatibility, and complexity of GMP and relevant technology needed because these three factors have consistently influenced in adoption behaviour of technical innovation than other factors [23].

In addition, Ram and Sheth [21] argue there are five barriers that weaken the adoption of innovation and may lead to the innovation resistance, which are: usage barrier, value barrier, risk barrier, tradition barrier and image barrier. The usage barrier happens when an innovation is not compatible with existing workflows, practices or habits. It is the most probable cause for resistance to innovations. The value barrier arises if the innovation does not offer significant performance-to-price compared to its substitutes. Risk barrier refers to the degree of risks an innovation entails (physical, economic and function). Tradition barrier related to the changes an innovation may cause in daily routines and deviate from established traditions. The image barrier arises due to a stereotyped thinking and perception of an innovation.

There was a study on the technology transfer of some Moroccan traditional dairy products to improve the traditional fermentation process [6]. It proposed the schemes of standardized production stages, in which the processing steps are basically the same as those used in traditional method with the required adjustments for standardization and enhancement of safety and quality of the final products.

Yuwono, Zakaria & Panjaitan [28] used the theory of perceived attribute innovation to study the factors affecting the implementation of GMP in the fish fillet processing unit in Java-Indonesia. The respondents who continue to apply GMP imply that the GMP implementation gave them relative advantages by expanding export market orientation and reducing rejected product. They also perceived that GMP is compatible with their values and customer's values (requirements of the customer and regulation of the export destination countries). They have received education, training, and manual guidance from the government thus they do not perceive GMP as complex. On the other hand, the respondents who decided to stop the GMP implementation perceived that the GMP implementation did not give them relative advantages, not compatible, and difficult to apply.

III. RESEARCH METHOD

The exploratory case study methodology is applied in this study. This research was conducted through four stages, which are: 1. Identification of the dairy SMEs profile in Pangalengan; 2. Identification of current processing technology; 3. Identification of technology adoption that might be acceptable and applied to address the problem; and 4. Identification of factors that may influence the adoption of new technology by the SMEs.

Data was collected by doing the field observation and semi-structured interviews with the respondents [5], [19]. All interviews were recorded and transcribed for analysis [27]. The participants were purposively sampled based on their experience and knowledge:

a. Respondent 1: The owner of AA enterprise, dairy SME in Pangalengan
b. Respondent 2: The owner of BB enterprise, dairy SME in Pangalengan
c. Respondent 3: The owner of CC enterprise, dairy SME in Pangalengan
d. Ir. Agus Sudibyo, MP (Respondent 4): Senior researcher at Center for Agro-based Industry
e. Drh. Asep Rahmat H. (Respondent 5): Processing Unit Manager at The Cooperatives of Bandung Regency Dairy Farmers (CBRDF)

The data were analysed using descriptive and interpretive analyses [27]. The field observation data were analysed by referring to the GMP standard and literature review or practical theory of milk caramel processing technology and quality assurance.

ISBN : 978-1-4673-7404-0

IV. FINDINGS AND DISCUSSION

A. Profile of dairy SMEs in Pangalengan & current technology applied

. BB Enterprise was the pioneer of dairy SMEs in Pangalengan and it is still the leading player in the region with the biggest production capacity, monthly income and number of workers. The government awarded BB Enterprose the Upakarti award as the small-medium scale entrepreneurs who had succeeded in business and surrounding community development.

AA & CC Enterprise were relatively new established (in 2003 and in 2008). The owner of CC was previously an employee of AA and BB. He was an experienced and skilled worker who decided to establish his own enterprise and succeeded. The detailed profile of dairy SMEs in Pangalengan can be seen in Table 1.

Table 1. Profile of dairy SMEs in Pangalengan

General Information	AA	BB	CC
Establishment's Year	2003	1970	2008
Production capacity (l)	200 -300	1000	250-250
Monthly income (Rp)	60,000,000 – 70,000,000	700,000,000 – 800,000,000	50,000,000 – 60,000,000
Human resources			
1. Number of permanent Workers	11	10	0
2. Number of daily workers	20	65	25
3. Education level of workers	Senior High school = 11 workers Elementary school & Junior high school = 20 workers	Senior High school = 10 workers Elementary school and Junior high school = 65 workers	Senior High school = 5 Drop out / Junior high school = 20 workers

Milk caramel is a processed dairy product with a soft chewy texture, brown colour and has a distinctive taste, flavour and aroma. The distinctive properties of milk caramel are the result of the reaction between sugar and milk proteins during the heating process (known as caramelisation and Maillard reaction). Milk fat decomposition during heating in the high-sugar environment also contributes to the distinctive taste of the product [1], [15].

The composition of raw materials and ingredients in the milk caramel consist of fresh milk, sugar, glucose syrup, and margarine. The packaging materials consist of oil paper and HVS paper (as a primary packaging) and printed plastic bag (as a secondary packaging).

The equipment and production technology being used are still simple and manually operated by the workers. The production equipment consists of: plastic milk container, aluminum boiling pan, gas stove, wooden stick stirrer, stainless steel knife, working table, plastic pan, aluminum tray, plastic tray, plastic packaging sealer, and production code stamp.

Heating and cooking is the key processing stage to evaporate the water content of the milk. The cooking process should be done with the stirring along the process to distribute the heat evenly throughout the dough and to avoid the coagulation of the mixture. The First stage of heating is pasteurization that aims to kill the pathogenic bacteria. The original type of heat treatment was a batch process in which milk washeated to 63°C in open vats and held at that temperaturefor 30 minutes [8]. The production process flow of milk caramels is shown in the Figure 1 below.

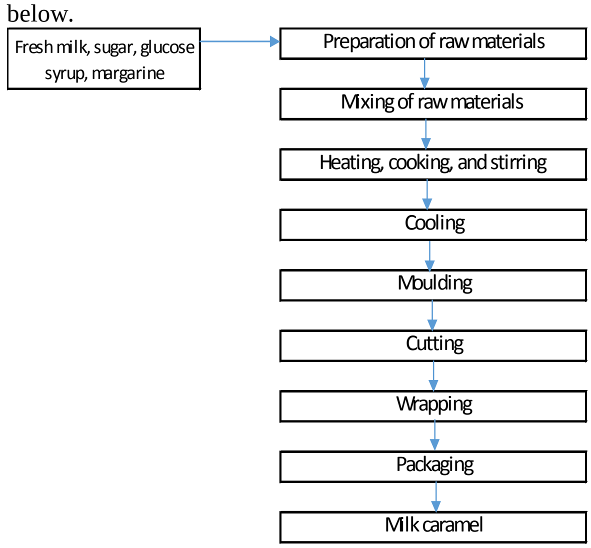

Figure 1. Flow chart of milk caramel production process

B. Problems of production and quality of the product faced by the dairy SMEs in Pangalengan

1. Finished product quality is not consistent in terms of taste, texture, size, and the shelf-life of the product. They often found some defect products in the retailer store before reaching its expiry date. The problems of product's texture & taste related to the production process control, especially in the heating and cooking stage (e.g. overcooking due to lack of time and temperature control).
2. The current secondary packaging, which is a transparent plastic bag, cannot protect the product properly from direct sunlight and high temperature when the product is being displayed in the retailer store. Under this condition, the fat content of milk caramel will seep into the wrapping paper, making it look defective, and the product texture is softened.
3. The causes of the problems are non-standardized production process, low level of GMP implementation and lack adoption of new technology. These SMEs do not have the process and quality control system established, thus the consistent quality of the product is difficult to achieve. In the view of respondent 5,
4. The GMP implementation evaluation shows that there are four main elements that need to be improved by the SMEs and directly affected the product's quality, they are: process control, personnel hygiene, hygiene and sanitation activities, and training of workers.

 ISBN : 978-1-4673-7404-0

C. Identification of technology innovation that might be accepted and adopted in implementing GMP to address the problems

Based on the interviews, field observations, and data analysis, it has been identified three types of technology in the framework of GMP that might be accepted and adopted to address the problems,

1. Process control system
   The SOP of production process is established as a guidance of production process. It ensures the production process is carried out through the same stages with standardized condition. The proposed scheme of a standardized production process can be seen in Table 2. The SOP of personal hygiene is established to ensure that food handlers who contact with food do not result in cross-contamination to the food. SOP for sanitation to ensure that all parts of the establishment are appropriately clean.

Table 2. Scheme of standardized production process

No	Process stage	Process quality control
1	Preparation of raw materials	The composition of raw materials is referred to the formulation sheets
2	Fresh milk is heated up the with the addition of sugar, glucose syrup, and margarine.	Milk is pasteurized in a temperature 63-70^{0}C for 30 minutes prior to addition of other ingredients.
3	The mixture is cook in a temperature 115-132^{0}C for 3-4 hours.	- The cooking process should be done by stirring the mixture throughout the process to distribute the heat evenly throughout the mixture and to avoid the coagulation of the mixture. - Temperature is checked by using thermometer. - The end point of cooking stage is determined by checking the mixture stickiness (expert judgement). The dough stickiness can be checked by pouring a sample of mixture into the glass of water. The end point is reached if the mixture hardens and can be broken off by finger.
4	The mixture is cooled until it reaches a temperature 45^{0}C and then it is poured into the molding pan.	The mixture is weighed in the molding pan to make sure the size consistency of each dough sheet .
5	The caramel sheet is sliced and cut into the desired size of milk caramel (1.5 cm x 1.5 cm).	The caramel chunk size is checked visually for its uniformity. SOP personel hygiene is referrred to as a process control of contamination from the foodhandlers.
6	The milk caramel is wraped. The first primary wrapping paper is the oil paper, the secondary wrapping paper is the printed HVS paper.	SOP personel hygiene SOP personel hygiene is referrred to as a process control of contamination from the foodhandlers.
7	Wrapped milk caramel is packed into the plastic bag and weighed as desired (e.g. 100 grams, 200 grams, or 500 grams).	The nett weight of each packed product is measured using the accurate scales.
8	The label sticker of expiry date is stamped on to the front side of the plastic bag.	The expiry date code is checked visually to make sure of the accuracy.

2. Mechanization of key processing stage is desirable, such as manual mixing to be replaced by the mechanically operated machines, the use of moulding and cutting machines, and the use of boiling pans equipped with a temperature monitoring devices (e.g. thermocouple)
3. Improvements in the product's packaging to enhance protection of the product thus extend the shelf life. It is suggested to modify the secondary packaging using standing pouch aluminium foil. Aluminium foil has a good tensile strength and an excellent barrier to light, liquid and foods [10]. Improvement in packaging design and materials will affect the consumer acceptance that might lead to the increase of product marketability.

D. Factors that may influence the adoption of technology by the dairy SMEs

Factors that influence the adoption of technology fall into three categories: 1. positive factors; 2. Negative factors; 3. The perceived attributes of the technology. Positive factors are those that encourage the SMEs to adopt the new technology. Negative factors are those considered to be barriers to technology adoption. While perceived attributes of technology are characteristic of technology innovation as perceived by the individuals.

1. Positive factors

a. <u>Motivation and efforts to improve the quality and performance of the product</u>

The SMEs realize that they have quality issues, and need to improve the production process by implementing GMP and applying relevant technology. Respondent 1 said,

> *"We realize that we still need to improve the quality of the product to be able to survive in this competitive business environment"*

Applying GMP and relevant technology are regarded as efforts of quality improvements and assurance of the products safety to gain consumers' trust. This finding conforms to previous research [16], [18].

b. <u>Consumers' demand for quality and good practices of manufacturing</u>

The increasing awareness of consumers regarding quality and good practices of manufacturing also encourage the respondents to adopt GMP. This is consistent with the previous study by Fernando, Ng and Yusoff [16] that highlighted consumer awareness of

ISBN : 978-1-4673-7404-0

food quality and safety, and the intention of industry to increase customer confidence.

c. Government or regulatory enforcement (e.g. home industry food licence)

To get the food licence, the food SMEs should be audited by the government official regarding the production facilities, production process, hygiene and sanitation requirements that are also included in the GMP. Therefore, the SMEs perceived that regulatory enforcement encourage them to implement GMP. This finding conforms with previous research [18], [28].

d. The Increase of production volumes

The SMEs recognize that they cannot rely on their current technology and working system if there is an increase of production volumes. Implementing quality assurance system such as GMP and adopting mechanized operating machines will become an urgent need to produce products that are safe and good quality.

2. Negative factors

a. Limited knowledge and educational background of the SMEs' human resources

The workers' education level is low because they had only limited secondary education. Consequently, the awareness and knowledge about food processing, hygiene and sanitation practices for the food industry is limited. They do not actively searching for the information for new and up-dated technology. They rely on the local government training event and some academics who visit their site to absorb the information on technology transfer. Respondent 5 said,

> *"Technological changes relate with the educational background of the adopters. In my experience, the high-level education workers are more willing to adapt to the changing of technology"*

b. Reluctance of the SMEs to change their current traditional practices (mindset, experience)

Technology adoption also involves social changes. Changing a mindset, people's attitude and ways of working are considered to be challenging by the SMEs. Respondent 5 said,

> *"These SMEs are still trapped in the stigma or idea that they are producing a traditional product. It is difficult to change their practices to use the GMP concept, as well as introducing the new technology that is relevant"*

GMP implementation requires changes of workers' behaviour and attitude towards hygiene practices. Applying new technology (e.g. moulding and cutting machinery) would require adjustment of knowledge and skill of the workers. Tradition barrier arises in this case and can hamper the adoption of such technology or innovation [11], [14], 21].

c. Financial cost

Improving facilities and equipment to meet the requirements of GMP and adopting new technology additional cost that must be borne by the SMEs. Improving packaging design and material will increase the production cost that eventually affect the product's selling price. Respondent 4 stated,

> *"New technology adoption, whether hardware or software will involve cost to improve the current facilities or technology being used"*

This will be the challenge faced by the SMEs in adopting new technology; otherwise there is government support for them. This finding confirms previous research [11], [14], [18], [28].

3. The technology perceived attributes

a. Relative advantage

The degree of relative advantage is often expressed in terms of economic profitability, meaning that the profit gained needs to be compared with the cost of adopting the technology. The SMEs consideration in adopting the new technology is its usefulness and function. Respondent 5 said,

> *"When we introduce new technology to the SMEs, they will calculate the money they spend against the benefit they will receive*"

In terms of implementing GMP, the benefits are as follows: the improvement of product's quality, assurance of food safety; reduced losses; better working environment; consumer satisfaction; and an extended shelf life for milk caramel. But, there will be costs for improving the hygiene facilities, investing on mechanization of processing stages, and preparing the adequate personal hygiene facility. The SMEs still think that the cost of implementing GMP is too high. Thus, it will need government support, technically and financially, to accelerate the GMP implementation by the SMEs.

Rogers [22] states that adopter incentives increase the relative advantage of the innovation. Adopter incentives can act as a cue-to-action in triggering the adoption of an innovation. To adopt a quality assurance system, SMEs need to believe that performance improvements are guaranteed, because they are not willing to invest in systems that promise only ''potential" returns somewhere along the way.

b. Compatibility

An innovation or technology can be compatible or incompatible with: 1. sociocultural values and beliefs; 2. previously introduced ideas; and 3. the needs for innovations [22]. The GMP implementation is compatible with the needs of the SMEs to address the problems of production and quality of the product. This fact is supported by the identified positive factor which is motivation and efforts to improve the quality and performance of the product.

The GMP implementation is perceived to be compatible with the needs of the customers. This has been identified in the positive factor which is consumer's demand for quality and good practices of manufacturing.

The GMP implementation is also perceived compatible with the government and regulation enforcement. In order to get the food licence, the SMEs should be audited by the local government officer to examine the properness of the establishment, and that include aspects required by GMP.

c. Complexity

Implementation of GMP and the new technology embodied in it are perceived as complicated by the SMEs. This is caused by their limited knowledge regarding the concept of GMP and the new technology itself. Respondent 3 said

> *"I'm not familiar with GMP, I don't think I have received the information or training about that. But as a food producer, of course, I implement some of the concepts, such as the cleanliness, and the hygiene practices"*

Complexity can be associated with tradition barrier of innovation adoption. Ram and Seth [21] suggest strategy to overcome the tradition barrier by educating the consumers of an innovation and the use of change agents.

Suitable training programs about GMP and the relevant technology ought to be provided to improve the competency of human resources in dairy SMEs. The change agent might refer to the officials of Local Government Bureau of Health (local food inspector) who assist and monitor the GMP implementation by the SMEs. This indicates that government's role is needed in distributing the information about GMP and transferring technology to the SMEs. This conforms with previous research [17], [18], [25], [28].

V. CONCLUSION

Problems related with the quality of the products have been identified and GMP implementation evaluation has been conducted. This research recommends the technology adoption that might be acceptable and adopted by the dairy SMEs to address the problem as follow:

1. Establishing a process control system. A scheme of standardized production process has been proposed.
2. Mechanization of key processing stage, such as moulding and cutting machines and the use of boiling pans equipped with the thermocouple.
3. Improvement of the product's packaging to enhance protection of the product thus will extend the shelf life. It is suggested to modify the secondary packaging using standing pouch aluminium foil.

The SMEs perceived that the relative advantage of GMP implementation is low due to the cost that arise as a results of facilities and equipment improvement. Implementation of GMP and the new technology embodied in it are perceived as complicated by the SMEs. This is caused by their limited knowledge of the concept of GMP and the new technology itself. However, the SMEs perceived that GMP implementation is compatible with their values, needs, consumer's demand, and government regulatory.

Implications of the Research

1. Implications of a practical kind at the workplace level in the SMEs

The proposed standardized production stages, raw material and finished product specification, SOP for personal hygiene, and SOP for sanitation might be implemented by the SMEs in daily operation.

2. Implications of a policy making kind by the government
   a. Local government needs to create a long-term and continuous program in assisting the SMEs to implement GMP and adopting the technology needed. Officials of Local Government Bureau of Health (local food inspector) can be the change agent who assist and monitor the GMP implementation by the SMEs.
   b. The government needs to play significant role, by supporting and providing the infrastructure for the SMEs, providing trainings related with the sanitary production process and good manufacturing process for SMEs, and conducting regular monitoring of GMP implementation.
   c. The government may participate in creating external business environment that would encourage the adoption of GMP with emphasis on information distribution and acknowledgement of GMP adoption by the SMEs to gain customers' trust.

Further Research Direction

To enlarge the scale of research in this field, the researcher suggests to involve more SMEs respondents in other regions (representatives of the population). The respondents' selection criteria can be based on those who already adopt the GMP and those who do not as a comparison. Quantitative analysis of GMP implementation evaluation, by using a numbering scale, would add more valuable information to this research.

Another interesting research topic would be to address the issue of GMP implementation relative advantages. Thus it will need a calculation of cost and benefit in implementing the GMP.

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ISBN : 978-1-4673-7404-0

Process Innovation for Producing Bioethanol from Oil Palm Empty Fruit Bunches by Improving Fermentation Conditions

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Abstract **- A research manufacture of bioethanol from oil palm empty fruit bunches to improving the fermentation conditions in the framework of the innovation process, in laboratory Process Engineering of Agricultural Products, and in the laboratory of Microbiology, Faculty of Agricultural Technology Universitas Andalas from March to October 2014. The objective was to understand and find The optimum fermentation conditions that can provide the highest ethanol yield, by applying some of the results of previous studies in the phase of the process. The results showed that of the long time fermentation 4, 5 and 6 days, the highest ethanol yield obtained on treatment for 5 days long fermentation using yeast *Saccharomyces cerevisiae* Strain BTCC Y-34, with stirring in the fermentation process is equal to 65.15% and the without stirring 61.20%. From the best treatment is then performed multiplication scale (mini scale up) to the number of samples used ten times as much. From the results of multiplication scale bioethanol yield the highest in the treatment with stirring in the amount of 21.04%. From this study it can be concluded that the long fermentation time, stirring and *Saccharomyces cerevisiae* strains used in the fermentation process, affecting the yield of bioethanol obtained, meaning that influential in the process of improving the fermentation process.**

Keyword **– bioethanol, hydrolysis, fermentation, Saccharomyces cerevisiae, oil palm empty fruit bunches**

I. INTRODUCTION

Bioethanol is an alcohol made from fermented biomass. Fermentation can be carried out on starchy materials, such as cassava, corn, grain sorghum, wheat, corn and potatoes; materials such sugary molasses (molasses), sugar cane juice, coconut juice, sweet sorghum stalks, palm sugar (palm), palm sap, sap gewang and palm sap; and lignocellulosic material eg agricultural waste materials such as rice straw, bagasse, corncob (cobs) of maize, cassava (tapioca waste), banana stems or from sawdust, logging waste and others [1], [2].

One potential lignocellulosic material for bioethanol is used as oil palm empty fruit bunches (EFB). EFB is one of solid waste palm oil processing industry that availability is abundant throughout the year. If the production of fresh fruit bunches (FFB) approximately 20.08 tons a year with a dry weight of 10.59 tonnes and TKKS amounted to 22% of TBS, then in one year will produce 4.42 tonnes of waste TKKS with a dry weight of 1.55 tons [3].

However, lignocellulosic material utilization as a producer of bioethanol is still constrained in a more complicated processing, which requires a preliminary process due to the presence of lignin, extractive substances, cellulose crystallinity and the presence of inhibitors as a byproduct during the hydrolysis and fermentation. Although basically lignocellulosic material prices are cheaper and easier to obtain, but the cost of production is still relatively higher than sugary and starchy material. Therefore it is the challenge of the bioconversion technology lignocellulosic material into bioethanol is still low productivity due to the still less optimal pretreatment process, hydrolysis and fermentation of glucose to ethanol [4].

Kasim dan Kasim (2013)[a] in his study trying to optimize a bioconversion process this lignocellulosic material into bioethanol, using empty fruit bunches of oil palm fiber is given a pretreatment in the form of mechanical treatment so as EFB fiber. In research done hydrolysis process using a low concentration of sulfuric acid (H_2SO_4 1%) with long hydrolysis 30, 60, 90, and 120 minutes; using a temperature of 120 ° C and 130 ° C. Hydrolysis is done by using autoclave with trailers of time and temperature. The results showed that the hydrolysis of empty fruit bunches of oil palm fiber with a long 60 minutes and a temperature of 130 ° C gives the results of reducing sugars and total sugars contained in the hydrolyzate highest of all treatments, ie 3.51%

ISBN : 978-1-4673-7404-0

and 4.30% for each. The hydrolyzate will later be processed into bioethanol through fermentation [5].

Kasim dan Kasim (2013)[b], has been conducting research with ferment sugar hydrolyzate prepared by the hydrolysis of EFB fiber for 60 minutes at a temperature of 130 ° C using sulfuric acid (H_2SO_4) 1%. Fermentation is carried out for 3 days (66 hours in practice), using the yeast Saccharomyces cerevisiae. Results of the study indicate that the ratio between the volume of ethanol obtained in actual (ml) with raw material volume (ml) obtained an average yield of 70.43% (v / v). However, in these studies has not reached the stage of testing the levels of bioethanol. And stage distillation done by using Rotary Vacuum Evaporator [6].

For that on this occasion the authors conducted a study to improve the fermentation process hydrolysates oil palm empty fruit bunches to look at the various factors that influence which in this case long fermentation time, stirring and strains of Saccharomyces are used, as an innovation of the research that has been done before, because the third These factors may affect the yield of ethanol produced.

II. MATERIALS AND METHODS

The procedure refers to research and Kasim Kasim (2013)[b] is modified. To produce bioethanol is done in several stages which includes the preparation of EFB fiber, fiber hydrolysis, fermentation, distillation and determination of the yield.

1. Preparation of EFB Fiber

TKKS shredded to a size of ± 5 cm, then felted, and dried to a moisture content of ± 10% using solar dryers. Fiber then smoothed using a hammer mill to a powder and screened with a sieve size of 40 mesh.

2. Hydrolysis of EFB Fiber

Enter TKKS fiber each as much as 20 g into 250 ml Erlenmeyer, add 200 ml of water and H2SO4 1% (1% of the volume of water). Comparison of samples with 1% H2SO4 was 1: 10 (w / v). Stir with a shaker incubator at 100 rpm for 5 minutes. Then hydrolysis in an autoclave (autoclave) at a temperature of 130oC for 1 hour. Then strain, so the sugar hydrolyzate obtained.

3. Fermentation with *Saccharomyces cerevisiae*

Culture preparation Saccharomyces cerevisiae

Yeast *S. cerevisiae* is used there are 2 strains, namely strain 1: American Type Culture Collection, USA (ATCC) 9674 (coded 1F) from the laboratories of Microbiology IPB, and strain 2: Biotechnology Culture Collection, LIPI, Cibinong, Indonesia (BTCC) Y-34 (coded 2F).

S. cerevisiae yeast isolates on PDA rejuvenated shaped to slant and incubated for 2 days (48 hours) at 37 ° C. After that cultivated in 200 ml of GDP media and incubated for 1 day (24 hours).

Substrate Preparation

Sugar hydrolyzate obtained from the hydrolysis process, was added to 250 ml Erlenmeyer, then added with 50% NaOH to adjust the pH of the hydrolyzate obtained to 4.5. Next add the S. cerevisiae as much as 10% (from 100 ml sugar hydrolyzate obtained), 0.13% urea, NPK and 0,028%.

Settings Fermentation Conditions

Do it ferment for as long as 4, 5 and 6 days. Each treatment was performed three replications. Anaerobic fermentation is done in a state with two conditions, namely with agitation (stirring) and without agitation. Fermentation samples by treatment with stirring performed on the shaker at a speed of 50 rpm at a temperature of 30 ° C, while the treatment without stirring, the fermentation process is carried out in an incubator temperature of 30 ^oC.

3. Separation Bioetanol with Water by Using Rotary Vacuum Evaporator

Fermented then measured its pH, evaporated by Rotary Vacuum Evaporator to separate ethanol and water, then measured the volume of bioethanol obtained and weighed.

4. Determination of Yield Bioethanol

Yield is calculated by comparing the weight and volume of ethanol were obtained with a sample weight of the raw materials used. The formula used to calculate the yield of ethanol is as follows:

$$\text{Yield (\% b/b)} = \frac{\text{Mass Ethanol Obtained Actual(g)}}{\text{Mass of Raw Material (g)}} \; x \; 100\%$$

5. Doubling Scale (Mini Scale Up)

Against the best treatment, which gives the highest bioethanol yield, do multiplication scale (mini scale up) ten times liput of regular treatment. Ie using a sample of 10 times (200 g). And the fermentation process and the same observations as lab-scale treatment.

III. RESULTS AND DISCUSSION

Fermentation with yeast Saccharomyces cerevisiae strain BTCC Y-34

From the research conducted, samples of fermented *Saccharomyces cerevisiae* strains 1: American Type Culture Collection, USA (ATCC) 9674 (coded 1F) for 4 and 5 days when evaporated by Rotary Vacuum Evaporator (to separate the ethanol with water), yet obtained bioethanol, although the smell of fermented ethanol. Bioethanol fermentation formed on day 6, where the volume of

 ISBN : 978-1-4673-7404-0

ethanol that is formed is 7.10 ml to treatment with the agitation and 11.57 ml on treatment without agitation; wherein each of bioethanol yield is 36% and 56.95% (Tables 1and 2).

Table 1. Volume, Weight and pH of the Sample Bioethanol Fermented with *Saccharomyces cerevisiae* Strain ATCC 9763

Days	Agitasi/ Non Agitasi	Bioethanol Volume (ml)				Weight of Bioetanol (g)				pH			
		Repetition			Ave rage	Repetition			Ave rage	Repetition			Ave rage
		1	2	3		1	2	3		1	2	3	
4	Agitation	0.3	0.1	0	0.13	-	-	-	-	4.6	4.6	4.5	-
	Non Agitation	0	0	0	0.00	-	-	-	-	4.6	4.6	4.6	-
5	Agitation	0.1	0.1	0.3	0.17	-	-	-	-	4.6	4.7	4.6	-
	Non Agitation	0.5	0.3	0	0.27	-	-	-	-	4.7	4.7	4.6	-
6	Agitation	7.50	6.10	7.70	7.10	8.01	5.89	7.69	7.20	4.7	4.7	4.7	4.7
	Non Agitation	9.50	15.00	10.20	11.57	9.09	14.54	10.53	11.39	4.6	4.7	4.7	4.7

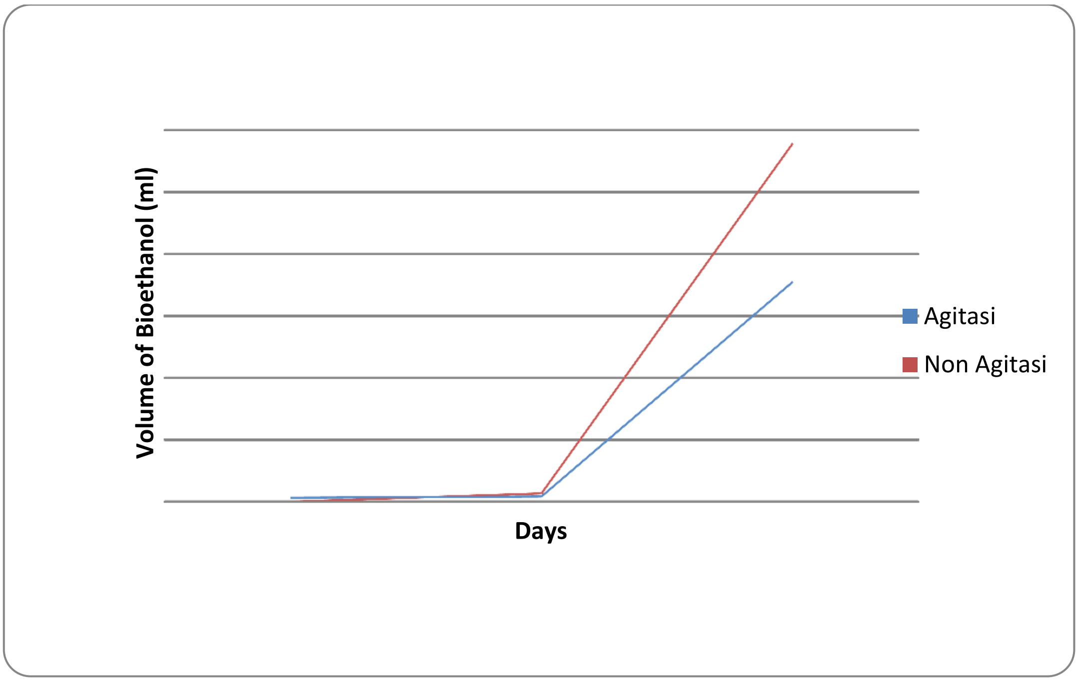

Figure 1. Bioethanol Volume of Sample Fermented with *Saccharomyces cerevisiae* Strain ATCC 9763

The treatment of agitation and non agitation in this case does not provide a clear result, even though theoretically the process of agitation assist in the fermentation process, provide better results compared with no agitation. This is presumably because the tools used in the process of agitation, the temperature is unstable because the tool is indeed experienced little interference so that the optimum temperature of S. cerevisiae which is set on the tool (ie a temperature of 30 ° C) is not stable during the fermentation process, are likely to rise to 35 ° C; whereas the treatment of non-agitation fermentation temperature is stable at a temperature of 30 ^{o}C

ISBN : 978-1-4673-7404-0

Table 2. The Yield of Bioethanol from Fermented Samples with *Saccharomyces cerevisiae* Strain ATCC 9763 and The BTCC Y-34

Treatments	Days	Yield of Bioethanol (%)	
		ATCC 9763	BTCC Y-34
Agitation	4	0	47.35
	5	0	65.15
	6	36.00	50.65
Non Agitation	4	0	58.35
	5	0	61.20
	6	56.95	47.05

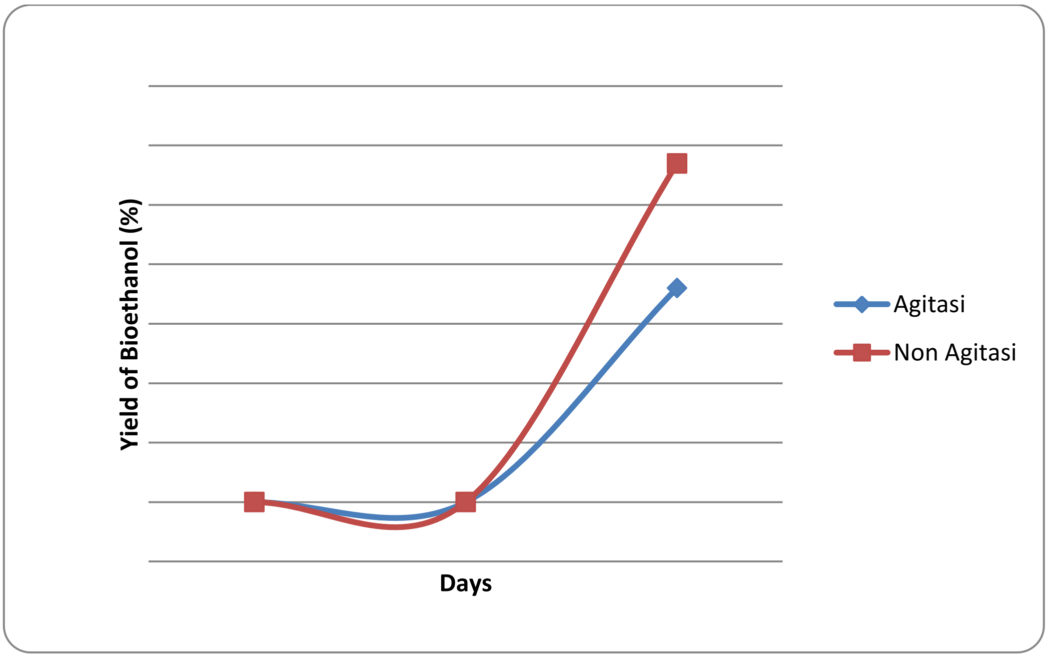

Figure 2. The Yield of Bioethanol from Fermented Samples with Saccharomyces cerevisiae strain ATCC 9763

Fermentation with Yeast Saccharomyces cerevisiae strain BTCC Y-34

For samples fermented with khamir Saccharomyces cerevisiae strain 2 (Biotechnology Culture Collection, LIPI, Cibinong, Indonesia (BTCC) Y-34 (coded 2F), on day 4 already formed bioethanol, volume and yield increasing bioethanol formed on day 5, but on day 6 back down. This means that the fermentation process is effective for 5 days, because if renewed S. cerevisiae poisoned instead of the product formed thereby lowering the yield of bioethanol (tables 3 and 4)

Table 3. Volume, Weight and pH of The Sample Bioethanol Fermented with *Saccharomyces cerevisiae* Strain BTCC Y-34

Days	Agitation/ Non Agitation	Volume of Bioethanol (ml)				Weight of Bioetanol (g)				pH			
		Repetition			Ave-rage	Repetition			Ave-rage	Repetition			Ave-rage
		1	2	3		1	2	3		1	2	3	
4	Agitation	5.50	12.50	11.50	9.83	5.22	12.14	11.04	9.47	5.3	4.5	4.4	4.7
	Non Agitation	11.00	13.00	12.00	12.00	11.02	12.53	11.45	11.67	4.4	4.5	4.5	4.5
5	Agitation	9.00	15.00	15.00	13.00	9.49	14.60	14.99	13.03	4.4	4.4	4.5	4.4
	Non Agitation	13.50	13.00	11.50	12.67	13.08	12.38	11.26	12.24	4.5	4.6	4.5	4.5
6	Agitation	9.00	8.50	14.00	10.50	8.57	8.24	13.58	10.13	4.4	4.6	4.5	4.5
	Non Agitation	9.50	6.50	13.40	9.80	9.08	6.09	13.05	9.41	4.5	4.5	4.5	4.5

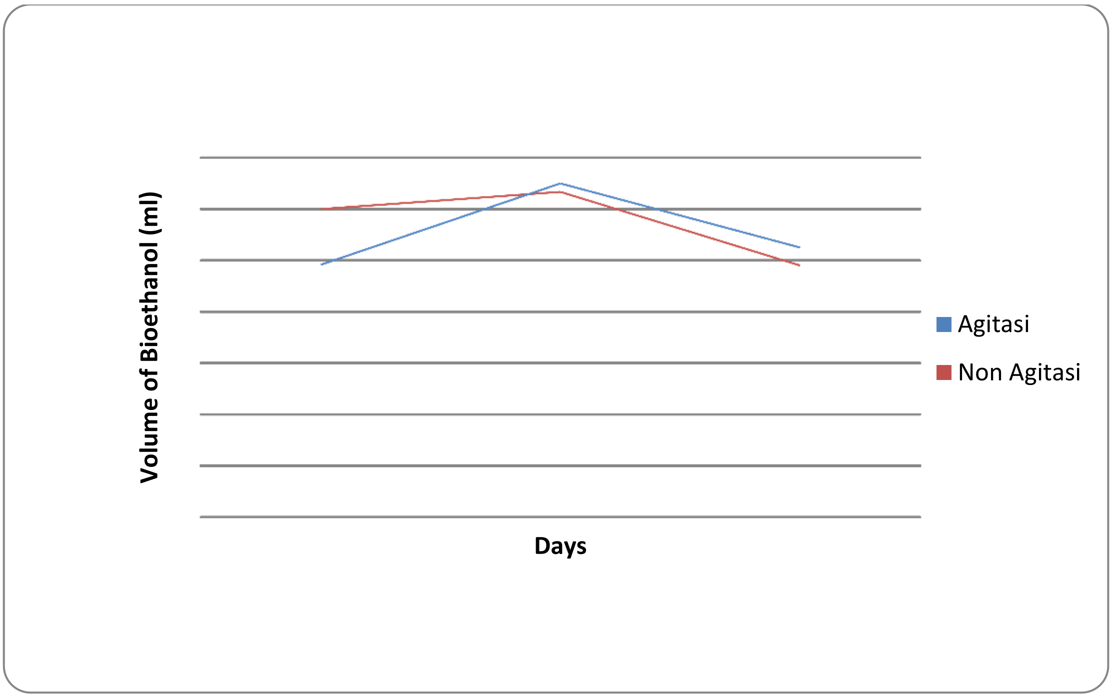

Figure 3. Volume of Bioethanol of Sample Fermented with *Saccharomyces cerevisiae* Strain BTCC Y-34

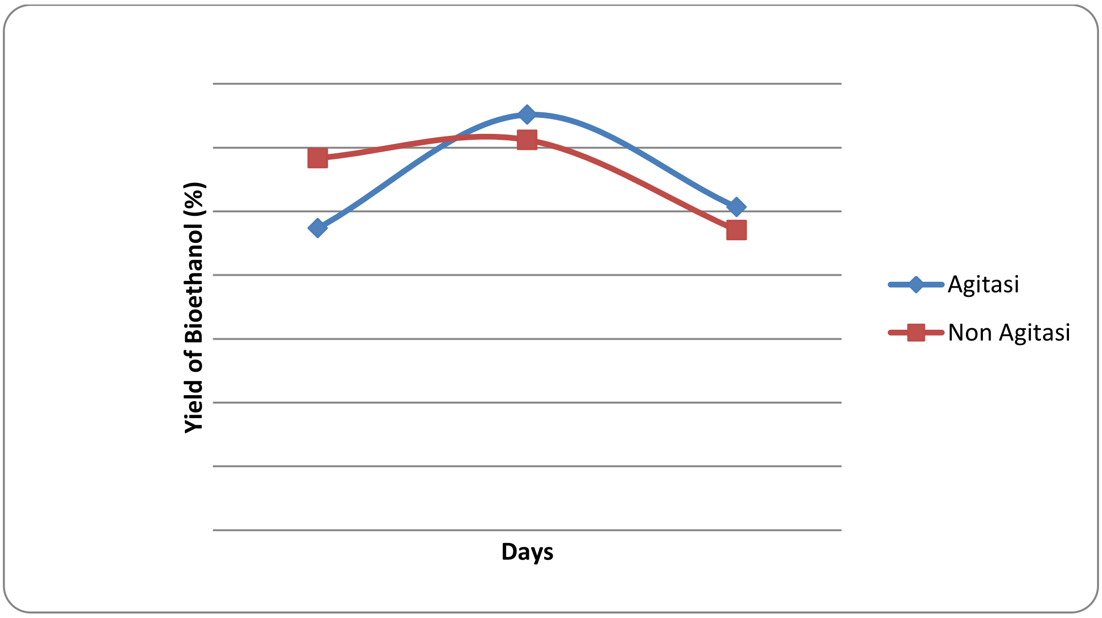

Figure 4. The Yield of Bioethanol from Fermented Samples with *Saccharomyces cerevisiae* Strain BTCC Y-34

Doubling Scale (Mini Scale up)

From the best treatment that is that gives the highest yield of bioethanol, which samples inoculated with Saccharomyces cerevisiae Stain BTCC Y-34, do multiplication scale up the number of samples used ten times as much, to obtain the volume, weight, pH and yield of bioethanol as shown in Table 5.

Table 4. Volume, Weight, pH and Yield Bioethanol from Fermented Samples with *Saccharomyces cerevisiae* Strain BTCC Y-34 on the Mini Scale Up

Days	Agitation/ Non Agitation	Volume of Bioethanol (ml)			Weight of Bioetanol (g)			pH			Yield of Bioetanol (%)
		Repetition		Ave-rage	Repetition		Ave-rage	Repetition		Ave-rage	
		1	2		1	2		1	2		
5	Agitation	48.00	39.00	43.50	46.59	37.58	42.09	4.8	4.5	4.7	21.04
	Non Agitation	35.50	42.00	38.75	34.69	40.71	37.70	4.7	4.8	4.8	18.85

VI. CONCLUSIONS AND SUGGESTIONS

Conclusion

From the research that has been done can be concluded that:

1. Long time effect on the yield of bioethanol fermentation produced.
2. Of the two strains of the yeast Saccharomyces cerevisiae is used, BTCC strain Y-34 gives results higher ethanol yield than the strain ATCC 9763.
3. The best treatment, which gives the highest yield of bioethanol which samples fermented with Saccharomyces cerevisiaestrainBTCC Y-34 for 5 days with agitation.
4. From the mini scale up is done obtained the highest bioethanol yield to treatment with the agitation that is equal to 21:04%.

Suggestion

From research conducted suggested:

1. Conducting the process of distillation to purify bioethanol formed.
2. To test the ethanol content of bioethanol obtained.

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ISBN : 978-1-4673-7404-0

Managing Innovation through Knowledge Sharing In an Indonesian Coconut SME

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***Abstract* - This research seeks to know and understand how knowledge sharing is developed to enhance innovation processes in an Indonesian coconut SME. This research conducted a case study approach in an innovative coconut SME, in which 3 competent people were interviewed in the company as a data collection method. The research has found that knowledge sharing is developed by two methods, direct and indirect. While the direct method focuses on the interaction of knowledge contributor and receiver, the indirect method uses the help of media as a means of knowledge sharing. The research results indicate that direct method has been a considerably more effective in achieving knowledge sharing, due to tacit knowledge usage. Meanwhile, the indirect method serves as leverage for the company to ensure that knowledge is available and accessible. Moreover, the role of knowledge brokers has given an additional understanding on how knowledge sharing is developed in an SME by broadening the knowledge throughout the company. This study has also explored that absorptive capacity becomes the main factor influencing the knowledge transfer success. Employees' awareness to become self learners, motivation, reward system, and level of education has emerged as reasons that determine the level of knowledge acceptance.**

I. INTRODUCTION

Indonesia supplies more than 19 million metric tonnes of world coconut needs, or 30% of total world production. However, despite being a number one producer of coconut all over the world, Indonesia has not yet felt the benefits from the advantage.

Manuscript received July 29, 2015. This work was supported in part by the Ministry of Industry of Indonesia.
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Most Indonesian coconut products are sold in forms of low end products, such as copra and crude coconut oil, which has less value compared to high end products. The condition of low added value products from Indonesia arises from the lack of innovative practices of coconut producers, due to the fact that the majority of producers are small and medium Enterprises (SMEs). Consequently, to raise Indonesian coconut products to a higher value, innovation is needed. There are many ways for SMEs to perform innovation. One of which is by having knowledge sharing in its organisation. The reason why knowledge sharing can be important for SMEs is because it becomes the foundation by which individuals can continuously contribute to the development of knowledge creation and management. However, only a small number of researches have focussed on knowledge sharing strategies in SMEs, where most literature has discussed knowledge sharing as part of knowledge management in large firms. Therefore, this study aims to investigate how the knowledge sharing is practiced in SMEs, especially in an Indonesian coconut SME, as an important factor that produces innovation.

II. LITERATURE REVIEW

A. The Nature of the Indonesian coconut SMEs

The Indonesian coconut industry is dominated by small scale companies in which, the majority of the products are produced using low technology. For example, Lay and Pasang (1998) mention products like copra, charcoal, and palm sugar involves only a small number of technologies in their production. Therefore, the quality of these products is considerably poor Suliyanto (2013). Meanwhile, the high-end exported products e.g. desiccated coconut, coconut oil, and active charcoal are produced by medium and high level enterprises. In this level, the technology involvement is more intense compared to the small level. Moreover, Lay and Pasang (1998) formulate strategies needed by Indonesian coconut SMEs to achieve sustainable development of Indonesian coconut industry. One of which is to have product diversifications. Product diversification in coconut industry can be varying, in which coconut trees provide a range of opportunity.

For Indonesian coconut SMEs, this condition is contradictory, since coconut trees provide a whole range of products opportunities, where added value

 ISBN : 978-1-4673-7404-0

from the coconut should be maximized to create a competitive advantage for SMEs. Dewi (2011) states that the opportunities of Indonesian coconut industry are: increasing market demand; opportunity on free export taxes; and the development of higher value added products.

B. Knowledge Management and Innovation

Knowledge in general is a conversion process of collected data to information. This information then becomes knowledge when it is applied into something we need. In most knowledge paradigms, it clearly states that knowledge comes from individual awareness and/or experience, which further becomes personal knowledge. Additionally, knowledge can be classified into two types; tacit and explicit. Polanyi (1967) defines tacit knowledge as a knowledge that we know more than we state. Meanwhile, explicit knowledge is the form of knowledge that has been already codified, thus make this knowledge as reachable and easy to communicate (Nonaka 1991) . Seidler-de Alwis and Hartmann (2008) argue that both tacit and explicit serve equally in knowledge creation. To be able to use knowledge, the explicit requires the presence of tacit.

Knowledge management comprises of three dimensions; knowledge creation, knowledge sharing, and knowledge utilisation. The basis of knowledge creation theory came from Nonaka and Takeuchi's work. They emphasize that knowledge creation comes initially from personal knowledge, and mostly in forms of tacit. In order to make knowledge becomes public domain and reachable, it needs to be socialized with other members within an organisation.

In addition, knowledge as a part of knowledge management (KM) has been discussed widely for its benefits in supporting innovation in organisations. For example, Maqsood (2006) explains that the link between innovation and knowledge management is that innovation comes from tacit knowledge of one person who acts as agent of change, and begins to influence people to innovate. Adding to this, Du Plessis (2007) views knowledge management serves as a 'catalyst' for innovation, as it provides the access to knowledge based resource that is needed to perform innovation. Firestone et al. (2005) define knowledge management as a continual process of knowledge development to improve results and the knowledge itself.

Leal-Rodríguez et al. (2013) argue that KM works by providing management with the necessary framework that is needed to perform innovation. This structure is essential for organisations so that they can keep improving their capability to innovate. Moreover, López-Nicolás and Meroño-Cerdán (2011) claim that KM supports companies to be creative, proficient and productive which raises their competitive advantage. Therefore, it is inevitable that KM leads to better firms performance through innovation process (Du Plessis 2007).

C. Knowledge Sharing in SMEs

Baptista Nunes et al. (2006) argue that SMEs are still low in applying knowledge management as part of their business strategy. As a result, SMEs need to apply knowledge management strategy as their core competency (McAdam & Reid 2001). Moreover, Guzmán, Serna and de Lema (2012) demonstrate three benefits of KM for SMEs as follow. Firstly KM can make SMEs aware of the outside knowledge that might be useful for them and bring it to the company. Secondly it helps the company to develop outside knowledge and utilize it to create competitiveness in their production. Thirdly KM is beneficial to ameliorate management system. Riege (2005) argues that SMEs are lack in maximizing their potential to use knowledge as their competitive strategy and do not have strategic approach to share knowledge, leading to a lack of innovative performances.

Du Plessis (2007) views that the absence of explicit knowledge in an organisation makes knowledge transfer process hard to achieve, leading to constraint in the innovation practice. Therefore, the process of shifting tacit to explicit is important for any organisation. Tsui et al. (2006) characterise three ways as knowledge sharing strategy based on the media used, which is writing, speaking and information technology. Although it is generally believed that knowledge sharing strategy has different outcomes between companies, some researchers have found similarities in methods of knowledge sharing practices. For example, Ohiorenoya and Obadan (2014) found that the most frequently used method for KS is verbal communication, in forms of face to face meeting. Extending this idea, McAdam and Reid (2001) compared 46 large firms to 49 SMEs in regards to their perspective in knowledge management, and found that the most practiced method to share tacit knowledge is by informal discussion. This method also appears to have full support from the companies. This view indicates that dialogue (in forms of informal discussion) has significant contribution in acquiring tacit knowledge. Besides methods of sharing knowledge, it is also important to explore factors that contribute to knowledge sharing processes. Much literature focuses on the individual factor as the main factor that influences knowledge sharing in organisations. Riege (2005), for instance, addresses three elements that need to be fulfilled by a company in order to have an effective knowledge sharing process, that is: individual factor (such as motivation, support, and incentive of employees to capture and share their knowledge); organisational factor (company goals and strategy in relation to knowledge sharing practices); and technological factor (knowledge accessibility to the organisation). From this framework, it can be seen that the knowledge sharing characteristic of a company will be different to others (due to the difference of company's culture), which means a

 ISBN : 978-1-4673-7404-0

competitive advantage for one company cannot be copied by others.

Szulanski (1996) states the effectiveness of knowledge transfer in organisations depends on three factors, namely: absorptive capacity of the recipient; causal ambiguity; and relationship between the source and the receiver. However, in SMEs where informal interaction dominates the activity, the causal ambiguity and individual relationship do not significantly affect the knowledge sharing process. Hence, the possible factor that might influence knowledge sharing in SMEs is absorptive capacity of recipients.

Similar to previous notions, Haldin-Herrgard (2000) points out main difficulties in tacit knowledge sharing are awareness and language. The issues are not only communicating and articulating what we know, but also how to make tacit connects to explicit. This idea is strengthened by Finally, the use of IT as a strategy to share knowledge has drawn attention to many academics. Several researchers have tried to discuss the importance of IT on knowledge sharing effectiveness. To illustrate, Choi, Lee and Yoo (2010) suggest that to have an effective knowledge sharing process, a company needs to consider the selection of their IT tools. A more general example is from Baptista Nunes et al. (2006) who state that the use of ICT as knowledge management approach has demonstrated to bring values for large companies, while in SMEs KM is performed in an informal way, which does not rely much on ICT systems.

TABLE 1
PROPOSED RESEARCH FRAMEWORK

Research Questions	Factors Examined	Key Literatures
How is knowledge sharing developed in an Indonesian coconut SME?	Method for sharing knowledge	Nonaka and Takeuchi (1991); McAdam and Reid (2001); Smith (2001);
What Factors are important to share knowledge in an Indonesian coconut SME?	Absorptive capacity, Role of knowledge broker, Role of IT	Riege (2005); Szulanski (1996); Haldin-Herrgard (2000); Tsui et al. (2006); Baptista Nunes et al. (2006)

III. RESEARCH METHOD

The data was collected using semi-structured interview in *SR* company. The company was selected as source of information for this study due to the reason of the company has been successfully practicing innovation in its daily activities and becoming source of knowledge for other coconut SMEs in Indonesia. It indicates that the company has knowledge sharing as a part of their business innovation. In addition, 3 people were selected as source of information for this research. They were selected for their abilities and experiences in relation to innovative practices in the company.

The interview was conducted in two periods. The first interview was done in person with the owner, and IT staff. The second was done by phone to the owner and marketing manager. The second interview was needed to complement data from the first interview. Each interview was tape-recorded and lasted between 40-60 minutes. Finally the data was analysed using descriptive and interpretive approach, in which researcher's interpretations were contrasted with past researches and literatures to give a more general understanding of knowledge sharing practices.

IV. FINDINGS AND DISCUSSION

A. How is knowledge sharing developed in an Indonesian coconut SME?

Knowledge sharing is developed by two methods, one direct and one indirect. The Direct method includes direct mentoring from the owner, training, apprentices, and assignments. The Indirect method involves media as means of knowledge transfer, such as information technology (IT) and paper. This method covers Standard Operating Procedure (SOP), digital video disk (DVD), and television.

The Direct method plays an important role in the effectiveness of knowledge sharing in the SME, as a majority of knowledge is shared in forms of tacit knowledge. Direct mentoring from the owner to selected employees has made the knowledge sharing more effective, where, both parties can make real-time communication, and then extend the learning process through dialogue. Although many researches and studies view tacit knowledge as knowledge that difficult to be shared because it's still in the forms of personal knowledge, which means that the tacit knowledge is only presence in people minds and hard to be accessed, but for companies that do not apply knowledge management strategy in its businesses tacit knowledge might serve as their valuable capital. This is probably because these companies have different culture with big companies. For example, Sumber Rejeki has an informal culture in their activities, in which most of information and knowledge sharing activities take place by informal discussion.

This finding accommodates McAdam and Reid (2001); and Smith (2001) theories, in which direct communication and informal interaction between the knowledge source and the recipient as a preferred method for SMEs to share knowledge. Since in this company tacit knowledge holds the biggest proportion of knowledge, this then confirms Nonaka and Takeuchi's theory in relation to tacit knowledge as an important part to create competitive advantage in an organisation.

Additionally, the role of knowledge brokers is surprisingly crucial in the SME. They work as trainers whose role is to spread knowledge wider inside the organisation. While, Tsui et.al. (2006) suggest that

ISBN : 978-1-4673-7404-0

knowledge brokers are important to bridge knowledge from organisation to outside parties (e.g. government and academics), the data shows that it is also important to have knowledge brokers inside small firms.

However, the data also indicates that the company only absorbs 30% of the owner's knowledge. Given this fact, the researcher considers that this might create disadvantage for the company in terms of performing innovative activities. Because, inadequate knowledge in the company might limit new ideas to be developed to create innovation.

The second method, indirect, contributes 30% of company knowledge. This method varies from media used to help knowledge transfer processes. The most used media is information technology (IT), where the owner tries to store and transfer his knowledge by using media such as company's website, and video instruction. Adding to this, the company also collaborates with local television channel to record his views, and then it can be accessed through a video-sharing website.

Seeing that the use of IT dominates all the indirect methods, company supports to accommodate these needs is important. Although the use of IT as part of strategies to share knowledge would be challenging for small companies in terms of providing designated person to manage IT, but the possibility of knowledge to be shared effectively is too important to be neglected. Hence, the role of government is crucial to help small companies to be competitive, one of which is by providing trainings in IT field. Additionally, the use of IT as tools to help knowledge sharing process (storing and accessing) resonates with Choi et.al (2010) who view that IT could help for knowledge sharing to be more effective. On the other side, this finding differs to Nunes et.al (2006) opinion that SMEs do not rely upon ICT as their knowledge management strategy. This is noticeable from the IT usage as the most frequently means to transfer explicit knowledge in the company. The owner's effort in shifting tacit to explicit is regarded as a risk managing strategy for the company. As the owner is aware of possible drawbacks that might arise if the tacit knowledge is not made explicit, he then codified his knowledge into manuals, website articles, and video instructions which can be accessed further by employees or anyone outside the company. The owner stated the following:

'Yes, indeed it becomes a threat. That is why if you visit our website, there will be a link to YouTube video. It has been 3 episodes, and we cooperate with local TV station. Thus, from the written knowledge I made it recorded into digital video disk. But the educational level determines the acceptance of someone'

As a result, the availability of explicit knowledge can help the company to ensure that its knowledge asset is accessible to anyone in the company. Another benefit to have explicit knowledge in the company is to ensure that the company can access knowledge when tacit knowledge becomes obsolete or when the key people leaving the company and bring their knowledge with them. In other words, explicit knowledge is as just as important as tacit knowledge for the company, and any company needs to make explicit knowledge to become its organisational knowledge. This finding is in accordance with Du Plessis's (2007) belief that the absence of explicit knowledge in a company might inhibit the innovation process.

However, the explicit knowledge in the company has an obstacle in relation to knowledge utilization. Employees often find difficulties in understanding and utilizing this explicit knowledge. The owner argues that level of education might influence the knowledge acceptance of employees. As Riege (2005) mentions education level as one of barriers in KS in large companies, this aspect appears to have an effect on small firms as well. In contrast with this finding, the level of education in tacit knowledge sharing does not affect knowledge acceptance of employees. This is probably because of the expertise of the owner who knows how to address recipients, and find ways to suit them.

B. What factors are important in knowledge sharing effectiveness in an Indonesian coconut SME?

Absorptive capacity (or knowledge acceptance) from receivers would appear to be the most significant contributing factor for establishing an effective knowledge sharing process in this company. Szulanski (1996) claims that absorptive capacity is one of the attributes that is significant for sharing knowledge, and the result of this study has acknowledged his view. Since absorptive capacity is influenced by individual factors, it is important for the company to deal with this issue by providing facilitating support. It means that the company needs to have secondary sources for employees accessing knowledge. For instance, employees have access to text books or manuals to enrich their knowledge or the company can allocate time to have discussion session with employees.

The owner claims that employees' awareness to become self-learners determines the effectiveness of knowledge sharing. This result shows that the motivation of individuals play a significant contribution to the progress of knowledge sharing.

Reward also serves as an enhancing factor for knowledge sharing. This relates to employees' motivation to be actively involved in the knowledge sharing process. The more employees contribute to knowledge use, leading to innovation processes, the greater the reward they can achieve. As this company rewards its employees by shares (not on a salary basis), it indicates that a person can have more shares if he/she makes a greater contribution in the knowledge sharing and innovation processes.

This study also supports Riege's (2005) idea about SMEs' strength in knowledge enabling environment. This might be because the company has an informal environment. Thus, the differences (e.g. age, level of education, status) among employees do not create obstacles to share ideas and experiences, and presumably new knowledge could arise from this condition.

Another important factor in effective knowledge sharing process is patience. The owner explains that it takes a certain time to be able to comprehend knowledge. Hence, a continual effort is required to apply knowledge. Due to this reason, the owner suggests patience as an important factor in effective knowledge sharing. In relation to theoretical contribution, this aspect extends the Baptista Nunes et al. (2006) and Cavusgil et.al, 2003 theory that argues if (tacit) knowledge requires effort and time to be transferred.

In addition, direct mentoring from the owner, who holds most of knowledge in the company, is seen as a preferable technique for knowledge sharing process. Direct mentoring provides guidance and supervision in drawing tacit knowledge from the source of knowledge. This can be perceived from the owner's statement, as he said: *'Yes, I feel that the direct mentoring is the most effective method to share knowledge. Even though i already provided them with instructional video and SOP, but at some extent they did not confident enough to do it. This is not only happen to people who have less formal education, but also for those who have tertiary education. I think this probably because they have a lack of achievement.'*

Therefore, this method implies that to be effectively shared, tacit knowledge requires continuous collaboration from both the knowledge contributor and receiver. It indicates that it is important to have people whose knowledge can guide the knowledge transfer within a company

C. Limitation of the Study

This research mainly concentrates on the practicality of knowledge sharing process and does not examine comprehensively the relationship between individuals e.g. trust among employees, motivation and retention to share knowledge. Because, addressing the interrelationship among individuals (e.g., motivation or retention to share knowledge) would be more difficult in the limited time frame. Therefore this research focuses on the individual factor as well as the practicality of knowledge sharing in a company.

D. Recommendation for Future Research

Although much of the literature has discussed the importance of explicit knowledge as an asset to perform innovation, this research found that the explicit knowledge is not the preferred option for the SME to share knowledge. This study also found that the role of knowledge broker may well increase the effectiveness of knowledge sharing in SMEs. Therefore, future research is required to further investigate factors that may contribute to the improvement of explicit knowledge sharing as well as the potential role of knowledge broker in SMEs.

E. Summary

Since knowledge serves as capital to conduct innovative activities, it is essential for SMEs to manage knowledge as one of its competitive advantage. Although tacit knowledge is a more preferable option for SME to share knowledge, but the presence of explicit knowledge needs to be considered as an important part in sharing knowledge strategy. SMEs also require facilitating knowledge management, and maximizing information technology as tools to enhance innovation towards knowledge sharing processes.

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ISBN : 978-1-4673-7404-0

Increasing Added Value of Banana by Producing Synbiotic Banana "*Sale*" Using Innovation & Technology Strategy Approach

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Abstract— **Banana is a potential agricultural commodity cultivated widely in tropical and subtropical area. It has a high nutritional value such as carbohydrate, dietary fiber, antioxidant, vitamins and mineral. However, it is a climateric fruit that its quality will be gradually decline after post harvest. This condition leads to a decrease of its nutritional and economical value. Therefore, the product diversification of banana is really needed to increase these values. An innovative approach has been taken to explore banana as a functional food that can be expected to confer health benefits in humans and raise the sale price of banana. A synbiotic banana "Sale" was a semi-wet product of banana considered as an prebiotic because of its natural resistant-starch content, and the addition of *Lactobacillus acidophillus* has made this product considered as probiotic food. The purposes of this product development are to improve their health effects, extend the shelf life of banana products, and increase its economic value. Therefore, this product was also use natural lactic acid of *Lactobacillus plantarum* kik as natural preservative and its financial analysis was also carried out to describe its ecomics potency.**

I. Introduction

INNOVATION and technology strategy has to be developed to reach competitive advantage in order to win the competition in the market. This approach will increase the value added of the product by providing the customer satisfaction to raise the selling point and extend the product life cycle. The high competition of agroindustrial market, especially will be more increasing as the Asian Economic Community (AEC) applied at the end of 2015, have forced the manufacturers to share the market with local and overseas competitor. AEC create a global market for all the member of Asian countries that joint at the community. The acces of international trade will be wider opened, and the products and investment flow are easier to be transferred. It has to be a crucial need that producers should develop a continous innovation on their products. It has been stated that an innovation strategy is an essential tool for product development and continued growth even in difficult times [1].

Banana (Musa spp.) is an important food crop cultivated widely in tropical and subtropical areas. It is one of potential commodity in Indonesia, because the productivity of this plants is very high. Reference [2] stated that Indonesia produced 5.814.580 ton of Banana and its plantation area was about 98.000 ha in 2010. Besides that Banana plantation is also easy to be cultivated by the farmer, and it has a high nutrition value, so that it can be consumed an fresh fruit or processed banana. The common processed banana products manufactured include banana puree, banana pulp, banana figs, banana flour or powder, banana chips, canned banana slices, banana jam, banana vinegar, banana wine, and banana juice. Banana is well known as good sources of dietary energy [3], rich in starch and that green bananas have high levels of resistant starch [4]. The latest characteristic has made the banana becomes the candidate of prebiotic, that is a one of functional food.

The conversion of banana into its derivative product will increase its added value by reduce the risk of decay process and improve its functional health. As banana is a climateric fruit, its respiration rate is very high after harvesting, and this condition lead the decay process of banana occures in a rapid rate. Therefore it need to be processed to extend the shelf-life. The aim of conversion banana in to functional banana "Sale" not only could prolong its shelf-life, but also improve

Manuscript received June 6, 2015. This work was supported in part by the Indonesian Department of Higher Education under Research Grant of "*Dosen Muda*" goes to Eka Ruriani as the head of researcher.

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ISBN : 978-1-4673-7404-0

the intrinsic value of local commodity, by adding functional effect of banana. Some researches has tried explore the functional properties of banana. It has been reported that banana contains certain amounts of fructooligosaccharides (FOS) which have been shown to exhibit beneficial health effects by stimulating the growth of lactic acid bacteria in the human colon, by surpression of putrefactive pathogens, and by reduction of serum cholesterol concentrations [5]-[7]. The biomass of green banana added by vitamins A, C and B complex (B1, B2 and niacin) has made this products rich in minerals essential for the proper functioning of the human body [8]. Several researches have been also published about the properties of green banana, which revealed the beneficial effects on some diseases such as colorectal cancer, diarrhea, glycemic index, insulin response, dyslipidemia, cardiovascular disease and celiac disease [9]-[14].

Based on the high productivity and its functional propertis, this research explored an innovative approach to improve banana as a functional food that can be expected to confer health benefits in humans and raise the sale price of banana. The purposes of this product development are to improve its health effects, extend the shelf life of banana products, and increase its economic value.

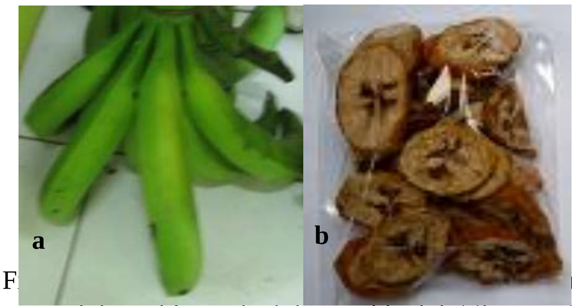
II. INNOVATION OF SYNBIOTIC BANANA "*SALE*"

An innovative strategy should fulfil the requirement of feasibility. It should be consider three aspects, ie. the economics, technology and market. It has been indicated that a useful representation of a product is a vector of attributes, which they consider also to include customer needs, customer requirements, product specifications, engineering characteristics, and technical performance metrics [15]. The customer need and demand lead the manufacturers to explore the technology to produce innovative products with a high acceptance of the consumer. Reference [16] also stated that conceptually, understanding customer needs leads to products that are desirable, feasible, and salable (to the mass market). According to reference [17] the success or failure of an innovation or a new product in the marketplace is determined by how well it is accepted by customers, how fast it diffuses among the adopter population, and how large a market it creates over a period of time. New product entry strategy and competitor responses to the entry also play important roles in the success or failure of the innovation.

The demand of specific products has continously increased. There are some attributes those should be developed to enter the exclusive market segmentation, such as local comodity utilization, environmental friendly process and products, eco-labelling, and functional effect improvement of the products. The special characteristic of the product will be a competitive and comparative advantage to get the high market share. It is proposed that among innovation characteristics, relative advantage refers to the functional superiority of the innovation over other alternatives [18]. It was mainly the advances in understanding the relationship between nutrition and health that resulted in the development of the concept of functional foods, which means a practical and new approach to achieve optimal health status by promoting the state of well-being and possibly reducing the risk of disease. Modern consumers are increasingly interested in their personal health, and expect the food that they eat to be healthy or even capable of preventing illness.

The need for improved health leads the consumers to seek out specific foods or physiologically active food components, also called the functional food. In recent years, the term functional, applied to food, has taken different connotation that is to provide an additional physiological benefit, beyond the basic nutritional needs [19].

The technology approach in combining local commodity utilization and functional effect improvement to increase the added value of banana was resulted in synbiotic banana "*Sale*" (SBS). This product development used banana of plantain variety (*Musa paradisiaca* formatypica) (Fig 1a) that was originated from Lumajang regency. It is located in East Java Province Indonesia. SBS is a semi-wet product of banana containing about 65-80% of water. The apperance of SBS is presented in Figure 1b.



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kık and L. acidophilus could inhibit the growth of contaminant microorganism : banana "*Sale*" control (a) and synbiotic banana "*Sale*" (b)

SBS is considered as prebiotic because of its natural resistant-starch content, and the addition of *Lactobacillus acidophillus* has made this product considered as probiotic food. Probiotics are defined as live microorganisms, as they are consumed in adequate numbers confer a health benefit on the host, with on going controversy as to whether cultures must be viable for effifacy in all cases [20]. *L. acidophilus* is one of lactic acid bacteria used in industry that has shown probiotic effects and has been applied extensively in food processing [21]. *L. acidophilus* colonises the intestinal tracts of man and higher animals and exerts a protective role by suppression of pathogenic microorganisms [22], and it has been reported that this bacteria possess antitumor activity, hypocholesterolemic actions, and the ability to synthesize various vitamins [21]. On the other hand, prebiotics are non-digestible dietary components that pass through to the colon and selectively stimulate the proliferation and/or activity of populations of desirable bacteria in situ [7], [23]. Due to the potential synergy between probiotics and prebiotics, foods containing a combination of these ingredients are often referred to as synbiotics. According to reference [24] products combining *L. acidophilus* (as probiotic) and certain fruits, such as banana (as prebiotic) that might provide functional benefits (as synbiotic). Furthermore, it has been combined the *L. acidophilus* and banana in a direct fermentation using banana puree as the medium [25].

This product was also use natural lactic acid of *Lactobacillus plantarum* kik as natural preservative to extend it shelf-life. This preservative could subtitute the synthetic preservative that is usually added into the food and considered give carsinogenic effect to the health. Based on the improved quality of this product, it is expected that the SBS will have much higher added value.

There were some steps in production of SBS. The first step was production of probiotic by cultivating *L.acidophillus* in coconut water as the substrate at temperature of 37°C for 16-18 hour. The cell then was separated by centrifugation and used for probiotic. The second step was production of natural preservative by cultivating *L.plantarum* kik in MRSB as the medium. After incubation the cell was separated by centrifugation, and the supernatant would be used for the preservative. The next step was production SBS by immersing the banana slice in the preservative liquid for approximately 1 hour, then the banana was removed and inoculated with probiotic that has been prepared in the previous step. The incubation took about 30 minutes, then the SBS was dried (sun drying) until the water content was about 65-80%.

This tecnology innovation could produce a probiotic food, such as Yakult and Activia, commercialized probiotics product. Probiotic foods should contain specific probiotic strains and maintain a suitable level of viable cells during the product's shelf life. In this SBS the viability of *L. acidophilus* is approximately 10^8 CFU/g. It can be explained that in 1 g of SBS the cells that retain to live under processed condition is about 10^8 CFU.

The synergy of natural lactic acid as preservative and *L. acidophillus* as probiotic was also able to inhibit the growth of contaminant microorganism such as yeast and mould that would lead to shorten the product shelf-life. Figure 1 showed that SBS the contaminant was not detected in SBS (Figure 1b). In contrast, the banana "*Sale*" without any addition of natural preservative and probiotic was contaminated by mould and yeast (Figure 1a).

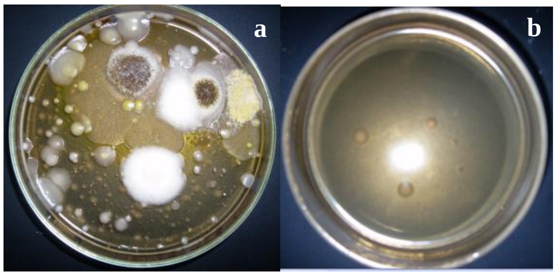

Fig 1 The synergy of lactic acid from L. plantarum kik and L. acidophilus could inhibit the growth of contaminant microorganism : banana "*Sale*" control (a) and synbiotic banana "*Sale*" (b)

III. ECONOMIC VALUE OF SYNBIOTIC BANANA "SALE"

Musa paradisiaca formatypica is an abundant agricultural commodities in Indonesia. This commodity is categorized as plaintain banana that should be processed before consumption. Nowdays it is usually only commerced as banana chip. This minimal processed has been already extended the added value of banana, however, its functional effect is low and its competitive advantage is still minimum. Table I showed product diversification of banana and its added value prediction.

TABLE I
ADDED VALUE PREDICTION OF BANANA PRODUCT DIVERSIVICATION

Products	Yield (%)	Added Value
Chips	20	100-150
Ledre	17-20	200-250
Sale	12-17	100-150
Gethuk	20-30	50-100
Puree	20-30	150-200
Flour	29-32	350-450
Jam	70-75	200-250

Table II explained that conversion banana to "*Sale*" will improve its added value 100-150% from its raw material with yield of the process 12-17% [26]. Although the added value of this product is not the highest among the derivative products, the "*Sale*" is the most potential product that could be developed as functional product, since it is a semi-wet product, so that the water content is suitable for probiotic growth. Another reason that the technology is easy to be applied in any scale of industry, so that it is impossible for the small medium enterprises to develop the products. This reason will be a crucial consideration, because almost the banana plantation is cultivated by smallholder farmers in Indonesia. Furthermore, the improvement of its functional properties by producing SBS is expected able to much more increase its added value rather than the original banana "*Sale*". It will be a beneficial advantage for the smallholder farmers to generate a higher income by processing the banana into SBS.

The feasibility study was carried out to calculate the economically feasibility of SBS. Some assumptions was used in the study, such as: the funding of the project was 100% self-finance, all the products was sold and the project period was 5 year. The economic feasibility presented in Table II.

Based on the Table the prospect of SBS business was economically feasible, since all the criteria of feasibility was well provided. It can be seen that the investment needs a short period to be returned, since the payback period is less than 1 year. The B/C ratio was 1.17 higher than 1. It means that that the business of SBS profitable with break even poin at revenue point 14,522,449 rupiahs. This calculation based on the price of product 10,000 rupiahs/100 g, whereas the the banana price is approximately 3,000 rupiah/100 g. It means that the added value was triple as stated in the reference [28].

TABLE II
FEASIBILITY STUDY OF SYNBIOTIC BANANA "*SALE*"

Parameters	Value	Decision
break even poin (Rupiah)	14,522,449	*economically feasible*
payback period (year)	0.98	
net present value	20,024,534.47	
internal rate return (IRR)	65.69%	
B/C ratio	1.17	

IV. CONCLUSION

The innovation of synbiotic banana "*Sale*" (SBS) increased the added value of banana. The technoloy of production should be developed to increase the product quality, especially the size, shape, colour and the availibility of *L.acidophilus*. It should be studied deeply about the role of lactic acid from *L. plantarum* kik to extend the product shelf life, therefore it is required to carry out analysis of product shelf life. Furthermore, the improvement of packaging design, labelling and marketing strategy will be the next challenge to reach the higher competitive and comparative advantage for this new product.

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ISBN : 978-1-4673-7404-0

Innovation Briquette of Fronds Oil Palms Through Non Carbonization Process

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***Abstract* - The development of fuel biobriket is one attempt to overcome the problem of the energy crisis, especially for household cooking needs. Currently, briquettes made from waste oil palm fronds are already being developed. Availability of abundant raw materials and process technology is growing, causing briquettes of the palm fronds to be cheaper compared to other biomass briquettes. One process that can be applied to obtain more economical results is through a non-carbonization process. The results of the study, using three types of specimens, has obtained the highest calorific value of 3,477.67 kCals/kg, the production cost of 830 IDR/kg and with a selling price that can be offered to consumers 1,300 IDR/kg.**

I. Introduction

Currently, the energy needs of the Indonesian society is still highly dependent on fossil fuels. For households, the majority of energy needs relied on oil and LPG. Therefore, the search for alternative fuels will lessen the burden on these types of fuels and create a healthier enviromnent while increasing profits.

Indonesia's energy consumption continues to increase at the historical average growth of 3.09% per year, from 2000 until 2010, where the number rose from 737 million BOE in 2000 to 1.012 million BOE in 2010. The highest energy consumption is dominated by the use of fuel oil in 2010, which reached a total of 31%, while biomass consumption in the form of firewood and charcoal at 28%, and the use of gas and coal by 13%. On the other hand, the supply of energy, particularly oil, in 2010 reached 344.89 million BOE with proven reserves, which can only provide oil for 11 years [1].

While the subsidized fuel quota for the year 2010, is as much as 38.228 million kiloliters and non-subsidized fuel quota until 2010 is as much as 27.041 million kiloliters, Indonesia has been importing fuel from other countries amounted to 26.02 million kiloliters [1].

As an agricultural country, Indonesia has a very large potential of biomass energy. Utilization of biomass energy has long been done and includes the oldest energy which role is very great, especially in the countryside. It is estimated that approximately 35% of total national energy consumption comes from biomass. The energy generated has been used for various purposes. For example, household needs (cooking and home industry), drying the agricultural harvest and timber industries, power plants in the timber industry and sugar [2].

One source of biomass energy that can be generated through the processing of agricultural waste is a solid fuel known also with briquettes. Basically, the briquettes can be generated through unused materials such as garbage, sawdust, rice husks or coconut shells. In studies that have been carried out, an alternative source of raw materials that will be used to produce briquettes are wastes produced by oil palm plantations, in this case is a waste of palm fronds.

This experimental research aimed at creating new innovations in alternative energy, especially through the utilization of raw materials such as waste oil palm fronds. Through the use of alternative energy sources, such as palm oil fronds briquette, it is expected to increase economic value and benefits to meet the needs of cooking in rural areas.

II. Literature Review

A. Innovation Concept

Innovation is the conceptualization activity and ideas to solve the problem by delivering economic value for the company and social value for the community. Innovation started from existing condition, then a new condition was created (value-added) [3]. Innovation can be classified into several types, such as administrative innovation, technical innovation, product/ service innovation, process innovation, radical innovation, and incremental innovation [4].

Administrative innovation is related to the organizational structure and administrative processes that are not directly related to the basic activities and work of an organization. This is directly related to the Company's management. *Technical innovation* is related to technology products, services, and production processes. *Product innovation* is a new product or service that was introduced by outside users or because of market requirements. *Process innovation* is a new element introduced in a

 ISBN : 978-1-4673-7404-0

production company or service operations. Its uses input from raw materials, specification of tasks, jobs and information, and equipment used for the production of a product or making services.

Furthermore, *radical innovation* and *incremental innovation* can be defined as the degree of the changes made in the implementation of enterprise adoption. *Radical Innovation* is a reorientation and innovation that are nonroutine basic procedures and the company's activities show a clear beginning of an implementation of the innovation. While *incremental innovation* is innovation routine, varied and instrumental [4].

B. Technological Innovation in briquetting

Briquette is one of the alternative fuels that can be used as a substitute for firewood cooking, especially on households that are located in rural areas. Various organic wastes have been widely used as raw material for making briquettes. Some of them are sawdust [5], rice husks, [6], a mixture of coconut shells and sawdust, [7], [8], corn cob [9], [10]. In addition, agricultural wastes also started to be used in producing the briquettes from oil palm plantations. Some parts of palm oil can be used as raw material for producing the briquettes include palm shells [11], empty fruit bunches [12], and also oil palm fronds or midrib [13].

Waste oil palm fronds are the most numerous and not fully utilized. Each harvesting, as many as 7-10 palm fronds, which should be cut down to make it easy for the process of taking fresh fruit bunches of oil palm. Palm fronds that had been cut down, are usually just stacked side section under the oil palm trunk. Its take a long time for decomposition and fertilization to occur naturally.

Generally, the process of briquetting is mostly done through the carbonization process, where the raw materials that have been destroyed, especially during altering process before the pressing process. But now, many researchers who have done briquetting without carbonization process [14]. In producing briquettes through the non carbonization process, requires certain adhesive materials such as starch and sago [15].

The parameters that must be considered in producing briquettes include ash content (ash content), water content (moisture), the levels of volatile matter (volatille matter), activated carbon, as well as the value of the pressure exerted. To obtain a quality briquettes with high calorific value, moisture content should be no more than 15%. Water content is strongly influenced by the duration of the drying process as well as the adhesive substance that is used [16]. Furthermore, the length of the ignition briquette influences the level of pressure exerted during the pressing process.

Briquettes produced through non-carbonization, relatively cheaper and efficient than the briquettes produced carbonization. This is because, on the non-carbonization process does not require the combustion process and generally shorter than the carbonization process.

C. Oil Palm Fronds.

Oil palm (Elaeis guineensis Jacq) is a plant made up of pieces that includes family Palmae. Elaeis genus name is derived from the Greek word meaning oil, while guineensis species originating from Guinea, which is a place where a botanist named Jacquin discovered oil palm plantations were first on the coast of Guinea [17]

Palm fronds or midrib oil palm is a kind of solid waste generated during the year by oil palm plantations. Palm frond containing lignin (24.5-32.8%), hemicellulose (20.5-21.83%), cellulose (54.35-62.6%), extractive substances (2.35- 13.84%), silica (1.6-3.5%), and ash (2.3-2.6 %). On palm leaf midrib cross section consists of two parts the cortex and central vascular, while the palm leaf midrib microscopically consists of three major vascular, skin, basic parenchyma and xylem.[18].

D. Energy Value in Palm Oil Waste

At this time, oil palm plantations have great potential to be converted into a variety of energy products. In addition to its main products produce palm oil (Crude Palm Oil - CPO), waste from oil palm plantations have also been developed to produce a variety of other byproducts. The types of waste palm oil in the first generation are solid waste consisting of empty fruit bunches, fronds or midrib and shell.

The energy content of several palm oil waste, can be described in the Table I, [19] :

TABLE I
CALORIFIC VALUE OF THE ENERGY FROM WASTE OIL PALM (BASED ON DRY WEIGHT)

Waste	Mean of Calorific Value (kJ/kg)	Calorific Range (kJ/kg)
Empty Bunches	18.795	18.000 - 19.920
Fiber	19.055	18.800 – 19.580
Shell	20.093	19.500 – 20.750
Stem	17.471	17.000 – 17.800
Fornds/ Midrib	15.719	15.400 – 15.860

E. Briquette Process Technology

Generally, the process of making all kinds of briquettes is the same, that is by giving pressure to the ash from the combustion or refining of raw materials so that the raw materials form a solid powder.

Briquetting technology can be divided into three ways [20]:

- High pressure briquetting.
- Briquetting pressure with heating medium.
- Low pressure briquetting with binder.

Briquette processing can be done by carbonization and non carbonization processes. To produce briquettes without carbonization process, use the following steps :

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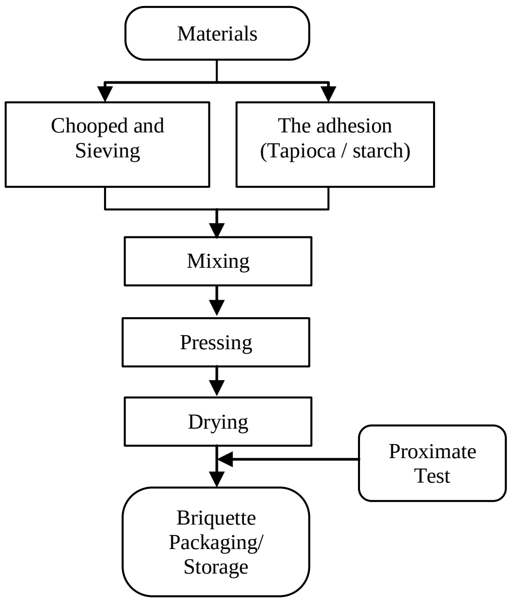

Fig 1. Briquette Non Carbonization Process

F. Proximate Test of Briquette

Proximate test is performed to determine the characteristics of solid fuel. In this study, conducted proximate test consists of three tests, such as calorific measurement, test the moisture content and ash content test [19].

a. Calorific Measurement

Calorific values determine the quality briquettes. To determine the calorific value of a solid fuel, the testing is done by using kaloribomb meter. Calorific value of briquettes, can also be measured by the following equation. First, calculate the highest heat value (HHV) by the equation :

$$HHV = (T_2 - T_1 - T_{kp}) \text{ x } c_v \text{ (kj/kg)} \qquad (1)$$

while, the lower heating value (LHV) is calculated the equation according to the formula:

$$LHV = HHV - 3240 \text{ (kj/kg)} \qquad (2)$$

where, T1 are temperatures of the cooling water before it is turned on (^oC), T2 are temperatures after the cooling water is turned on (^oC), Tkp are temperatures rise of the wire igniter = 0.05 (^oC), and Cv are Heat types of tools = 73,529.6 (kJ / KGC).

b. Water Content Test

Test the water content is done by comparing the weight of chips before being dried with a weight of chips after being dried by using a machine and a drying oven under the hot sun. Formulation:

$$\text{Water Content (\%)} = \frac{G_0 - G_1}{G_0} \times 100\% \qquad (4)$$

where,
G_0 = sample weight before drying (g)
G_1 = weight of sample after drying (g).

c. Ash Content Test

Furthermore, ash is the remaining part of the combustion products, in this case is the combustion of briquettes. One of former of the ash is silica. Unfavorable influence on the calorific value of briquettes, it can cause the quality of the briquettes to be low [21].

The ash content can be measured by the following equation :

$$\text{Ash Content (\%)} = (C/A) \text{ x } 100\% \qquad (5)$$

where:
A = weight of the material before combustion (g)
C = The weight of ash / residue after combustion (g)

III. Materials and Methods

The innovation in the use of oil palm fronds into briquettes is designed in a research experiment. Design of experiments is defined as a series of activities and tests that aim to make changes to the input variables of the process or system so that we can know and identify the cause of a change in output. Experimental design can used to interpret a study design with every step and action that truly defined such that information relating to can be studied and obtained.

A. Materials

In this study, is the use of oil palm fronds or midrib as the main raw material. Midrib obtained from three different places, such as from the local palm oil in Pekanbaru (K1), midrib of palm oil plantations in PT Asian Agri (K2) and the midrib of palm plantations located in the area of Kampar Kiri Danau Raja (K3).

B. Stage of Processes.

In designing briquettes from palm fronds, there are several stages of processing, which describes the process of making briquettes. The stages of the experiment in making briquettes from oil palm fronds are shown at fig-1.

a. Preparation of Raw Materials

The main raw material used to produce briquettes are palm fronds. To produce good midrib and simplify subsequent process, first, it is necessary to remove the leaves and palm leaf rib that exist in stems of midrib. Two-thirds of the midrib is used the rost is discanded due to its hardness and large size, which can damage the machine chooper. After the cleaning process of leaves and palm leaf rib, palm fronds have an average weight of 7 kg. Next, midrib cut into smaller pieces (approximately 0.5 until 1 m) to make ease the process of chopping.

ISBN : 978-1-4673-7404-0

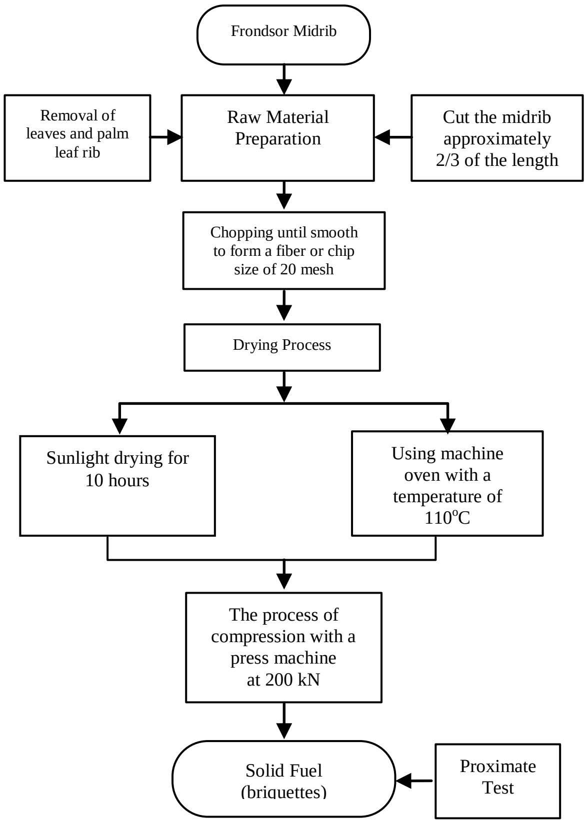

Fig 2. Diagram of fronds oil palms briquette processes

b. Chooping Process

In this experiment, the process of chopping is done in three ways and with different equipment. Thus, yield results different of the chopper. For the first specimen (K1), the process is done by using coconut grater machines. Then for the second specimen (K2), done using machines chooper-1. And for the third specimen (K3) was performed using machine chooper-2. The results of these three tools chopping process can be seen in the fig 3.

Fig 3. Results of the process chopping with Three different tools

c. Drying Process

The drying through two processes, such as drying material under the sun, or can be done using equipment such as machine oven. To enable the raw material to dry completely, it needs to be done drying process by using machine oven at 110oC temperature for 10 hours.

After the drying process using the oven, the drying process can continue under the hot sun directly. It aims to ensure that water vapor is trapped inside the chips can be completely lost. The results of the drying process that has been done by several methods, can be seen in the following figure.

Fig 4. Results of drying process

d. Weighing Process

In order to obtain the mass of a standard size, the raw materials that have been dried to be weighed. This process is done to facilitate the briquetting process with a view to making briquettes with almost the same weight. It uses digital weighing scales with three variations of weight, which is 20 grams, 30 grams and 50 grams.

Fig 5. The result of the weighing process

e. Moulding Process with Press Machine

The next process is the process of molding the raw material into bars of briquettes using a press machine with an average pressure of 200 kN. The higher the level of pressure, will give best results. The high value of pressure will affect the duration of the combustion process briquettes.

Fig 6. Results of the briquetting process

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IV. Results

A. Proximate Test Results

The results of measurements of heat from the existing three specimens can be seen in the following table :

TABLE II
CALORIFIC VALUE TEST RESULTS

Specimens	Calorific Value (kJ/kg)	Calorific Value (kCal/kg)
K1	14,550.90	3,477.67
K2	13,288.11	3,175.86
K3	13,436.49	3,211.32
Rat-rata	13,758.50	3,288.28

Through the table it can be seen that, the highest calorific value found in first raw material (K1), is 14,550.90 kJ / kg, equivalent to 3,477.67 kCal / kg. Whereas the average heat that can be generated from the three specimens is equal to 13,758.50 kJ / kg, equivalent to 3,288.28 kCal / kg.

Moisture content before briquetting process contained in the raw material, are as follows:

TABLE III
WATER CONTENT TEST RESULTS

Specimen	Initial weight (gr)	Dry weight (gr)	Water weight (gr)	Water Contents (%)	Biomass Contents (gr)
K1	1,614.7	613.6	1001.1	62.0%	38.0%
K2	975.4	416.4	559.0	57.3%	42.7%
K3	1,379.8	464.4	915.4	66.3%	33.7%

Differences in the test results briquettes moisture content of oil palm fronds are due to the different stages of manufacture of the briquettes palm fronds with other biobriket. This is due to the process of briquetting palm fronds, the testing phase moisture content is calculated after the raw materials undergo a drying process prior to the briquetting process. While, on the other biobriquette, testing the water content is done after the press process.

Furthermore, the ash content of the briquettes, can be seen through next table:

TABLE IV
ASH CONTENT TEST RESULTS

Specimens (gr)		Initial Weight (gr)	Residu Weight (gr)	Ash Content (%)
K1	1	20	0.24	1.20%
	2	30	0.76	2.53%
	3	50	2.25	4.50%
K2	1	20	0.33	1.65%
	2	30	0.61	2.03%
	3	50	3.19	6.38%
K3	1	20	1.67	8.35%
	2	30	2.68	8.93%
	3	50	6.29	12.58%

B. Economic Value Analysis

Some of the key aspects in determining the economic value of the product briquettes include: capacity of production equipment, raw material prices, cost of production, as well as the expected profit margin.

In this study, pembriktan done using equipment with a capacity of up to 1,260 kg / day. In addition, capacity chooper machine and drying machine each is 7,000 kg / day and 3,000 kg / day. The following table, describes the the full capacity of machine and the number of machines needed to produce briquettes palm fronds.

TABLE V
CAPACITY AND THE NUMBER OF MACHINES

Machine	Maximum Capacity (kg)	Capacity in Use (kg)	Output (kg)	Eff (%)	Qty (Unit)
Chooper	7,000	2,071.72	1,968.13	29.60%	1
Dryer	3,000	1,968.13	1,082.47	65.60%	1
Press	1,260	1,082.47	1,050.00	85.91%	1

To produces 1,050 kg of briquettes, require raw materials 2,071.72 kg midrib, or as much as 259 kg rod, (assuming a weight of 1 stem midrib is 8 kg). In the process of briquette production drying process causing severe depreciation very large, up to 45%. This is because, at this stage of drying the chip should be completely non water.

To produce briquettes, require the production costs, including the cost of purchasing raw materials, labor cost, cost of energy needs, cost of purchase of equipment and depreciation costs

Totally, requirement of production cost are Rp. 871,000/day. It means, to produces 1 kg of briquettes, it will cost Rp. 830. So, if the maximum profit margin of 50%, the product briquettes can be marketed at a price of Rp. 1,300/kg.

When compared with kerosene and gas (LPG), the selling price of briquettes, relatively much cheaper. In Indonesia, currently for 3 kg LPG is sold at 4,750 IDR/kg, while kerosene is 2,500 IDR/lt or 3,125 IDR/ kg (assuming the density of kerosene is 0.8 kg/lt) [22]. However, due to very limited supply, the price of kerosene in the market, could reach 15,000 IDR/lt or equivalent to 18,750 IDR/kg. The calorific value that can be produced from the kerosene is 11,000 kCal / kg, LPG gas amounted to 11,900 kCal /kg [23]. Meanwhile, heat oil palm fronds briquettes amounted to 3,477.67 kCal/kg.

By comparing between the selling price and the calorific value that can be produced by each of the fuel, it can be seen that the price/calorie kerosene is 1.70 IDR and price/calorie LPG is 0.39 IDR. While palm oil briquettes, value price/calorie is 0.37 IDR. So, from the comparison, palm fronds briquettes more efficient than kerosene and LPG gas.

TABLE VI
EFFICIENCY CALORIFIC VALUE KEROSENE, LPG AND BRIQUETTES OF OIL PALM FRONDS

Fuels	Calorific (kKal/kg)	Prices (IDR/kg)	Price/kCal (IDR/kKal)
Kerosene	11,000.00	15,000	1.702
LPG	11,900.00	4,750	0.399
Briquette	3,477.67	1,300	0.373

V. CONCLUSION

Innovation on design product of alternative energy that was done in this study, produced one of the solid fuel in the form of briquettes by utilizing waste oil palm fronds. It is very important to continue to carry out the process of innovation, particularly in the development of new sources to meet growing energy needs. Various strategies can be applied innovations, both from a technical aspect as well as from other aspects.

To produce innovative products, many ways that can be done, including through elaboration and combination of the results of research and development has been done by previous researchers, will be a starting point in creating innovative products that have economic value in the future.

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ISBN : 978-1-4673-7404-0

 ISBN : 978-1-4673-7404-0

GRAPHIC DESIGN INNOVATION AS BRAND IDENTITY FOR "MAHLZEIT N 'DAS BROT " BREAD PACKAGING

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***Abstract*—Besides being useful for protecting food, packaging design also serves as a media campaign. So hopefully, Mahlzeit Bread n 'Das Brot can compete with other bakers and even can be a pioneer as an authentic German bread maker in Indonesia. This research was conducted by collecting information from the client (Mahlzeit n 'Das Brot owner). This information was used to obtain a verbal brand identity, then translated visually. The use of illustrations also become the most important visual images to present the image of Germany Elegant Vintage and privilege in explaining the products of Mahlzeit n 'Das Brot. The colors used are natural colors and traditionally the colors brown and green to indicate an authentic image of Mahlzeit n 'Das Brot.**

I. Introduction

A good package design will allow the consumer to carry the contents with privacy, advertise a product, and attract potential customers, especially if the product being consumed is appealing. In addition to the identity of the product, packaging can indicate when to a product is ready to be eaten.

Standing in the heart of the city of Bogor, Mahlzeit n 'Das Brot presents as an alternative for the lovers of bread among the top to enjoy the authentic bread typical of Germany. Bread packaging Mahlzeit n 'Das Brot has the concept of bakery take away, which shows packaging can be used as a means of promoting the product and carrying out a media campaign.

It is necessary to provide graphical innovations in packaging high tensile power. Besides being useful for protecting food, packaging design also serves as a media campaign. So hopefully, Mahlzeit Bread n 'Das Brot can compete with other bakers and even can be a pioneer as an authentic German bread maker in Indonesia.

Category of *Breads and Rolls*	Category of *Sweets and Cakes*	Category of *Sandwich*
		

Fig. 1. Study Mahlzeit N' Das Brot Packaging Before

II. Methodology

This research was conducted by collecting information from the client (Mahlzeit n 'Das Brot owner). This information was used to obtain a verbal brand identity, then translated visually. The preferences and weightings were made by an professional designer.

Brainstorming
↓
Sketch
↓
Digitalization
↓
Application Packaging Design

Fig. 2. Study Stages

III. Brainstorming

In this process the researchers recorded matters relating to Mahlzeit n 'Das Brot in particular the concept of the company, the products, the expectations and wishes of the client in packaging innovation. Through this brainstorming researchers began studying the creative process and creative

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ideas.

A. Form and Packaging Elements

Food Grade Kraft paper is paper which has its sides laminated using PE (polyethylene). This material was chosen because paper color is brown and textured, making this paper reflect the vintage and natural impression. The impression is very suitable to describe the identity of Mahlzeit n 'Das Brot. Food-grade paper material can also guarantee food is safe from contamination, making loaves Mahlzeit n 'Das Brot quality safe and excellent. The packaging used is made up of a paper bag. Determination of paper bag size is based on measurements of the loaves of bread produced by Mahlzeit n 'Das Brot.

B. Conceptual Creative Ideas

Client wants package as a brand identity, which shows an German side with a strong sense of authentic vintage. "Vintage German" packaging design is a conceptual idea. It highlights the quality of the product. Mahlzeit n 'Das Brot itself has the advantage of a product that is very quality, a fusion of classic recipes, as well as materials quality are directly imported from Germany, which is then processed by reliable hands of an expert chef, resulting in bread with flavor high quality healthy for consumption.

Therefore, it is obliged to produce a packaging design that can keep bread quality and excellence as well as presenting information or messages effective and communicative. So expect upscale target market will more and more are interested to buy bread in Mahlzeit n 'Das Brot. Figure 3 bellow, allows us to follow the conceptual idea of the graphic.

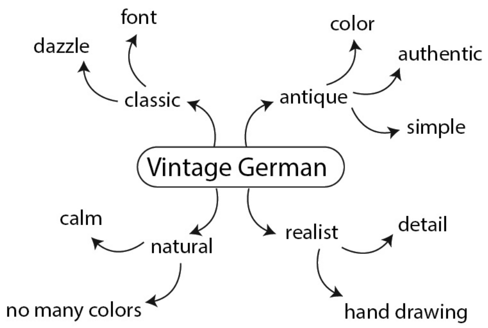


Fig. 3. Conceptual graphic idea Mahlzeit n 'Das Brot

With exclusive packaging along with memorable characters that have a distinctive German design, Mahlzeit n 'Das Brot is able to show vintage style which strengthens the authentic elements of bread. In addition, at the front of the pack there are logos and product illustrations and photos. On the back, there is the full address, phone numbers, a reminder not to litter, and descriptions of the excellenct quality of the products produced by Mahlzeit n 'Das Brot.

SKETCH

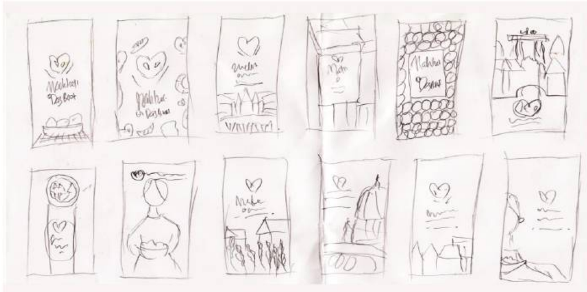


Fig. 4. Rough Sketch tumbnail

This a rough sketch of the conceptual ideas visualized graphically by Mahlzeit n 'Das Brot. This is a rough sketch done by an expert preference packaging designer. After a rough sketch, the next step is the manufacture of five alternative design sketches derived from the rough sketch. Here are 5 alternative design sketches along with the theme.

Sketch I	Sketch II	Sketch III	Sketch IV	Sketch V
Panorama Nature Germany with castle Neushwanstein	A view of a typical classical building in Germany	Jugendstil motif overview of the natural wealth of Germany	German women carrying a basket of bread in a field of wheat	Enjoy the scenery Accompany Bread in Dresden Frauenkirche
				

Fig. 5. Sketch Design Alternative

IV. DIGITALIZATION

From five alternate sketchs, the experts reduce the number to only three design alternatives through the digitization process design.

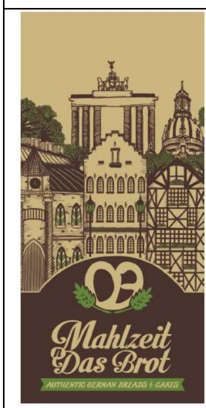
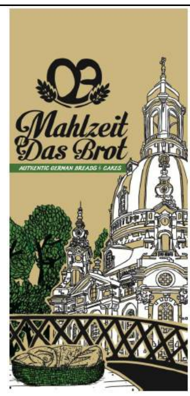
Design I	Design II	Design III
A view of a typical classical building Germany	Women Germany Takes Bread basket in Wheat Field	Bread enjoy Accompanied Landscape Dresden Frauenkirche
		

Fig. 6. Digital Design

V. BREAD PACKAGING DESIGN MAHLZEIT N 'DAS BROT CHOSEN

From three comprehensive designs made, an assessment is made by the owner based on the criteria validated by experts. The selected design will be used on packaging design Mahlzeit Bread n 'Das Brot. The design is the first comprehensive design, entitled "Views of a classic building typical German".

criteria	weight	DI		DII		DIII	
		Score	Value	Score	Value	Score	Value
Typical classic German	3	8	24	7	21	7	21
Realist Society	2	7	14	7	14	8	16
Natural color	3	8	24	6	18	7	21
Classic fonts that graceful	2	8	16	8	16	8	16
Total Value			78		69		74

Table. 1. Assessment elegant vintage graphics

The first comprehensive design chosen because it has many advantages compared with other comprehensive design, namely by displaying an icon of classic buildings with Brandenburg Gate as the main object. The Brandenburg Gate is an icon that is well known in Germany and internationally, so it is easy for consumers to instantly be able to recognize the characteristics of Germany from stores Mahlzeit n 'Das Brot. In addition, the illustration also implies a view of the typical architecture of Europe and depicts of the lives of the upper classes in Germany. The illustrations also convey origins of making bread with the symbols in the form of traditional houses so that the various impressions can be conveyed through a classic illustration of houses.

Vintage impression is also visible from the color brown which is used. Green color gives the design a sweet, healthy and natural impression. By using the symmetrical balance principle and the concept of duo-tone, this packaging design conveys the Vintage German impression that Mahlzeit n 'Das Brot wants to display. Font script Old School Class also has a strong visual vintage classic appeal which can be read easily, so it blends well with the overall design style. Additionally, the first comprehensive design is the most convenient design and suitable for application to products by Mahlzeit n 'Das Brot, such as cakes and sandwiches, because they do not have the look of bakery products itself. Hence products other than bread can also use this illustration.

VI. GRAPHIC PACKAGING APPLICATIONS IN DESIGN

Fig. 7. Packaging Mahlzeit Bread n 'Das Brot: Front (a), Rear (b), and Side (c)

Fig. 8. Packaging Cake Mahlzeit n 'Das Brot: Looks Right Side (a), Front Back (b,) and Left (c)

VII. CONCLUSION

Graphic design elements are used in the manufacture of packaging designs of Mahlzeit bread n 'Das Brot. Such elements as the field, the color and contrast of darkness (value). On the element field, geometrics are employed more to reflect the formal impression of Mahlzeit n 'Das Brot. As well as the dark-light contrasts (value), more colors are used that contrast with the surface of the packaging, in order to appear more conspicuous and easy to read. In addition to the design elements of packaging, the brand of Mahlzeit n 'Das Brot is used with a memorable typography script for a natural affect, and San Serrif that is both functional for small print sizes. The use of illustrations also become the most important visual images to present the image of Germany Elegant Vintage and privilege in explaining the products of Mahlzeit n 'Das Brot. The colors used are natural colors and traditionally the colors brown and green to indicate an authentic image of Mahlzeit n 'Das Brot.

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 ISBN : 978-1-4673-7404-0

An AHP Application For Selecting A Business Innovation Strategy of Chocolate SMEs in East Java

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***Abstract*— The purpose of this study is to formulate a business innovation strategy of chocolate SMEs using Analytic Hierarchy Process (AHP). This study focus on chocolate SMEs in East Java to improve the business performance. The participants are the representative of government, cocoa association and chocolate SMEs. Based on the findings, product diversification is the most chosen strategy meanwhile a product with taste characteristic is the most preferred best practice by respondents. This research result might not able to be generalized. However as practical implications, chocolate SMEs in East Java might apply the product diversification by creating a product with a distinctive flavor as an innovative strategy for their business.**

Keywords: Analytic Hierarchy Process (AHP), East Java, chocolate SMEs, business innovation strategy

I. INTRODUCTION

The East Java province has a high potential to fulfill the domestic supply of cocoa downstream industries. Several supporting factors of the potential are mentioned below:

1. Based on the data of Indonesian Directorate General of Estate from 2009 until 2013, East Java has led other provinces in Java island in cocoa production. In 2013, this province cocoa production was 29.888 tons, meanwhile West Java and DI.Yogyakarta around 2,696 tons and 1,106 tons.
2. As the second-biggest province in Indonesia, this region has sufficient infrastructure such as transport and power generation to support the industrial development from the small enterprise until the big one [1].

The Indonesian government has issued policies to improve the national cocoa downstream industries. One of them is from the Indonesia Ministry of Industry. Cocoa processing industries are included on the Indonesian Road Map of Developing Agro-industry Priority Cluster Industry 2010-2014. Chocolate as one of the cocoa downstream products might be developed by SMEs. Several well-known chocolate SMEs in Java region are *Monggo Chocolate* from Yogyakarta and *Chocodot* from West Java [2].

According to the data from Industry and Trade Agency of East Java in 2012, there were 25 chocolate SMEs in this province. However, chocolate product from SMEs in this province is more difficult to found in the domestic market if compared to chocolate products of SMEs from other regions that have fewer cocoa productions. It is considered as a gap between cocoa production and the business performance of chocolate SMEs.

The innovative strategy might offers a solution for SMEs to improve the business performance. Innovation is associated with the entrepreneurial vision and directly proportional to the improvement of SMEs business performance in East Java [3]. The appropriate levels of product, process, and marketing sources of ideas are necessary to facilitate innovation that influences company performance [4].

The relation between innovation and SMEs performance depends on the sustainability of firm, the type of innovation, and the culture in the company [5]. In accordance with Tidd, Pavitt and Bessant [6] innovation strategy in this study focus on process, product, management, and marketing.

This research intends to choose a business innovation strategy to improve the business performance of the small and medium chocolate enterprises in East Java using Analytic Hierarchy Process (AHP).

Manuscript received July 20, 2015. This work was supported in part by the Indonesia Ministry of Industry.

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II. LITERATURE STUDY

A. *The performance and innovativeness of Indonesian SMEs*

This research uses the definition of small and medium enterprise (SME) based on Statistics Indonesia (BPS) that SME is an enterprise with less than 100 workers. According to Anggadwita and Mustafid [7], the Indonesian SMEs contribution towards Gross Domestic Product (GDP) was about 60% and provided 97% of the total worker. The majority of the Indonesian SMEs concern in agriculture, followed by service and industry.

The SMEs in Indonesia might exist in a long term due to several factors. They have a niche market and provide employment for Indonesian society. However, only some of them are sustainable because the majority of SME entrepreneurs do not consider their lack as a serious matter [8]. The weaknesses of SMEs development in Indonesia are funding, lack of cooperation among government institution and knowledge of human resources [9].

Based on Kusumawardhani, McCarthy and Perera [10] SMEs in Indonesia have adopted innovation to sustain in the competitive environment and has a significant influence on the performance improvement. It is supported by Santosa and McMichael [1] that SMEs in East Java have innovative ability to develop their business.

Related to the business performance of SMEs, a research from Kurniawati and Yuliando [11] shows that human resources play a role in improving productivity. However, the entrepreneurial aspects have more influence than human resource because the owner characteristic still determines the company orientation [7].

B. *Innovation strategy for the improvement of business performance in the SMEs*

The trigger of innovation in an enterprise is the quality of business performance [12]. Innovation has a relation with business performance, even in a small enterprise context because it might improve business performance in the term of growth, profitability, and productivity [13]. However, Blumentritt and Danis [14] argue that innovation approach in an enterprise depends on the strategic directions of the business .

Innovation strategy aims to the level and company method innovation to perform the business strategy and to develop the performance [15] in [16]. In the SMEs, innovative strategy requires adequate resources and capabilities [5]. Tidd, Pavitt and Bessant [6] imply that innovation can be managed through a strategy. The strategy focus might be based on the innovation in product, process, marketing, and management as described in the table 1.

Table 1. Focus of strategy in Innovation

Focus of strategy	Changes
Product innovation	products or services
process innovation	the ways in the product created or the service delivered
position innovation	how the products or services are introduced (marketing method)
paradigm innovation	management in an organization

(Adopted from [6])

Based on Trott [12] technology mastery becomes a significant factor of the innovation strategy that focus on product and process. Related to product innovation, the lack of resources becomes the barriers of SMEs to do research and development (R & D). According to Qian [17] product diversification is a solution to solve the problem of research and development in SMEs. His research finding confirms if company performance in terms of profitability is likely to increase as the arising index of product diversification.

Related to marketing strategy, the market vision is an insight to facilitate innovation. It becomes an early step of marketing process in innovation. Schaper et al. [18] declare that there are several influential factors of market entry. Those factors are entry timing, positioning, and scale of entry.This research considers that new market creation might become a part of marketing strategy. According to Sarasvathy and Dew [19] new market creation might occur through effectuation approach of entrepreneurship network. Aside from new market creation, branding strategy is an essential element in the marketing. As stated by Trott [12] a success brand is the combination of efficient product, distinctive identity, and added value. The purpose of branding is to show the product position in a competitive environment.

C. *The Analytic Hierarchy Process (AHP)*

The Analytic Hierarchy Process (AHP) is a hierarchy of problem that presented in a systematic procedure [20]. The principle of AHP is a measurement of intangible things through pairwise comparisons where expert judgments are used to determine priorities. AHP has been used in various fields and subjects including strategy election. AHP makes a possibility for a decision maker to merge quantitative and qualitative data [21].

AHP is a blend of qualitative and quantitative aspects [22] for the strategy selection. Besides, AHP might be applied despite the limited availability of experts [23]. In a study involving multi-participant, the application of AHP is based on the size of the weight criteria [24]. According to Saaty and Vargas [25], the elements in AHP should clearly describe the content

 ISBN : 978-1-4673-7404-0

relationship and should be an equal comparison. Hence, both the element of AHP and the expert judgement might be re-examined.

III. RESEARCH METHOD

A. *Data Collection*

In this research, the data collection consisted of:

- Literature study
- Field observation
- AHP questionnaire for the experts

There were nine respondents as mentioned below:

a) Five entrepreneurs of chocolate SMEs in East Java
b) One representative from Indonesian Ministry of Industry
c) One representative from Industry and Trade Agency of East Java province
d) Chairman of The Indonesian Cocoa Industry and Chocolate Association
e) Representative from The Indonesian Cocoa Board (ICB)

B. *Data Analysis*

Literature study and field observation were used for construct the elements of Analytic Hierarchy Process (AHP). The AHP structure was being consulted with two experts from the Department of Agro-indutrial Technology, Bogor Agricultural University.

The AHP was judged by the nine participants as mentioned before. This study used the *Expert Choice* software for determining the weight value of the contents. Based on the software result, a business innovation strategy for chocolate SMEs in East Java would be determined.

IV. DATA ANALYSIS

The hierarchy was designed into two parts. The first part was for selecting the innovative strategy meanwhile the second part for choosing the best practice of chosen strategy. This was done to gain a comprehensive aspect in details. The best practice might give approach of each strategy in the main hierarchy.

The proposed alternatives of innovation strategy in this research were focus on process, product, management, and marketing based on the concepts of Tidd, Pavitt and Bessant [6]. The measurement results of AHP in the form of weight value are displayed in

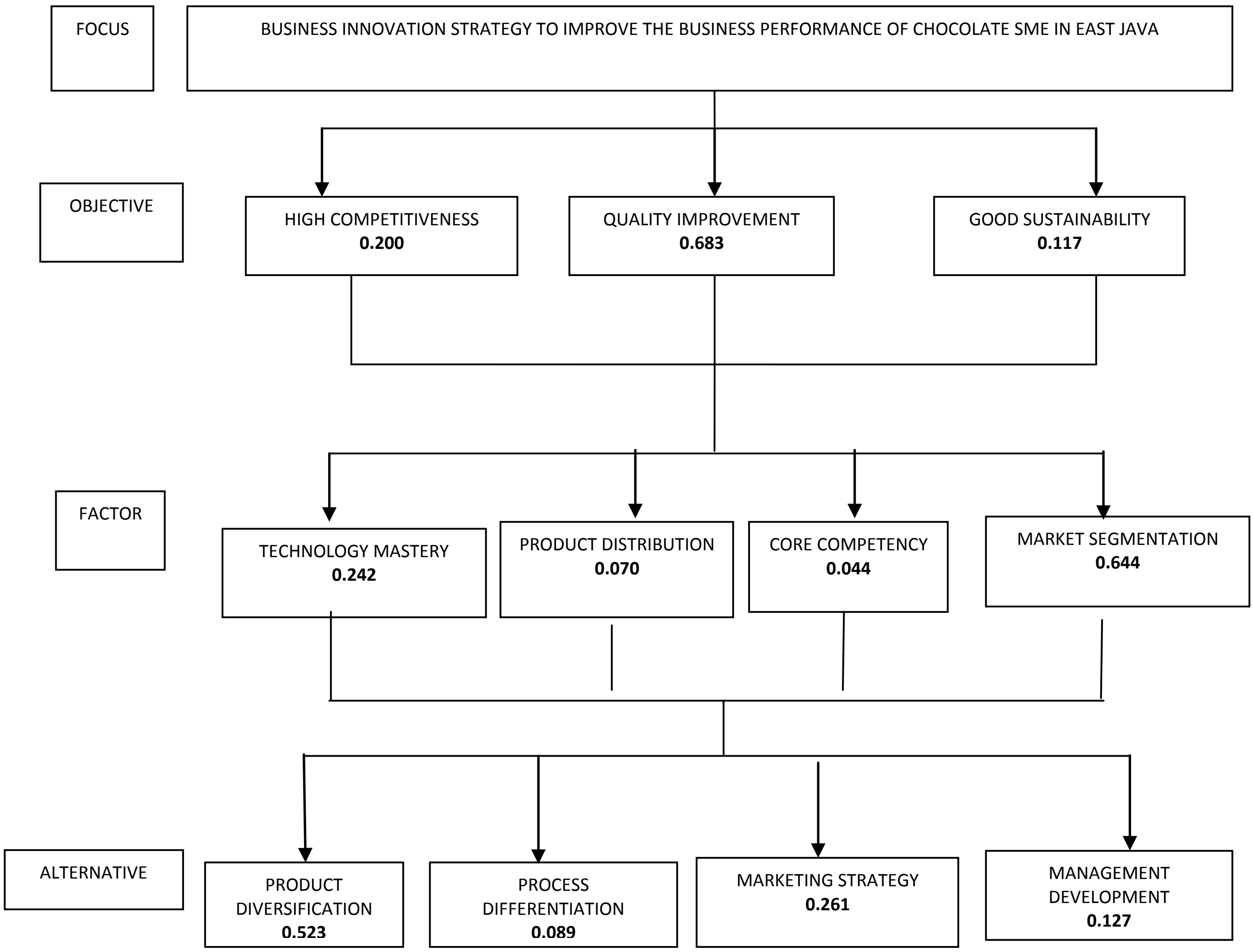

Figure 1. The measurement result of AHP for selecting an innovative strategy

ISBN : 978-1-4673-7404-0

figure 1.

Development in quality (0.683) is the main objective of the innovation strategy for chocolate SMEs rather than high competitiveness (0.200) and good sustainability (0.117). Based on the results of AHP measurement, the market segmentation (0.644) is the most important factor than technology mastery, product distribution, and core competency. It is in accordance with Schaper et al. [17] that market vision is an insight to facilitate innovation in a company. The rank of each alternative strategy is given in the table 2.

Table 2. Alternative rank of proposed business innovation strategy

Proposed Strategy	Weight Value	Rank
Product Diversification	0.523	1
Process Differentiation	0.089	4
Marketing Strategy	0.261	2
Management Development	0.127	3

From table 2, it obvious that product diversification is the most chosen alternative strategy among the respondent, followed by marketing strategy, management development, and process differentiation.

The result indicates that respondents prefer the chocolate SMEs to do innovation strategy through product diversification. This alternative is based on their market segmentation to achieve a quality improvement.

Product diversification is one form of innovation that focuses on the product. Preferences of product diversification as an innovative strategy indicates that the SMEs business performance still depends on the product as a value proposition. The respondents might consider that product innovation is the type of innovative strategy which could easily be done by chocolate SMEs in East Java.This finding aligns with Qian [16] that profit is proportional with the product diversification in the business performance.

Furthermore, several practical alternatives were made for each strategy. As for product diversification, the best practices were designed from the concept of Trott [12]. He stated that product innovation could be creating a new product or a development of the existing products. Hence, shape, packaging, and taste were proposed as the focus for the practical alternatives. The AHP structure could be seen in figure 2, meanwhile the output is ranked as given in the table 3.

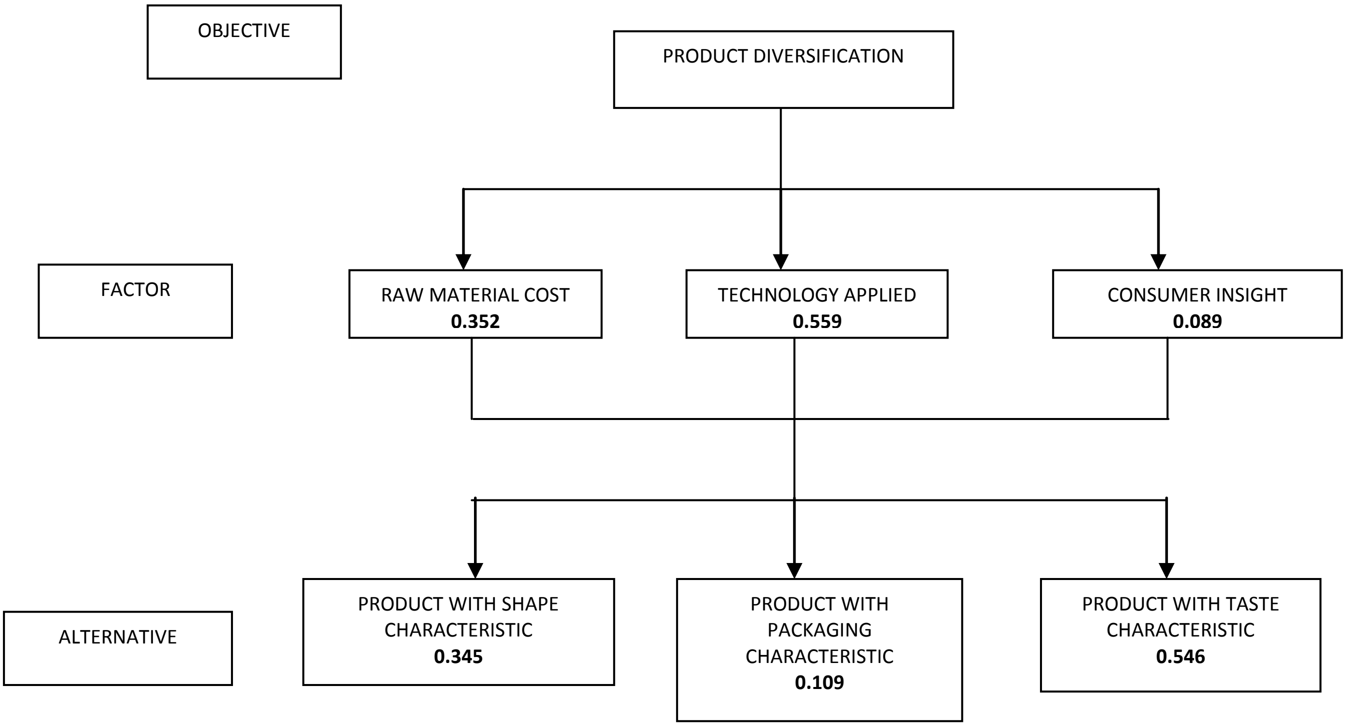

Figure 2. The measurement results of AHP for product diversification alternative

ISBN : 978-1-4673-7404-0

In table 3, a product with taste characteristic comes as the most preferred practice for product diversification. Meanwhile, product with shape characteristic and packaging characteristic ranked second and third, respectively.

Table 3. Alternative rank of proposed product diversification

Product Diversification	Weight Value	Rank
Product with distinctive feature	0.345	2
Product with unique packaging	0.109	3
Product with distinctive flavour	0.546	1

The selection of distinctive flavor as an alternative best practice indicates that respondents believe SMEs can make a breakthrough in the field of flavors. They believe SMEs can make chocolate with a distinctive flavor that describes the characteristics of eastern Java.

This research has two weaknesses. Firstly, due to limited amount of participant the result might not able to be generalized. Secondly, there was no separation of strategy between the new SMEs and the well-known established SMEs in the domestic market. There was a possibility of differences in resource and capabilities to innovate between new SMEs and the stable one.

V. CONCLUSION

Product diversification comes as the most chosen alternative strategy. Meanwhile, a product with taste characteristic is the most selected best practice by respondents as a business innovation strategy. Implications from this research is chocolate SMEs in East Java might apply the product diversification by creating a product with a distinctive flavor as an innovative strategy for their business.

This study makes two recommendations for further research. The research centre role as another stakeholder might be involved in the future study because the scope of this study is limited on the SMEs and government. In addition, because there is no differentiation of strategy between new SMEs and the existing one in this research, further research needs to consider the separation.

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ISBN : 978-1-4673-7404-0

Understanding local food consumers and their motivations: A case study in Padang city

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Abstract-Local food systems are alternative food systems that can encourage sustainable food production and consumption. The objective of this study is to explore consumers' various motivations when eating local foods at restaurants using the Means-End Chain analysis. The identified motives can be used for advertising strategies to encourage people to consume more local foods. Means-End Chain (MEC) theory has been employed to link the attributes, consequences and values that are represented in a tree-like diagram called Hierarchy Value Map (HVM). The total respondents involved in this study were 91 local food consumers in Padang City. Three main hierarchies are identified within the HVM namely 'inexpensive', 'good health' and 'taste matters'. These motives can be used for marketing strategies of local foods and applied in any programs to foster the sustainable food system.

Keywords: alternative marketing, sustainable food system, Minangkabau ethnic group, local food, means-end chain, restaurant.

I. INTRODUCTION

Local food system (LFS) is an alternative to the global food system that is considered more sustainable for food production and consumption. Local food system consists of many aspects of food production and consumption, including the aspects of production, processing, packaging and distribution from farmers to consumers. Local food system is different from food system in general in that in the former the local foods are produced and sold near the consumers [1]. The local food system is believed to be more economic, which makes it a viable alternative food system for both farmers and consumers. It has an ecological sound production and enhances social equity due to its short distribution system [2]. According to [1], local food system can reduce environmental effects due to short transportation system. The advantages which can be achieved from this system are less packaging materials and gas emission. LFS also encourages farmers to promote environmentally-friendly production system, such as organic farming, and to protect local agricultural landscape and its biodiversity [2]. In terms of economic sustainability, local food system can reduce the dependencies on external market forces and create employment opportunities for local people. As food supplies are commonly provided by local farmers in Indonesia, this system can increase the food security.

The Indonesian Government has promoted local food system to solve the basic problems of consumption, such as low food consumption and low variety of foods to consume. The President Decree no. 22 of year 2009 is a significant policy to urge Indonesian people to diversify their food consumption using local foods [17]. In order to encourage Indonesia people to consume more local foods, it is necessary to understand how consumers behave and what motivate them to purchase and consume local foods.

A means-end chain approach is a qualitative approach that has been employed widely in marketing research to understand why people buy or not to buy particular food [3]. This method has been used to re-link the relationships among attributes of a product to consequences due to consuming or using the particular product and service as well as values that consumers want to be achieve. It is assumed that consumers will choose a product to achieve the highest desired values [4]. This study aims to explore consumers' true motives when eating local foods at restaurants for a Minangkabau ethnic group who live in Padang City.

II. LITERATURE REVIEW

A. *Local food system*

The conceptualizations of what 'local' means differ greatly among consumers (for example [5]-[7]). Reference [8] stated that the simple rule of thumb for the meaning of 'local' was that:

> "The salad on your bowl doesn't come from a farm thousands of miles away, or from another country (p.1)".

According to [9] who reported a study of consumers' perceptions of local foods in Indonesia, it is mentioned by respondents that the term 'local' is strongly associated with the place where the foods are produced and sold. Foods produced and sold within a village to a regency area are accepted as

ISBN : 978-1-4673-7404-0

local foods by Indonesian consumers. This is consistent with the definition developed by [2] that:

> "Local food systems are rooted in particular places, aim to be economically viable for farmers and consumers, use ecologically sound production and distribution practices and enhance social equity and democracy for all members of the community (p. 28)".

As the local food system relies on small farmers and short distribution system, it is expected to have less negative impacts, such as air pollution from the distribution and industries, degrading biodiversity and waste of packaging [10].

B. Means-End Chain analysis

The means-end chain approach has been employed to uncover the underlying attributes, consequences and values that drive consumers to choose a particular product. This method employs a laddering interviewing technique -a face-to-face and in-depth interview- using a basic question "Why this is important for you". The means-end chain approach is based on a theory that consumers can relate between attributes of products and services (A) to consequences (C) that may emerge as product benefits or risks. The consequences can be categorised into functional and psychosocial consequences [3]. The tangible benefits or risks achieved from consuming or using a product or service are the functional consequence, whereas the psychosocial consequences are emotional benefits from experiencing with the products [11]. Reference [12] defined values (V) as the state of mind that consumers are trying to fulfil. The illustration of the means-end chain approach can be seen in Figure 1.

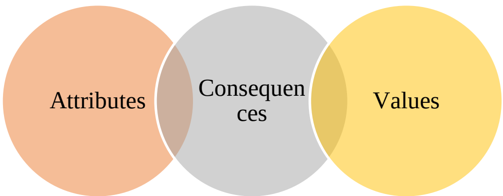

Figure 1. The means-end chain approach.

The means-end chain analysis involves four steps in the data analysis process: 1) laddering interview, 2) content analysis procedure, 3) generating and 4) interpreting Hierarchy Value Maps (HVMs) [3]. Content analysis is a coding process of a complete interview advanced by [14]. The next step is to generate the implication matrix that displays the frequency of both direct and indirect relationships between A-C-V. Direct relationship is the implicative associations between adjacent elements whereas indirect relationships are the relations of two elements when there is another element between them [11]. A Hierarchy Value Map is created based on Abstractness Ratio (AR) and Centrality Index (CI). Abstractness ratio ranges from 0 to 1. The higher the abstractness ratio of an element means that the element serves as a value. The centrality index represents the role of each element within the HVM. The higher centrality index describes that the element is often mentioned by respondents and is central in the HVM [15]. To construct the HVM, a cut-off level is needed. The rule of thumb to choose a cut-off level is that 3 to 5 cut-off levels are suggested for approximately 50 respondents. Reference [15] suggested that two third of links over all links within the HVM can be used to choose an appropriate cut-off level.

C. Minangkabau ethnic group

Padang City is the largest city in the west coastal region of Sumatra Island; it is also the capital city of West Sumatra province. The people of Padang City mostly belong to the Minangkabau ethnic group (90%). The Minangkabau people often migrate and spread across Indonesia and even to foreign countries. They have a wide variety of professional occupations and are well known to be a well-educated group of people. *Padang* food is popular among Indonesian people and is commonly served in restaurants in many parts in Indonesia and even overseas. The basic ingredients of food for the Minangese are rice, fish, beef and chicken meat [16]. The food is characterised by spiciness, mainly using herbs like ginger, galangal, turmeric and chillies. It is also a crucial component of both traditional ceremonies and daily living.

III. DATA COLLECTION METHODS

Respondents were selected using multistage random sampling. Three sub-districts were selected purposively, which include West Padang, East Padang and Kototangah sub-districts. Two villages were then chosen randomly from each sub district. Next, respondents of two neighborhoods were chosen randomly. The respondents should be food deciders at the households and eat local food at restaurants at least one in a year. This sampling frame and respondents of this study are part of a larger survey conducted by [17]. In this study, a restaurant is defined as *"a place where people pay to sit and eat meals that are cooked and served on the premises"* (Oxford dictionary online). Ninety one respondents were interviewed using laddering technique. The interviews were then transcribed and coded following the content analysis procedure [14]. An implication matrix was created to calculate the frequency of direct and indirect relationships between elements. A hierarchy value map was then constructed by calculating the abstractness value (AR) and centrality index (CI). The detailed calculation of AR and CI can be seen in Table 2.

ISBN : 978-1-4673-7404-0

Table 1 presents the socio-demographic characteristics of respondents in Padang City.

Table 1. Characteristics of Respondents in Padang City.

Characteristics	(%)
Gender	
Female	90.1
Age (years)	
< 30	15.4
30 - <50	57.1
50 - <70	24.2
≥70	3.3
Education	
Primary School	13.2
Junior High School	12.1
Senior High School	38.4
Collage/University	36.3
Occupation	
Housewife	42.3
Trader	27.7
Civil servant	6.7
Private employee	13.3
Student	6.7
Pensioner	3.3

Most of the respondents are dominated by females staying at home as housewives. They are between 30 to 50 years old and have completed senior high school and university degree.

IV. RESULTS AND DISCUSSION

Laddering technique was employed in this study that produced 183 ladders. The results of the abstractness ratio (AR) and centrality index (CI) are presented in Table 2. These indexes were used to construct the HVM. The master codes used in this study followed the study conducted by [17]. The laddering interviews produce 5 attributes with zero abstractness values. These are 'familiar product', enjoyable food', inexpensive', 'healthy food', and 'food quality'. Among attributes, 'inexpensive' element has the highest centrality index (0.06) that shows this element is the central attributes for respondents in making local food decision. Ten consequences are identified from the HVM with the abstractness ratio ranging from 0.36 to 0.67. The highest centrality index of the consequences is 'save money' (0.08) and 'good health' (0.07) and 'family eats a lot' (0.07) follow. Among three values, 'life satisfaction' is the most important values for respondents (CI=0.04). The cut-off level of 5 was selected to construct the HVM (Figure 1) that represents 63.7 per cent active links over the total of active links at or above the cut-off level.

Table 2. The Indexes of Abstractness Ratio (AR) and Centrality Index (CI) of Local Foods Consumption at Restaurants in Padang City.

Content Codes	AR	CI
Enjoyable food	0	0.03
Familiar product	0	0.02
Food quality	0	0.04
Healty food	0	0.03
Inexpensive	0	0.06
Match with taste	0.06	0.05
Prosperous family/area/nation	0.36	0.01
Controlling budget	0.42	0.03
Save time and energy	0.43	0.02
Good health	0.45	**0.07**
Family eats a lot	0.46	**0.07**
Save money	0.54	**0.08**
Social interaction	0.6	0.05
Money for other things	0.66	0.04
Self respect	0.67	0.01
Life satisfaction	0.94	0.04
Happy	0.99	0.2
Health is the most valuable thing in life	1	0.01

ISBN : 978-1-4673-7404-0

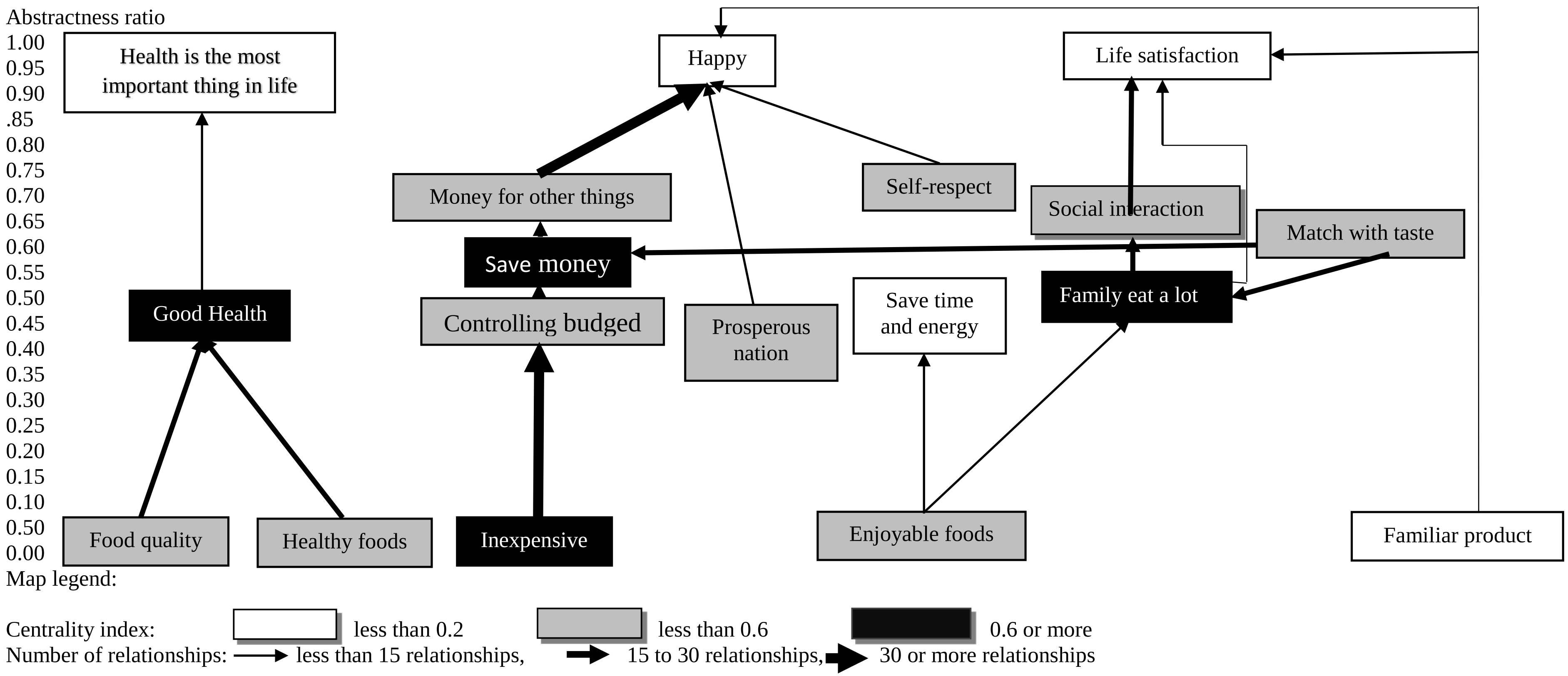

Figure 1: The HVM of consuming local foods at restaurants in Padang city.

ISBN : 978-1-4673-7404-0

The main hierarchies are then identified from the HVM based on the centrality index and the frequency of links mentioned by respondents. Three main themes are identified when eating local foods at restaurants for Padang people namely: 'inexpensive', 'taste matters' and 'good health' as summarised below:

1. Inexpensive
   Inexpensive→ controlling budged→ save money→ money for other things→ happy
2. Good health
   a. Food quality → good health→ health is the most important thing in life
   b. Healthy food→ good health→ health is the most important thing in life
3. Taste matters
   a. Match with taste→ family eats a lot→ social interaction→ life satisfaction
   b. Match with taste→ save money→ money for other things→ happy

It is clearly that consumers consider 'price', 'food quality', 'heathy food' and 'match with taste' when choosing local foods at restaurants. Local foods are considered inexpensive by consumers, so that they can control their money and pay bills or other needs. This can lead to happiness. The second motivation to buy local foods are that they are healthy and good in quality. Therefore respondents can be healthy. For consumers, health is the most important thing in life. The last motivation is that local foods match with respondents' taste. As they eat at restaurant to treat colleagues, friends and family or to celebrate a special events such as birthday party, graduation celebration, so that 'match with taste' is an important consideration, so that family can eat a lot. By eating with friends and family, respondents expect to have a good social interaction that leads to life satisfaction. 'Match with taste' motivation also relates to saving money, so that money can use for other things. This also bring to happiness. These themes can be used as advertising strategy when promoting local food at restaurants.

V. CONSLUSIONS

The means-end chain approach is a powerful approach to reveal the motives behind purchasing local foods. The three identified motives namely 'inexpensive', 'good health' and 'taste matters' can be used as advertising messages to promote local food.

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 ISBN : 978-1-4673-7404-0

SPATIAL MODEL DESIGN FOR COMPETITIVE IMPROVEMENT OF SMALL MEDIUM SCALES ENTERPRISES (CASE STUDY: BOGOR AREA)

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***Abstract*— The roles of Small and Medium Enterprises (SMEs) in supporting Indonesian economic activity are significant such as labor recruitment, increase in the Gross Domestic Product (GDP) as well as the value of national exports and investment. Geographic Information Systems (GIS) is a spatial information system and widely used as a tool for spatial mapping and analyzing to support decision- makers in policies development related to spatial problems. Currently data on the SMEs existing in Bogor area are not yet available in full, accurate, especially for the SMEs existing owned by private parties. This research aimed to develop spatial mapping Design Model of SMEs in Bogor area in order to improve the competitiveness of products in Bogor city. The model is validated for Bogor city. The survey results of identifying SMEs in the city of Bogor shows only 41 SMEs are still identified operating in the city of Bogor. The 41 SMEs is plotted on a map of the city of Bogor. Each point indicates the position of SMEs is equipped with SME's name, owner, products, capacity, marketing, area, level of technology used, capital source and allocation. The analysis based on four factors related to Techno-ware, Human-ware, Info-ware and Organo-ware indicate that under current conditions, even though the technology used by SMEs is relatively low and under-skilled workforce capabilities, the SMEs in Bogor are still survived and contribute to the economic condition in Bogor. Government should have priority program for SMEs development in Bogor city. Further analysis on SMEs competitive strategy mapping resulting in that the position of Bogor city SMEs is placed on "Grow and Build" strategy quadrant. In this quadrant, SMEs should be focused on the strategy for market penetration and product development. Government needs to prioritize specific programs for SMEs to compete in the global market.**

I. INTRODUCTION

The roles of Small and Medium Enterprises (SMEs) in supporting Indonesian economic activity are significant. The support of SMEs for the economic activities consists of the recruitment of labor, an increase in the Gross Domestic Product (GDP) as well as the value of national exports and investment. At the time of economic crisis happened in Indonesia, SMEs have shown their performance as the surviving and leading industries since they used the raw materials within the country. Based on data of 2013, there were 5.2 million SMEs in Indonesia with a growth of 7-8% per year (Ministry of Cooperative and SMEs, 2013). SMEs face many obstacles in their business development such as capital, marketing, raw materials, technology, management, bureaucracy, infrastructure and partnerships. SMEs need the role of other parties, especially the government (related agencies) to solve this problem. Ministry of Cooperatives and SMEs have created programs that can assist SME development and maintenance. Geographic Information Systems (GIS) is a spatial information system based can be used for data input, manipulate, analyze and present spatial data that are connected with tabular data attributes. GIS has been used to solve a variety of problems in the field of planning, research and management. GIS is widely used as a tool for spatial mapping and analyzing to support decision-makers in policies development related to spatial problems since GIS has the ability to store and analyze spatial data. Spatial analysis of the existence and location-based SMEs contribution to economic activity could facilitate decision-makers in understanding the spatial distribution patterns of SMEs in a particular area.

Currently data on the SMEs existing in Bogor area are not yet available in full, true and accurate, especially for the SMEs existing owned by private parties. Bogor government have tried to complete data on the existence and condition of SMEs in the region in order to formulate appropriate policies for the development of SMEs in Bogor region. Government or Department of Cooperatives and SMEs in Bogor region have never done the spatial mapping of SMEs as the baseline data of SMEs in Bogor area. This study aimed to establish

 ISBN : 978-1-4673-7404-0

the spatial mapping Design Model of SMEs in Bogor area in order to improve the competitiveness of products in Bogor area. In the development of spatial mapping model design, in addition to the specific location where SMEs will also be added to the conditions of SMEs including regional product marketing. Expected outputs from this study could support decision-makers in Bogor area on deciding related policy development, especially for SMEs to increase the competitiveness of products. The model will be validated for Bogor area.

II. METHODOLOGY

Time and Location

Research was conducted from April to November 2014. The research is taken place at Computing Systems Laboratory in the Master of Science in Information Technology for Natural Resource Management IPB Campus located at SEAMEO BIOTROP, Jalan Raya Tajur, Km 6, Bogor.

Equipment Needed

The Software for spatial mapping should be GIS-based software. In addition, the selection of the proper hardware should be compatible with the software in order not to cause problems in the analysis process. The computer powered by a high-speed internet-connection is needed for this study for the purpose of downloading data. Spatial Mapping Models for SME development required Net-logo, Arc View, Arc GIS and Microsoft Office software.

Data Resources

Required data consists of maps of Bogor profiles for initial information about the study area. Data SME presence in Bogor area could be obtained from the Ministry of Cooperation and SMEs, the Ministry of Industry and related agencies. Data are validated with ground check to detect the real existence of SMEs. That's made the survey of primary data on SMEs that have been identified and validated with ground check is very important. The data listed above is collected from relevant agencies such as the BPS, Ministry of Cooperatives and SMEs, the Ministry of Industry and Office-related agencies. Survey in order to validate the existence of SMEs will also be conducted.

Methods

The methodology used is the system approach (Hartrisari , 2007). Systems Approach is a holistic perspective focuses on the integration and linkages between components. This approach can change the perspective and pattern thinking in addressing the problems by using a simplified model of a system (Hartrisari , 2007) . The use of systems approach will result in good achievement while the problem condition is fulfilling several conditions: (1) the purpose of the system is well define, and can be recognized when it can not be quantified, (2) centralized decision -making procedures , and (3) long-term planning allows to do . Stages in the systems approach according Manetsch and Park (1977) is as follows: (1) Needs Analysis, (2) Formulation Problems, (3) Identification System , (4) modeling , (5) Verification, validation and (6) implementation . Analysis of the needs assessment is an initial stage of a system study. At this stage the identified needs of each system stakeholders. Based on the results of the needs analysis identified the need for synergistic or contradictory. The purpose of the system will be difficult to achieve if in the needs analysis phase we identified the contradictory needs. This will requires completion solutions such as win-win solution. In general, the solution obtained from the understanding of the mechanisms involved in the system identification step. Under such a mechanism, the relationship between factors can be determined so that a solution can be determined based on knowledge of the relationship between elements.

Understanding the system mechanism is done on the system identification stage and usually expressed in the input-output diagram. Models will be developed after the understanding of the system mechanism. Verification and validation of the model is done to ensure that the models built can be used to solve problems encountered in real systems. If the model has been proved valid, it will be proposed to be implement on the real state

In the model designing process we really need economic data from specified SMEs, especially on production capacity, labor and other form of statistical data. These data are categorized as non-spatial data that should be prepared for being integrated in the spatial data. Arc View and Microsoft Excel are the software for preparing non-spatial data to be integrated in the spatial data using Arc GIS software. Interface model will be designed using Netlogo software.

The method used on determining the strategy to improve the competitiveness of SMEs is a quantitative SWOT analysis (Strengths Weaknesses Opportunities Threats) to calculate external and internal factors, better known by analysis IFA (Internal Factor Analysis) and EFA (External Factor Analysis). Based on the results of the EFA analysis IFA and existing SMEs in the Bogor area will be mapped in 9 quadrant based on the values of IFA and EFA. Several criteria for SMEs categorize determination are as follows: potential resource of Bogor area, leading commodities produced at Bogor area, agro-industrial markets for agricultural commodities produced, the consumer market for agro-products, the number and capacity of the processing industry and factors related to the manufacturing of leading commodity. Based on the SMEs position at the quadrant we could develop prioritize strategy for SMEs in order to increase the competitiveness.

ISBN : 978-1-4673-7404-0

III. RESULTS AND DISCUSSION

Identification of SMEs at Bogor area

Based on the early stages of systems approach, we determined stakeholders in the agro-based system for SME development in the city of Bogor. Stakeholders included in the development of SMEs in Indonesia are : government, SMEs, community, financial institutions, farmers' groups, universities and exporter. Based on the results of needs analysis we obtained the following results.

Table 1. Needs Analysis Result for agro-based SMEs development for increasing the global competitive

No.	Stakeholders	Needs Analysis
1	Government	- global competitiveness of SMES - increase of PAD - Agro-based SMEs baseline data
2	Agro-based SMEs	- global competitiveness of SMEs - solution of critical factors for SMEs development - increase of profit - government support
3	Community	- availability of products - reasonable price - quality assurance - credit distribution
4	Financial Institution	- profit from loan - non-performing loans are not existed
5	Group of farmers	- market assurance - competitive price - capital fund agriculture input
6	Universities	- consultation program - incubator business development - cooperative program of community services
7	Exporters	- collected products - competitive price - increase of profit

Based on the needs analysis result, it can be seen that there are some similar or contradictory needs of stakeholders. Something similar or synergistic needs are improving the competitiveness of SMEs that will increase profits for SMEs and the local revenue. Contradictory need is the price of raw materials from farmers who want to be bought at high prices. However, given that the purchase of raw materials is considered as a cost for industry / SMEs, it is certainly desirable to be bought at a low price. The products produced by SMEs is expected to sell with a high price, but the community as users want to buy good quality products at reasonable prices. The government should control the price condition to avoid conflicts between farmers, SMEs and the public. Another thing can become a potential conflict is the required skill of human resources in SMEs for facing the competitive global market. Table 2 presents the contradictory factors that can cause conflict from stakeholders needs that have been identified in the previous

Table 2. Problem formulation result

No	Contradictory needs	Alternative of solution
1	Price of raw material	Profit balance between actors on supply chain development
2	Skill of SMEs' human resources	Government program including the increase of competitiveness using 4 factors: organoware, technoware, humanware and infoware

Based on the results of a needs analysis and formulation of the problem, it it can be be made as a basic input output diagram for modeling dynamic. This diagram will be modified again when the spatial analysis has been completed. At this early stage of information systems to map the location of SMEs and create a data base on the initial information of SMEs in the city of Bogor. This is done based on data provided by the Department of Industry has not been it can be verify its validity. Some of the industries that had not operated still listed as industry data / SME at the Department of Industry in Bogor. The survey results of identifying SMEs in the city of Bogor shows that based on secondary data provided by the Dinas Perindustrian of Bogor we could found that only 41 SMEs are still identified operating in the city of Bogor. The number of identified SMEs has not yet been separated based on food and non-food industries. Based on the products (food and non-food), there are 21 business / industrial that operated in non-food and 20 operated in food industries. Primary data collected for all 41 SMEs consists of SMEs name, owner, location, coordinates, contact person, the products produced, the amount of labor, production capacity, management, the level of technology used, raw materials, suppliers, markets, environment and turn over. The 41 SMEs will be plotted on a spatial information system

Spatial model design of SMEs at Bogor Area

For the research result in the first year, the spatial mapping of SMEs will be developed as a system of information by integrating the spatial position. Each SME location coordinates plotted on a map of the city of Bogor. For each point indicates the position of SMEs will be equipped with data on SMEs as SME name, owner, products, capacity, area marketing, technology used and the level of capital and capital allocation. Display information system of SMEs can be seen in Figure 4. We could see in the figure shows that the 21 SMEs has been plotted

ISBN : 978-1-4673-7404-0

spatially according to the location coordinates that we have taken when conducting a survey. For each red point clicked, it will display specific data on SMEs. The information system that has been built should be modified so that it can be used on mobile phones. Display for mobile phone has a different format from the display to the computer because of limitations of wide monitors.

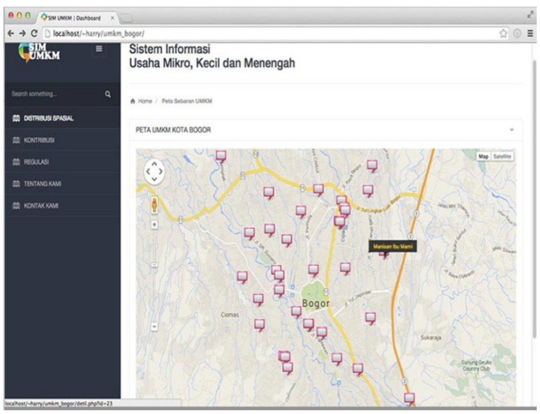

Fig 2. Information System of spatial zonation of SMEs at Bogor

Zonation spatial analysis

Based on primary data obtained from the survey results and based on the results of information systems we conducted tha analysis for 41 SMEs that are divided into categories of food and non food. The analysis is based on four factors according to Porter (2000) is Technoware, Humanware, Infoware and Organoware. In this study, technoware represented by the level of technology while the humanware is represented by the amount of labor. Modifications made to the definition and organoware and infoware based on data obtained. The infoware is represent by market share, while ownership is the factor of organoware. The results of the analysis can be seen in Figure 3. Referring to the figure, it shows that the analysis has been conducted based on 4 factors (THIO). The results indicate that the value of Infoware and Organoware of SMEs in the city of Bogor is above 6 and value of Technoware and Humanware are under 6 except for SMEs Papapia (No. 8)

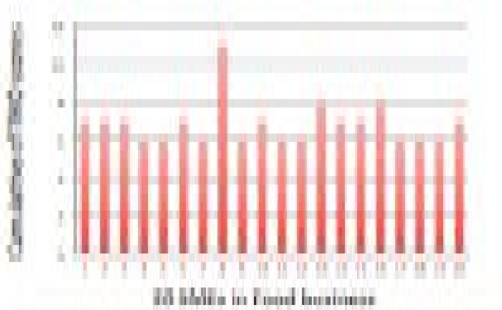

Fig 3. Result of THIO analysis for food industries

Result showed that under current conditions, even though the technology used by SMEs is relatively low and workforce capabilities owned are not achieve the requirement skills, SMEs in Bogor still survive. This should be a priority for the city of Bogor to develop SMEs as a priority program.

Competitive strategy of SMEs

Determination of competitive strategy of SMEs is conducted through IFE (internal factor evaluation) and EFE (external factor evaluation) analysis. This analysis is similar to the SWOT analysis that consists of Strength, Weaknesses, Opportunity and Threats. In this study, strength consists of the amount of labor, production capacity, turnover and the amount of equity capital. Weakness consists of the technology used and the availability of raw materials. Opportunities consist of market share, government policy and the government's policy of strengthening capital, while threats consist of environmental conditions, the power supplier and quality advantages over the competition. The results of the IFE and EFE analysis can be seen in Figure 4. We can see in the figure that the Bogor city SMEs position is in quadrant II. In this quadrant, then the condition is in a state of SMEs Grow and Build.

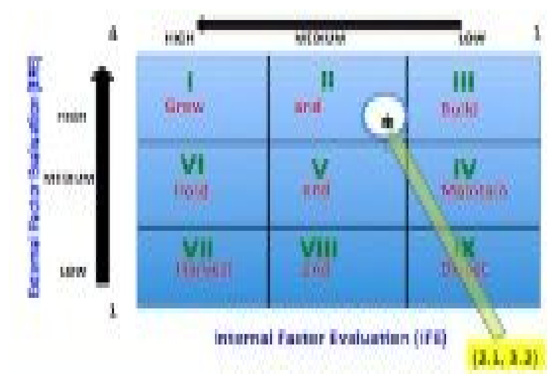

Fig 4. IFE and EFE result

The strategy must be carried out by SMEs who are in this quadrant should be focused on three things: the penetration of the market and the development of products and markets. This is consistent with the current state of SMEs that is still not given the priority by the government. The results of this study indicate that the government needs to prioritize specific programs for SMEs to compete in the global market. Governments need to identify in advance the readiness of SMEs to enter the global market. SMEs can be categorized in SMEs that have the potential products but not yet ready to compete globally, SMEs who are ready to compete, but need assistance in entering the global market as well as SMEs that is ready to compete globally and has

 ISBN : 978-1-4673-7404-0

entered the global market. On the other side, there are SMEs that are not ready to compete globally both in terms of products and markets. For SMEs who are not ready to compete globally both in terms of products and markets, a strategy that should be done is to prepare SMEs is to create products that meet the standards for the domestic market. For SMEs that have the potential products but not yet ready to compete in a global strategy to do is assisting in the development of products according to the demand of global market who want a competitive advantage. For SMEs who are ready to compete, but need assistance in entering the global market strategy to do is assisting in the development of the SME market in order to it can be enter the global market. As for SMEs who are ready to compete globally and has entered the global market, the government must maintain this state so that SMEs could grow better.

IV. CONCLUSION AND RECOMMENDATION

Spatial information system of SMEs mapping with a case study of SMEs in Bogor can be used as reference data for the government or relevant stakeholders in order to identify SMEs are still operating in a particular area. Based on the results of the analysis we could state that SMEs at Bogor city could sustain its operations in current conditions where not many SMEs specialized coaching program priorities defined by the governments. We need to do a survey with in-depth interviews for SMEs in order to obtain a complete and valid data for the preparation of spatial models of SMEs. Information system as the initial phase model needs to be expanded again with model base in order to design the complete model of GEO-SME version 1.0.

ACKNOWLEDGMENT

The authors gratefully acknowledge SEAMEO BIOTROP for funding this research.

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 ISBN : 978-1-4673-7404-0

A System Analysis and Design For Selecting Chitin and Chitosan Industry Location By Using Comparative Performance Index Method

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***Abstract*— The chitin and chitosan industry development is motivated by its wide application of chitin and chitosan as biopolymer and by its potential raw material from crustacean shell which is known as waste in shrimp processing industry, to help reducing the environment pollution. Indonesia only has three establish chitin and chitosan industries, all centralized in Java Island. Non-Java location expansion is required in order to support industrialization focus of government policy. This paper presents a system analysis and design with Business Process Modeling and Notation to select best location for a new initiative of chitin and chitosan industry. Several steps for location selection formed alternatives of location by identifying selection criteria for chitin and chitosan industry, and eventually deciding the best location. The Pairwise Comparison Method was deployed in deciding the best location and supported with Comparative Performance Index Method. The computation results revealed that North Sumatera Province is the best location for a new chitin and chitosan industry.**

I. INTRODUCTION

CHITIN and chitosan are new renewable resources of polymer from crustacean shell and used widely in industrial, food, medical and agriculture. In industrial uses, chitosan are used for water treatment, waste water treatment and metal removal. In food uses, chitosan mainly used as natural preservative and edible coating for fruit, foods and meat. Chitosan give higher value for medical used. In medical needs, chitosan can be used for cosmetic, wound healing and drug delivery. In contrary, agriculture uses contribute low value from chitosan. in agricultural uses, chitosan is applied for soil conditioners, coating seed, and fungicide.

Based on its function, chitin and chitosan have a good prospect to be developed. It is also stated by Ministry of Industry Regulation No. 41 year 2010 about Strategy Map and Key Performance Indicator and Echelon 1 Ministry of Industry, that one of target for agro based industrial cluster in 2010-2015 is to increase the use of sea product waste to be functional food material and pharmaceutical/supplement e.g. gelatin and chitin and chitosan. Another government support is represented by Decision of Directorate General of Non Consumption Fisheries Product Processing and Marketing No 17 Year 2013 about General Guideline for Registration of Non Consumption Fisheries Products Handling and Processing Unit that chitin and chitosan are one of the non-consumption products which become another focus to develop.

On the other hand, Indonesia has almost 170 shrimp processing industries scattered on all over islands. They generate a typical by-product such as shrimp waste (shells and head) with estimation 300.000 tons of shrimp waste per year are generated. This huge amount of shrimp waste is potency for chitin and chitosan industrial development due to its raw material availability. Meanwhile, Indonesia has only three (3) established chitin and chitosan industries which are centralized in Java Island. This fact is contradictive with one of the goals of industrialization as stated in the Law No 3 year 2014 about Industrialization, that industrial development must be equal in all regions of Indonesia. Recalling that law, it is important to support the industrialization development of chitin and chitosan industry by locating new industry out of Java Island.

A system analysis and design for selecting a new location for chitin and chitosan industry is needed to provide a general view of a complex system. The system is approached by modeling its business process based on its activities. A business process is a collection of activities or related tasks that have a starting and ending point, as well as clearly defined

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Manuscript received July 30, 2015. This work was supported in part by the Centre of Knowledge and Training, Ministry of Industry, Republic of Indonesia.

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 ISBN : 978-1-4673-7404-0

inputs and outputs, focus on the way the activity is carried out within organization. A business process can be decomposed into several sub-processes, with specific features that together contribute the aims of basic process [3].

A research about a generic structure for business process modeling was conducted [7]. It helps to understand BPM methods as modeling method that represent processes activities. Another research about solving a location selection problem by using the Utility Additive (UTA) method as one of a Multi-Criteria Decision-Making (MCDM) tools was also conducted [5]. Another related work is how to design the decision supports model for industrial location selection based on Analytical Hierarchy Process, focused on how to determine factor priority to select industrial location [6].

The objectives of this paper are: to analyze and design the chitin and chitosan industrial development system, to identify location alternatives that are suitable for chitin and chitosan planning location, to identify the criteria for factory location selection, and determine the best location. Furthermore, problem description and methodology of this paper is described consecutively in section 2 and 3. Finally, results and discussion are provided in section 4, followed by conclusions in section 5.

II. PROBLEM DESCRIPTION

In this paper, the system analysis and design for the development of chitin and chitosan industry in Indonesia is focused on the processes of how to select the best location for industry by using a business process modelling (BPM) approach. BPM is used to represent the system. Identify, explain and decompose a business process (collection of activities) related to the system [3].

Based on objectives of this paper, there are four (4) main activities that will be discussed in the next section, which are (1) Analyzing and designing chitin and chitosan industrial development system, (2) identifying the alternative location for new chitin and chitosan industry, (3) identifying the criteria for location selection and (4) determining the best location. There are 4 general procedures for making location decisions: decide the criteria to evaluate location alternatives, identify important factors, develops location alternatives and evaluate the alternatives and make a selection [2].

III. METHODOLOGY

Business Process Model Notation (BPMN) is selected as a language to make a model of business process in location selection for new chitin and chitosan industry. The BPMN is chosen because of its ability to capture the business processes in the system development [1]. On the other hand, the primary goal of BPMN is to provide a notation that is readily understandable from analyst that create initial drafts of the processes, to the technical developers responsible to implement the technology that will perform those process and finally to stakeholder who will manage and monitor those processes. There are four step in BPMN method:

1. Identifying element systems. System consists of its inputs, outputs, stakeholder, entities, controls, roles, objectives, opportunities, threats and constraints.
2. Creating the Process Hierarchy Diagram (PHD). Process Hierarchy Diagram (PHD) is a high level diagram, which analyze the function of business as a hierarchy process. PHD consists of a set of processes and decomposition link that connect them.
3. Creating the Business Process Diagram (BPD). Business Process Diagram (BPD) is a graphic view from control flow or data flow between processes on each level of system. BPD provides a relationship among processes, workflow and stakeholder.
4. Building the Business Process Modelling Notation (BPMN). BPMN is a graphic view that represents all detailed relationship among process, sub process, workflow, stakeholder and formulation which are involved in the system.

IV. RESULTS AND DISSCUSSION

A. *Analyzing and Designing Location Selection System*

The goal of this system is deciding the best location for new chitin and chitosan industry or for expansion. To achieve that goal, the system needs three inputs: chitin and chitosan industries distribution data, criteria factor for location selection, and the value data for all criteria in each Indonesian Provinces.

Based on business process analysis, there are three (3) stakeholders with different and important roles, who are involved in this system: Secretary of General Director for Industrial Areal Development (*Sesdirjen PPI*), Head of Center of Data and Information (*Pusdatin*) and Director of Food, Marine and Fisheries Product Industries (*Dir. IMHLP*). All stakeholders are working under Minister of Industry who has the big role for industrial development in Indonesia. In this system *Dir. IMHLP* plays an important role, due to its responsibility for the development of chitin and chitosan industry. *Dir. IMHLP* cannot work individually because the system needs interaction with *Sesdirjen PPI* for determination criteria factor of location selection and with Head of *Pusdatin* for providing the data.

The system entity for selecting new location for chitin and chitosan industry is illustrated on Fig. 1.

ISBN : 978-1-4673-7404-0

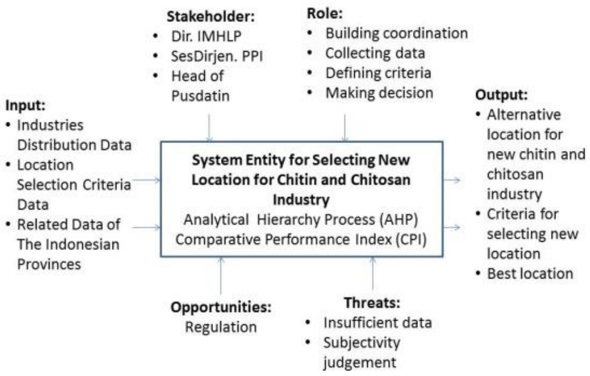

Fig. 1. System Entity for Location Selection

B. Identifying alternative location

After constructing the element system, next step is identifying alternative location. This process involves *Sesdirjen PPI* as a stakeholder who is responsible in determining alternative location. In this system, the location is focused in the province level. So, the output for this system is to determine which province in Indonesia that suitable for new chitin and chitosan industry or for expansion.

Supporting with BPMN diagram as shown in Fig. 2, there are 5 sub processes included in the process of identifying alternative location. First sub process is collecting data of all provinces in Indonesia. The second is collecting the distribution of registered chitin and chitosan industries data in all provinces in Indonesia. In the collecting data process, Data and Information Center is involved to provide the data.

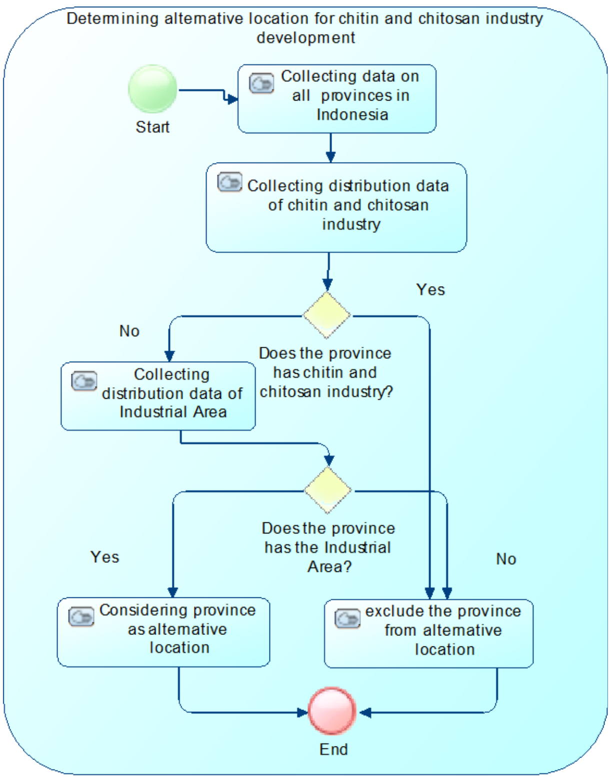

Fig. 2. Process in determining alternatives of location

There are 2 decisions making in this process. First decision is whether the province has one or more chitin and chitosan industry or not. If the answer is yes, then remove location from list of alternative location. If the answer is no, then continue the process to collect distribution data of Industrial Area location. The industrial area in this research refers to Industrial Area which has been established and still in the development planning.

The second decision is whether the province has industrial area or not. Based on Government Regulation No 24 Year 2009 about Industrial Area, Indonesian Government obliges new industry to be located inside the industrial area. Thus, province which has an Industrial Area is considered as an alternative location for new chitin and chitosan industry or expansion. Meanwhile, if the province does not have Industrial Area location, then exclude it from the list of alternative location.

Another consideration that, the alternative location is focused on decentralization industries out of Java Island, thus all provinces in Java Island is excluded from the list of alternative location. From 34 provinces in Indonesia, 28 alternative provinces are remained and then filtered again into 14 alternative provinces, which are North Sumatera, West Sumatera, Riau, Lampung, Bangka Belitung, West Kalimantan, South Kalimantan, North Sulawesi, Central Sulawesi, South Sulawesi, Southeast Sulawesi, North Maluku and West Papua.

C. Identifying the criteria for location selection

Location selection is important in industry in term of minimizing risk and maximizing profit, recalling that the location affects the fixed cost and the variable cost [4]. Selection of industrial location largely depends on many criteria, which have either direct or indirect impact on the product operation [5].

Process of identifying criteria for location selection for chitin and chitosan industry involves *Dir. IMHLP* as stakeholder. As shown in Fig. 3, the process consist 2 sub processes which are (1) determining general criteria for industrial location selection, and (2) determining criteria for chitin and chitosan industry location by using Pairwise comparison method.

Based on sub process (1), the general criteria for industrial location selection are obtained from discussion with *Sesdirjen PPI* as a responsible stakeholder. In line with it, characteristic of chitin and chitosan industry is assessed by *Dir. IMHLP* cooperated with related industrial player or industrial association. The characteristic are required in the process next subprocess of criteria selection for chitin and chitosan industry location. As shown in Figure 3, after collecting general criteria for industrial location, then move to sub process (2) to obtain important criteria by using Pairwise Comparison from expert analysis and judgment. Pairwise Comparison method is used as a step to

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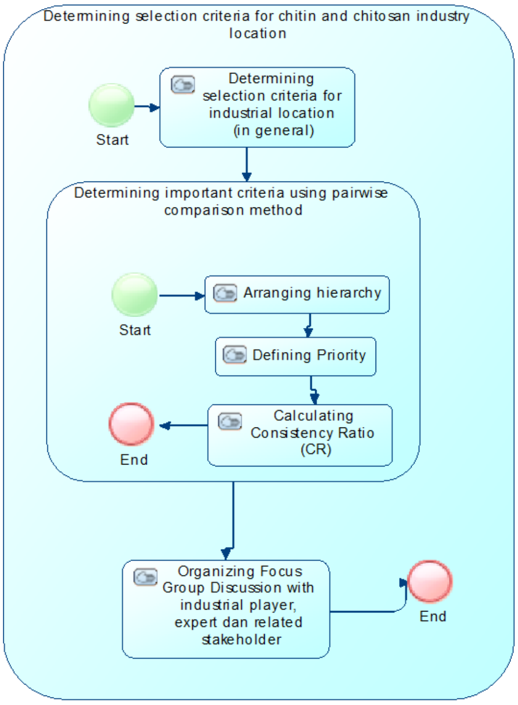

Fig. 3. Process in determining criteria for chitin and chitosan industry location

determine location factors priority and provide a rating based on qualitative factors [10].

There are 6 factors for industrial site selection, society, proximity to market, labor, availability of raw material and supplier, facility and transportation cost, and another natural resources [9]. As stated in sub process (2), steps for pairwise comparison are arranging hierarchy (Fig. 4), defining priority and calculating consistency ratio.

To define priority of criteria by pairwise comparison, Saaty Comparison Scale is used to quantify the expert judgment [8]. The comparison scale (Table I), is used by an expert as a guide to fulfill the pairwise comparison matrices (Table II).

To get the Total Priority Value (TPV), the priority value of all criteria are calculated by using the matrices manipulation with formulation 1,2,3 and 4 on the next page,

1. $$JK_j = \sum_{i=1}^{n} a_{ij}$$

2. $$b_{ij} = \frac{a_{ij}}{JK_j}$$

$$\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}$$

3. $$JBi = \sum_{j=1}^{n} b_{ij}$$

4. $$PR_i = \frac{JB_i}{n}$$

Where,

n	:	the number of criteria
i,j	:	1,2,..., n
a_{ij}	:	element of pairwise matrices A, row-i column-j
JKj	:	the number of column-j
bij	:	element of new matrices, row-i column-j
JBi	:	the number of row-i
PRi	:	TPV row/criteria-i

Fig. 4. Hierarchy for Pairwise Comparison

Based on formulation 1,2,3 and 4, shown the results that the dominance criteria in location selection are availability of raw material and supplier (0,325), proximity to market (0,213), labor (0,2) and facility and transportation cost (0,123).

TABLE I
Comparison Scale by Saaty

Preference Level	Definition
1	Vertical factor equal importance with horizontal factor
3	Vertical factor moderate importance compared with horizontal factor
5	Vertical factor strong importance compared with horizontal factor
7	Vertical factor very Strong importance compared with horizontal factor
9	Vertical factor extreme importance compared with horizontal factor
2,4,6,8	Uncertainty between two nearest elements
1/(2-9)	In contrary with value of 2-9

TABLE II
. Pairwise Comparison Matrices

Criteria	A	B	C	D	E	F
A. Society	1	1/3	1/3	1/4	1/3	1/3
B. Proximity to market		1	1	1/2	3	3
C. Labor			1	1/2	3	2
D. Availability of Raw Material				1	3	4
E. Facility and transportation cost					1	3
F. Other Natural Resources						1

For the next analysis, availability of raw material and supplier will be approached by the amount of shrimp processing industries who are supplying the shrimp shell as raw material. In term of proximity to market, the criteria will be approached by the amount of processing and preservation industries (fish, meat, fruit and vegetable) as potential users. In term of labor factor, will be approached based on the lowest nominal of regional minimum salary. On the other hand, facility and transportation cost criteria will be approached by the amount of seaports because it is related to product distribution (raw material and finished product).

D. Determining the best location

After identifying the alternative locations and criteria for chitin and chitosan industry location, next process is finding the method to select several alternative locations that fulfil most of the criteria and decide it as the best location. Comparative Performance Index (CPI) is one of Multiple Criteria Decision Making (MCDM) method that usually used to determine the best location. CPI is chosen for this analysis since the criteria for location selection have different units [8].

Process of determining the best location involves *Dir. IMHLP* as a stakeholder. The process is divided into two sub processes: homogeneous sizing value (Fig. 5), and calculating score of each criterias (Fig. 6).

Fig. 5 illustrates the steps on homogeneous sizing value process. Before move to the process, it is important to find actual data from reliable source to fulfill the value of each criteria in all provinces. Table III represents the value of 4 criteria in 14 different alternative locations.

Regarding to Fig. 5, the first step is homogeneous sizing the value of all criteria in each province. Homogeneous sizing value process consists of three stages:

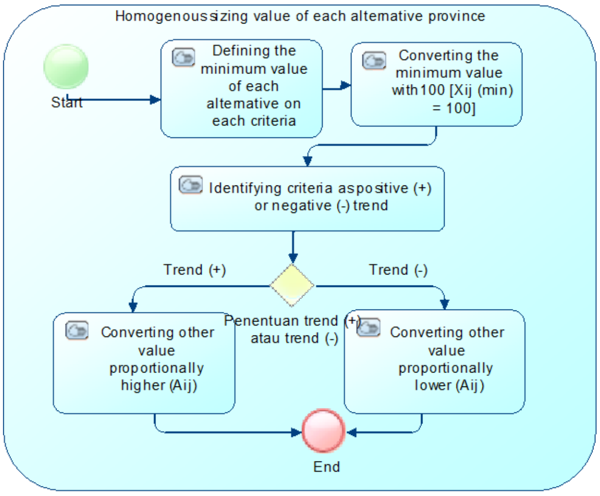

Fig. 5. Process of homogeneous sizing value

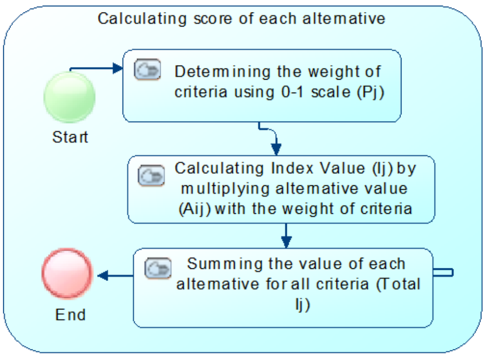

Fig. 6. Process of Score Calculation

(1) Defining minimum value of alternative in each criteria. Refers to Regional Minimum Salary (UMR) criteria in Table III, Central Sulawesi is the alternative location with minimum UMR. Meanwhile, for other criteria such as amount of processing and preservative industry (fish, meat and fruit), amount of seaport and amount of shrimp processing industry, the province that has minimum value are consecutively North Maluku (4 industries), South Kalimantan (5 seaports) and North Sulawesi (1 industries).

(2) Converting minimum value into 100. Regarding to the data in Table III, change the value of criteria 1 for Central Sulawesi, criteria 2 for North Maluku, criteria 3 for South Kalimantan and criteria 4 for North Sulawesi into 100.

(3) Identifying whether the data trend are positive or negative. Positive trend means the higher the value of alternative for each criterias, the better the value is. Whilst, negative trend means the lower the value of alternative, the better the value is. From Table III, it can be seen that alternative value for Regional Minimum Salary (UMR) criteria has negative trend, while Processing and Preservation Industry, amount of seaport and shrimp processing industry criteria have positive trend. For positive trend, convert the other value proportionally higher. In contrary, convert the other value proportionally lower. In order to obtain the homogeneous data, convert the value in Table III by using equation I and II.

$$A_{ij} = \frac{x_{ij(min)}}{x_{ij(\min)}} \text{x}100 \qquad \text{Eq. 1}$$

$$A_{i+1.j} = \frac{x_{(i+1.j)}}{x_{ij(\min)}} \text{x}100 \qquad \text{Eq. II}$$

Where,

A_{ij} = Alternative value –i for criteria-j

$x_{ij(min)}$ = Alternative value –i for minimum initial criteria-j

$A_{i+1.j}$ = Alternative value –i+1 for criteria-j

$X_{(i+1.j)}$ = Alternative value -1+1 for initial criteria-j

After homogenous sizing the value of every criterias in every province, continue to the second sub process (Fig. 6) which is calculating the score of each alternative. Calculating score process consists of three subprocess, determining the weight of criteria, calculating Index Value and summing the value of all crteria for each alternative location

The score can be obtained after determining the weight of each criterias from pairwise comparison value and then defining Index Value by multiplying the homogenized value with the weight (Equation III). Then, the total index is obtained by adding alternative value for all criteria (Equation IV).

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TABLE III
Decision Matrices for Location Selection

Alternative (i)	Criteria (j)			
	[1] Regional Minimum Salary (Upah/month)	[2] Amount of Processing and Preservation Industry (Fish, meat and fruit)	[3] Amount of seaport	[4] Amount of Shrimp Processing Industry
North Sumatera	Rp1.375.000	57	30	8
West Sumatera	Rp1.350.000	43	8	1
Riau	Rp1.400.000	12	43	1
Lampung	Rp1.150.000	16	6	4
Bangka Belitung Islands	Rp1.265.000	22	9	2
West Kalimantan	Rp1.060.000	7	7	2
South Kalimantan	Rp1.337.500	21	5	8
East Kalimantan	Rp1.752.100	13	14	9
North Sulawesi	Rp1.550.000	11	7	1
Central Sulawesi	Rp995.000	14	14	1
South Sulawesi	Rp1.440.000	7	62	11
South East Soulawesi	Rp1.125.200	8	6	1
North Maluku	Rp1.200.600	4	143	1
West Papua	Rp1.720.000	5	7	6

Source (Accessed: June 2015)
1. BPS, 2013; 2.Kemenperin.go.id; 3.gis.dephub.go.id; 4.kkp.go.id

$$I_{ij} = A_{ij} x P_j \quad \text{Eq. III}$$

$$I_i = \sum_{j=1}^{n} (I_{ij}) \quad \text{Eq. IV}$$

Where,

P_j = Weight of criteria-j

I_i = Alternative index-i

I_{ij} = Combination Criteria Index for alternative-i

i = 1,2,3,...n

j = 1,2,3,...n

Based on Eq. IV, it can be calculated which province that has the highest alternative value. Based on the final results in Table IV, the highest Index Value total is owned by North Sumatera, followed by North Maluku and South Sulawesi. Thus, North Sumatera is the best location for planning a new chitin and chitosan industry or an expansion.

This research hopefully could be used as a simple guide to capture a complex situation into simple model that understandable. System design of location selection constructed in this paper also could be applied not only for chitin and chitosan industry but also for any type of industry that needs an expansion or move to a new location. In spite of the advantages, this system needs more improvement in detailing the processes into more depth sub processes and involving more related stakeholder.

TABLE IV
Decision Matrices for Location Selection (After Transformation)

No	Alternative (i)	Criteria (j)				Index Value Total (Ii)	Rank
		Regional Minimum Salary (Salary/ month)	Amount of Processing and Preservation Industry (Fish, meat and fruit)	Amount of seaport	Amount of Shrimp Processing Industry		
1	North Sumatera	72	1.425	600	400	521,80	1
2	West Sumatera	74	1.075	160	50	279,65	4
3	Riau	71	300	860	50	200,14	7
4	Lampung	87	400	120	200	182,26	9
5	Bangka Belitung Islands	79	550	180	100	187,52	8
6	West Kalimantan	94	175	140	100	105,77	12
7	South Kalimantan	74	525	100	400	269,00	5
8	East Kalimantan	57	325	280	450	261,27	6
9	North Sulawesi	64	275	140	50	104,88	13
10	Central Sulawesi	100	350	280	50	145,24	11
11	South Sulawesi	69	175	1240	550	382,36	3
12	South East Soulawesi	88	200	120	50	91,30	14
13	North Maluku	83	100	2860	50	405,91	2
14	West Papua	58	125	140	300	152,91	10
	Weight	0,2	0,213	0,123	0,325		

V. CONCLUSION

A system approach can be used for industrial location selection. By identifying alternative locations, it can be defined fourteen provinces as alternative location. The criteria for location selection is prioritized in accordance with its level of importance and obtained 4 specific criteria for chitin and chitosan industry. Finally, North Sumatera province is chosen as the best province for new chitin and chitosan industry location.

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ISBN : 978-1-4673-7404-0

ISBN : 978-1-4673-7404-0

Arduino-Based Temperature Monitoring Device for Cold Chain Transportation

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***Abstract*— The aim of this study is to build a system and device prototype to monitoring temperature of cold chain transportation. The device use Arduino open source microcontroller platform as the basis. The data of the temperature stored inside SD card as a log file to report the temperature history during transportation. The device will transmit warning to drivers and related stakeholders. Warning activity occurred if the fluctuation of the container temperature reach or exceed temperature upper threshold. When the warning activity occurred, the device that connected through GSM network will send notification message to the related stakeholders and turn on warning lamp inside driver's cockpit. Several performance tests were done, including basic feature test, recording test, and transportation simulation test. The advantages of this device are open source, easy to modify and duplicate, inexpensive, easy to save the log files, and responsive. The disadvantages of this device are needed power supply and GSM network signal.**
Keyword: microcontroller, Arduino, temperature monitoring, cold chain transportation

I. INTRODUCTION

Nowadays, frozen food consumption plays an important role in modern society. Frozen food allows people to get food in good quality that is maintained in the low temperature storage. This trend will lead to the demand and the great need for frozen food products in the future. However, problems arise as a result of the nature of frozen products stored and distributed to the consumer with the cold chain system, which in case of errors in each aspect can make defective products [1].

To ensure the quality of the frozen product then all the processes that take place and the tools used must be ensured to work well. The quality of agriculture product is influenced by several factors, among others, post-harvest treatment (cooling, heating), humidity, packaging and others. The main idea of cold storage is by storing the commodity at a low temperature, so the process of respiration and senescence is delayed, and in the end can extend the shelf life of the commodity [2]. Spiess [3] also stated that the lowering the temperature of the product is one of the gentlest measures that can be used to retard food life spoilage and be able to reduce the metabolic activity of microorganisms.

Specifically, supply chain or logistics network is a system of organizations, people, technology, information, and resources involved in moving a product or service from producer to consumer [1]. Cold chain is a supply chain with controlled temperature, which a concept is born from the specific requirements related to the distribution of products that are sensitive to changes in temperature using refrigerated transport. Heap [4] stated that refrigerated transport of cold products is related to the displacement operation of the cold product from one storage area to another. The scope of refrigerated transport is very wide, depending on the needs. In the simplest example, refrigerated transport can be insulated ice box, and the most complex can be intermodal freight container with integral refrigeration machinery [4].

The highest potential for quality losses are happens after the storage transportation. It means that cold chain distribution and transportation have a high risk of quality losses. Maintain storage temperature is a key factor to prevent a variety of risks that can affect the safety and quality of food [5].Wright [6] stated that, the best way to assure that a product will be safe and of an acceptable quality when consumed is to control the temperature during storage and distribution and to integrate the temperature exposure over time.

Monitoring the temperature during distribution has become a very important issue in recent years. Several different technologies that can be applied to

 ISBN : 978-1-4673-7404-0

other recording storage temperature between chart recorders, time-temperature indicator (TTI), a label with the color change, and the data logger [1].

The aim of this work was to develop a system and device prototype to monitor the temperature during cold chain transportation with Arduino software and hardware. It was generate a possibility to connect the device through the GSM network so the device can send the warning and notification of the temperature history during transportation to the related stakeholder, either the producer, trucking service, or retailer. Thus the devices could act as quality assurance of cold product through the temperature monitoring of the product during cold chain transportation.

II. MATERIALS AND METHODS

2.1. Materials

In this research used open source hardware and software platform, DFRduino Uno R3 as microcontroller platform. It was also used Grove High Temperature Sensor (HTS) as an input to read the room temperature. The Grove-Temperature Sensor using a K-type thermocouple sensor. The detectable range of this sensor is -50-600 ℃.

Type of shields used in this research was SD card Shield and GSM/GPRS shield. SD Card shield was SeedStudio 4th generation SD card shield, which have I2C and UART port already attached on the shield. GSM/GPRS shield used in this research is IComSat v 1.1-SIM 900 that also serves as a RTC (real time clock) module and is critical to the temperature data recording activity.

2.2. Method

Methodology used in this research consists of three steps: system and software design, hardware design and prototyping.

2.2.1. System Design and Implementation

This part was focused to define the architecture, components, modules, interfaces, and data for a system to satisfy specified requirements. Implementation of the system design in this research used Arduino IDE (Integrated Development Environment), a development platform for Arduino microcontroller with C based language. Relationship between each component function shown in Figure 1 below

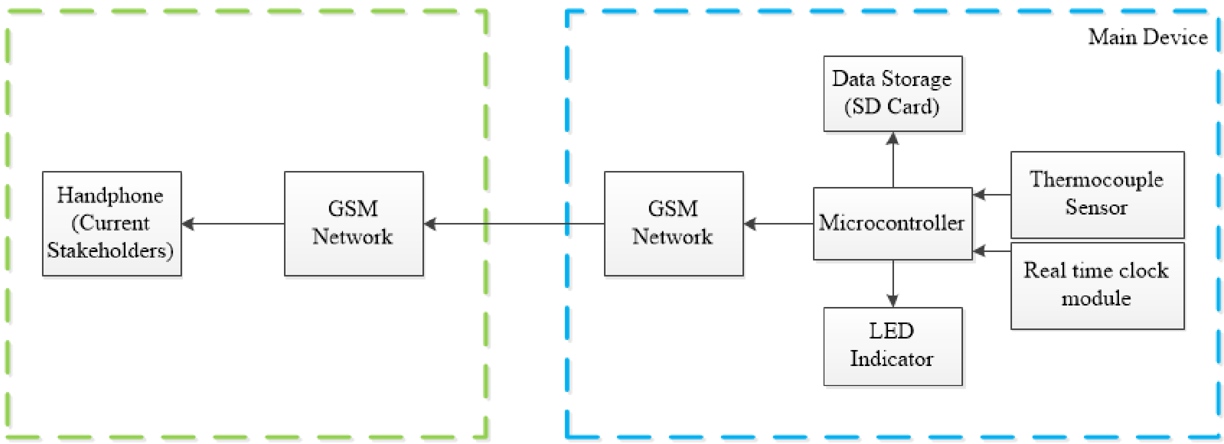

Figure 1 System architecture diagram

The output generated by the microcontroller is a log file that is saved to the storage media (SD card) in a .csv format that consists of temperature data and time. The log file (.csv file) can be opened using Microsoft Excel software. Other outputs are LED lights as cold container temperature indicator, and short message notification send through GSM network connected to the GSM shield as data flow diagram shown in below in Figure 2.

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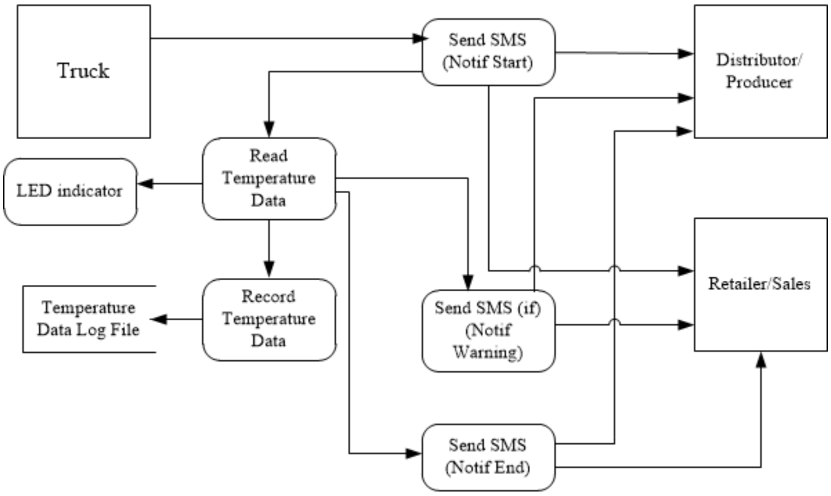

Figure 2 Data flow diagram

2.2.2. Hardware and Prototype Design

Hardware and prototype design begins with list of hardware needed based on the needs of system design. All hardware used in this research using the stackable shield component, so all additional components (sensors, modules, etc.) can be directly stacked on top of pins on the microcontroller and the other shield. Prototype design is done by uploading the program code from Arduino IDE to the microcontroller

III. RESULT AND DISCUSSION

3.1. System Design and Implementation

As illustrated in the system architecture diagram, the main device consists of thermocouple sensor, real time clock module, microcontroller, data storage (SD card), and LED indicator, connected to GSM network through short message service (SMS).

Microcontroller acts as the main control device that receives input and process to produce output. Input received to the microcontroller comes from thermocouple temperature sensor (Grove Temperature Sensor) which uses the ambient temperature as input data. The temperature sensor is the main input regarding the main function of this device as temperature recorder during the cold chain transportation. In addition to temperature sensor, other input is derived from the input time from real time clock (RTC) module which already attached into IComSat GSM / GPRS shield. RTC functions to produce time data, which is useful when the data logging process takes place by recording the temperature and time data simultaneously and continue, to generate the log data of temperature exposure over time. Device workflow diagram was shown in Figure 3 below.

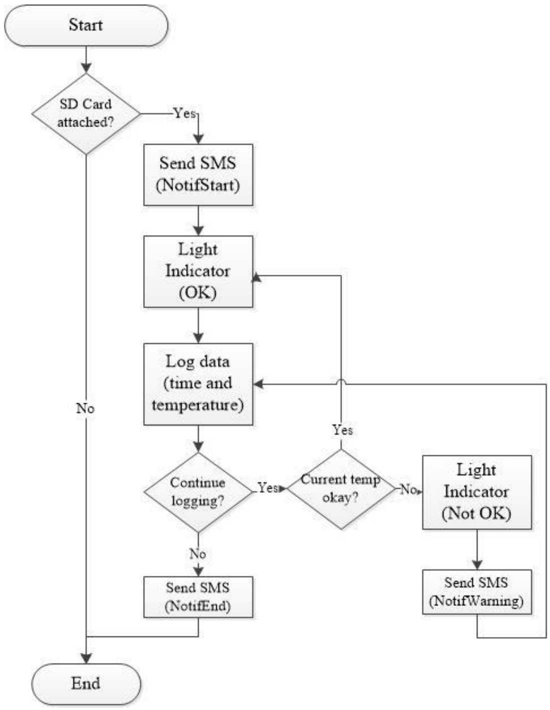

Figure 3 Device workflow diagram

Notification message received by the relevant stakeholders will be sent when important events occur when the transport takes place, such as, when it started to transport (start logging), when temperature rises above the maximum temperature threshold (warning notification), and when arrive at the destination (end logging). This notification serves as an event log that will be the secondary log event other than the log files recorded on the SD card. Log files recorded on the SD card will be accessed and saved as a complete transport records and can be used as an archive for all relevant stakeholders, while event logs sent via SMS will be quick report. An example of the usefulness of this quick

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report is can give warning when the temperature rises above the threshold, so that stakeholders can contact the truck to ask whether there is any problem with the truck refrigeration equipment.

Stakeholders who receive event log messages depend on the supply chain schemes undertaken by the company. If the company acts as a producer and distributor as well of its products to the retail (sales), then only the producer and retailer who act as receivers of the message. If producer do the distribution functions through third party (distribution company) before being handed over to the retailer, then the three parties, producer, distributor (3rd party), and the retailer becomes stakeholder and event log receiver.

If the current temperature exceeds the threshold then yellow indicator light turned on and notification message sent to stakeholders. Notification message contained information that there was a rise in container temperature exceeds the temperature upper threshold at that time. The device workflow could terminate when the transportation finished and the materials handed to other stakeholder.

The system design applied into a program computer. A computer program is a coded series of instructions that tells the computers what to do. The programs that run on Arduino are called sketches [7] and the software use to write the instruction code for Arduino is Arduino IDE (Integrated Development Program). Arduino IDE can be downloaded free from http://arduino.cc/en/Main/Software. The screen shot of the program can be seen in Figure 4.

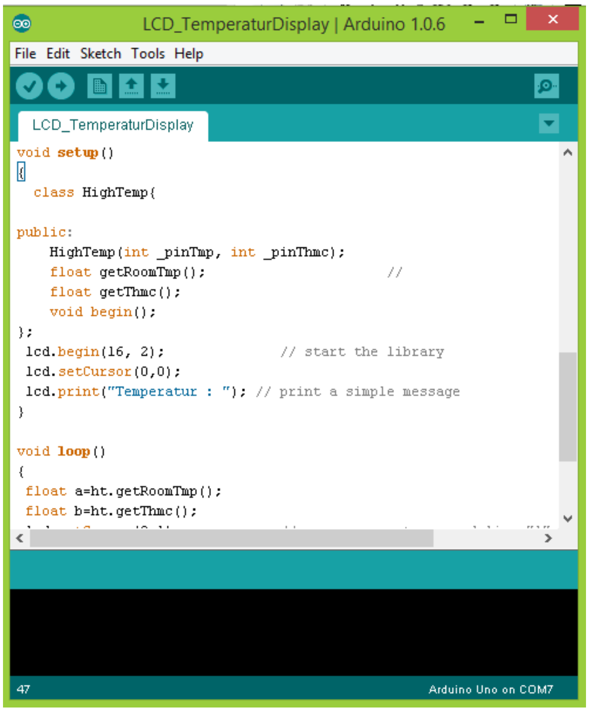

Figure 4 Screen shoot of Arduino IDE software

3.2. Hardware and Prototype Design

Arduino shield used as component connected to Arduino microcontroller can be stacked above another component and does not required jumper cable to connect and assemble the device. Shield has “male pins” at the bottom of their board which can plug into Arduino pin headers. Shield also has pin headers that can be connected with another shield. Protoytping done after all components were assembled. Device prototype was shown in Figure 5.

Figure 5 Device prototype

When the device turned on, it will run setup to process the program code uploaded to the microcontroller board. The device sends a notification for all stakeholders related (producers, distributors, retailer, etc.) that the transportation has started at that time, acquired from real time clock module (RTC). Log file (.csv format) created inside SD card to record the time and temperature during transportation every 5 minute. Log file example shown in Figure 6

Temperature Record Data Truck 093-TIN Expedition		
Date	Time	Temperature
1/6/2015	9:20	33.89
1/6/2015	9:25	35.05
1/6/2015	9:30	35.05
1/6/2015	9:35	33.89
1/6/2015	9:40	33.31
1/6/2015	9:45	33.41
1/6/2015	9:50	33.7
1/6/2015	9:55	33.41
1/6/2015	10:00	33.6

Figure 6 Recording log file example

ISBN : 978-1-4673-7404-0

3.3. Advantage and Disadvantage

This device has several advantages and disadvantages. The advantages of this device are open source, easy to store log files, and have responsive warning activity feature. Arduino, an open source hardware and software makes this device inexpensive and easily duplicated and modified as needed with the addition of other sensors, such as pH sensor and humidity sensor. Log files can be archived easily on the computer because it is already stored in .csv file format.

Warning activity provide actual information about temperature inside the container to the driver and stakeholder related to the cold chain transportation. Stakeholders can immediately know about the events occurred during transportation takes place, such as when the transportation started, when the transportation ended, and when the container's temperature reach or exceed upper threshold. The stakeholders then could ask to the driver to ask for confirmation if there was any notification sent to their mobile phone.

The disadvantages of this device are in need of electric power supply and GSM signal network to perform. Lack of GSM signal network during transportation could affect the notification message delivery and information given into stakeholders mobile phone may not actual, or even the device failed to deliver the notification message.

IV. CONCLUSION

In this paper, we combine cold chain transportation with open source platform software and hardware to create an inexpensive system and prototype to monitor temperature during cold chain transportation. This configuration and model allow small and medium-sized enterprise (SME) to build temperature monitoring device with low cost. With this model, stakeholders related to cold chain transportation can easily receive report and log file about temperature history of their product and ensure quality product. For distributors this device also used to diagnose whether there was any failure or interference with their refrigerated truck equipment. The advantage of this device is easy to modify and duplicate because using open source platform. The disadvantage of this device is require electrical power supply and GSM network signal

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ISBN : 978-1-4673-7404-0

[Late-Breaking Paper]: Development of Downstream Cocoa Industry: Exploring the Role of Government and Small and Medium Industry in Partnership

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***Abstract*— Although the development of the downstream industry based on the local commodities has been a government agenda, particularly in Indonesia, few studies address the development of the industry at Small and Medium Industry (SMI) level. These papers examine the role of Government and SMI in partnership to develop the downstream cocoa industry. The six participant that represent government, academia, and the industry have been interviewed to explore the current partnership in the development of the downstream cocoa industry. Findings show the stakeholders that related to the downstream cocoa industry. The collaboration between the stakeholders lead by the government can affect the partnership in the development of the downstream cocoa industry. The study findings imply the importance of government initiatives, sustainable program, database creation, market creation, research partnership, and entrepreneurial spirit as a factor that must be enhanced to increase the partnership. The empirical findings of this study can be used as a basic knowledge to improve the development of the downstream cocoa industry at SMI level.**

I. Introduction

Indonesia, as stated in Presidential Decree No. 28 Year 2008 on National Industrial Policy, want to be an industrialized country in 2020. To achieve these objectives, the development of SMI based on strong local commodities is substantial. One of many Indonesian local commodities that have strong resources is cocoa.

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Indonesia is the third largest cocoa bean producers in the world [1]. It puts cocoa as an essential commodity that can contribute in sizeable economy development for the country. As one of the cocoa-producing country, the Indonesian government intend to develop the downstream industries cocoa products, by issuing policy. The policy related to the industry is Ministerial Regulation No. 67/PMK.011/2010 and updated through No.128/PMK.011/2011, which sets out the duty for cocoa beans for export that effective since April 2010. The policies aim to ensure the availability of raw materials to increase the competitiveness of domestic processing industries. This policy eventually develop the domestic cocoa industry [2].

Small and Medium Industry (SMI) play an important role in economic development, both in developing and developed countries. The role of SMI in developing country, such as Indonesia, have been more vital since they contribute to improvement in several area, such as create new employment, export growth, increase the foreign exchange, and poverty reduction.

Unfortunately, the partnership between the government and SMI still become an issues. Thus, this research aims to explore the partnership between the government and SMI in the development of downstream cocoa industry at SMI level.

The challenges present in the partnership between the government and SMI in the development of cocoa downstream industry. The challenges are related to cooperation, communication, and objectives between stakeholder in the industry including the government and the SMI [3]-[4]. Whereas, learning from others successful SMI development, partnership between government and SMI is important [5]-[7].

The research will unite different views of government, academic, and SMI to explore the partnership between the government and the SMI in the development of downstream cocoa industry. The role of government, academic, and SMI is very

 ISBN : 978-1-4673-7404-0

important in the development of economic region[8], so, it will be interesting to identify the common ground of their views' in the development of downstream cocoa industry at SMI level before taking further action. Considering the description above, the research question is: What can we learn from the government, academic, and SMI point of view regarding the government and SMI partnership in development of the downstream cocoa industry?

As the result of the study, the government will have the several field that should be enhance to increase the partnership with the SMI in the development of downstream cocoa industry. Hopefully, this would help policy makers develop policies favoring future partnership with the SMI.

II. LITERATURE REVIEW

Cocoa value chain is the full range of tangible and intangible cocoa activities to adding a value to deliver a cocoa product from the start of cocoa tree live until the end [9]. The cocoa value chain that have been presented well in another study [10], can be seen in the Figure 1.

Fig. 1. Cocoa Value Chain

According to the Ministry of Industry [11], the upstream cocoa industry start from the production stage until the marketing stage. The intermediary cocoa industry is the result of processing stage, namely, cocoa paste, cocoa liquor, cocoa butter, and cocoa powder. The rest is the downstream cocoa industry, the industry that use an intermediary cocoa industry product as the raw material.

A study in value chain improvement for Indonesian cocoa industry have conducted [10]. The study state that cocoa industry resources and industries related to the cocoa industry has not been optimized to support the development of the cocoa industry.

The development of the industry in SMI level is essential due to their contribution in economic development. Previous research [12]-[13] has indicated a need to develop the downstream cocoa industry to increase the industry performance. A study in policy formulation of cocoa industry [14] indicate that the partnership between the government and the industry is important in the development of the cocoa industry. However, the study does not discuss the development in the downstream industry.

The literature demonstrate that in the development of downstream cocoa industry, the research focused on improvement on the upstream industry level or the intermediate product of cocoa industry [12]-[13]. Yet, a study exploring the development of cocoa downstream industry at SMI level need to be review. Moreover, in the development of SMI level, government and SMI should have create a good partnership in order to successfully develop the industry [15]-[18]. Thus, it becomes important to conduct the research.

III. METHODS

This study took place in Bogor, West Java, Indonesia. The city of Bogor have two institutions and one SMI that can represent the government researcher, academic, and SMI. The institutions are the government research center, an Agricultural University, and two cocoa based SMI in Bogor.

To get the insight about the partnership between the government and SMI in the development of cocoa industry, the researcher conducted interviews with six participants. The sampling procedures used by the researcher was purposive sampling. The participants were selected to those, according the researcher, are the expert in the development of cocoa industry.

The data collection process took place over an eight-week time period. The data were collected through interviews. Each interview was tape-recorded for accuracy and lasted between 60 and 100 minutes.

The collected data were transcribed and categorized in terms of research questions and emergent themes. Specific interview questions were matched to answer the research questions. The researcher use Framework method to analyze the data.

IV. FINDINGS AND DISCUSSION

A. Findings

The Government and SMI Partnership: Government Researchers Views

The interview was conducted with the government researcher. The point revealed from the interview are:

1. The stakeholders in development of downstream

ISBN : 978-1-4673-7404-0

cocoa industry according to the government researcher have their own role in the development of the industry at the SMI level.

The SMI. Interviewees reported that the SMI is a stakeholder in the downstream cocoa industry that process the product for the consumer.

Big industry. Interviewee reported that the big industry supply the raw materials such as cocoa powder and cocoa paste for the SMI.

Government. Interviewees reported that the government act as the facilitator for the SMI. Interestingly, the government that the interviewee said is from several institution, namely, Ministry of Industry, Ministry of Agriculture, Ministry of Trade, and the local government.

Research centers and Universities. Interviewees reported that the both institution should be a partner for the SMI.

Associations. Participant 1 said that if the strategy for the development of downstream cocoa industry want to use a cluster, creating an association would be necessary.

Cooperatives. SMI cannot buy a raw materials at retail from the big industry. Participant 1 suggest there must be another institution such cooperatives that can bridge the SMI and Big industry so they can buy the raw materials.

Entrepreneurship. One strategy to develop the downstream cocoa industry is increasing the new entrepreneur. Furthermore, the new entrepreneur that have an entrepreneurial spirit.

2. From the interviews it revealed that the role of the government cover a further details.

Policy makers. To maintain the sustainability of downstream cocoa industry, the government have already make a policy from upstream to downstream industry. Participant 1 reported that in the upstream cocoa industry level, the government has been to provide a guidance for the farmers to increase the quality and quantity of cocoa beans through the ministry of agriculture. Moreover, in the downstream industry the ministry of Industry should have more role to the development of the industry.

Facilitators. Up until now, the government already have several programmed to assist the SMI. Some of the programs are research for product development, training, and providing the assistance in the form of buying a machine for the SMI.

3. The SMI role in the partnership with the government according to the government researcher are the producer.

Producer. Currently, the SMI have been already to make a contribution in the development of downstream cocoa industry. The contribution is in product diversification.

4. Learning from the government and the SMI current partnership, the government researcher suggest the strategies to increase the partnership in the development of downstream cocoa industry.

Sustainable program. Development of downstream product of the cocoa industry should be planned well by the government. Especially in collaboration between the stake holder.

Entrepreneur spirit. It is important for the SMI to have an entrepreneur spirit because problem usually arise for the SMI.

The Government and SMI Partnership: Academic Views

The interview was conducted with the government researcher. The point revealed from the interview are:

1. The stakeholders in development of downstream cocoa industry should be interlinked to develop the downstream cocoa industry.

Government. The government must educate the consumer to consume the product that made by the local industry.

Research center. The research center including university already have a role as a partner for the government and the SMI. However, there are some factors that should be improve.

Industry. The industry role is in the manufacture of downstream products from cocoa. Participant 4 explained that:” The first downstream industry is the industry that sells cocoa butter, cocoa liquor and cocoa powder. Furthermore, the next downstream industry is an industry that sells products to consumers, most of them are multi-national companies.”

2. The government role in the partnership with the SMI according to the academics are given a trainer, assistances, and an equipment provision.

Trainer. Up until now, the SMI have been given several training by the government, like Participant 3 reported:” So far, the government has provided guidance sanitation, GMP, and registration certification.”

Assistance. The government usually give some assistance through the local government.

Equipment provision. Participant 4 reported that even though the government give equipment provision, sometime the machinery is different from what the SMI need.

3. The SMI role in the partnership with the government according to the academics are product development, and beneficiaries.

Product development. Participant 4 said that the SMI is participating in the development of downstream cocoa industry.

Beneficiaries. Participant 3 explained that the role of SMI in the partnership is as beneficiaries from the government.

4. Learning from the government and the SMI

 ISBN : 978-1-4673-7404-0

current partnership, the academics suggest the strategies to increase the partnership in the development of downstream cocoa industry. The strategies are:

Pilot project. Currently the development of the downstream cocoa industry has not shown a tangible result. The measurement is the SMI who known as a good result from the government program.

Education. To develop the downstream cocoa industry the stakeholders should educate the consumer about the importance of cocoa product.

Third party. Because of the government cannot accommodate all the problem related to the downstream cocoa industry there are arise some institution who can act as a bridge for the SMI to communicate with the government.

Research funding assistance. It turns out that not only the SMI who cannot make a partnership with the research center, but also the local government that try to make a collaboration with the research center due to the financial regulation.

Entrepreneur. It is important to government to test the spirit of entrepreneurship of the SMI before providing some assistance, like purchasing a machinery for the SMI.

Market creation. In the development of downstream industry, sometime the SMI cannot create their own market.

The Government and SMI Partnership: SMI Views

The interview was conducted with the government researcher. The point revealed from the interview are:

1. The stakeholders in development of downstream cocoa industry according to the SMI are government, association and research center.

Government. Overall, the role of government in development of downstream cocoa industry at SMI level is need to be enhanced.

Association. The association has not able to play a role in the development of the development of downstream cocoa industry if the purpose is to export the product. The problem arise because the Indonesian chocolate composition is different from other countries.

Research center. In general, SMI have not been able to utilize the results of the research conducted by the research center. Two factors arises according to the participant. First, it is too expensive that only a big industry who can make a collaboration, next the result of the research is not applicable for the SMI.

2. The government role in the partnership with the SMI according to the SMI views are given some training and participation in exhibition.

Training. According to the Participant 5, the trainings given by the government is useful for the SMI. The SMI can have a lot of knowledge that can be used in increasing the company performance.

Participation in an Exhibition. Participant 6 explained that the participation in an exhibition for the new enterprise is important to promote the product.

3. The SMI role in the partnership with the government according to the SMI are product development and promoting the local wisdom.

Product development. In the SMI level, the development of downstream product of cocoa industry should be start from the intermediary product of cocoa industry such as cocoa paste, cocoa butter, and cocoa powder. It is unaffordable for the SMI to produce it from cocoa beans.

Promoting the local wisdom. Besides creating the product, the SMI also inserting the local wisdom in their product, so that they promotes the local culture. The part of the product that they utilize is the packaging.

4. Learning from the current partnership between the government and the SMI, the SMI suggest there are several things that must be improved, there are:

Information sharing. It is necessary for the SMI to promote their product, one of them is on exhibition. However, since there are usually a financial issues in the SMI, the government usually have a programed to facilitate the SMI to attend the exhibition.

Special Event. It turns out that the peak season for the downstream cocoa product SMI is when there are a special event. The special event that help the SMI are, Valentine's Day, Ramadhan Event, Christmas, New Year's event, and events held by the school or campus.

Database. It is important for the government to have the SMI database. With the SMI database, the government can have the SMI training history. Using that data, the government can share the training facility equally.

Persistent. Training given by the government is the right place for the SMI to increase their knowledge. Because it limitations, sometime the knowledge sharing between the trainer and the SMI is limited. In fact, not many SMI realize that actually the training session is an event when the SMI can make a connection with the trainer. In the future the connection is important if the SMI have a problem.

B. Discussion

In this study, it is revealed that the government have a major role in the development of downstream cocoa industry. Other than the government, the stakeholders in the development of downstream cocoa industry are the big industry that produce the upstream cocoa industry product, the SMI itself, the research center, cooperatives, a consumer, and another institution as an alternative solution between the SMI and the research center. The relationship between the stakeholders, can

 ISBN : 978-1-4673-7404-0

be describe like in the picture bellow.

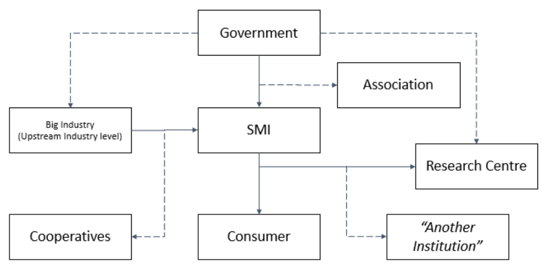

Fig. 2. The Stakeholders Relationship

According to the interview, currently every stakeholders is running independently and not collaborate well. This study also reveal that the SMI association still have less contribution in development of cocoa industry. Whereas, the SMI Association should have a role to facilitate the SMI in communicating with the government. The same condition is happened with the cooperatives, even though their existence is important in order to facilitate the SMI to order the raw material from the large Industry. This study also revealed that there are no institution who have roles as the cooperatives, so the SMI can have an advantages in supplying the raw material. It is contrary to what the government's objective in establishing associations and cooperatives [19]. Those institutions role actually an extension of government support for the SMI.

From the government side, the government realized that they should act as the facilitators for the SMI. Further actions that can be taken by the government as a SMI facilitator is to increase the role of government research center to facilitate the SMI in order to increase the SMI innovation. The previous study in the role of R&D institution [20] explained the important of research institution as a trigger for the technology absorption in the industry. Therefore, with the government support as a facilitators, the SMI can have a sustainable growth and development [16].

Interestingly, this study also revealed the existence of “Another Institution” as a bridge between the SMI and the research center. Previous research [21]-[23] already explained that this institutions come up because the inability of SMI to have access to the research center. In one hand this institutions actually helping the government to assist the SMI. On the other hand, this institution showed that the research center cannot give a good service to the SMI. In accordance to the existence of this institutions, the researcher suggest that this institutions should have make a collaboration with the research center. With this collaboration, both institution can share the service to the SMI.

To successfully develop the downstream cocoa industry, there should be strong partnership between the government and the SMI. Since both the government and the SMI already have their role in the development process, it is necessary to increase the partnership in order to foster the development.

There are several role that we can suggest based on the analysis of the current role that the government and the SMI already done.

Sustainable program. Government program in the development of downstream cocoa industry should be planned well. From the interview, there are a condition where the stake holder should consider that cocoa is not a daily product that the consumer use. Two strategies can be proposed to overcome this situation. First is by doing an education to the consumer using a role model from the public figure. Another strategy is promoting the downstream cocoa product by creating an event.

Database creation. In the development for the SMI based on cocoa downstream industry, creating the SMI database can give some advantages to the government. First, the government can give a facilitation evenly among the SMI, then the government can monitor the result. Another proposed program for the government is to create a pilot project for development of SMI from the start until they are successfully independent [24]. If the program success, the multiplier effect will be interesting. The government can develop a franchise of the successful SMI and there will be follower that imitating the successful company.

Market creation. In the development of the downstream cocoa industry, increasing the number of the SMI in the industry is also important. The important of that is can also help the regional economic development by increasing the job opportunities. The government and the SMI can take part in this market creation. For the government, creating a policy in the market creation would be appropriate [25]-[26]. As for the SMI, they can be an agent in creating the new entrepreneur by sharing their experience.

Entrepreneurial spirit. This spirit can be known by the individual personality character such as risk-taking, persistence, good control, and have a strong motivation [27]. It is important for the government to make a test, before giving a facilities to the SMI, especially in giving a machinery. This study revealed that there are a lot of SMI’s owner who failed to develop their company after they have been given some facilities. The government researcher and the academic in this interview agreed that this condition because the SMI does not have an entrepreneurial spirit. By having this spirit usually the people will not easily give up when facing the barrier. The entrepreneurial spirit also important for the established SMI in order to solve the problem in order to growth

ISBN : 978-1-4673-7404-0

[28].

Research partnership. Previous study [6] reported that the government support is significantly related to the innovation in SMI. From this study, the researcher found that the absence of partnership between the SMI and the government research center. The research to solve the SMI problem unaffordable for the SMI. In fact, there is evidence that research partnerships have a positive impact on the performance of firms and regions [29].

V. CONCLUSION

In the development of the downstream cocoa industry there are at least six parties involved as the stakeholders. The stakeholders are government, SMI, association, research center, consumer, big industry, cooperatives, and another institution. Based on the analysis, there are four area that should be develop in order to increase the partnership between the government and the SMI: 1) Sustainable Program; 2) Database Creations; 3) Market Creations; 4) Entrepreneurial Spirit; 5) Research Partnership. The result wishes to become a useful foundation for the future research in the development of the downstream cocoa industry.

ACKNOWLEDGMENT

This work is supported by the Ministry of Industry of Republic Indonesia.

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ISBN : 978-1-4673-7404-0

The Role of Communication in The Technology Transfer Process (A Case Study at The Centre for Agro-based Industry)

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Abstract*—In the 21st century, countries throughout the world face the need to change their focus on national strategic planning from a resource-based to a knowledge-based economy. Many countries increasingly use public research as their broad strategies in industrial development. Consequently, technology transfer and commercialization of research become critical factors as universities and public research institutions (PRIs) become key institutions in the process of economy "catch-up". As one of the research institutions under the Ministry of Industry, the Centre for Agro-based Industry (CABI) is responsible to conduct research with a focus on the agro-based products. However, the research at CABI still have a relatively low application rate because most of the research were not commercially implemented in the industry. This research project aims to identify the communication channels used in the technology transfer process that occurs in CABI and to further identified and suggest a way to maximize the number of CABI's R&D application to the SMEs. The research is conducted using a case study method with an interpretive approach. Data collection is done using semi-structured interviews with respondents consist of CABI's researchers and staff and SMEs. The result shows that there are ten communication channels used by CABI's staff in technology transfer, namely: research collaboration; scientific publication; research dissemination; "client hunting" program; CABI's events such are seminar and workshop; exhibition; free trial offer; leaflets or brochures; and Forum Group Discussion. However, from those ten channels, only three channels of communication perceived by the SMEs, that lead them to the technology transfer process. It is implied that the communication channels used by CABI are still intended for broad users, therefore it is necessary for CABI to narrowing down the potential users and aligning the perception they have about the technology with the capacity and need of the SMEs in order to increase the success rate of technology transfer.

Keywords: technology transfer, communication channels, public research institution, Indonesia.

Manuscript received July 29, 2015.
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I. INTRODUCTION

A. Background

In the 21st century, countries throughout the world face the need to change their focus on national strategic planning from a resource-based to a knowledge-based economy. There is a need to develop a system for improving science, technology, and innovation because these intellectual properties are gradually measured as capital [1].

Many countries increasingly use public research as their broad strategies in industrial development. Consequently, universities and public research institutions (PRIs) become key institutions in the process of economy "catch-up". As public research conducted by PRIs and universities are increasingly needed, technology transfer and commercialization become critical areas that must be studied to help us understand how the process occurs [2][3][4].

In Indonesia, the R&D activities still have a relatively low productivity. Based on their funding sources, the performance of government-funded R&D institution display less performance than institution with self-sufficient funding [5]. Aside of that, there is also a challenge in technology transfer, as it is found that the level of research collaboration between PRIs and industry in Indonesia is still low [6]. As one of research institutions under Ministry of Industry, Centre for Agro-based Industry (CABI) has obligation to disseminate its research and applied them to SMEs. However, though some attempts in the technology

ISBN : 978-1-4673-7404-0

transfer process has been done, the research conducted at CABI still have low successful application rate to the SMEs. This particular problem will become the main focus of the research with the attention to the communication and relationship that occur during the technology transfer process in CABI.

B. Research Questions

In this research, the main research questions are:
RQ1. What are the channels of communication used by CABI's staff in the technology transfer process?

C. Research Significance

Only limited studies have been conducted in the technology transfer process that occurs in government research institution in Indonesia. This research will reduce the gap on a limited study of Indonesian R&D performance. PRIs might be less flexible in terms of technology transfer policies and might also have less focus on gaining revenue through technology transfer and the commercialization process compared to private R&D institution. This condition has arisen due to the nature of PRIs that still have a dependency in the government funding and policies [5][7].

Aside of that, there are also limited studies that investigate the process of technology transfer that occurs in developing countries that may exhibit different condition compare to developed countries. Some of them are shown in their weak innovation systems and low R&D intensity [8]. For instances, most of the SMEs in developing countries are found to have capital constraints, low human capabilities and low technological capabilities [9][10]. All of these characteristics may make the SMEs in developing economies to perform less R&D activities than PRIs and therefore, make the need for technology transfer is higher than those in developed countries.

D. Limitation

This study focuses more on the formal communication that occurs during the technology transfer process. It did not concentrate in the informal networking, how the stakeholders relate using it in the absence of good formal networking. Furthermore, it was conducted as a single case study, therefore the result might only valid be for implementation in a research organization that has a similar condition with CABI. It does not examine in detail the motivation of stakeholders that may that might influence the perception of the researchers and the SMEs in seeing the technology and affect their engagement in the technology transfer process.

II. LITERATURE REVIEW

A. Indonesian R&D: in a glance

The economic challenge that the globalization brings has made Indonesian Government pay more attention in the productivity of government-funded research, in the hope that the technology transfer will support SMEs in their innovation process [5]. Research productivity in public research institution (PRIs) has always become the concern of many nations as loads of investment is given to the public R&D centre. People want to see that their money is well spent and not wasted. Therefore, the pressure for PRIs to produce applicable research is increasing [6].

Public R&D Institutions (PRIs) in Indonesia are categorized into 4 types which are: Universities; Non-Ministerial Government Research Institution (GRI-NMs); Ministerial Research and Development Agencies (R&D-Ms); and State-owned Enterprises R&D Agencies (R&D-SOs). The source of funding for these types of R&D institution is different. Universities (State Universities) have source of funding that is primarily derived from market mechanism and only small amount of them comes from government budgets; GRI-NMs and R&D-Ms have source of funding that mainly derived from government budget mechanism; and R&D-SOs are usually gathered its funding sources from their self-sufficient internal funding [5]. The government is mainly funding research activities of PRIs. Because of this, there is a growing attention to the effectiveness and productivity of the research system to make sure that the investment are well returned [11].

B. The Concept of Technology Transfer

Technology transfer is defined in many different ways, referring to the purpose and discipline to which the research applies. This interdisciplinary dimension of technology transfer allows the definition and concept of technology transfer to be described from many perspectives. Most definitions of technology transfer viewed technology as something that does not change during the transfer process. Few of the first definitions of technology transfer describe technology transfer as a process of innovation adoption that occurs between two organizations where the ideas move from research related in laboratory to the production related phase in the industry [12][13].

However, other researchers studying the technology transfer process argue that the technology transfer process is essentially a communication process, therefore there is an interactive process that occurs between two or more entities [14][15]. It implies that in the process of technology transfer; individuals may become a receptor organization if he actively seeks for answers about their problem from R&D organizations or other source of information.

Technology transfer arises via various channels of communication, both public and personal, such as *spin-off, licensing, publications, meetings or person-to-person interaction,* and, *cooperatives R&D agreements* [16]. Aside of that, there are also informal/personal information exchange and consulting [3]. Based on *World Intellectual Property Organizations* (WIPO), there are three phases in technology transfer mechanism, which are creation;

 ISBN : 978-1-4673-7404-0

protection; and exploitation, as seen in *Fig. 1.* below:

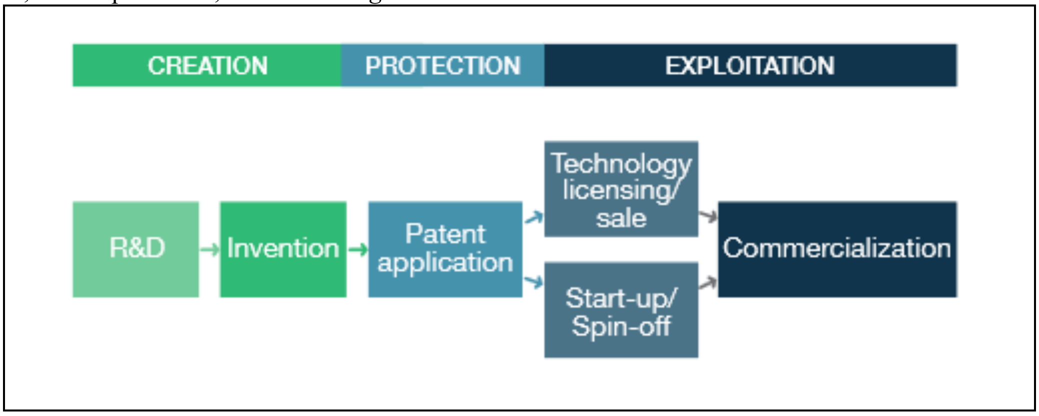

Fig. 1. The technology transfer flowchart (source: World Intellectual Property Organizations; http://www.wipo.int/edocs/pubdocs/en/general/1033/wipo_pub_1033.pdf)

The success of research transfer depends on the very nature of its research type and technology. Each field may have a different level of risk as well as chance to be successfully implemented in the industry. The supporting policies and regulation, organization, and market context may also be influential in the technology transfer and commercialization process of research [19][20].

C. Technology Transfer: from communication perspectives

Communication has been found to be one of the most essential factors in the success of technology transfer [18][21]. With uncertainty and complexity that follows the technology transfer process, the increasing expectation in enhancing technology transfer from R&D institution had become one of the issues in the innovation process. During the technology transfer process, there are two communications linkage that are important to the successful process of technology transfer. These factors comprise functional linkages between the internal organization and its networks linkage with other organizations. Both linkages are correlated to the communication patterns that exist in the organization and play an important role in understanding the value of intangible organizational assets [22][23][24].

According to reference [25], internal communication within the organization is very important in technology transfer since it can help increase technical performance of the technology being transferred. There are two criteria in choosing communication channels. The first one is accessibility, which reflects how easy it is to contact and approach the channel. The second criteria is technical ability, which reflect the reliability of the channel in generating information. Each criterion is equally important in communication and is chosen based on the individuals' perception towards his environment.

Government agencies are known for the bureaucracy and hierarchy that exist within the organization. The issues that often occurs in this type of organization are the presence of deep bureaucratic structures, weak change culture, and high-powered incentives. This kind of company tends to be internally focused and has a slow response to the market changes [26].

The technology transfer conducted by government research institution usually differs than of the corporation technology transfer in term of motives and method. Government agencies perform technology transfer as an obligation to the legal mandates that are given to them and often these motives do not well-disperse within the organization. It makes the research output from government R&D laboratories are rarely at the level desired by the firms. Aside of that, the technology transfer conducted by government agencies are intended to be widely disseminated to as many SMEs as possible. That is why the methods used in the process are very general and "distant" [20].

In addition, the presence of particular independent organization that handles commercialization process is important to foster the relationship between the university and the industry in technology transfer and commercialization. Liaison offices or units are needed because not all of the researchers have the ability in marketing and management area, all of which are important in the commercialization of research. Furthermore, other factors such as the existence of well-defined incentive policy also give researchers good motivation to commercialize their ideas [27][28].

Based on all of the above reviews, it can be concluded that technology transfer is an interactive process, and the communication become the critical factor that are affecting the technology transfer process. Limited studies in government technology transfer process that deal with agro-industrial development, particularly ones in developing countries create a gap with previous research studies. Therefore, this research attempts to investigate further about the technology transfer process from the perspective of communication process in the hope that it may be able to give some insight into other government research institutions, particularly one that deals in the same fields of agro-industrial development.

ISBN : 978-1-4673-7404-0

III. RESEARCH METHODOLOGY

A. Introduction

As stated in the previous chapter, in the current state of CABI's research section, the implementation of research to the industry is still considered low. Therefore, there is an attempt to increase the performance of CABI's R&D using an effective technology transfer process. In order to holistically understand the phenomenon that occurs in a real-life event, this study uses a descriptive single-case study approach. A case study is often used as a tool in social science to describe a complex process or phenomena. This approach helps the researcher to obtain the whole characteristic and pattern that occurs in real- life event [29]. Nevertheless, the researcher also aware about the limitation that occurs in case study approach. A case study approach can only provide a limited basis for scientific generalization because it is only specific to the environment of the sample being investigated. Aside from that, the other limitation that occurs is the theoretical framework that is being used in the case study that often builds a specific perspective for the researcher to see the phenomenon [29].

B. Data Collection

This study was conducted in Bogor Regency, with Centre for Agro-based Industry (CABI) as a case study. CABI is one of research institutions under The Ministry of Industry that provides research and technical services to the industrial community, particularly agro-industry community.

This study applies a case study approach and the data collection is gained through interviews and CABI's annual report. The framework for the research can be seen in this *Fig. 2*. below:

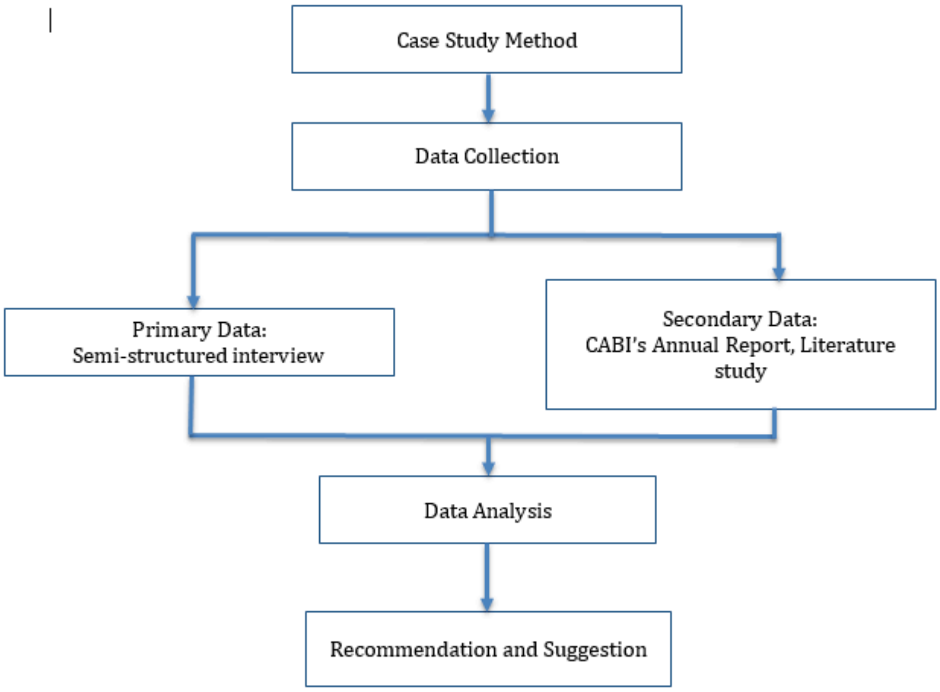

Fig. 2. Research framework

This study seeks to explain about the current situation in the technology transfer process and understand better about its performance. Based on this reason, the sampling approach that is chosen in this study is single case study with interviews as a way to collect the data. Ref [29] mentions that case study allows researchers to explore complex social phenomena holistically. The participants are chosen using purposive sampling. All of the respondents are chosen for their experience in technology transfer process. The researchers and staff are chosen based on their activities in delivering research result to the SMEs, while the SMEs are chosen based on their current experience in research collaboration with CABI.

The data were collected through a semi-structured interview where six sets of open-ended main questions and eleven subset of questions were prepared. Semi-structured interview was chosen to explore new ideas and perspectives that might be brought up by the interviewees during the interview. This method allows the researcher to probe the information and clarification provide by the interviewee's answers [30].

Specific topics and themes were chosen to provide guidelines for the interview. Total of 8 interviews are conducted for 45-60 minutes. Face to face interviews

ISBN : 978-1-4673-7404-0

and international phone calls are arranged for the interview, followed up by emails and text messages. In the interview process, there were two respondents that interviewed at the same time and place. The reason for this was they were only willing to participate if they were interviewed together.

C. Data Analysis

The first step in data analysis is the preparation of data. In this stage, the data obtained through notes and recording then transcribed verbatim. After that, initial reading then administered to the transcribed interview to get insights and understandings of a phenomenon that emerged from the data. In this stage, the data started to be coded and categorized based on themes that emerge. Next, themes that are being produced from the coding stage then identified and clustered based on the research questions. The last stage is the translation of data from Indonesian language to English. The translation has been kept to the last stage to avoid misperception and misinterpretation.

I. RESULT AND DISCUSSION

Based on the data analysis, there are several themes that emerge during the interviews. Those themes then categorized based on research questions.

RQ1. What are the channels of communication used by CABI's staff in the technology transfer process?

Table 1. Communication channels used by CABI's staff in the technology transfer process

Researcher	
Channels	**Sample text**
1. Seminar/ Workshop	"The promotion is done by dissemination, seminar, exhibition…" (R3)
2. Exhibition	"…By exhibition we can display our research products to advertise our institution, what is important is to make CABI known by the SMEs" (R3)
3. CABI's website	"..we can also use CABI's website. In the website, we've uploaded our research abstract, but unfortunately many SMEs do not know it.." (R2)
4. "Client hunting" program	"…Starting this year, marketing section invite me to join their program to visit the industry…we promote our services, including R&D services…" (R2)
5. Research dissemination	"..involved in research dissemination and promotional activities of research services" (R5)
6. Forum group Discussion (FGD)	"..in FGD and research dissemination, SMEs's problems usually fastly handled because they can consult straight to the researcher itself" (R1)
7. Free trial offer	"..for small industries, what matter is whether the technology is free or not. If it is free and he/she can increase the product quality, he/she will gladly accept the offer" (R3)
8. Scientific publication	"a research must also be able to write as a scientific publication for publication interest" (R2)
9. Leaflet/ Brochures	"research result can also be made as leaflet as a promotion to SMEs" (R4)
10. Research collaboration	"in 2013, there are research collaboration with Ministry of Research and Technology (MoRT) and PT. Tama Coklat…" (R2)
SMEs	
1. Seminar/ Workshop	"the second time is when I was invited to cocoa convention in Bogor. One of the speaker is CABI director" (SM1)
2. Research Collaboration	"I have had a research collaboration with CABI about coffee from dates seeds" (SM2)
3. Consultation services	"The idea came from me. It occurs because I saw my housemaid throwing kilos of dates seeds and I wonder whether we can make something from it and not just waste it away …then I came to CABI and consult about it, we agree to make some research on it…" (SM2)

Based on Table 1., the analysis of interviews suggests that there are ten communication channels used by CABI's staffs in the technology transfer process. All of them represent the attempt CABI has made to introduce research to the SMEs. However, from the perspective of SMEs, they mentioned only three channels of communication that lead them to the technology transfer process. Those are seminars/workshops; research collaborations; and consultation services. The latter is perceived by the SME as a way of how they know about CABI's R&D services for the first time.

 ISBN : 978-1-4673-7404-0

Technology transfer is a process of moving knowledge from the originators' place to the recipients' place. As the knowledge is mostly seen as a tacit form, the transfer process requires a 'bridge' to be able to connect the knowledge from the donors' side to the recipients' side. The result shows that during the interaction between SMEs and CABI in the technology transfer process, there are ten communication channels used by CABI. However, from all of the channels, only research collaboration and seminar/workshop are mentioned by the SMEs as communication channels in the technology transfer process in addition to consultation services.

Communication channels are often chosen based on their accessibility and technological ability. Seminars/workshops, consultation services, and research collaborations are mentioned by the SMEs because they see that these channels are more accessible for them compared to the other channels. SMEs are tend to see the problem they have as the most crucial part. Therefore, they come to CABI and ask for consultation and training programs before deciding to take participation in research collaboration. Using these three channels, they have easier access to approach the researcher and ask about their problem. These activities create a good interactive process between both parties so that the researcher knows better about the SMEs' need and that will benefit the technology transfer process.

Based on this finding, it is implied that the existence of consultation and training program is essential in accelerating the process of technology transfer from CABI to the SMEs. These programs help create opportunities for CABI's researchers to share their research to the SMEs. It confirms previous research that states that training and consultation program is necessary to the success of technology transfer process. These mechanisms must exist at the early stage of technology transfer until the company start-up stage, where the technology is then transferred to the customer [31][32][33].

As implied by all of the respondents, the technology transfer process is an interactive process that occurs between actors and it requires various communication activities. Seeing the technology transfer process as a communication phenomenon, we have to take into account the importance of identifying the barriers in a communication process.

One of the barriers that arise during the interviews is the different perception of the technology from both of SMEs and researchers that often causes the transfer of technology failed to happen. Researchers tend to see the technology from the scientific perspective while SMEs tend to see it from the economic perspective. The SMEs mentioned that it is important for them to consider the customer acceptance of their product as well as the operational and production cost that may affect their product price after the use of the technology. For them, all of those factors are important because those factors have impact on their business.

In contrast, some of the researchers mentioned about the importance of having a research that can potentially leads to scientific publication. It means that in conducting a research, the economic perspective of the research does not become their main focus. For them, research is seen as a scientific area of study. This condition create a gap between researchers and SMEs since there will be no exchange taking place if there is no benefit for both parties and it makes the technology unsuccessfully transferred to the SMEs. In dealing with this issue, the researchers must ensure that their research is desired and eagerly anticipated by the SMEs.

In addition to the finding, it is also implied that the communication channels conducted by CABI in technology transfer still intended for broad consumers, as seen from the selection of communication channel, such as: scientific publication, research dissemination, and seminar/workshop. There are also still fewer efforts to monitor the extent to which SMEs can use a given technology. This particular stage is the stage where the technology transfer process often fails to deliver. It is known that government approach in technology transfer process is often very general and unfocused, due to their obligation to deliver the research to as many SMEs as possible [20].

There are two issues that arise in this condition. First is that CABI must be able to identify potential users for their research and choose few of them so that CABI can focus its attention and also control the process. The second is CABI should built a good communication/relationship with the receptor to be able to successfully transfer the technology.

Consistent with all the findings mentioned above, Ref [21], state that the communication barriers in technology transfer occur in different ways, such as different vocabularies used by individuals; different individual motives; how individuals represent the organizations with different cultures; and how the transfer process represents a variation of highly abstract concepts to concrete products.

Ref [34] mention that it is very important for the researchers to communicate with the SME to understand better about the problem that the SMEs have and to understand how far the capacity or capability that the SMEs have in order to accept the technology. That is why CABI as an R&D institution should start to use an upward communication approach to communicating with the SME.

This approach is actually has been used by CABI in the hope that both CABI's researchers and SMEs have same views about the value and the potential use of the technology. Started from two years ago, CABI conducts a "client hunting" program to better understand the need of the industry and to offer to solve the problem together through research collaboration, providing training and consultation programs during the process, and conducting yearly

ISBN : 978-1-4673-7404-0

evaluation to the SMEs. However, how effectives this program is as a communication channel in the technology transfer process has not been measured yet. It will be best for CABI to pay more attention in this process because this channel seems to be the best approach for CABI to understand the need of SMEs.

I. Conclusion

Based on the discussion above, it is known that the role of the communication in the technology transfer process at CABI is essential. It provides accessibility for the information flow from CABI to the SMEs and vice versa. As it is found, the issue of trustworthiness is important to the success of technology transfer process. Different perceptions about the technology between SMEs and CABI's researcher often lead to a gap that can make the transfer of technology fail. Therefore, this issue will be worth to investigate further in another research series to understand more about their perception and motivation in conducting a contract research or technology transfer

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ISBN : 978-1-4673-7404-0

The Centre for Pulp and Paper Appraising Its Productivity In Generating Industry-Applicable Research: A Good Practice Illustration

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***Abstract*—This research is designed to find out factors that influenced the productivity of a research center in Ministry of Industry based on case study of the good practice and has been conducted using mix method. The quantitative methods are used for preliminary stage to obtain the sample of the best practice and to measure the productivity of selected research center. Qualitative method is used to investigate the factors that contributed to productivity in research activity. Quantitative method has been used annual performance report of each research centers under the Ministry of Industry during 2010-2014 as sources of secondary data. Qualitative method has been carried out using interview with exploratory approach. The respondent for interview is focused and limited into internal organization, consist of management level (structural position/echelon) and researchers.**

Based on the preliminary stage, Center for Pulp and Paper (CPP) has been selected as the best practice for case study because it has the highest number of implemented research in industries during 2010-2014. The productivity of CPP has been measured using the number of technological products/services each year.

Based on the productivity measurement, CPP has higher productivity and efficiency compared to productivity of several R&D institutions observed on previous study. Based on interview, there are several factors that influenced the productivity in CCP and divided into two main categories which are internal and external factors. The internal factors are human resources, method/knowledge, infrastructures, mindset, internal organization policy and organization support. The external factors consist of government policy, budget allocation, the condition of pulp and paper industry, and networking.

Keywords: productivity, efficiency, measurement

I. Introduction

INDUSTRIAL sector has been a backbone and prime mover of economic growth in many countries including Indonesia. According to Ministry of Industry Performance Report 2014, the growth of non-oil manufacturing sector for 2014 grew by 5.61 percent, higher than the economic growth of 5.02 percent. The industrial sector, excluding the non-oil processing industry, is still the largest contributor to the national GDP compared to eight other economic sectors, with a contribution of approximately 48%, 49%, 49% and 45% during 2010-2013 respectively [1] [2] [3] [4]. This condition showed that industry plays an important role as leading sector, which triggered the growth of other economic sectors. The growth of the industrial sector is a prerequisite for the job opportunities creation and poverty alleviation. Growth in the industrial sector will contribute to economic growth and per capita income. In the end, the role of the industry is to improve the welfare of society, as has been mandated in the Constitution of Indonesia.

However, the growth of industrial sector in Indonesia is strongly influenced by the availability of raw materials and capital goods obtained through imports. This condition has given the big impact to the competitiveness of the industry, especially in the context of the free trade era. In the other hand, the competitiveness of an industry is determined by the support of the government as the policy maker. The government also has a role as technology providers technology providers, generated through universities and research institutions owned by the government. Furthermore, the government has a role in transfer technology from it research institutions to the industries, including Ministry of Industry.

The role of technology development in Ministry of Industry is charged to BPKIMI (Agency for the Assessment of Climate Policy, and Industrial Quality) as a unit under the Ministry of Industry, formerly known as Agency for Industrial Research and Development. BPKIMI has twenty two research centres spread across Indonesia. Each research centres has different core competences and R&D focuses. The role of these research centres in generating and diffusing research results is vary greatly in terms of productivity and effectiveness. According to internal report for research centres performance during 2010 -

ISBN : 978-1-4673-7404-0

2015, Research Centre for Pulp and Paper has the highest productivity in term of generating and diffusing it research results to industries. However, since 2012 there was substantial decline for the number of research that generated and transferred to industry. The same case also happened to another 21 research centres.

This study is conducted to identify external and internal factors that influenced the research center in generating applicable research, based on the research center that has higher number of implemented research to industries, which is Center for Pulp and Paper (CPP). This study furthermore aimed to explore the influence of external and internal factor toward productivity and effectiveness of CPP in generating and transferring it research results to the industries.

This study is conducted using mix method, which are quantitative method as preliminary stage to obtain data about the number of research that has conducted in and the number of research results that has been implemented to industries last five years during 2010 - 2014. The quantitative method also applied in measuring productivity and effectiveness of selected research center to identify the influence of external and internal factors toward it productivity and effectiveness. Qualitative method is conducted to investigate the external and internal factors that contributed to productivity and effectiveness. Quantitative method is conducted by using secondary data obtained from internal report in Ministry of Industry and qualitative method is carried out using depth interview in exploratory approach. The respondent for interview will be focused and limited into internal organization, consist of management level (structural position/echelon) and technical level (functional position, which is the researcher).

II. LITERATURE STUDY

A. The Role of Research Centers in the Ministry of Industry

According to World Economic Forum in Global Competitiveness report from 2010-2013 [1] [2] [3] [4]., industrial sector has gave the biggest contribution to GDP of Indonesia for both manufacture and non-manufacture industry. However, the manufacturing sector showed a gradual decline in the contribution to GDP, while the non-manufacturing sector showed the contrary, as shown in Table 1.

The high contribution of industry to GDP cannot be separated from the high level of public consumption and the increased of investment in the industrial sector which is very significant to maintain the performance of the manufacturing industry. However, the growth of the industrial sector is highly dependent on imports, especially capital goods (iron and steel, machinery and automotive), which is widely used by domestic industry to carry out production activities (Industry Performance and Ministry of Industry Performance Report)[5].

TABLE I.
CONTRIBUTION OF GDP IN INDONESIA BASED ON WORLD ECONOMIC FORUM, GLOBAL COMPETITIVENESS REPORT 2010-2013 [1] [2] [3] [4].

Year	Agriculture (%)	Industrial Sector		Services (%)
		Manufacturing industry (%)	Non-manufacturing industry (%)	
2010-2011	14	28	20	37
2011-2012	16	27	22	35
2012-2013	16	26	23	35
2013-2014	17	11	34	38

Research centers in Ministry of Industry have the same role as the university in term of both institutions conducting R&D activities, so that in the concept of the triple helix those research centers are positioned as academicians. Carayannis and Alexander [6] proposed that knowledge transfer between the three actors of triple helix involving innovative process where the cycle of knowledge transfer creating feedback loops involving knowledge generation, diffusion and sharing processes.

Beerkens [7] mentioned that universities as well as any research institutional, including research center are a part of center of excellence. His research focused on three countries, including Indonesia. He showed that even the global model for center of excellence has been adapted and adopted in Indonesia, local factors also affected the ways of global model implementation. In his case, the lack of funding from government has forced university to conduct more private partner involvement and international scientific cooperation. Furthermore, research in sample university in Indonesia showed that university actually has been conducting applied research and not so much touched strategic research.

According to Irvine and Martin (1984) in Beerkens [7] "strategic research is basic research carried out with the expectation that it will produce a broad base of knowledge, which is likely to form the background to the solution of recognized current or future practical problems". He also suggested some field that currently has become emerging technologies that are projected to have a strong prospective for future application are nano-science, biotechnology, energy, IT, advance materials science, and so forth.

Those emerging technologies has been set as research focus by Indonesian government through Ministry of Research and Technology, and also has been adapted and adopted by Ministry of Industry in their research strategic plan through it research centers. Based on the linear model of innovation process in Indonesia as shown in figure 1 (Mulyanto [8], R&D institutions including research centers under the Ministry of Industry have a responsibility to conduct adaptive and innovative research in their sector on the down-stream side.

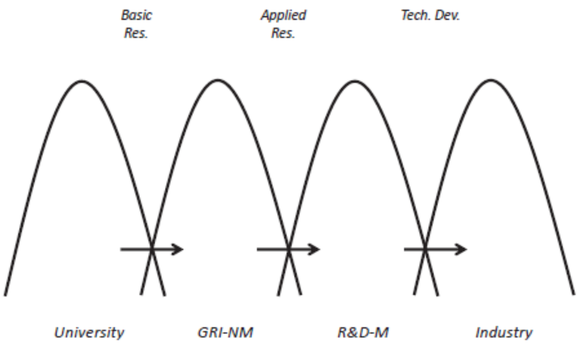

Figure 1. The linear model of innovation process in Indonesia: role of each R&D institutions

B. *Productivity Measurement*

Productivity measurement usually followed classic economic theory where the variables closely related to production and cost theory. The conventional method to measure productivity is dividing the output of production with the input. According to Elnasri and Fox [9], productivity is a measurement of how efficiently an economy utilizes finite resources to produce goods and services. Hence, roductivity is a ratio of output to input. There are two ways to improve the total output, first it can be increased by increasing the utilization of resources and second by improving the efficiency with which resources are employed. Lanjouw and Schankermann [10] proposed that productivity in research activities is measured by considering to break the patent to R&D ratio into its two component parts: the patent to invention ratio, and the invention to R&D ratio.

Ramsden [11] mentioned that the most critical indicator of research productivity is publication, regarded as the main source of esteem, as a requirement for individual promotion, as evidence of institutional excellence, and as a sine qua non for obtaining competitive research funds, publication is central to scholarly activity and recognition. According to Ramsden [11], quantity is the simplest way to measure the productivity of research.

Barnett *et al.* [12] in their study measures of researcher productivity over four years post-funding using several outputs: numbers of articles published, numbers of citations to those articles, the most cited article, and the number of highly cited articles. Several previous studies use publications as a parameter for output in measuring productivity (Kocher [13], Rufaidah [14], Lakitan *et al.* [15], Mulyanto {8], Arimoto *et al.* [16]), while the other study use patent as the proxy of output parameter (Henderson and Cockburn [17], Zuker *et al.*, [18]. However, this study did not use publication as the output parameter since there is no clear and sufficient data to support productivity measurement, especially international publication. This study also did not use patent as the parameter of output because the number of patent granted in Ministry of Industry is very low. Furthermore, patenting is difficult and rare event because it requires an expensive process and not all innovations generate sufficiently profitable revenues (Falavigna and Manello [19]).

In this research, the productivity measurement using technological products or services generated from the research center as the output parameter and the number of researchers and budget as the parameter for input. This measurement is chosen so that the result of this study can be compared to a previous study by Mulyanto [8]. In previous study conducted by Mulyanto [8], he defined technological productivity as:

Productivity = technological products (services)/researcher/year

C. *Factors Contribute to Productivity*

Henderson [20] stated that productivity of the research is very depends on allocation of resources, including knowledge. He also observed that 20% - more 70% research activities are duplicative, trivial and wrong as results of poor communication between research centers. His observation pinpointed that knowledge sharing between research centers is the main key to increase productivity of research center by avoiding duplication and spend more cost.

According to Mulyanto [8], several factors that contribute to productivity of research institutions are: individual factors such as age, gender, type of positions occupied by scholars, scientific disciplines, training, etc; and institutional factors such as the average age and the positions of colleagues, the quality of institutions and colleagues, non-permanent researchers, size institution, funding, scientific collaboration. His study also discover that the type of R&D institutions, source of funding, institutional size and unit cost index are the factors that influences R&D productivity, especially R&D institution in Indonesia.

Previous study by Chen *et al.* [21] discovered the factors driving the productivity of research consist of investment factors (extrinsic rewards) and consumption factors (intrinsic rewards). Extrinsic rewards are involves an increase in salary, academic position and promotion, while the intrinsic rewards include researcher satisfaction with the results of research, contributing lecturer on the faculty accreditation and recognition from co-workers.

Bland and Ruffin [22] identified some of the

ISBN : 978-1-4673-7404-0

environmental variables associated with high research productivity. There are twelve common characteristics of a productive research environment, consist of:

(1) clear goals that serve a coordinating function, (2) research emphasis, (3) distinctive culture, (4) positive group climate, (5) assertive participative governance, (6) decentralized organization, (7) frequent communication, (8) accessible resources, particularly human, (9) sufficient size, age and diversity of the research group, (10) appropriate rewards, (11) concentration on recruitment and selection, and (12) leadership with research expertise and skill in both initiating appropriate organizational structure and using participatory management practices.

Arimoto *et al.* [16] examined the productivity of academic institution in Japan. They found out that several factors contribute to productivity, which are:

1) Social attributes (gender, age).
2) Career (highest degree obtained, academic rank).
3) Organizational climate (type of university, evaluation of research activities, expectations of research activity in faculty evaluation, and intellectual atmosphere).
4) Research resource (research funding, assessment of research equipment and instruments, quality of students).
5) Attitude (preference for teaching or research activity).
6) Professional activities (time spent on research, attendance at disciplinary conferences).

According to Arimoto *et al.* [16], factors that have highest level of significance to productivity in academic institutions in Japan were research funding, conference attendance, and the level of degree followed by preference for research.

III. RESEARCH METHOD

A. Data Collection

This research is conducted using mixed method approaches, which are quantitative and qualitative approach. The quantitative method are used as a preliminary treatment to obtain a research centre that has higher number of implemented research result in industries as a sample for case study and to measure productivity base on selected sample. The qualitative method is conducted through interview using exploratory approach. This research has been conducted in the research centre under the Ministry of Industry in one year, from July 2014 – June 2015. The location of this research is in the Center for Pulp and Paper of the Ministry of Industry.

The sampling procedure used in this study is divided into two types, based on quantitative and qualitative methods. The quantitative method has been used the whole population, which are the 22 research centers in Ministry of Industry. Meanwhile the qualitative method will use purposive sampling based on the result of preliminary treatment. The sample in qualitative method is research center that has higher number of implemented research result in industries.

The first participants in quantitative method are all the research centers in the Ministry of Industry and the second participant is the research center that has higher number of implemented research result in industries. The second participants consist of six researchers as the respondent that representative of academician and the management level (structural function) as a representative of government, which is the head of division for research and standardization.

Mixed method has been used in this study and adopting the case study approach. Data collection are obtained using secondary data for the quantitative method using the Ministry of Industry's Research Centers performance report and primary data using interview for the qualitative method.

This study has been used secondary data obtained from research centers performance report to produces information regarding to number of implemented research in industries. The expected information from the secondary data is the number of research that has been implemented by the industries for each research centers. Research center with largest number of implemented research will be used as the sample for the case study. The secondary data also used to obtain the number of research project within five years since 2010-2014 in selected research center based on preliminary result. The qualitative method has been used interview to identify the perspectives, thought and feelings of the participants regarding to research topic. The interview has been conducted using international phone calls. Exploratory approach has been used to identify the factors that affected productivity in generating applicable research in research center in the Ministry of Industry.

The research will conducted through several steps. First is mapping the actual condition of research center in the Ministry of Industry. The purpose of mapping is to identify the number of applicable research in research centers in the Ministry of Industry. The mapping has been conducted by using secondary data from annual performance report of each Research Centers in the Ministry of Industry. Second is selecting the research center that has highest number of applicable research as the object for the case study. Third is doing interview and exploratory analysis to identify the factors that contributed to productivity in generating applicable research in research center in Ministry of Industry.

B. Data Analysis

1. Productivity Measurement

Productivity measurement followed the previous study by Mulyanto [8] using technological products/services as the output parameters, while the number of researcher and budget as the input

 ISBN : 978-1-4673-7404-0

parameters. However, he differentiated the calculation of productivity which budget as the input parameter as the technological efficiency. The equation for the technological productivity, Pt (#/res./y) is defined by Eq. (1) and technological efficiency, Et (#/Billion Rp), as defined by Eq. (2).

Pt = technological products(services)/researcher/year (1)
Et = technological products(services)/R&D budget (2)

2. Exploratory Analysis

The exploratory analysis is aimed to obtain information regarding the factors that contributed to productivity and effectiveness in generating applicable research.

IV. RESULTS AND DISCUSSION

A. Productivity of The Centre for Pulp and Paper

Research on productivity of R & D institutions was not new study. However, previous research has a wide range of different parameters to measure productivity. Kocher *et al*. [13] measured productivity of research in economic between 21 countries of OECD members using the number of publications as the output factors and R&D expenditures, number of populations and number of universities with economic department as the input factors. His finding suggested that some countries showed positive responses by increased the number of the input factor that influenced the number of the output factor, hence improving the number of productivity.

While the other studies conducted by Henderson and Cockburn [17] examined productivity of pharmaceutical firms who conduct research in the fields of pharmaceuticals by using patent as a measure of output. Research results conclude that firms with a large capacity more productive. This is because larger firms have advantages in terms of capital, which in the field of pharmaceutical research requires equipment as fixed assets are costly. The company also benefited from the spill over of resources including knowledge so as to make it more productive. The impact of inter-firm spill over on research productivity has increased significantly over the last two decades.

Based on the equation above, productivity and efficiency for CPP each year during 2010-2014 is shown in table 2. In this study, the number of research project that has been used only research project that funded through government funding, not included research project that funded by industry.

According to the measurement as show in table 2, there was gradual decline in productivity and efficiency during 2010-2014. The number of research project was also has tendency to decreased, while the number of researcher experienced the opposite. However, the number of research budget had an increase until 2012 and then gradually decreased.

TABLE II.
PRODUCTIVITY AND EFFICIENCY OF CENTRE FOR PULP AND PAPER 2010-2014

Year	Technological Products/ Services	No of Researcher	Budget (in Billion Rp)	Productivity	Efficiency
2010	20	13	0.689	1.54	29.045
2011	12	15	0.542	0.80	22.121
2012	15	25	0.901	0.60	16.646
2013	12	27	0.823	0.44	14.582
2014	8	25	0.627	0.32	12.765

Comparing to the result from previous study by Mulyanto [8], while he calculated productivity and efficiency for several R&D institutions in Indonesia for 2012, including Ministry of Industry in general, productivity of CPP is higher than any observed R&D institutions. However, the number of productivity of CPP in 2013 and 2014 were slightly lower than productivity of two State-Owned Research Centre, which are Coffee and Cocoa Research Centre and Oil Palm Research Centre, with productivity value for that State-owned Research Centre are 0,543 and 0,456 respectively. Meanwhile, the value of efficiency for CCP still higher than any observed R&D institutions.

This result suggest that CCP has better productivity and efficiency in conducting research compared to another R&D institutions in Indonesia. The funding for research in CPP sourced primarily from government. However, CPP also conducts join research with several industries, which also provide the funding for the research, as mentioned by interviewee CPP2.

"usually researcher and marketing division build communication channel to offer training and join research with industry, and if the industry have an interest, CPP will make cost bidding" (CPP2)

According to Mulyanto [8], CPP is categorized as A-type R&D institutions because the source of research funding mainly from government. However, the actual condition shows that CPP was shifted from A-type to B-type R&D institutions because CPP also gain the funding for joint research from industries (fig. 2).

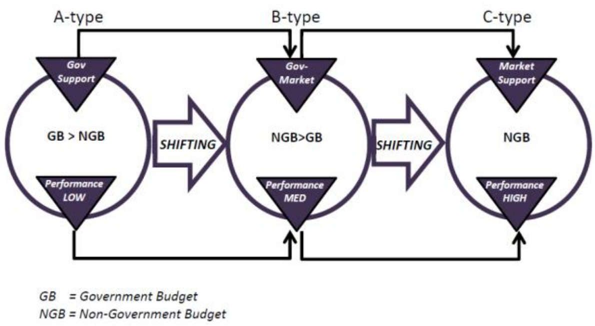

Figure 2. The 3-types of R&D institutions based on their funding sources

It is a common thing for the industry, especially in

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Indonesia that they are not easily willing to fund and use the research generated by R & D institutions particularly those owned by the government. According to Zucker *et al.* [18], one factor that moved joint research is the need to transfer the tacit knowledge that occurs in form of new knowledge that has been arose from various problems that happened in industry. The industry need to solve their problems that might impede their production and productivity. Moreover industry lack of experience and competence to solve all those problems. In the other hand, CPP has the competence and experience to resolve the problems faced by industry, as well as contribute to generated new knowledge.

B. Factors Influence Productivity cf Center for Pulp and Paper

Some previous research examines the various factors that affect productivity of research activities in R & D institutions in Indonesia, both universities and government research institutions. Margaretha and Saragih [23] conducted a study on the determinants factors of lecturer's research productivity revealed that several factors such as age, academic position, gender, investment factor, consumption factor and organization support were not significantly affecting productivity. Furthermore, they found out that years of service was the only factor that has significant impact to productivity of lecturer research. Meanwhile Mulyanto [8] propounded that type of R&D institutions, source of funding, institutional size and unit cost index as the factors that influenced productivity of R&D institutions.

Based on conducted interview with seven respondents, this study has been discovered some factors that influenced productivity in CCP and divided into two category as internal and external factors. Internal factor is factors that come from within the organization and in general are controllable, while the external factor is factors that come from outside organizations and independent.

The internal factors that has been found are human resources, method/knowledge, infrastructures, mindset, internal organization policy and organization support. The external factors consist of government policy, budget allocation, the condition of pulp and paper industry, and networking. Each of these factors individually and simultaneously influenced productivity of CPP.

4.3.1 Internal Factors

a) Human resources

Powers [24] mentioned human capital resources as the one of independent variables that has very significant roles for research institution, especially in transferring technology and established a reputation. Human resources in CPP that play important role in conducting research are researcher and engineers. However, other division such as marketing and auditor for certification are also play an important role. Human resources as a factor that contributes to productivity is mentioned in interview by CCP2, CCP4 and CPP7.

b) Method/Knowledge

Carayannis and Alexander {6] mentioned that knowledge has specific qualities that distinguish it from other capital, such as financial or physical capital. Knowledge can be exchanged between individual or group, but once knowledge being exchanged, it is held by both the giver and the recipient. Method and knowledge is an important capital to produce reliable research and embedded with researcher as one integrity. The importance of knowledge was reflected in interview as mentioned by CCP2, CCP3, CCP5 and CCP7.

c) Infrastructures

Infrastructure is a vital tool to carry out research, especially for R & D institution with research output in the form of technology, both prototypes and processes. According to Dundar and Lewis [25], institutions with better infrastructure support should contribute to increasing their research productivity. Based on the interview, 5 out of 7 interviewees mentioned infrastructure as important factor in conducting valid and reliable research in R&D institutions (CPP1, CPP2, CPP5, CPP6 and CPP7).

d) Mindset

Some previous studies did not mention mindset explicitly as a factor that affecting research productivity. Chen *et al.* [21] stated that the motivation or encouragement of personal influence on research productivity. He divides motivation into intrinsic and extrinsic rewards. Extrinsic rewards emphasized that research productivity determined by the outcome (impact) that will be received by the researcher. Intrinsic reward more emphasizes to personal (researcher) satisfaction after doing research, the contribution he/she made to the science and recognition he/she will gained from co-workers. Mindset explicitly mentioned in interview only by one interviewee (CPP3), but also mentioned implicitly by another interviewees.

"researchers need to focus on conducting applicable research instead of basic research" (CPP4),

"the implementation of ISO 17025-2005 and remuneration has changed mindset of CPP's employees including researcher to be more discipline in achieving their target/objective, hence increase their productivity" (CPP5),

"limitation of budget for research has been forcing researchers to be creative and more improvised" (CPP6, CPP7),

"CPP researcher has been utilised modification process in pulp and paper industry as interesting

ISBN : 978-1-4673-7404-0

research fields to study, but also beneficial for the industry, mainly because not many pulp and paper industry is the focus on that field" (CPP1).

e) Internal Organization Policy

Internal organization policy means that the internal organization (CPP) establishes its own policies that are considered beneficial to the organization. Internal organization policy is more flexible, which means it can change at any time depends on the organization needs. According to Luecke [26], "organizations typically respond to the challenges of new technologies, new competitors, new markets, and demands for greater performance with various programs, each designed to overcome obstacles and enhance business performance". Some internal organization policies that obtained from interview are the implementation of ISO 17025-2005 as a general requirement for the competence of testing and calibration laboratories (CPP2, CPP4 and CPP5), and conducting regular meeting as a media for knowledge sharing between researcher, especially for mentoring from senior researcher to junior researcher (CPP7).

f) Organization Support

Collins [27] stated that human relation in an organization should be thought of as co-operative, social, as opposed to mechanistic systems. Meanwhile organization's structure and culture have clear implications for managerial choice in the area of strategy (Burnes) [28]. CPP realized that researcher is important assets for the institution, hence organization through management level will keep the researchers stay in the right track in running their duties and functions well, including competency upgrading through education and training. In addition to the management level also keep the researchers for not lagging behind in collecting the required number of credits as functional researcher (CPP7).

4.3.2 External Factors

a) Government Policy

The role of government in making policies to support the industry's growth and enhance the activity as well as the use of science and technology is very important. According to Wade [29], mostly the firms in now developed countries has been through a stage where the government protecting the firms with industrial assistance policy before all the firms ready and capable to compete within the free trade regulation. The importance of government's role is also reflected in the Chinese government's success in improving economic growth. Before the Chinese government introduced several economic growth reforms in 1979, the average annual real GDP growth rate from 1960-1978 in China was estimated at 4,4% according to the Congressional Research Service (Morrison0 [30], and now since 1979 the annual growth rate stood at 10%. Indonesian government support to the industry is reflected in the laws on industrial No. 3 2014, where the government supports the development and use of technology for the industry, as set out in clauses 36-42. Government stated in clause 40: "the government guarantees the risks on utilization of Industrial Technology developed in the country".

The existence of these regulations shows that the government considers the importance of the use of technology developed by domestic research institutions to improve the competence of industry. However, several government policies have a positive impact and vice versa. Based on the interview, some of interviewees mentioned that since the remuneration implementation in Ministry of Industry in 2012, there are several impacts against research performance in CPP. In one side, the remuneration implementation stimulated productivity of CPP employees in general and researcher in particular, through incentive rewards based on work performance achievements. In the other side, the determination of work performance indicators has changed the way of R&D centres in Ministry of Industry in determine the indicators, especially in research activities, to be more cautious. Those R&D centres has been set only small number of research projects as the output of research activities as a strategy, in order to make it more achievable. If they determined large number of research projects as the output for research activities indicator and in the end of financial year the achievement were bad, it will affect their work performance, more over will decrease their remuneration incentive rewards and conversely. The impact of remuneration mentioned in interview by CPP1, CPP3, CPP4, CPP5 and CPP6.

Bureaucratic problems also came up as an issue by several interviewees. According to CPP4 "research that conducted in CPP take longer time because several administrative and bureaucracy obstacle, while the industry need fast response for their problem to solved". Similar opinion also mentioned by CPP2, "researcher also burdened with administrative task that interfered research activities" and "the procurement process was not on time, thus disrupted the research activities".

b) Budget

As mentioned before, according to Mulyanto [8] R&D centres under the Ministry of Industry is A-type R&D institutions, which the source of research funding is mainly from government. The mechanism of direct funding for R&D activities is one of the main policy instruments used by governments to support science and innovation in each priority areas. Based on the interview, more than half of interviewees mentioned about the amount of research budget allocation for CPP, as said by CPP4, CPP5, CPP6 and CPP7. In their opinions, the budgets for research activities were decreased year by year especially after

ISBN : 978-1-4673-7404-0

2012, as shown in table 2.

The decreased in the number of research allocations are also considered as the trigger for the decline in productivity of research activities in the CPP because the amount of funded research became less. However, the decreased in the number of research projects especially after the 2012 CPP was also caused by the changed in CPP strategy in conducting researches, by funded research projects that more applicable for industry and more complex. This kind of research activities often require greater cost (CPP3).

c) The Condition of Pulp and Paper Industry

According to Indonesia Commercial Newsletter 2011, Indonesia has the potential to become the top three of the pulp and paper industry in the world, because the production of pulp and paper in Indonesia gained the benefit from natural conditions of Indonesian soil and geographical location in equator. Indonesia currently ranks eleventh in worlds for the paper industry and ranks ninth in the world for the pulp industry. However, productivity of pulp and paper industry in Indonesia are also influenced by the demand of market both domestic and export. According to statement from director of Sinarmas Pulp and Paper, Suhendra Wiyadinata as reported by Kontan Newspaper (2012), Indonesian paper consumption for 2012 has reached 30 kilograms (kg) per capita per year, far below the average of paper consumption in ASEAN countries, which reached 55 kg per capita per year. Meanwhile, European countries that has higher average of paper consumption were decreased in paper demand due to global crisis impact. He also stated that 50% of paper production in Indonesia is for export to several countries around the world, while the rest of the production for domestic market.

This condition has also contributed to research productivity in CPP. According to CPP1, the demands for joint research activities from pulp and paper industry were decrease since 2012. Similar statement was also mentioned by CPP7.

d) Networking

Carayannis and Alexander [6], observed that there were increasing in cooperation between firms and the rise in R&D partnerships involving government, university and industry. This emerging strategy has largely developed from observations of how competition in high technology, knowledge-intensive industries differs substantially from traditional modes of competition. Etzkowitz [31] stated that the interaction of University-Government-Industry as triple-helix is the key for innovation improvement for knowledge-based society. Industry in triple helix plays a role as the locus for production activities, while government acts as the source of contractual relations that guarantee stable interaction and change, and University as the source of new knowledge and technology. Based on the conducted interview, most of interviewee mentioned about networking or partnership with industry as the important factor in research activity. The relationship between CPP and industry reflected through joint research, training, seminar, and utilization of testing services in CPP laboratories. CPP1 also mentioned about the role technical directorate in Ministry of Industry as the adviser and connector between CPP and industries.

V. CONCLUSION AND RECOMENDATION

The conclusions that can be drawn from this study are:

1. Using the same calculation method with previous research, the result from this study shows that productivity CPP is higher than productivity of other R & D institutions that has been first studied.
2. Factors that influenced productivity in CCP are divided into two main categories which are internal and external factors. The internal factors are human resources, method/knowledge, infrastructures, mindset, internal organization policy and organization support. The external factors consist of government policy, budget allocation, the condition of pulp and paper industry, and networking.
3. Both internal and external factors are related and affecting each other. Networking is the most central factor that has been influenced productivity of CPP, followed by government policy, knowledge and infrastructures.
4. Infrastructure, competent human resource (researcher), knowledge and budget allocation for research funding are factors that need to improved based on interviewee's opinion.
5. Focus on requirements of the industry by listening to their problems is the key to successful communication that led to good relationship between the CPP and the industry. This success story later can be adopted by another research centers under the Ministry of Industry, as well as any R&D institutions.

According to triple helix concept, this study has been conducted from R&D institution perspectives merely. Furthermore, this research only used one single case study based on success story of research centre within the Ministry of Industry. For further research, author recommends to involves industry and government to see different perspectives from other actors of triple helix concept. Author also recommends to use several research centres within the Ministry of Industry as samples, instead of single case study, to obtain more comprehensive information regarding to R&D productivity.

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Frontier Approach in Process and Bioprocess Engineering

ISBN : 978-1-4673-7404-0

IDENTIFICATION OF FLAVOR COMPOUNDS IN *CEMCEM* (*Spondiaz pinata* (L.f) Kurz) LEAVES EXTRACT

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***Abstract*— One plant that is used as a functional beverage in Bali is cemcem (Spondiaz pinata (L.f) Kurz) leaf extract. This product such as herbs and has a typical color and flavor. Cemcem leaf extract is traditionally used to maintain a healthy and disease prevention such increase appetite, treat coughs, deodorizing and body refreshing.. Cemcem leaf extract is available in traditional markets and traditional restaurants in Bali. This study aims to identify the flavor compounds in the Cemcem leaf extract obtained in the district of Abiansemal, Bali Province using Gas Chromatografy Mass Spectrometry (GC-MS). Cemcem leaf extracts obtained using ethanol maceration process for 2 hours, at the ambient temperature, and fractionation performed with hexane and ethyl acetate. The result showed that the hexane fraction has 58 peaks, the ethyl acetate fraction has 14 peaks, and the ethanol fraction consists of 7 peaks. The dominant flavor compounds in the cemcem leaf extract were terpenoids, alkanes, alkenes, carboxylic acid ester, benzene, and alcohol.**

I. INTRODUCTION

Spondias pinnata (Linn. F.) Kurz (Family - Anacardiaceae) is a plant that originated from the regions of India, Sri Lanka and Southeast Asia. Spondias genus consists of 17 species and is most known in Indonesia is *Spondias dulcis* and *Spondias pinnata* [1].

In Bali, *Spondias pinnata* are usually called *Cemcem* or *Kecemcem.* Stem bark is often used as a remedy dysentery, the fruit is used as a cough medicine, the leaves are used as a flavoring and as a traditional beverage. Empirically, beverage from the leaves of *Cemcem* mentioned can treating cough, increase appetite and body refreshing effect. Besides used as a beverage, *Cemcem* leaves are also used as a flavor enhancer in processed fish products.

Phytochemical compounds contained in the genus Spondias has been widely studied. Crude extract of the bark is reported to have antibacterial activity and is able to treat dysentery. Methanol and ethyl acetate extract of Spondias stem has a hepatoprotective activity[2]. Methanol and chloroform extracts of Spondias stem contain phytochemical compounds such as flavoniod, glycosides, alkaloids, carbohydrates, saponins, steroids, and resin[3].

Pulp of *Cemcem* fruit has potential as an antimicrobial and bark potential as natural antioxidants [1], [4]. The extract of resin from Spondias able to inhibit the growth of gram-positive (+) bacteria [5].

Research on the content of bioactive compounds from ethanol extract of *Cemcem* leaves already been done. The extract contains steroids, flavonoids and triterpenoids. The 80% ethanol extract of the leaves contain terpenoids, flavonoids and flavonon. Extract at concentrations of 10 and 100 mg / mL have the ability as an antituberculosis. It also said that the ethanol extract or extract the polar solvent has the ability to inhibit the growth of tuberculosis bacteria which is expected to be a candidate fitofarmaka in the treatment of tuberculosis[6].

Research conducted by Wrasiati [7] stated that the ethanol extract of *Cemcem* leaves derivied from the area of Bukit Jimbaran, Badung has the ability as an antioxidant by 43.80 percent, total phenol content 38.95 mg GAE /100 g, tannin 11.01 percent, and ascorbic acid content 135.06 mg /100 g. There are 17 compounds detected by GC-MS, these compounds belonged alkenes, alcohols, phenols compounds and esters of fatty acids. The whole compounds were the

Manuscript received May 10, 2015. This work was supported in part by the Ministry of National Education and Culture, Republic of Indonesia.
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ISBN : 978-1-4673-7404-0

building blocks of *Cemcem* leaves from Bukit Jimbaran Regency.

Research on the components of flavor in Cemcem leaves have not been studied. Headspace analysis is one of the options for instrumental determination of volatile compounds in a sample as the headspace contains all the volatiles that are responsible for the odor sensation. There are several options to isolate and concentrate the volatile compounds from the matrix, such as steam distillation/extraction or supercritical CO2 extraction or the solid phase microextraction (SPME). The common method in instrumental volatile compound measurement is gas chromatograph-mass spectrometer (GC-MS). GC-MS combines two techniques: a gas chromatograph to separate out the volatiles mixture in a sample and a mass-spectrometer to characterize each of the components individually [8].

The aim of this study is to identify and define the constituent compounds of Cemcem leaves flavor derivied on Abiansemal, Badung area, Bali Province. Abiansemal is one area in Badung regency which has an area of 69.01 km^2. Abiansemal has a protected forest area is well known that Sangeh. Around of the protected forest, there are many *Cemcem* plants which is used as a traditional drink by the locals.

II. Materials and methods

A. Materials and Chemicals

Materials used in this research were Cemcem leaves were collected from Abiansemal-Badung Regency, ethanol, hexane, etil acetate, aquadestilata, and whatmann filter paper.

B. Equipments

The equipments used in this study are incubator, shieves, analytical balance, separation flask, rotary vacuum evaporator, oven drier, vacuum filter, magnetic stirrer, GC-MS, and glassware.

C. Samples Preparation

Cemcem leaves obtained from Abiansemal, Badung, Bali Province were sorted to obtain fresh leaves. Furthermore, fresh leaves are dried for 24 hours in an oven dryer at a temperature of 60^0C until the moisture content of 8%. Cemcem dried leaves is called the simplicia of Cemcem. Simplicia mashed in a blender and sieved to obtain a powder size of 60 mesh and then stored in the refrigerator temperature -4ºC prior to the extraction process.

The research was conducted through the insulating phase fractionation followed by GC-MS analysis phase. Cemcem leaf extract prepared by mixing 5 g of powder and put into a glass beaker, then 96% ethanol was added to a volume of 200 ml. This mixture was put in an incubator with a temperature of 28ºC and left to 2 hours. After that, the mixture was filtered with Whatmann paper and evaporated with a vacuum rotary evaporator at a temperature of 45°C until all of the solvent evaporates. Solvent-free extract was mixed with 50 ml ethanol and put into a flask, add 50 ml separating hexane and shaken for 15 minutes until homogeneous. Subsequently the mixture is allowed to stand for two hours resulting in the partition between hexane and ethanol fractions. Hexane and ethanol fractions were separated, and the fraction of ethanol re-inserted into the flask split and partitioned again with 50 ml of ethyl acetate, and separated in the same manner with the fractions of hexane above. Fraction of hexane, ethyl acetate, and ethanol was then evaporated with a rotary vacuum evaporator to obtain extracts with a volume of about 10 ml. Already vaporized, the fraction is then analyzed by GC-MS devices[9].

GC-MS analysis carried out by the method of Erdem and Olmez[10]. The carrier gas used was helium with a flow rate of 30 ml per minute. GC temperature is set as follows. Column type : AGILENT HP 5MS, column temperature 70^0C, injector temperature 310ºC, oven initial temperature was 100°C, the rate of temperature rise 5ºC/min, and the final temperature of the oven to 310ºC. Identification of compounds is done with using software Wiley 8 Library.

III. Results and Discussion

Chromatogram of the hexane fraction, ethyl acetate, and ethanol presented in Figures 1, 2 and 3. At the hexane fraction was detected 58 peaks with a retention time of 3.384 minutes up to 68.166 minutes. At the ethyl acetate fraction was detected 14 peaks with a retention time 3.546 minutes up to 28.921 minutes, and at the ethanol fraction was detected 7 peaks, with a retention time 21.238 minutes up to 28.672 min. Hexane fraction is the non-polar hexane, ethyl acetate is a semi-polar fraction and the ethanol is classified as polar fraction.

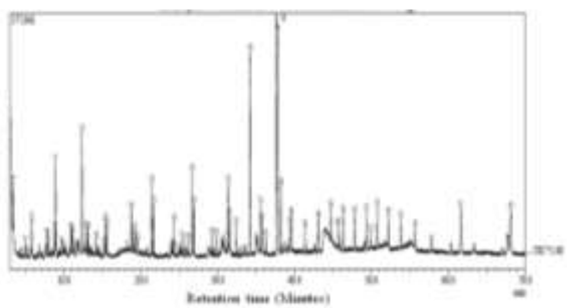

Figure 1. Chromatogram of Hexane Fraction

Flavor constituent compounds suspected contained in the hexane fraction, fraction of ethyl acetate, and ethanol respectively, presented in Table 1, Table 2, and Table 3. The compounds presented has a relatively higher concentration than or equal to 1 percent.

ISBN : 978-1-4673-7404-0

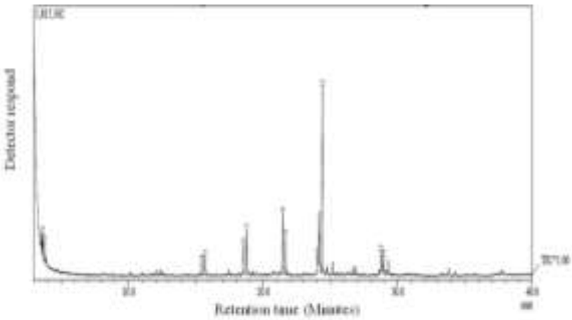

Figure 2. Chromatogram of Ethyl Acetate Fraction

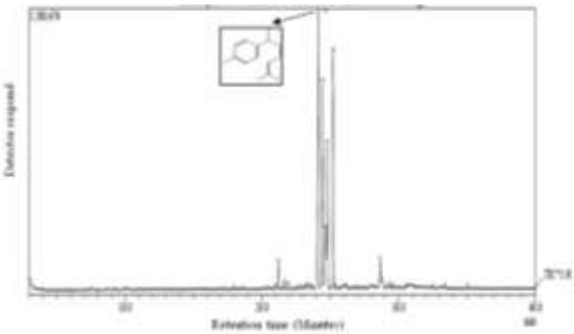

Figure 3. Chromatogram of Ethanol Fraction

TABLE 1.
CONSTITUENT COMPOUNDS ARE SUSPECTED IN HEXANE FRACTION OF THE CEMCEM LEAVES POWDER

No.	Relative Concentration (%)	Molecular Formula	Name of Compound	Compound Class	Similarity (SI)
1	2,60	C_7H_8	Methylbenzene	Benzene	92
2	1,27	C_6H_{14}	Hexane	Alkane	96
3	1,15	C_9H_{12}	1,2,3-trimethylbenzene	Benzene	96
4	5,00	$C_{12}H_{26}$	Dodecane	Alkane	96
5	1,06	$C_{10}H_{14}$	1,2,4,5-tetramethylbenzene	Benzene	92
6	1,35	$C_{12}H_{24}$	1-dodecene	Alkene	95
7	2,67	$C_{14}H_{30}$	Tetradecane	Alkane	96
8	1,19	$C_{14}H_{30}$	2,3,5,8-tetramethyldecane	Alkane	91
9	3,10	$C_{16}H_{34}O$	1-hexadecanol	Alcohol	95
10	1,96	$C_{16}H_{34}$	Hexadecane	Alkane	97
11	2,49	$C_{16}H_{32}$	1-hexadecene	Alkene	97
12	8,38	$C_{21}H_{42}O_2$	Eicosanoic acid, methyl ester	Ester of Carboxylic acid	94
13	1,10	$C_{20}H_{42}$	Eicosane	Alkane	95
14	11,74	$C_{19}H_{34}O_2$	9,12-octadecadienoic acid, methyl ester, (E,E)-	Ester of Carboxylic acid	94
15	10,54	$C_{19}H_{36}O_2$	9-octadecenoid acid (Z)-, methyl ester	Ester of Carboxylic acid	92
16	2,71	$C_{19}H_{38}O_2$	Octadecanoic acid, methyl ester	Ester of Carboxylic acid	95
17	1,06	$C_{23}H_{48}$	Tricosane	Alkane	96
18	1,03	$C_{17}H_{36}$	Heptadecane	Alkane	96
19	1,34	$C_{30}H_{62}$	Triacontane	Alkane	95
20	1,44	$C_{28}H_{58}$	Octacosane	Alkane	96

Overall, the building blocks of flavor contained in the Cemcem leaves are the terpenoids compounds, benzene, alkanes, alkenes, carboxylic acid esters, and alcohols. Benzenes have a 42.72% of relative concentration, Alkanes have a 72.68% of relative concentration, Alkenes have 38.65% of relative concentration, Ester of Carboxylic Acid compounds have 37.86% of relative concentration, and terpenoid compounds have a 55.86% of relative concentration. Based on the classification of flavor compounds were detected in each fraction, terpenoids are compounds that have the highest relative concentration (Table 4). Compounds into the terpenoid is 1.3-Cyclohexadiene, 5- (1,5-dimethyl-4hexenyl) -2-methyl [S- (R *, S *)] -, Cyclohexene, 1-methyl-4 - (5-methyl-1-methylene-4-hexenyl) -, and Beta-sesquiphellandrene. Greek Citrus aurantium L. essential oils are a potential natural source of monoterpenes such as limonene, β-pinene, linalool and linalyl acetate [11].

TABLE 2.
CONSTITUENT COMPOUNDS ARE SUSPECTED IN ETHYL ACETATE FRACTION OF THE CEMCEM LEAVES POWDER

No.	Relative Concentration (%)	Molecular Formula	Name of Compound	Compound Class	Similarity (SI)
1	1,30	C_8H_{16}	2-hexene, 2,5-dimethyl-	Alkene	91
2	2,50	$C_6H_{12}O_2$	Acetic acid, 2-methylpropyl ester	Ester of Carboxylic acid	93
3	1,99	$C_6H_{10}O_2$	2-propenoic acid, 2-methyl-, ethyl ester	Ester of Carboxylic acid	92
4	2,19	$C_{11}H_{22}$	1-undecene	Alkene	96
5	2,95	$C_{12}H_{26}$	Dodecane	Alkane	97
6	4,92	$C_{12}H_{24}$	1-Dodecene	Alkene	95
7	7,81	$C_{12}H_{26}$	Dodecane	Alkane	97
8	11,38	$C_{14}H_{28}$	1-tetradecene	Alkene	96
9	6,90	$C_{12}H_{26}$	Dodecane	Alkane	97
10	3,18	$C_{15}H_{22}$	Benzene, 1-(1,5-dimethyl-4-hexenyl)-4-methyl-	Benzene	91
11	9,50	$C_{14}H_{28}$	1-tetradecene	Alkene	96
12	39,96	$C_{15}H_{32}$	Pentadecane	Alkane	95
13	3,32	$C_{15}H_{30}$	1-pentadecene	Alkene	92
14	2,10	$C_{17}H_{34}$	Heptadec-8-ene	Alkene	95

TABLE 3.
CONSTITUENT COMPOUNDS ARE SUSPECTED IN ETHANOL FRACTION OF THE CEMCEM LEAVES POWDER

No.	Relative Concentration (%)	Molecular Formula	Name of Compound	Compound class	Similarity (SI)
1	34,65	$C_{15}H_{22}$	Benzene, 1-(1,5-dimethyl-4-hexenyl)-4-methyl-	Benzene	92
2	19,26	$C_{15}H_{24}$	1,3-Cyclohexadiene, 5-(1,5-Dimethyl-4Hexenyl)-2-Methyl-[S-(R*,S*)]-	Terpenoid	93
3	12,80	$C_{15}H_{24}$	Cyclohexene, 1-Methyl-4-(5-Methyl-1-Methylene-4-Hexenyl)-	Terpenoid	93
4	23,80	$C_{15}H_{24}$	Beta-Sesquiphellandrene	Terpenoid	92

Terpenoids are commonly present in higher plants and more than 23,000 individual structures have been identified. Terpenoids are normally produced in vegetative tissues, flowers, and, occasionally roots. Monoterpenes and sesquiterpenes are the majority of volatile compounds released from plants after herbivore damage, attracting arthropods that prey on or parasitize herbivores, then avoiding further damage. In addition to volatile terpenoids, certain diterpenes and sesquiterpenes are phytoalexins involved in the direct defense of plants against herbivores, and microbial pathogens [12], [13].

Formation of volatile compounds is spatially regulated. In the past decade, several investigations have shown that terpenoid volatiles are often synthesized de novo in some special physical structures, such as the oil glands or resin ducts[14], [15], [16]. The monoterpenes and sesquiterpenes emitted as volatiles contribute to indirect defenses against herbivores, whereas diterpenoids and some of the sesquiterpenoids provide direct protection through formation of phytoalexins[15].

IV. CONCLUSION

Based on analysis using GC-MS instrument, the flavor constituent compounds contained in the Cemcem leaves are terpenoids, benzene, alkanes, alkenes, carboxylic acid esters, and alcohols. Terpenoids class of compounds has the highest relative concentration. Compounds into the class of terpenoids are 1,3-Cyclohexadiene, 5- (1,5-dimethyl-4hexenyl) -2-methyl [S- (R *, S *)] -, Cyclohexene, 1-methyl-4 - (5-methyl-1-methylene-4-hexenyl) -, and Beta-sesquiphellandrene..

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 ISBN : 978-1-4673-7404-0

Synthesis and characterization of nanosilica from boiler ash with co-precipitation method

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Abstract*—Boiler ash known as solid waste of sugar industry with high silicon dioxide. Nanosilica can be synthesized from boiler ash with co-precipitation method. Precipitation still produced amorphous and heterogenous nanoparticles because of reaction spontanity. Modification using polysaccharides as dispersing agent improved its ability to synthesize homogenous silica nanoparticles. This study aimed to synthesize and characterize nanosilica from boiler ash with co-precipitation method. Polysaccharides that were used on this research include rice flour and agar powder with concentration 25% (w/w) silica. The characteristics of nanosilica were observed by particle size distribution, crystallinity, crystal size and morphology. Based on analysis, the use of polysaccharides as dispersing agent on precipitation method altered characterististics of nanosilica. Agar powder and rice flour reduced particle size and polydispersity index, turned crystallinity and crystal size, and formed unique particle morphology. The best characteristic of nanosilica was resulted by co-precipitation method using rice flour. It had average particle size 185.25 nm, polydispersity index 0.26, crystallinity 28.76%, average crystal size 22.44 nm.

I. Introduction

Boiler ash is a form of solid waste generated by the production activity of sugar industry. It is the result of chemical changes of pure bagasse burning at temperatures of 550-600°C for 4-8 hours. A large-scale sugar industry can produce 1.5-2.0% of the total sugarcane milled or about 1.7 to 2.3 million tons per year. Boiler ash has been utilized as the additional material for organic fertilizer, the fill of damaged roads and landslides [1]. Boiler ash is categorized as fly ash type F indicating that the boiler ash has a chemical composition of SiO_2, Al_2O_3 and Fe_2O_3 more than 70% and CaO less than 8%. It is this composition that makes boiler ash potential to be synthesized into silica. The synthesis of silica into nanosilica is carried out to expand the surface so that the reactivity increases.

The prevalent method of nanosilica synthesis is chemical precipitation, since it is excellent in the energy use efficiency and processing time. However, the use of precipitation method has not produced homogeneous nanosilica particles and a low degree of crystallinity [1]-[5]. An effort can be made to produce nanosilica particles with uniform size distribution is by the addition of a dispersing agent.In synthesis of nanosized oxide-based materials, polysaccharide played multiple roles, namely coating/capping, functionalizing, stabilizing, poring and or cordinating agent [6].Polysaccharide is a type of dispersing agent which is abundantly available and the residue management is relatively simple. The polysaccharides could be used in this study are rice and agar. Rice was one of agricultural comodities which could be used as non-metalic bio-precuesors to synthesize functional materials. Amylose and amylopectin of rice were representing the key structural elements for the synthesis of new functional nanomaterials [6]. Previously, rice used to synthesize zinc oxide nanoparticles [6]. Agarwas a natural, biocompatible and biodegradable carbohydrate derived from marine algae. Agar was composed of agarose and agaropectin. Agarose was preferred due to that it was porous, cheap, and environmental friendly. It has been used to prepare alumina nanoparticle [7] and the result was relatively good. The polysaccharide concentration used in the synthesis process will greatly affectedin its ability to control the particle sizes. Based on the research conducted by [8] for some types of polysaccharide-based dispersing agents, the polysaccharide concentration used was 25% (w/w).

Manuscript received April29, 2015. This work was supported in part by the Department of Agroindustrial Technologywith research grant (161a/IT3.6.3/km/2014).

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ISBN : 978-1-4673-7404-0

II. Materials and Methods

A. Materials

Boiler ash (BA) was obtained from PT Gunung Madu Plantation Lampung. BA from sugar factory cleaned by distilled water and burnt at 700°C for 7 hours. Sodium hydroxide (reagent grade), sulphuric acid and ammonium hydroxide (analytical grade) were purchased from Merck. Rice flour (RF) and agar powder (AP) was purchased from local market in Dramaga Bogor.

B. Synthesis of pure nanosilica from boiler ash

Ten grams BA on 80 ml 2.5 N sodium hydroxide solution was boiled in covered 250 ml erlenmeyer flask for 3 hours. The solution was filtered by whatman paper and the residues were washed with 20 ml boiling water. Then, the filtrate was allowed to cool down to room temperature and titrated 5 M H_2SO_4 until reached pH 2. Afterward, it was titrated again with NH_4OH until pH 7. Sol aged for 3.5 hours at room temperature then it was dried at 105°C for 12 hours [1][2][4].

C. Synthesis of nanosilica

Pure silica was refluxed on HCl 3 N for 6 hours. Thereafter, it was cleaned repeately with distilled water to free the acid. After that, it was dissolved on 2.5 N NOH by constant stirring on magnetic stirrer for 4 hours. Rice flour or agar powder 25% (w/w silica) was added into the solution after one hour. Then, 5M H_2SO_4 was titrated into solution to adjust pH 7.0-8.5. The precipitated silica was cleaned repeately with warm water to free the alkaly. At the end, it was dried in the oven 60°C 3 hours and burned at 700°C for 4 hours to calcinate the polysaccharides.

III. Characterization

Particle size distribution of nanosilica was observed by *Vasco Particle Size Analyzer*. Exactly 0.1 grams nanosilica powder was dispersed into distilled water. Then, iIt was stirred on magnetic stirrer for 10 minutes and sonicated for 1 minute. Nanosilica particles were scanned by PSA for 2-5 minutes.

The diffraction pattern, crystallinity, size and phase of crystal was observed by *Shimadzu XRD-7000 Maxima X* with Cu-Ka radiation, voltage 40 kV, impendance 30 mA, and λ=1.54Å. Diffractograms was scanned at 10-60° with scanning rate 2°/minute on room temperature. Crystallinity of nanosilica was calculated by XRD-7000 software while crystal size of nanosilica was calculated by Scherrer Formula.

IV. Result and Discussion

A. Transformation of boiler ash became nanosilica

Boiler ash (BA) in this study was burned at 700°C for 7 hours in order to eliminate trash materials and change the crystallinity. Fresh BA was composed of 82.76% silicon dioxide and other compounds. Silicon dioxide compound increased after burning process became 99.00%. The crystallinity also increased from 50.26% became 97.56%.

The silica was extracted by sodium hydroxide with hydrolisis process at 90-100°C for 3 hours to form natrium silicate. Natrium silicate and silicon dioxide was obtained via the following reactions:

$$SiO_2 + NaOH \rightarrow Na_2SiO_3 + H_2O$$
$$Na_2SiO_3 + H_2SO_4 \rightarrow SiO_2 + Na_2SO_4 + H_2O$$

Natrium silicate was precipitated by sulphuric acid to reach stability of silica sol. The sol of silica reach stability at pH 8.5 and aging time 3.5 hours at 60 °C.

Synthesis of nanosilica was done by extraction process with high concentration of hydrochloric acid. The particle size of silica would be reduced in this process. The smaller particle was precipitated again with same reaction. The second precipitation process resulted the sol with smaller droplet size.

B. Particle size distribution of nanosilica

The use of synthesis method affected homogeneity of nanosilica particle sizes. *Fig. 1(a-c)* shows a shift in the value of particle size distribution. The average size and polydispersity of nanosilica particles decreased, regardless of the methods start from precipitation, co-precipitation AP, until co-precipitation RF. The curve width lessened with the use of polysaccharide in the precipitation process which showed the decline in the size range and dispersity of particles in the dispersion media.

Nanosilica as the result of precipitation had a maximum size of 9774.96 nm and the minimum 28.19 nm. The range of nanosilica particle sizes shifted and became narrower when agar was used as a dispersing agent with the largest particle size of 4676.59 nm and the smallest 23.45 nm. The size distribution curve shifted, becoming narrower when rice was used as a dispersing agent with the largest particle size of 1288.58 nm and the smallest 29.52 nm.

The precipitation could synthesize nanosilica with an average particle size of 269.42 nm, with a polydispersity index of 0.9190. The high index value of polydispersity indicated that the nanosilica particles produced by precipitation technique had a deficient particle size distribution. Extraction with hydrochloric acid was able to reduce the size of nanosilica but had not been able to prevent the agglomeration of particles spontaneously[1].

ISBN : 978-1-4673-7404-0

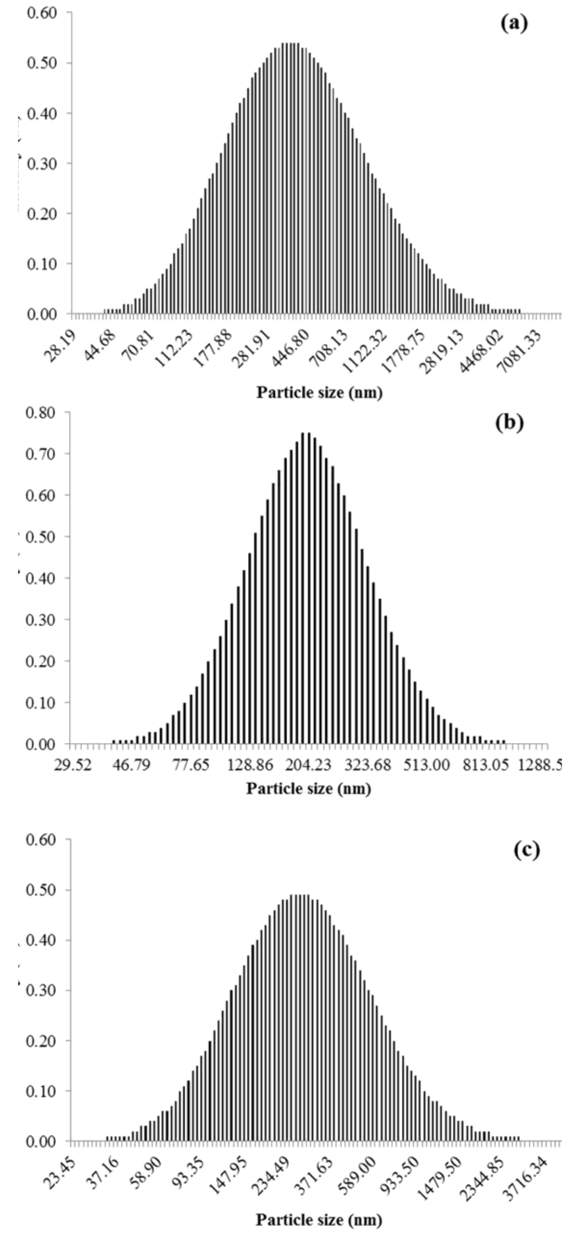

Fig. 1. Particles size distribution of nanosilica with different synthesis method (a) precipitation (b)co-precipitation RF (c)co-precipitation AP.

The use of polysaccharides in the precipitation process was able to synthesize nanosilica particle size distribution better than the synthesis result with ordinary precipitation. Rice flour as a dispersing agent in the precipitation process produced nanosilica particles with an average size of 185.45 nm, with a polydispersity index of 0.2540. Rice has starch granules consist of amylose molecules and amilopectin. In nanosilica synthesis, the carbon matrix have a helix shape in amylose and have a role in providing the morphological form and the uniformity of nanoparticle sizes.The hydroxyl groups ofamylopectin could be involved both in intra- and/orintermolecular supramolecular association. It had ability to coordinate transition metal ions, maintaining the nanoparticles highly aggregated [6]. RF on this research was obtained from high amylose rice, so that in nanosilica synthesis, amylose had more ability to control shape and size of particle.

As a result, the average size of synthesized nanosilica with co-precipitation AP was 252.22 nm, with a polydispersity index of 0.6520. The outcome of nanosilica formed still did not have a good size distribution. Resemble with rice, agar has granules which is consist of agarose and agaropectin. The high aggregation of nanosilica particle suspected due to the presence of high agarose relatively in the agar which was used as a dispersing agent. Agaropectin has the ability to associate into intra- or inter-molecules as a balancing agent Si^{2+} ion transition and maintaining a high aggregation between silica particles.

C. XRD analysis of nanosilica

The diffractograms in *Fig.2*illustrates the nanosilica diffraction pattern as a result of precipitation which had a value of 2θ with high intensity at 32.03°, 33.90°, 19.06°, and 28.07°. The highest intensity was at 32.03° which indicated the phase of cristobalite crystal [1]. Points 2θ 19.06° and 28.07° showed the presence of tridymite phase while the peak point (33.90°) indicated the presence of mullite phase. Domination of cristobalite phase showed that precipitated silica nanoparticles had good thermal stability. Cristobalite known as crystal phase of silica which was formed at 700-800 °C.

The precipitated silica nanoparticles with agar powder as the dispersing agent, had a diffraction pattern similar to precipitated nanosilica with higher intensity. The peak point with the highest intensity was found at 31.99°, 33.86°, 19.01°, and 28.04°. Based on *Fig. 2c*, there was not the peak point of agar. It indicates that agar was eliminated by calcination process at 700°C.

Meanwhile, nanosilica as a result of a synthesis with rice as the dispersing agent had the strongest peak at an angle of 2θ 22-23° which indicated an amorphous silica phase. Amorphous silica phase could be opal-A, opal CT or opal C. Crystalline phase was showed by the strong peak at 31.58° (cristobalite), 19.16° (trydimite) and 33.97° (mullite).

The degree of crystallinity indicated the proportion of the crystal phase which existed in the material. The nanosilica synthesis using the precipitation method produced particles with a crystallinity of 33.22% with a dominant silica cristobalite phase. The rice flour used as the dispersing agent was able to reduce the crystallinity of the particles up to 28.76%. Meanwhile, the agar flour was able to increase the crystallinity of the particles up to 59.53%. This crystallinity change was related to the composition of amylose in rice and agarose agar since both of the major compounds forming crystallinity.

ISBN : 978-1-4673-7404-0

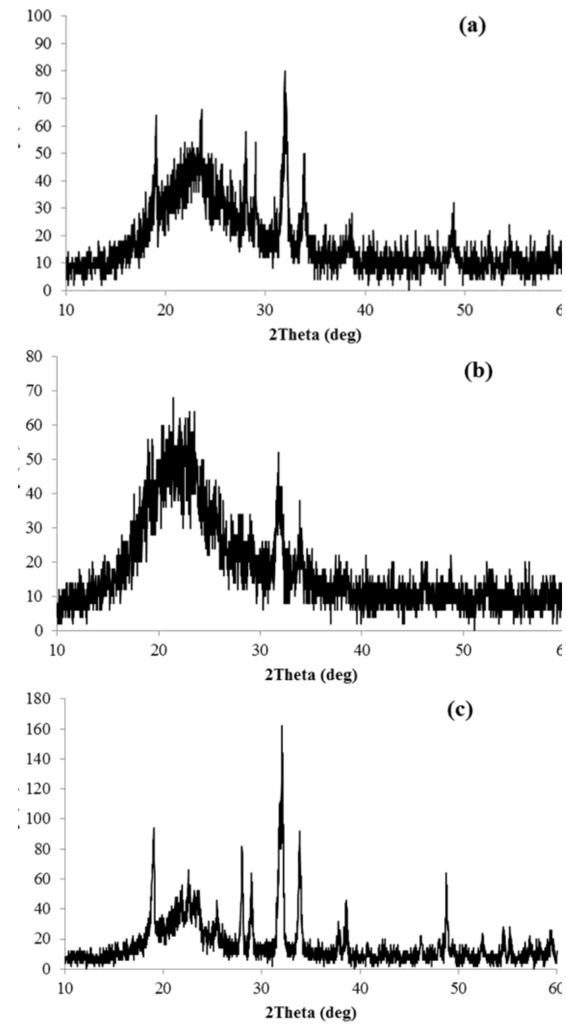

Fig. 2. Diffraction pattern of nanosilica with different synthesis method (a) precipitation (b)co-precipitation RF (c)co-precipitation AP.

In aqueous solution, rice granules swelled and their semi-crystalline structure was lost as smaller amylose molecule. The small amylose molecules could form a complex with Si^{2+} because of their high number of functional groups. Silicon ions and starch molecule would be asssociated then nucleation and initial crystal growth occured within regions of their high concentration. Van der Waals interaction between the surface molecules formed the driving force for self assembly. Then, SiO_2 nanocrystals can be assembled to reach larger size [6]. Similar to rice, agar granules also swelled in aqueous solution and formed larger agarose molecules. Agarose had same role with amylose, could be associated with silicon ions to form the nanocrystalline silicon dioxide.

Despite its fairly low degree of crystallinity, the crystal formed from the synthesis process had a relatively small size (Table1). The crystal size was obtained by calculating the average size of the crystals with high intensity. It was given by Scherrer formula [7].

$$D=\frac{k\lambda}{\beta\cos\theta}$$

where D crystallite size (nm), k Scherrer constant (0.9), λ wavelenght of Cu (0.154 nm), β full width at half maximum (FWHM), θ diffraction angle (deg).

The highest crystal size was obtained from nanosilica precipitation with an average crystal size of 27.17 nm, followed by agar nanosilica co-precipitation 26.80 nm and rice co-precipitation 22.44 nm. The third sample of nanosilica crystal size was smaller than the size of silica 91.53 nm. In general, the three methods of nanosilica synthesis were able to reduce the silica crystal size up to 70-75%. Acid hydrolisis on this process broke structure of silica crystal.

TABLE I
THE CRYSTAL SIZE OF NANOSILICA WITH DIFFERENT SYNTHESIS METHOD

Nanosilica									Crystal phase
Precipitation			Co-precipitation RF			Co-precipitation AP			
2θ (deg)	D(nm)	β (rad)	2θ (deg)	D(nm)	β (rad)	2θ (deg)	D(nm)	β (rad)	
19.06	26.28	0.0053	19.16	10.81	0.0126	19.01	27.05	0.0050	trydimite
22.65	25.05	0.0056	20.06	7.49	0.0181	22.60	18.63	0.0073	quartz
28.07	30.00	0.0047	28.01	30.42	0.0045	28.04	36.45	0.0038	seifertite
29.02	28.99	0.0049	29.16	66.07	0.0021	28.98	38.85	0.0036	cristobalite
32.03	**18.87**	**0.0079**	**31,85**	**12.28**	**0.0113**	**31.99**	**17.46**	**0.0080**	**cristobalite**
33.90	28.33	0.0051	33.97	21.11	0.0066	33.86	29.06	0.0048	cristobalite

Despite of crystal properties, XRD analysis could be used to analyze chemical composition of silica nanoparticles. It would be very important to assure purity of silica. Qualitative analysis of XRD on silica nanoparticles showed that SiO_2had high percentage 90-99% while another metal oxide had 1-10% in percentage. Functional group of silica by infra red spectra not to be expressed because the main characteristics of silica nanoparticle more enough. Silica nanoparticle which produced by co-precipitation RF had better properties if it to be applied for electrolyte membrane additive. Based on FTIR analysis [9], the band at 1072 cm^{-1} illustrated the presence of Si-O-Si, the band at 902 cm^{-1} for Si-O-H. Amorphous silica is known to have the ability as a semiconductor material due to its mechanical resistance, electricity, and good selectivity of chemical modification.

ISBN : 978-1-4673-7404-0

V. Acknowledgment

The author would like to thank DGHE, Ministry of Research, Technology and Higher Education for research grant supporting this study. For instrument, gratitute to be expressed to Head of Material Analysis Laboratory, Physic Department, Bogor Agricultural University; and Material Analysis Laboratory, Center of Forest Research and Development, Forestry Department, Gunung Batu Bogor.

VI. Conclusion

Nanosilica can be synthesized from the boiler ash of sugar industry using both precipitation method and co-precipitation method. Modification of the precipitation process with agar powder and rice flour as a dispersing agent proved able to reduce the particle sizes, increase the particle size distribution, lower the crystal size, and change the crystallinity of nanosilica. The rice flour used in the precipitation produced nanosilica with the best characteristic, that is, with a particle size of 185.45 nm, polydispersity index of 0.2540, crystal size of 22.44 nm.

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ISBN : 978-1-4673-7404-0

The Comparison Of Media On The Microalgaee *Nannochloropsis* sp. Culture

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***Abstract*— The purpose of this research were to determine the influence of variety of media on the cell biomass and lipid content of microalgaee *Nannochloropsis* sp. and to find out the appropriate kind of media to produce highest cell biomass and lipid content of microalgaee *Nannochloropsis* sp . This research used randomized block design with single factor. The treatment was variety of media that were walne media, agriculture media, and Allen-Miquel (MQ) media. All treatments had 5 replication, in order to obtain 15 trial units. All data was analyzed using ANOVA follow by least significance different test when significant different among treatment were found.The result showed that the treatment had very significant effect (p<0,01) on the cell biomass and lipid content of microalgaee *Nannochloropsis* sp. Walne media was appropriate to produce the highest biomass cell and lipid content of microalgaee *Nannochloropsis* sp. namely 0.27 g/l and 9.38%, respectively.**
Keyword: biomass, lipid, media, *Nannochloropsis* sp.

I. INTRODUCTION

Nowadays, there are many efforts to find out bio fuel resources to replace fossil fuels. One of bio fuel is biodiesel that was commercially produced from plant or animal oil. The usage of plant specially grains as a bio diesel resource will not advantage because it is used as food and need wide place for planting it [1]. Alga was potentially to solve this problem. Reference [2] reported that the best alga for bio diesel production was microalgae because it contained high lipid compared with macroalga. Its growing rapidly as well [1]-[2]. Some kind of microalgaes have isolated from Bali sea shore, one of them had high stability and very high growth acceleration was *Nannochloropsis* sp. [3]. Growth of microalgae was affected by kind of media or nutrition factor. Various kind of media had different nutrition compounds therefore, it can influential on the yield of the lipid concentration.

The purpose of this research were to determine the influence of variety of media on the cell biomass and lipid content of microalgaee *Nannochloropsis* sp. and to find out the appropriate kind of media to produce highest cell biomass and lipid content of microalgaee *Nannochloropsis* sp.

II. METHOD

Material and equipment

Nannochloropsis sp from bioindustry and environmental laboratory, walne media (Table 1), agriculture media (Table 2), Allen-Miquel (MQ) media (Table 3), and sea water from Pandawa Beach, Bali.

Table 1. Composition of Walne Media [5]

Nutrition	Amount
$NaH_2PO_4 . 2H_2O$	20 g
$NaNO_3$	100 g
H_3BO_3	10 g
$FeCl_3$	1,3 g
$MnCl_2 .H_2O$	0,36 g
Na_2SiO_3	40 g
Na_2EDTA	5 g
Destilated water	1000 ml
Trace elemen solution:	1 ml
$ZnCl_2$	21 g
$CoCl_2 . 6H_2O$	2 g
$(NH_4)_8 .Mo_7O_{24} .4H_2O$	0,9 g
$FeCl_3 . 6H_2O$	3,15 g
$CuSO_4 . 7H_2O$	20 g
Destilated water	100 ml

Research Design

This research used randomized block design with single factor. The treatment was variety of media that were walne media, agriculture media and Allen-Miquel (MQ) media. All treatments had 6 replications, in order to obtain 18 trial units. All data

 ISBN : 978-1-4673-7404-0

was analyzed using ANOVA follow by least significance different test when significant different among treatment were found [4].

Table 2. Composition of Agriculture media [6]

Nutrition	Amount
Urea	240 g
TSP	80 g
ZA	160 g
FeCl	12 g
Na_2EDTA	12 g
Destilated water	1000 ml

Table 3. Composition of Allen-Miquel Media [6]

Nutrition	Amount
Solution A :	
KNO_3	20,2 g
Destilated water	100 ml
Solution B :	
HCl	11,2 ml
Na_2HPO_4	4 g
$CaCl_2. 6H_2O$	2,3 g
Destilated water	80 ml
Solution C :	
Klewat	20 g
Destilated water	200 ml

Media Preparation

Walne media was made based on [5], agriculture media and MQ media based on [6].

Starter Production

Starter of *Nannochloropsis* sp. (1 L) was made with comparation between sea water and starter of 70:30, then 1 ml walne media [5] or 1 ml agriculture media [6], or MQ media (consist of 2 ml solution A, 1 ml Solution B and 3ml Klewat) [6] was added (depend on the treatment). Aeration was provided continuously and 3000 Lux light intensity for the period of incubation. After 7 days incubation, *Nannochloropsis* sp. starter was ready to use for biomass production (upscale).

Scaling Up

Upscale was done to produce high quantity of biomass. Microalgae *Nannochloropsis* sp. was cultivate when it was in the end of exponential phase. This culture used batch cultur in 20 L volume. The procedure as same as starter production.

Harvesting

Harvesting of *Nannochloropsis* sp. was done by precipitation method. Precipitant was rinse using destilated water until its salinity was 0 ppt. After that, microalgae biomass was dried by oven for 24 hours at 80 ^{o}C then dried biomass was harvested and balanced.

Analysis of Biomass Concentration

Biomass Concentration was analysed based on [10]. One ml sample was put in the effendorf then centrifuse at 4000 rpm for 3 minutes. Precipitant was rinse using destilated water until its salinity is 0 ppt. After that, microalgae biomass was being dried by oven for 24 hours at 80 ^{o}C then dried biomass was balanced.

III. RESULT AND DISCUSSION

Nannochloropsis sp. Growth Phase

The growth of microalgae *Nannochloropsis* sp. was analyzed every day with account of dried-cell biomass weight in order to know its growth phase. The growth phase of microalgae *Nannochloropsis* sp. was showed in figure 1.

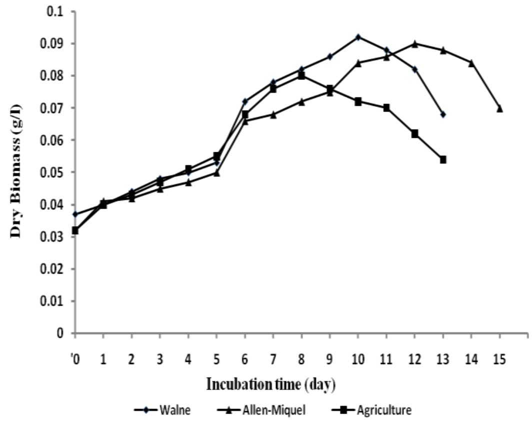

Fig. 1 *Nannochloropsis* sp. growth phase

Fig. 1 demonstrated that dried – cell biomass concentration was different in each media. In the beginning of incubation (0 day) till 5 days incubation, microalgae *Nannochloropsis* sp. which was cultivated on the various media still in the lag phase. Kind of media that was suitable for their growth will prompt lag phase hence it could growth rapidly [7]. After 5 days incubation, cell was in the log phase. The different kind of media causes the end of log phase happened in different incubation day. The end of log phase in walne media, agriculture media, and allen miquel media happened on 10, 8, and 12 days incubation, respectively. Those are a little bit different with [8], who confirmed that the end of log phase of *Nannochloropsis* sp. in walne media arise in 9 days incubation. Reference [9] proved that optimum growth of *Nannochloropsis* sp. happened on the 10 days incubation.

ISBN : 978-1-4673-7404-0

Reference [10]-[11] explained that the end of log phase was the best time for microalgae harvesting, because on this phase cell structure was still in normal condition and based on nutrition there was balance between nutrient in the culture media and nutrient in the cell. Beside that, cell will contain highest nutrition compounds when it on the log phase, hence microalgae on the optimum condition.

Nannochloropsis sp. Biomass Concentration

Concentration of *Nannochloropsis* sp. Biomass was biomass concentration which harvested at the end of log phase in each media culture. Analysis of variance showed that kind of media culture had very significant effect on the *Nannochloropsis* sp. biomass concentration ($p<0.01$). It was illustrated at the Table 1.

Table 1. *Nannochloropsis* sp biomass concentration (g/l)

Media	Harvest time (day)	Biomass conceentration (g/l)						Total	Average
		1	2	3	4	5	6		
Walne	10	0.25	0.27	0.23	0.30	0.32	0.25	1.62	0.27 a
Agriculture	8	0.18	0.19	0.17	0.20	0.19	0.18	1.10	0.18 b
Allen-Miquel	12	0.15	0.17	0.18	0.15	0.19	0.20	1.03	0.17 b

Note: different letter behind the average showed very significant effect ($P<0.01$)

Table 1. showed that the highest cell biomass concentration was *Nannochloropsis* sp. that was cultivated in the walne media amount of 0.27 g/l while the lowest was *Nannochloropsis* sp. that was cultivated in the Allen-Miquel media amount of 0.17 g/l and it had no significant effect on the *Nannochloropsis* sp. it was cultivated in the agriculture media amount of 0.18 g/l. Differences of kind of media related with nutrient composition contained by media therefore, effect microalgae growth.

Content of *Nannochlorosip* sp. Lipid

Analysis of variance showed that kind of media culture had very significant effect on the lipid content ($p<0.01$). The average of lipid content of *Nannochloropsis* sp. that was cultivated in the various media illustrated at the Table 2.

Table 2. Lipid content of *Nannochloropsis* sp.

Media	Lipid content (%)						Total	Average
	1	2	3	4	5	6		
Walne	9.11	9.43	9.70	9.38	9.23	9.45	56.30	9.38 a
Agriculture	9.26	8.58	9.12	8.26	8.00	8.22	51.44	8.57 b
Allen-Miquel	6.31	5.72	6.02	6.54	5.02	6.25	35.86	5.97 c

Note: different letter behind the average showed very significant effect ($P<0.01$)

Table 2 showed that highest lipid content was produced by *Nannochloropsis* sp. that was cultivated in walne media amount of 9.4%, while the lowest was *Nannochloropsis* sp. that was cultivated in Allen-Miquel media amount of 6.0%. [12] explained that the quality of nutrient compound of microalgae related to culture media and quality of water. [5] proved that *Chaetoceros gracilis* which was cultivated in walne media produced lipid content of omega 3 EPA amount of 6.59% (lower) than it was cultivated in Guillard media (8.16%). [13] showed that increasing of NaNO3 and KH2PO4 in culture media increased protein content and polyunsaturated fatty acids (PUFAs) of *Nannochloropsis*, but it decreased carbohydrate, lipid total and total of fatty acid. The highest lipid content and 1.00 gL-1 dry-weight were recorded from the culture to which treated 100% N(-) [14].

IV. CONCLUCION

Walne media was appropriate to produce the highest biomass cell and lipid content of microalgaee *Nannochloropsis* sp. namely 0.27 g/l and 9.38%, respectively.

ACKNOWLEDGMENT

We would like to express our gratitude to Directorate General of Higher Education, Indonesia for funding this experiment through Decentralization Research Grant 2015.

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 ISBN : 978-1-4673-7404-0

Identification of Media and Indicator Liquid as A Recorder Smart Label

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Abstract

In this research, identification of liquid as color indicator and media i.e. paper as diffusion media, has been studied. This study used several types of paper as diffusion media (buffalo paper, HVS 80 gr, photo paper, concord, drawing paper and cardboard duplex). It also used high viscosity liquid (cooking oil, oil A and oil B) as the indicator liquid. The research was begun by paper and liquid characterizations including gramature, density, mass density and viscosity. Indicator liquid as much as 20 mL was poured into chamber and the edge of paper was immersed into the liquid. The chambers were stored at 50°C for cooking oil, while 30.15°C and 5°C for other oil. Length of liquid diffused in the paper was measured in cm. Measurement was done at at 24, 48, 72 and 96 h. A graphic of paper length (L) vs time (t) was plotted and diffuse rate constant (k) as well as activation energy (Ea) was determined. Best media of indicator liquid and paper was selected based on their high value of Ea. Result showed that cooking oil, oil A and oil B showed slow diffusion rate. These materials were able to detect up to 4 days of shelf life of such product during storage. Based on activation energy, the most suitable indicator for recorder smart label was oil A. The best materials for this label development sequentially from low-to-high activation energy were buffalo paper, cardboard, drawing paper, concord, HVS 80 g and photo paper.

Keyword: liquid indicator, diffusion, shelf life recorder

1. Introduction

Shelf life is an important for determining the quality and safety of food product. Generally, refrigerator is an alternative storage in effort to extending product shelf life. People store either fresh or processed food in refrigerator without tagging the record of its shelf life. Therefore, when the product is again consumed, there do not know how long the food have been already stored into the refrigerator. A smart label of Time Indicators (TI) can be attached into food packed and it will record the product shelf life based on its storage time.

Shelf life is the period between when the product begins to be packed with quality products that are still eligible to be consumed. Information about the shelf life of the product is very important to be included as closely linked to the quality and safety of food products. A recorder smart label is a label tagging that can record the shelf life of the product and inform it to consumer. The principles is such colored liquid as ink diffuse into the paper as media along the period of storage.

This research identified medium and correspond indicators for label producing. Paper and cardboard was chosen as the material for the impregnation medium. Diffusion rate is influenced by the viscosity, where the higher the viscosity of the fluid thus it will result on higher flow rate [1]. Basically the label will be applied to the recording of the shelf life of the products stored in the refrigerator, so that the liquid will be selected based on the lowest possible power absorbing to facilitate application of labels.

Recorder smart labels will be produced using the principle of diffusion of liquid, wherein the liquid indicator will be allowed to diffuse in the paper during the period of storage by utilizing long-impregnation as registrar duration of product storage in a refrigerator at days 1, 2, 3, 4 and so on. The label will record the time of storage products based on the power of liquid permeation (diffusion). The longer the storage process, the longer it will also impregnating liquid on the media. Therefore, it is necessary to further study related types of indicator liquid and

ISBN : 978-1-4673-7404-0

the medium used as impregnation medium in order to produce smart labels that can record the shelf life of the product.

2. Theory

Sorption of ink/liquid indicator in such media (paper) is controlled by the rate of expansion and follows a first-order kinetic equation [2,3]:

$$- \partial L/\partial t = k(L_t - L_0) \quad (1)$$

where L is the length of the media; k is a first-order rate constant; L_t and L_0 represent the length of paper at time of equilibrium, t and time 0 respectively.

Integration of equation (1) with the boundary condition $L_0 = 0$ at $t = 0$ results in:

$$kt = \ln [L_t/(L_t - L_0)] \quad (2)$$

Thus the rate constant, k, is estimated from the slope of a plot of ln ($L_t - L_0$) versus time, t.

The rate constant is strongly temperature dependant. In most cases, the relationship between the logarithm of the rate constant and the reciprocal of the absolute temperature over a certain range of temperatures is linear and is quantitatively described by the Arrhenius equation [2,3]:

$$k = A \times e^{-Ea/RT} \quad (3)$$

where A is the frequency factor; E_a is the activation energy; R is the ideal gas constant and T is the absolute temperature. Thus, the activation energy, E_a, and the frequency factor, A, can be estimated from the slope and intercept of a plot of ln k versus 1/T respectively (equation 4).

$$\ln k = - E_a/RT + \ln A \quad (4)$$

3. Material and Method

3.1. Material

The material used in this study were five types of paper and one type of cardboard i.e buffalo, HVS 80 g, photo paper, concord, and drawing paper.a s medium of sorption. It is also use high viscosity liquid of as indicator i.e. cooking oil, oil A and oil B. The equipments were scissors, pen, ruler, fridge, jar, measuring cup, thickness gauge, tube Ostwald, pycnometer, water bath, analytical balance, spatula, incubators, room thermometer and pipette.

3.2. Method

3.2.1. Media and liquid characterization

The media of sorption of paper and the liquid were measured of its characteristic including gramature and mass density (for paper) as well as density and viscosity for liquid.

3.2.2. Sorption of liquid into media

Paper or cardboard was cut in a rectangle with a size of 20 cm × 1.5 cm, then dipped into a jar containing liquid dye which has been given previously. Paper was marked at the edges for easy measurement of observation at hours-0. Furthermore, the sample was stored at room temperature for 96 hours to conduct a long recording of liquid sorption at hour of 24, 48, 72 and 96. The length of sorption liquid in the paper L were recorded.

The experiment were done in three different of temperature i.e room temperature, 5°C at refrigerator and 50°C at incubation. The rate constant and activation energy and then were obtained as equation (2) and (3).

3.3. Results and Discussion

3.3.1. Media and liquid characterization

(i) Gramature

Gramature is the mass of a sheet of paper divided by the unit area of paper in square meters, measured under standard conditions [4]. This value of each paper or cardboard that was used in this research can be seen in Figure 1. It can be seen that the value of paper gramature of buffalo,

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HVS 80 g, photos paper, concord, drawings paper and cardboard were 152 222 g / m2, 85.556 g / m2, 235.556 g / m2, 231.111 g/m2, 151.111 g/m2, and 1055.556 g/m2 respectively.

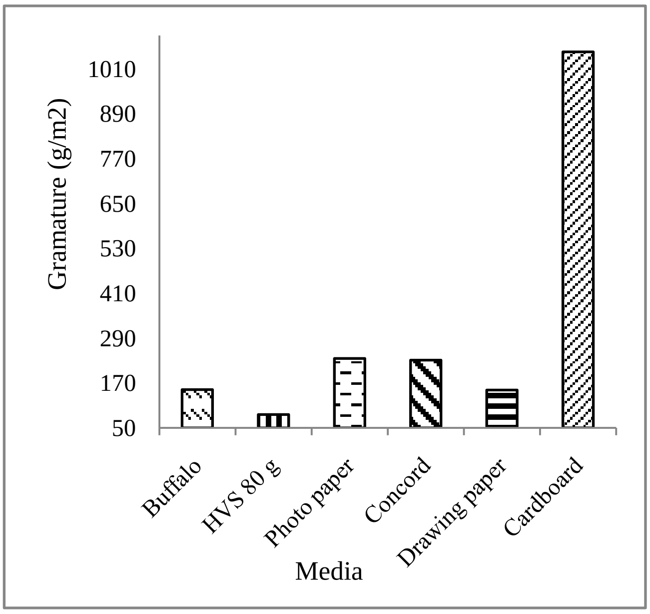

Figure 1. Gramature of paper

(ii) Mass density

Mass density is the mass of the paper sheet in kilograms divided by the unit volume in cubic meters or it is calculated from the value of gramature divided the thickness of paper, measured under standard conditions [4]. Based on the calculation of this value, the result was displayed in Figure 2.

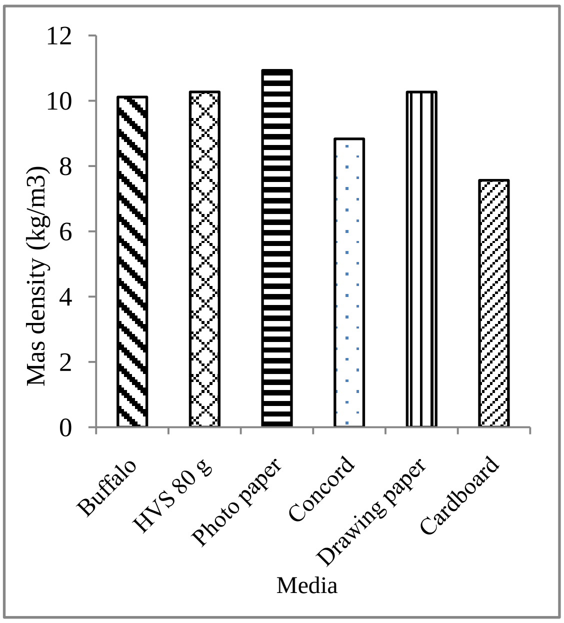

Figure 2. Mass density of paper

(iii) Density

Density is the result of mass per unit of volume of substance. Density changes due to temperature change. This value of density of the liquid tended to decreasing as a result of temperature rising (Figure 3). At a temperature of 25°C for cooking oil, oil A and oil B had the density of 0.910 g/mL, 0818 g/mL and 0804 g/mL. At a temperature of 40°C density values of cooking oil, oil A and oil B were 0907 g/mL, 0817 g/mL and 0803 g/mL, while the value of the density at 50°C for cooking oil, oil A and oil B were 0906 g/mL, 0.810 g/mL, 0802 g / mL.

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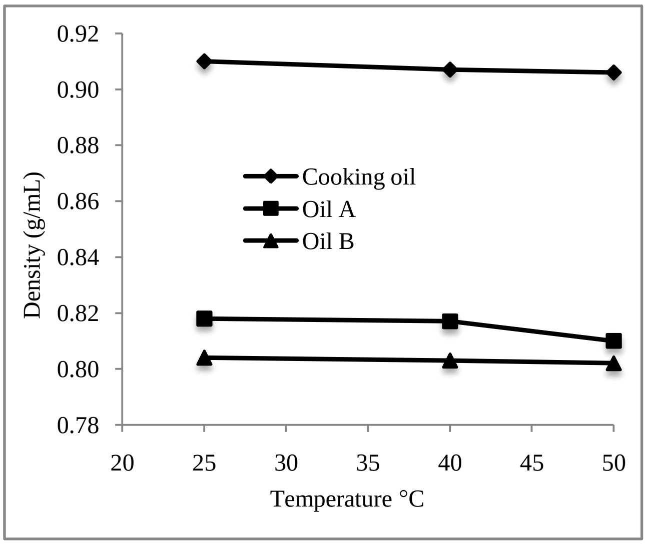

Figure 3. Density of liquid

(iv) Viscosity

Viscosity is a quantity expressing the magnitude of internal friction, as measured by the force per unit area resisting a flow in which parallel layers unit distance apart have unit speed relative to one another. The slower flow means the viscosity is high, and vice versa the faster flow means the lower the viscosity [5]. The oil viscosity used in this experiment was as follow (Table 1).

Tabel 1 The viscosity of solvent

Solvent	Viscosity at 40°C (cSt)
Cooking oil	23.365
Oil A	56.491
Oil B	51.835

3.3.2. Absorption rate constant and activation energy

Rate constant k and was obtained from the slope plot length impregnation paper versus time. Otherwise, the activation energy between each medium and the solvent can be known from the value of the plot slope of length impregnation performed at different temperature conditions. The temperature used for testing were room temperature (30.15°C) and refrigerator temperatures (5°C). The value of k and Ea is shown in Table 2.

Tabel 2 Rate rate contant and activation energy liquid in media of paper

Jenis Zat Cair	Jenis Kertas	Absorpsion constant k (cm/jam)			Activation energy Ea (J/mol)
		5°C	30.15°C	50°C	
Cooking oil	Buffalo		0.0573	0.0178	-132002.936
	HVS 80 g		0.1133	0.0161	-172106.323
	Photo paper		0.0840	0.0171	-147669.839
	Concord		0.1560	0.0164	-115929.788
	Drawing paperr		0.1079	0.0159	-182986.608
	Cardboard		0.1330	0.0167	-159795.352
Oil A	Buffalo	0.0250	0.0680		-1961.938
	HVS 80 g	0.0223	0.0730		1578.496
	Photo paper	0.0229	0.0517		1881.541
	Concord	0.0230	0.1035		1416.872
	Drawing paperr	0.0227	0.0579		1318.351
	Cardboard	0.0220	0.0766		1116.986
Oil B	Buffalo	0.0240	0.0678		-468.236
	HVS 80 g	0.0259	0.0783		-1776.536
	Photo paper	0.0255	0.0479		-1457.777
	Concord	0.0232	0.1098		1060.284
	Drawing paperr	0.0227	0.0566		1279.275
	Cardboard	0.0248	0.0788		-913.542

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Cooking oil in all types of medium showed a negative slope value, however, oil A, slope on the graph broadly positive value except on paper buffalo, while the indicator of oil B, value of its slope varies.

4. Conclusion

Paper gramature in order from the lowest to the highest was HVS 80g, buffalo, drawing paper, concord, photo paper and cardboard. While the mass density was cardboard, concord, buffalo, drawing paper, HVS 80 g and photos paper. Temperature was greatly affects the absorbing of liquid into the medium. Low temperature caused low absorption. Based on the value of activation energy, the most suitable type of indicator, namely oil A with the highest activation energy values than other solvent.. Cooking oil and oil B has a negative activation energy

5. Acknowledgment

The authors would like to say great gratitude to the Directorate General for Higher Education for the funding of this research.

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 ISBN : 978-1-4673-7404-0

THE EFFECT OF CONSENTRATION OF MES SURFACTANT FROM PALM OIL AND CONSENTRASION OF INORGANIC SALT TO INTERFACIAL TENSION VALLUE

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***Abstract*— The application of methyl ester sulfonate (MES) surfactant for enhance oil recovery (EOR) was due to its ability to reduce interfacial tension in crude oil-water system that reaches 10-3 dyne/cm. Performance of methyl ester sulfonate (MES) surfactant from palm oil can be identified with the spinning drop IFT method. The objectives of this research were to determine of MES surfactant performance with addition of inorganic salt in different conditions. The dispersing media used in this research is the demineralized water and formation water. The spinning drop IFT method was conducted using spinning drop tensiometer TX500D tested in 40, 50 and 60 oC. The researched showed that reduction of IFT value was affected by MES surfactant and inorganic salt in the demineralized water and formation water as dispersion medium. The best result of phase behavior methode was found in formation water dispersion medium with the 0,3% of methyl esteer sulfonat (MES) addition.**

I. INTRODUCTION

The application of surfactant for enhance oil recovery (EOR) needed particular requirements such as: ultralow interfacial tension ($\leq 10^{-3}$ dyne/cm), compatible with formation water and stable to reservoir temperature, pH interval 6-8, had III phase (middle phase) or phase II (-), and oil recovery incremental between 15-20% original oil in place (OOIIP) [1]. If surfactant had ultralow interfacial tension ($<10^{-2}$ dyne/cm), it was predicted that surfactant could be able to increase oil recovery about 10-20% [2].

One of surfactant that needed to be developed for enhance oil recovery (EOR) requirement was methyl ester sulfonate (MES) surfactant of palm oil. According to IFT in MES analysis, it was known that IFT value is 7,7 x 10^{-3} and stable to reservoir temperature, up to 80˚C. It had proven that MES could produce low IFT, 10^{-3} dyne/cm, for sandstone field in Indonesia and resistant to reservoir temperature.

Methyl ester sulfonate was anionic surfactant that had been developed as petroleum sulfonate substitution. MES shown good dispersion characteristic, good detergention, especially in hard water, and there was no phosphate in it, ester fat-acid C_{14}, C_{16} and C_{18} gave the best detergention and easily degradated (good biodegradability). Compared to petroleum sulfonate, MES surfactant shown some advantages, such as: for low concentration MES, detergention capacity was equal to petroleum sulfonate, it could defend enzim activity better, it had better calcium tolerance, and it had lower di-salt [3].

Surfactant injection in water-oil system would make surfactant dispersed then oil emulsion would be formed in the water. Drops of oil could not be produced by water injection if they were trapped inside pore throat because capilarity effect and high interfacial tension. Water-oil interfacial tension was expected to decrease by adding surfactant, so capillary oil pressure and rock would decrease. High capillary pressure caused low recovery factor. Low capillary pressure was needed to recover the rest of oil that trapped after waterflooding. Oil would be concentrated on the rock surface when interfacial tension decreased [4]. At last, surfactant could bind the oil and oil could be produced. IFT effect in oil recovery was modelled

Manuscript received April 27, 2015. Thanks to SBRC LPPM IPB for all facilities, so this research could be done.

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 ISBN : 978-1-4673-7404-0

by capillary desaturation curve, where residual oil saturation corelated with capillary number function. Capillary number (Nc) was defined as viscocity ratio and capillary force. Generally, capillary number could be calculated by the equation below:

$$Nc = \frac{v\mu}{\sigma \cos \theta}$$

Where:
V = effective flow rate (cm/s)
μ = viscocity of solution pusher (cp)
σ = interfacial tension (dyne/cm)
θ = wetting angle

Important factor to get minimum IFT value was surfactant concentration and organic salt in solution. IFT decreased along with surfactant concentration increasement. Minimum interfacial tension value would be reached when IFT decreased to certain concentration. Interfacial tension value would increase when surfactant concentration was increased over the critical concentration [5]. This research used two water that had salinity difference, demineralized water and formation water. Formation water was used as electrolyte solution. Electrolyte in surfactant system would decrease surfactant-water interaction. Lipophilic group of ionic surfactant would half-bind or full-bind with electrolyte, so each molecule would bind with the right molecule. Negative charge of active lipophilic group would have a positive interaction with positive charge of salt molecule when anionic surfactant was used, for example was Na^+ molecule in NaCl solution [6,7]. It was different from demineralized water which had neither salt nor electrolyte in it, so surfactant-water interaction was bigger than surfactant-oil interaction.

II. Procedure

There were two steps of this research. The first step was basic commodity formulation and the second was main test of solution interfacial tension.

A. Basic Commodity Formulation

1. *Formulation of demineralized water with different surfactant concentration*

MES was formulized with demineralized water. Total weight of formulation result was 25 gram for one formulation, two samples were made for each formulation in this research. Total weight of formulation result for trial procedure was 25 gram. MES surfactant concentrations that would be added were 0,1%, 0,3%, 0,5%, 0,7%, 1%, 1,5% dan 2%. Calculation example of surfactant weight was shown below:

0,3% x 25 gram = 0,075 gram

After that, formation water was added up to 25 gram. All of formulation result were stirred by magnetic stirrer in room temperature (27 °C) for an hour. Then, density test and IFT value test were done.

2. *MES surfactant formulation and demineralized water with different anorganic salt concentration.*

Demineralized water was formulized with 0,3% MES surfactant. Anorganic salt soncentrations that would be added were 0%, 1%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, and 10%. Accroding to previous research SBRC, optimum MES surfactant concentration was 0,3%. Total weight of formulation result for trial procedure was 25 gram for one formulation, two samples were made for each salt concentration in this research. Formula 1 was formulation of anorganic salt with demineralized water. It was made by measuring anorganic salt to be 0%, 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, and 10%. Calculation example of salt weight was shown below:

1% x 25 gram = 0,25 gram

After that, demineralized water was added to each tube up to 25 gram. All of formulation result were stirred by magnetic stirrer in room temperature (27 °C) for 15 minutes until it was equaly blended. Then, MES surfactant was measured, 0,3% of 25 gram, 0,075 gram MES surfactant were placed in different tube. Then, formula 1 was added to MES surfactant tube until its weight reached 25 gram.

In this research, case study in oil field was done. The oil field had salt concentration that fit with performance of MES surfactant according to IFT test result of demineralized water. Same treatment was done to formation water.

B. *Interfacial Tension (IFT) Value Test*

Interfacial tension was measured by spinning drop method. Following steps were procedure of spinning drop interfacial method. Turn on the device and the LED button. Heated the spinning drop device, then set the temperature at 40 °C (fit to test condition). When it was stable, certain concentration of surfactant that had been made was added to glass tube, then crude oil was added. Air bubble was not allowed in the glass tube. Then, the glass tube was put in the spinning drop device, glass tube surface faced outside. Spinning speed was set to be stable at 6000 rpm. Drop radius was read when the device temperature reached 40 °C. The reading was repeated until the value of drop radius was constant. Test was repeated for temperature 50°C and 60°C.

When the fluid drop had cylindrical form, cylinder radius was measured (r), difference of drop density

(Δρ) and drop spinning speed (ω). Spinning Drop Tensiometer coul measure interfacial tension (IFT) up to 10^{-6} mN/m. At last, interfacial tension (γ) was calculated by following equation [8].

$$\gamma = \frac{1}{4} r^3 \Delta \rho r \omega^2$$

Where:

r : radius

γ : interfacial tension

Δρ : difference of drop density

ω : spinning speed

III. Result and Explanation

Optimum surfactant concentration for demineralized water formula as dispersion medium was 0,7% of MES surfactant, but it did not meet the ultralow interfacial tension (Picture 1). The result of IFT value for demineralized water as dispersion medium at temperature 40 °C was 6,75 x 10^0 dyne/cm, at temperature 50 °C was 1,12 x 10^1 dyne/cm, at temperature 60 °C was 8,31 x 10^0 dyne/cm.

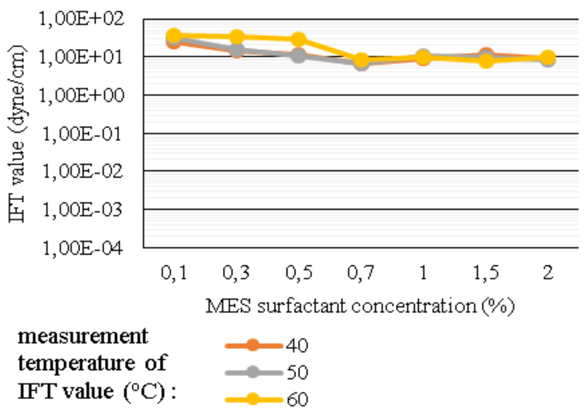

Fig. 1.Interaction of MES surfactant concentration and measurement temperature to IFT value of surfactant solution with demineralized water as dispersion medium.

Next formulation step was optimal salinity by adding NaCl to demineralized water then 0,3% MES surfactant was added. According to previous research by SBRC IPB, surfactant that would be added was 0,3%. Salt addition caused IFT value decreased and then would increased again along with salt concentration increasement at various temperatures, 40°C, 50°C, and 60°C.

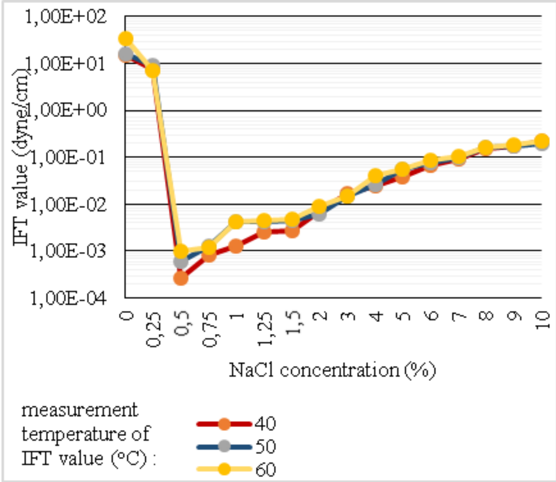

Fig. 2.Interaction of salt (NaCl) concentration effect and measurement temperature to IFT value of 0,3% MES surfactant solution with demineralized water as dispersion medium.

According to Picture 2, demineralized water formula with NaCl and 0,3% SMES addition had minimum IFT value when salt concentration at 0,5% or 5000 ppm. IFT value that wanted by oil industry was $\leq 10^{-3}$ dyne/cm. According to test result at Picture 2, optimum salt concentration for MES surfactant was 5000 ppm to 30000 ppm or 0,5% to 3%. Therefore, field fluid X was used for case study, which had salt concentration 5795 ppm and included in optimum range. As for reservoir that had lower concentration or higher than 5000-30000 ppm could not use this surfactant.

The result of IFT test at formation water as dispersion medium with 0,3% palm oil surfactant addition could meet ultralow interfacial tension. IFT value at temperature 40 °C was 4,40 x 10^{-3} dyne/cm, IFT value at temperature 50 °C was 1,68 x 10^{-3} dyne/cm and IFT value at temperature 60 °C was 1,10 x 10^{-3} dyne/cm. The result of IFT test was shown in Picture 3.

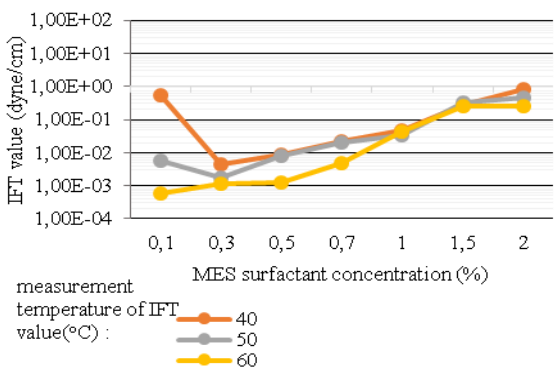

Fig.3.Interaction of MES surfactant concentration and measurement temperature to IFT value of surfactant solution with formation water as dispersion medium.

ISBN : 978-1-4673-7404-0

At surfactant addition formula, difference between IFT test result of surfactant solution with demineralized water as dispersion medium and IFT test result of surfactant solution with formation water as dispersion medium was caused by difference of water salinity, where formation water salinity reached 5795 ppm (Table 1) as for demineralized water salinity was 0 ppm. When salinity condition was optimum, minimum value of IFT could occur and emulsion that formed could reach phase III. IFT decreased along with surfactant concentration increasement. Minimum value of interfacial tension would be reached when surfactant decrease up to certain concentration. When surfactant concentration was increased over the critical concentration, value of interfacial tension would increase [5]. This interaction could be seen in Picture 1 and Picture 3.

Result of IFT test could give the image of oil respond, which was different between demineralized water as dispersion medium and formation water. The oil that used for sample of demineralized water as dispersion medium had constantly round form during the IFT test. As for formation water as dispersion medium, the oil from sandstone field was twisted and stretched lengthwise during the IFT test. It showed that the oil coould not blend even though surfactant was added, because there was not salt in it.

Repulsion of inter-head group of surfactant molecule that occured in solution was one of the most affected factor to surfactant molecular self-assembly to form micelle. In anionic surfactant solution, repulsion occured because surfactang head group had same charge. This repulsion would obstruct surfactant molecules to agregate, so it had to be decreased [9]. Repulsion of surfactant solution occured because ionic power of the solution was weak. Salt could be added to increase ionic power of the solution, like formation water as dispersion medium. Salt ions would give screen out effect, so repulsion of inter-head group would decrease. This caused decreasement of free energy that formed micelle, so surfactant molecules would be easier to unite and micelle that formed would be bigger [10].

The inclination of micelle growth was affected by variety and concentration of additional salt [11]. Screen out effect that occured would be bigger when additional salt had higher concentration, and at last thi inclination of micelle growth would be bigger. Therefore, addition of high concentration salt in concentrated surfactant solution would make micelle grew became flexible cylindrical form (worm like) as shown in oil respond with formation water as dispersion medium [12]. In MES solution with NaCl, micelle growth was caused by screen out effect from Na^+ ion of dissolved NaCl. Na^+ ion of NaCl would netralize the charge of group of sulfonate in MES molecule head group, so repulsion of inter-head group that caused by same charge could be decreased. Image of bigger micelle formation with salt concentration addition was shown in next formula in Picture 2 and Picture 4. More salt that was added would make higher IFT value.

The mechanism of oil interfacial tension decreasement with water because of surfactant solution injection was as follows: organic surfactant had hydrocarbon (R) as basic group and it bound to inorganic compound (group of sulfonate) SO_3. Its chemical equation was $R\text{-}SO_3H$. In the water, this kind of surfactant would be ionized became SO_3^- and H^+. When ion of RSO_3^- molecule han contact with nonpolar compound (oil), group of R^- would do adhesive force (surfactant-oil), whereas the surfactant molecule would occur cohesive force between RSO_3^-, this adhesive force effect would decrease the resultant value of the oil cohesive force that caused decreasement of interfacial force between oil and water [13]. If IFT could be decrease to 10^{-3} dyne/cm, so oil fraction inside rock pores could be mobilized better [14].

In formation water with 0,3% surfactant and NaCl addition, the result of IFT value increased along with the increasement of NaCl concentration that added.

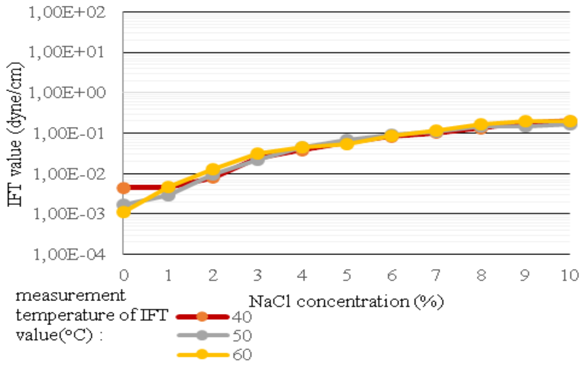

Fig. 4.Interaction of salt (NaCl) concentration effect and measurement temperature to IFT value of 0,3% MES surfactant solution with formation water as dispersion medium.

Addition of NaCl concentration to demineralized water and formation water caused the increasement of IFT value. For sample of formation water as dispersion medium, the lowest IFT value was gotten at formulation without NaCl addition. It explained that formation water had reached optimum salinity at salinity concentration 5795 ppm with addition of MES surfactant concentration 0,3%. Higher addition of NaCl concentration caused bigger IFT value.

According to result of this research, salt addition to solution up to optimum concentration would decrease IFT value. MES surfactant that used in this research had optimum salt concentration 5000-30000 ppm. If salt concentration in the solution over 5000 ppm, IFT value of the solution would start to increase as shown in Picture 2 and Picture 4. This occured because

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disodium carboxy sulfonate was formed when salt in the solution was over the optimum salt limit of surfactant itself. Salt in the solution that had MES would cause MES lost its facial active characteristic because MES reacted to form disodium carboxy sulfonate (di-salt). Anionic surfactant (MES) that at first bound one Na molecule would bind more Na from salt (NaCl) solution, so there would be two Na in one molecule [15,16]. Reaction mechanism of disodium carboxy sulfonate formation could be explained in Picture 5. This caused the decreasement of surfactant performance, so IFT value would be bigger.

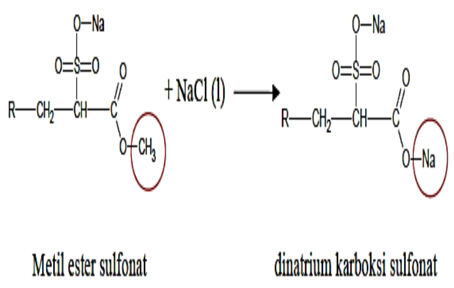

Fig. 5.Reaction mechanism of disodium carboxy sulfonate formation

According to test resul, IFT value of the sample with demineralized water as dispersion medium was lower than IFT value of formation water, with same salt concentration and MES surfactant concentration 0,3%. The lowest result was gotten at concentration 0,5% or 5000 ppm, this salt concentration was close to salt concentration in formation water. Test result at three variety of temperatures with 5000-7500 ppm salt addition with demineralized water as dispersion medium, IFT value was 2,64 x 10^{-4} – 1,3 x 10^{-3} dyne/cm. This result had lower IFT value than IFT value in formation water, which was 1,10 x 10^{-3} – 4,40 x 10^{-3} dyne/cm. This could be affected by the amount of electrolyte beside NaCl in demineralized water was less than in formation water. The existence of another electrolyte beside NaCl was expected to obstruct decreasement reaction of IFT value by surfactant.

Hard water like formation water contained cation Ca^{2+} (12,2 mg/L) or Mg^{2+} (9,08 mg/L), chemical physic characteristic could be seen in Table 1. Cation concentration in the water woulb be higher when hardness level of the water was higher. For MES surfactant which was anionic surfactant with active group that had negative charge, when this surfactant met hard water, the active group would form bond with ion Ca^{2+} or Mg^{2+}. The bond between negative ion in surfactant and this cation would decrease performance of MES surfactant at decreasing interfacial tension, this was recognized by the high of interfacial tension value. undissolved component that formed was $(RCH(SO_3Na)CO_2Ca$ [17]. Undissolved component in surfactant solution would decrease surfactant solubility in the water, so MES surfactant performance at decreasing interfacial tension would be less.

TABLE 1
FLUID CHEMICAL PHYSIC CHARACTERISTIC OF SANDSTONE FIELD WATER THAT USED IN THIS RESEARCH

Parameter	Unit	Injection Water	Formation water	Methods *) Part Number
Anion				
SO_4^{2-}	mg/L	<1.44	<1.44	4500-SO_4^{2-}E
HCO_3^-	mg/L	2947	1989	2320 B
Cl^-	mg/L	5105	3515	4500-Cl-D
Kation				
Na^+	mg/L	2933	2344	3120 B, 3030 E
K^+	mg/L	24,3	13,9	3121 B, 3030 E
Ca^{2+}	mg/L	25,7	12,2	3122 B, 3030 E
Mg^{2+}	mg/L	12,9	9,08	3123 B, 3030 E
Ba^{2+}	mg/L	0,73	0,14	3124 B, 3030 E
Sr^{2+}	mg/L	3,71	1,87	3125 B, 3030 E
Fe^{3+}	mg/L	0,26	0,1	3126 B, 3030 E
pH	mg/L	8,3	8,5	4500-H^+-B
Salinity as NaCl	mg/L	8417	5795	2520 B
Total Hardness as $CaCO_3$	mg/L	117	67,9	2340 B
Total Suspended Solid	mg/L	32	18	2540 D
Oil & Grace	mg/L	< 2	< 2	5520 B
Dissolved Oxygen	mg/L	5,59	5,74	4500-O-G

TABLE 2
FLUID CHEMICAL PHYSIC CHARACTERISTIC OF SANDSTONE FIELD OIL THAT USED IN THIS RESEARCH

Parameter	Measurement Temperature (ºC)					
	40		50		60	
Density (g/cm³)	0,91483		0,90803		0,90142	
Temperature	40,02		49,99		59,97	
API Density (g/cm³) (15ºC)	0,9314		0,9313		0,9313	
API Gravity (15ºC)	20,27		20,3		20,28	
API Specific Grafity (15ºC)	0,9323		0,9322		0,932	
Viscosity (cP)	25,60	25,24	16,53	16,45	11,69	11,76
Speed (rpm)	60,00	90,00	60,00	90,00	60,00	90,00
Torque (%)	51,22	75,73	33,09	49,36	23,39	35,28
Shear Stress	20,27	29,98	13,10	19,54	9,26	13,97
Shear Rate (1/s)	79,20	118,80	79,20	118,80	79,20	118,80

IV. CONCLUSION AND SUGESTION

A. Conclusion

Performance of surfactant could be affected by the addition of surfactant concentration and inorganic salt. Methyl Ester Sulfonate surfactant could react better at

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salinity range 5000 – 25000 ppm. Minimum IFT value in demineralized water as dispersion medium was gotten at salt addition formula 5000 ppm The best result shown that for 0,3% surfactant in formation water as dispersion medium could have IFT value that the oil industry wanted.

B. Sugestion

More reserach for aditive addition and another test need to be done, so this surfactant was ready to use in oil industry.

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ISBN : 978-1-4673-7404-0

The Effect of Nano Zinc Oxide on Characteristic Bionanocomposite

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Abstract. **Demand of plastic is increasing along with the increasing use of plastics invarious fields. Plastics are hard to decompose biologically, so that it will give negative impacts to environment. One of ways to decrease those negative impacts is by using eco-friendly materials. Bionanocomposite is one of eco-friendly materials for plastics; this composite can be made from natural polymer and nano particle. This research used nano zinc oxide as nano particle for bionanocomposite. Bionanocomposite can be used as packaging, semiconductor, and medical materials. This research aims to know the effects of various type of nano zinc oxide (nano zinc oxide from galvanic industry waste, commercial, and without nano zinc oxide), and concentration of poly vinyl alcohol (0.5%, 1%, and 1.5%) on the bionanocomposite characteristics. The produced bionanocomposites was analyzed based on its mechanical properties, morphology, and biodegradation. The result showed that nano zinc oxide have effects to tensile strength and elongation of bionanocomposite, it also produces homogenous structure. Bionanocomposite can be degraded for 4 weeks.**

Keyword: Bionanocomposite, nanoparticle, plastic, nano zinc oxide, eco- friendly materials

I. INTRODUCTION

The demand of plastic packaging is increasing because of the increasing demand on food or non-food packaging materials. The type of plastics consumed in Indonesia in year 2010 were polypropylene (34%), polyethylene (29%), polyethylene terephthalate (15%), polyvinyl carbonate (12%), polystyrene (5%), and others (5%) [1]. Plastics contributed significantly to the waste generation. In DKI Jakarta only, plastic waste production in 2010 reached 523.6 ton/day [2].

Awareness on green environment are increasing. It leads to the increasing demand of eco-friendly packaging materials, which are renewable and mostly come from natural polymers. The natural polymers are categorized into four groups, namely (1) agro-polymer produced from biomass, (2) polyester produced from fermentation of biomass, (3) polyester produced from synthesis from biomass monomer, and (4) polyester produced from synthesis of petroleum [3]. The application of natural polymer can be divided into three generations, namely the natural polymer content of 5%-20% (decomposable for 3-5 years), natural polymer content of 40% - 70% (decomposable for 2 – 3 years), and the total natural polymer which are completely compostable [4].

Polymer can be used also as composite. It is made from combination two or more materials, which have different of mechanic properties. The mixture will then produce new materials that will have new mechanic properties and characteristic different from original material [5]. If one of component (matrix, amplifier or additive) has a nanoparticle size, it will be called nanocomposite [6]. Nano zinc oxide is often used for nanocomposite, because of it photocatalitic characteristics [7], semiconductor [8], antimicrobial [9], sunscreen [10], antibacterial [11]. Research's used nanoparticle as nanocomposite film from mixture of nano argentums oxide and nano zinc oxide showed that it could decreased microbial content [12]. Combination of chitosan with nano zinc oxide could also increase antimicrobial activity [10].

The development of composite is not only from synthetic composites but also biopolymer composites, because the biopolymeris quantitatively available, renewable, biodegradable, light and strong. So, it leads to reduce the polymer consumption from

 ISBN : 978-1-4673-7404-0

petrochemicals that are pollutants of the environment [13]. Bionanocomposite is a packaging material consisted of biopolymer in nanoparticle size, so it has new functional material. The natural polymer is used as matrix and organic/anorganic materials as filler or amplifier or additive [6]. The characteristic of bionanocomposite shows the increased mechanical characteristics and thermal stability. It has some advantages, such as biocompatible, biodegradable, and unique functionality according to the inorganic materials added [14].

This research aimed to evaluate the effects of nano zinc oxide from waste industrial galvanized to the bionanocomposite characteristic.

II. METHOD

a. *Materials and equipment's*

Materials used in this research included nano zinc oxide (produce from synthesis of zinc acetate from waste zinc dross). Tapioca starch (Orang Tani brand), polyvinil alcohol (PVOH) from Bratachem, caragenan, glycerol from Bratachem, nano zinc oxide from Sigma Aldrich, aquadest, and chemicals for analysis. Equipment which used in this research include oven memmert, magnetic stirrer magsuda 5N, glassware, molding, stirrer, Sartorius analytic scale BSA 2245-CW, tensile strength and elongation analysis equipment.

b. *Methods*

Nano zinc oxide process. Ten gram zinc acetate (product from extraction of zinc dross with acetic acid) was filled in 100 ml methanol and mixed for 30 minutes. The solution of zinc acetate were applied by ultrasonification for 30 minutes, it was then added with natrium hidroxide 10% to adjust pH 10. It was applied again by ultrasonification for 30 minutes.The sedimentation process was conducted for 24 hour and then the liquid was filtrated. The sediment was dried at 100^oC for 8 hours and was calcinated at 800^oC for 3 hour. It was then grinded to puree.

Preparation of Bionanocomposite Film. Bio-nanocomposite film were prepared under various condition, namely polyvinyl alcohol concentrations (0.5%. 1.0% and 1.5%) and nano zinc oxide types (nano zinc oxide from waste, nano zinc oxide commercial, and no nano zinc oxide). The nano zinc oxide was dissolved with 200 ml distillate water; it was mixed for 1 hour. It was added with glycerol 1%, and was mixed for 15 minutes. The mixture was then added with carrageenan 1%, and mixed for 15 minutes. The mixture was preheated and added with polyvinyl alcohol, it was then preheat until 70 ^oC with addition of tapioca starch 5%. It was preheated again to 125^oC until the gelatinization process occured. It was poured in mold (30cmx20cm). It was dried in oven at 50 ^oC for 48 hour, chilled at 27 ^oC and the film was removed from mold, saved in desiccator.

In the further research step, the production of bionanocomposite film were realized with polyvinyl alcohol concentrations of 0.5%, 1.0%, and 1.5%, and nano zinc oxide concentrations of 0.05%, 0.10% and 0.15%.

Characterization of the Bionanocomposite Film. Bionanocomposite film were analyzed its mechanical properties to know thickness, tensile strength and elongation, analysis of morphology to know nanoparticle of nano zinc oxide position and analysis biodegradation of bionanocomposite using burial method.

III. RESULT AND DISCUSSION

a. *Formulation of bionanocomposite as eco-friendly material*

The bionanocomposite formulation used some materials, such as tapioca starch, polyvinyl alcohol (PVOH), carrageenan, and glycerol and nano zinc oxide. The materials have unique function in the preparation process of bionanocomposite. The polymer film formation can be done with were dry process or wet process. The dry process use low water content using extruder. In the wet process the polymers were dispersed with solution and pourit in mold allowing it will dry [15].

There are there methods for bio-nanocomposite preparation, namely (1) in situ polymerization, the nanoparticles were mixed with monomer solution, and preheated or given radiation, (2) Solution casting, the polymer was dissolved with solvent or nanoparticle and was dispersed with solvent, and (3) melt processing, the nanoparticle was mixed with polymer in batch, and stirred and heated until polymer to be nanocomposite film [16]. This research used solution casting method. This method used water for media dispersion, because water is good media for nano zinc oxide, cheap, safe and eco-friendly.

b. *Mechanical properties of bionanocomposite film*

Analysis of bionanocomposite film mechanical properties aimed to know the homogeneous of bionanocomposite materials. The bionanocomposite mechanical properties included the thickness, the tensile strength and the elongation. Nano zinc oxide was added

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as additive of bionanocomposite, so it can effect the thickness, tensile strenght and elongation. Analysis the thickness of bionanocomposite film is shown at Fig. 1. The bionanocomposite film used nano zinc oxide from waste was thicker bio-nanocomposite film than the bionanocomposite film used commercial nano zinc oxide or without nano zinc oxide. The film's thickness was influenced by concentration of nano oxide and homogeneous of materials, this was due to molecul density decrease and free space at matrixes film increase so the film thickness increase.

The tensile strength of bionanocomposite film is shown in Fig. 2. The bionanocomposite film used nano zinc oxide from waste has the tensile strength higher than the bionanocomposite film used commercial nano zinc oxide or without nano zinc oxide. Analysis for the elongation of bionanocomposite film is shown in Fig. 3. The bionanocomposite film used nano zinc oxide from waste has the elongation higher than the bionanocomposite film used commercial nano zinc oxide or without nano zinc oxide. Analysis from mechanical properties above showed that the nano zinc oxide from waste has a potential to be used for preparation of bionanocomposite film.

Analysis of the thickness of bionanocomposite film use various concentrations of nano zinc oxide and various concentrations of polyvinyl alcohol is shown in Fig. 4. It was shown that the thickness of bionanocomposite film was 0.35 mm – 0.47 mm. The bionanocomposite film has the highest thickness at a nano zinc oxide concentration of 0.15% and a polyvinyl alcohol concentration of 1.0%. The tensile strength of bionanocomposite film is showed in Fig. 5. The tensile strength bionanocomposite film were 0.23MPa–9.57MPa. The bionanocomposite film has the highest tensile strength at a nano zinc oxide concentration of 1.0% with a polyvinyl alcohol concentration of 0.05%. The tensile strength explains about homogeneity of materials mixture in the bionanocomposite film.

The latest research explained that the higher addition of magnesium hydroxide, the lower tensile strength of bionanocomposite film produce [10]. Thermoplastic starch (TPS) decreased the tensile strength of bionanocomposite film, while compatibilizer increased the tensile strength of bionanocomposite film [17].

The elongation of film bionanocomposite film used concentration of nano zinc oxide with concentration of polyvinyl alcohol is shown in Fig. 6. The film elongations of 9.95%-37.85% were observed then at a polyvinyl alcohol concentration of 1.0% with nano zinc oxide concentration of 0.1%. The elongation of bionanocomposite film shows that it has good flexibility for material packaging. Bio-nanocomposite was used for medical, agricultural, packaging, sunscreen, pharmacy [18]. The filler with nanoparticle starch increased the tensile strength and decreased the elongation of bionanocomposite film [19]. The bionanocomposite film have sago starch as matrix and nano zinc oxide as filler increased the tensile strength and decreased the bionanocomposite film elongation [20]. Glycerol in bionanocomposite can decrease the tensile strength and the elongation [21].

Analysis for mechanical properties of bionanocomposite film had the best thickness of 0.37%, the tensile strength of 6.99 MPa and the elongation of 37.85%, observed at a nano zinc oxideconcentration of 0.10% and a polyvinyl alcohol concentration of 1.0%. This showed that this film has good thickness, strength and elasticity, so it is suitable for material packaging.

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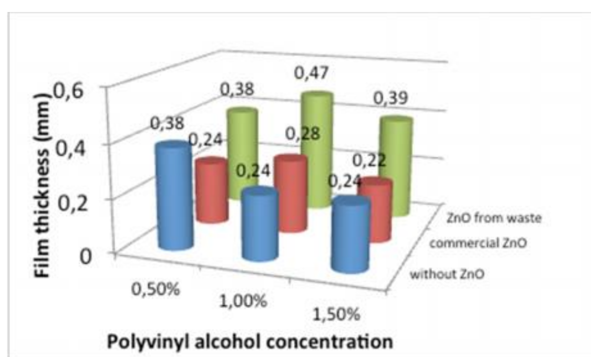

Figure 1. Analysis of the film thickness of bionanocomposite based on nano ZnO types

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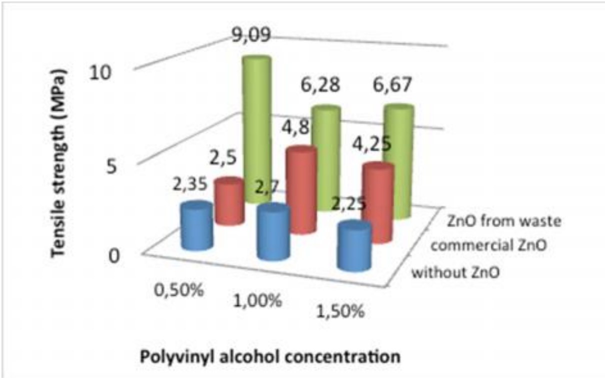

Figure 2. Analysis of the tensile strength of bionanocomposite based on nano ZnO types

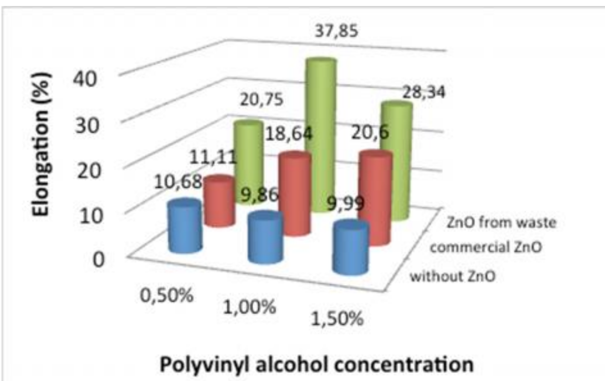

Figure 3. Analysis of the elongation of bionanocomposite based on nano ZnO types

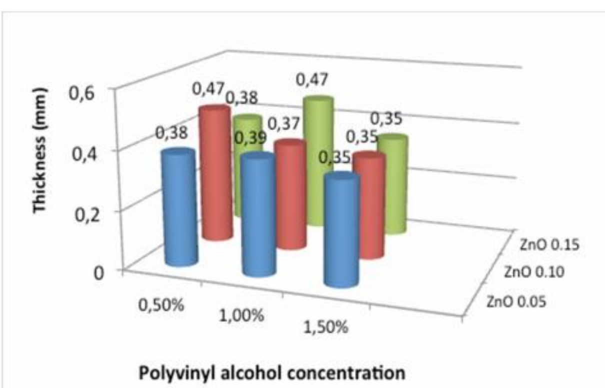

Figure 4. Analysis of the film thickness of bionanocomposite based on nano ZnO concentration

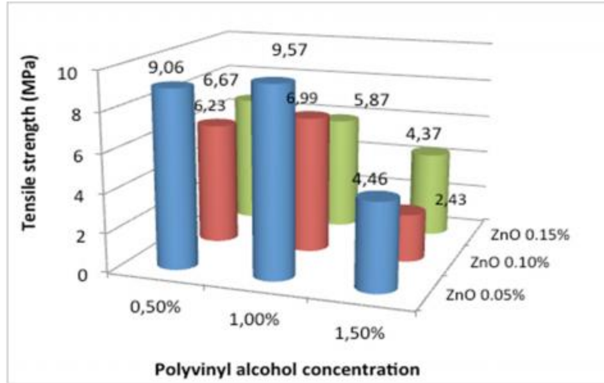

Figure 5. Analysis of the tensile strength of bionanocomposite based on nano ZnO concentration

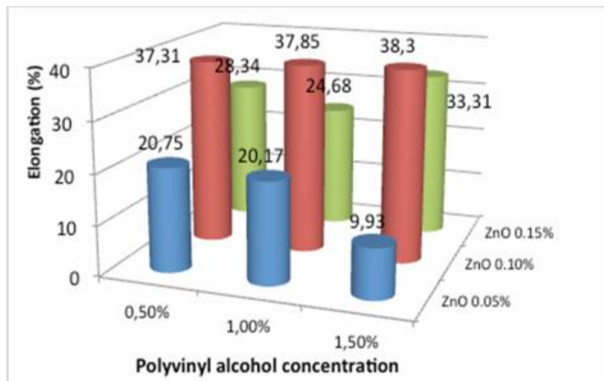

Figure 6. Analysis of the elongation of bionanocomposite based on nano ZnO concentration

c. The morphology of nano zinc oxide

Characterization of the bionanocomposite film morphology aimed to know the nanoparticle zinc oxide position in the bionanocomposite film. This was analyzed by using Scanning Electron Microscope (SEM) [16]. The morphology of nano particle zinc oxide bionanocomposite is shown in Fig 7. The composite of particle are isotropic, and the articles were interface bond with the matrix. This composite have advantages of small particle size [22].

The figure depicts that the nano zinc oxide concentration of 0.10% is more spread on the bionanocomposite surface. In hot water, glycerol and tapioca starch mode adhesion bond, so the nano zinc oxide can be bound in the matrix [18].

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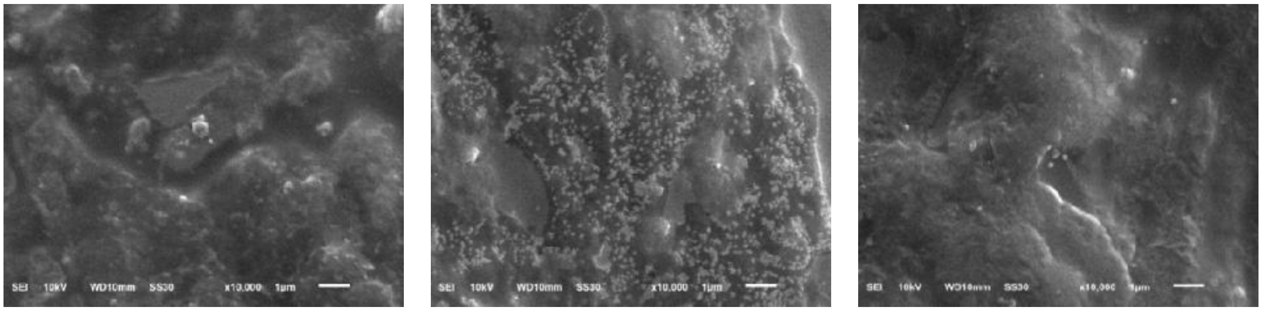

Nano ZnO 0,05 % Nano ZnO 0,10 % Nano ZnO 0,15 %

Fig.7. Morphology of nano partikel zinc oxide bionanocomposite

Fig 7 also shows that the bionanocomposite film are homogenous mixture of polyvinyl alcohol, tapioca starch and carrageenan, so surface area is good and flat, and the nanoparticle zinc oxide was attached on the matrix.

d. Biodegradibility of bionanocomposite

Analysis for the bionanocomposite film biodegradability aimed to know the degradability of polymer in the bionanocomposite film. The biodegradation process was observed in several ways, in which oxidation and radiation were applied. The plastic waste containing content dissolve polymer could be processed by the activated sludge and composting methods. The activated sludge method degraded the polymer waste for 2 weeks, while the composting method degraded the polymer waste in several weeks [23].

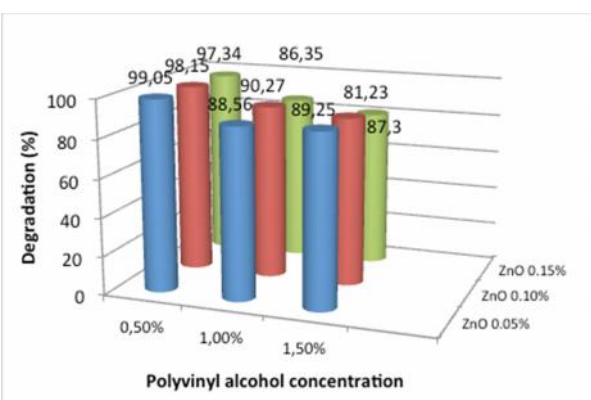

Figure 8. Film degradation of bionanocomposite for 4 weeks

The soil burial method can degrade the natural polymer [17]. The increase of starch concentration and period of soil burial increased the weight loss, because many starch was degrade by microbial in composting soil [24]. This research used soil burial test. The result of soil burial test during 4 weeks was shown at Fig. 8. The highest degradation level of bionanocomposite film of 99.05% was observed at polyvinyl alcohol concentration of 0.5% with nano zinc oxide concentration of 0.05%.

IV. CONCLUSION

Bionanocomposite can be made by formulation of tapioca starch, carrageenan, glycerol, polyvinyl alcohol and nano zinc oxide. Nano zinc oxide from waste of industrial galvanized can be used for bionanocomposite film process as additive. The bionanocomposite film prepared from nano zinc oxide from waste of industrial galvanized was characterized by higher thickness, tensile strength and elongation than the bionanocomposite films without nano zinc oxide addition, or with the commercial nano zinc oxide. The best thickness, tensile strength and elongation of bionanocomposite film were observed at nano zinc oxide concentration of 0.10%. Good structure of the bionanocomposite film was found at a nano zinc oxide concentration of 0.10%. Approximately 81.23%-99.05% of the bionanocomposite film could be degraded with soil burial method for 4 weeks. The bionanocomposite film content nano zinc oxide from waste industrial galvanized could be used for ecofriendly packaging material 0.10% and polyvinyl alcohol concentration of 1.0%.

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 ISBN : 978-1-4673-7404-0

The Effects of Molar Ratio of Glycerol 80% and Palm Oleic Acid on the Synthesis Process of Ester Glycerol

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***Abstract*—Glycerol ester was synthesized by esterification of glycerol and palm oleic acid using methyl ester sulfonic acid (MESA) as catalyst. The purpose of this study was to obtain the best molar ratio in the esterification of 80% glycerol with palm oleic acid using 0.5% MESA catalyst. Glycerol 80% was esterified by using a nitrogen stream at 180°C and a stirring speed of 400 rpm for 90 minutes. Results showed that the best molar ratio was 0.8:1 (glycerol: oleic acid) which produced glycerol ester with the yield of 75.33%, density of 0938 g/cm^3, acid number of 39 ml KOH/g sample, viscosity value of 92 cP (30^{o}C), kinematic viscosity of 53 cSt (40°C), flash point at 204°C, pour point at 0°C, and boiling point at 105°C.**

I. Introduction

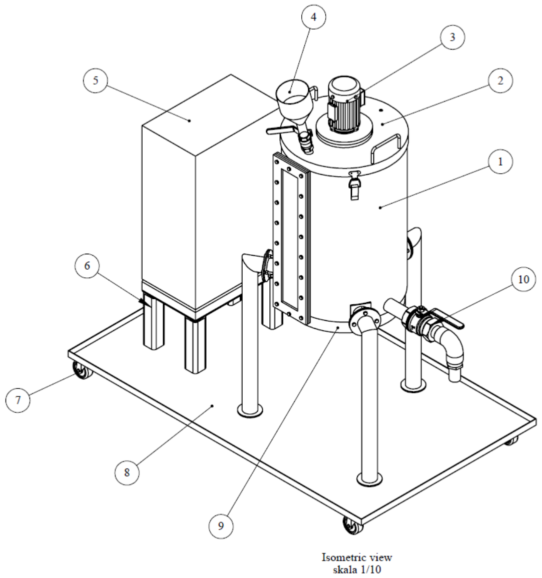
GLYCEROL ester can be synthesized through an esterification process by reacting glycerol with carboxylic acid and catalyst. This process produce s water as a by-product. Esterification is a reversible process so that one of the reactants needs to be priorly fed in order to push the reaction to the right side or to product formation. A catalyst is used to avoid the need of high temperature, longer reaction time, and the formation of dark-colored product [18].

Handayani *et al*. [5] stated that reactant-catalyst ratio was one of the factors affecting reaction effectiveness. In the esterification of glycerol with oleic acid, the molar ratio of glycerol to oleic acid reactant is an important factor to observe. In this study, the esterification was done with glycerol 80%: oleic acid reactant ratios of 0.8:1; 1.7:1; and 2.6:1. Methyl ester sulfonic acid 0.5% was used as a catalyst.

II. Procedure

A. *Purification of Glycerol as a By-product of Biodiesel Production*

Glycerol purification was done by using a purification reactor of 25 L scale. The purification device is shown in Figure 1.



Component of purification rector

1. Purification tank	6. Framework of panel
2. Cap tank	7. Wheel
3. Electric motor	8. Unit holder
4. Entry funnel	9. Cooker unit
5. Control panel	10. Output

Figure 1. Design of purification reactor of 25 L scale

Glycerol purification process was done under a condition process used by [15] with some modifications. First, crude glycerol, a by-product of biodiesel industry, was placed in a purification tank

 ISBN : 978-1-4673-7404-0

and heated until the temperature reached 50^{o}C. Then, 85% technical grade phosphoric acid was added in by 5% (v/v), the temperature was raised to 80°C. The mixture was heated and stirred for 4 hours before it was left for 30 minutes until three layers were formed. From top to bottom, the three layers consisted of free fatty acid, glycerol (product of purification), and salt. Glycerol and salt were taken out from the purification tank before they were separated by using a filtration device.

B. Esterification of Purified Glycerol

In this synthesis of glycerol done through esterification, glycerol resulted from the purification was reacted with oleic acid in molar ratios (glycerol:oleic acid) of 0.8:1, 1.7:1, and 2.6:1 with an addition of MESA catalyst (w/w) by 0.3%. The esterification was conducted in triple neck flasks put on hot plates at 180°C for 90 minutes. During the esterification process, nitrogen was flown into the flasks at the rate of 100 mL/minutes to avoid the existence of oxygen and push the formed water vapor out to the condenser.

C. Analyses of Glycerol, MESA Catalyst, and Glycerol Ester

Analysis of glycerol, MESA catalyst, and glycerol ester were done to measure glycerol content, density (DMA 4500M Anton Paar), viscosity (Brookfield DV-III ultra), pH, acid number, kinematic viscosity (ASTM D 445), boiling point (ASTM D 86), flash point (ASTM D 92), and pour point (ASTM D 97).

D. Data Analysis

A factorial completely randomized design with two replicates was used. The factor was MESA catalyst concentration (A). The experimental design model was:

$$\boldsymbol{Y_{ij} = \mu + A_i + \varepsilon_{ij}} \qquad (1)$$

where:

Y_{ijk} = Observation value as affected by factor A at i-level

μ = Mean value

A_i = Effect of molar ratio at j-level (j=0.8:1; 1.7:1; 2.6:1)

ε_{ij} = Error of experimental unit at i-level of factor A and j-level of replicate (j=1,2)

Data were subjected to analysis of variance by using SPSS 16.0 program and a Duncan test at α = 5%. The test was done to measure inter-level differences in a factor.

III. RESULT AND DISCUSSION

A. Physicochemical Properties of Purified Glycerol

Crude glycerol was purified by the addition of 85% phosphoric acid by 5% (v/v). The acid reacted with the remains of potassium hydrochloride catalyst to form a potassium phosphate salt and at the same time separate free fatty acids. The remaining methanol, which did not react, evaporated when glycerol was heated at 65°C. The result was 80% pure glycerol having different physicochemical properties from those of crude glycerol. These differences are shown in Table 1. Purification process increased glycerol level, lowered viscosity and density levels, and brightened the color.

TABLE I
PHYSICOCHEMICAL PROPERTIES OF CRUDE AND PURIFIED GLYCEROL

Parameter	Unit	Crude glycerol	Purified glycerol	Pure glycerol*
Level of glycerol	%	45 ± 2.05	84 ± 2.00	100%
Viscosity at 30°C	cP	625 ± 1.07	189 ± 0.70	1499
Density at 25°C	g/cm^3	1.0745 ± 0.0001	1.2576 ± 00001	1.261
Color		Blackish brown	Brownish yellow	No color
Boiling point	°C	80 ± 3.25	82 ± 2.05	290

* [7], [13]

B. Physicochemical Properties of MESA Catalyst

MESA (*methyl ester sulfonic acid)* is an intermediate compound resulted from the sulphonation reaction of methyl ester. It is dark colored and acidic. The properties of MESA in this study are shown in Table 2. Based on its pH value, MESA is strongly acidic. This specific property of MESA has been the basis of its use as catalyst in esterification. As in other acidic catalysts, the acidity of MESA is suspected to result in the protonation of oleic acid which is the initiation of ester formation process.

TABLE 2.
PHYSICOCHEMICAL PROPERTIES OF MESA CATALYST

Parameter	Unit	Value
pH (1% in distilled water)		2.2 ± 0.20
Density at 25°C	g/cm^3	0.9173 ± 0.0001
Color		Black

C. Physicochemical Properties of Glycerol Ester

Esterification is the formation of ester by reacting fatty acid with alcohol. Glycerol ester is an ester whose alcohol molecule is glycerol. As the esterification result, two layers are formed. The top layer is glycerol ester and the bottom layer is the remaining glycerol which does not react. In this study, the resulted glycerol ester was a mixture of monooleic, dioleic, and trioleic glycerols and the remaining fatty acids which did not react.

According to [16], in order to get optimum product, the reaction balance of esterification should be pushed to the right position or product formation by supplying energy to the reaction, overfeeding the reactants, and

ISBN : 978-1-4673-7404-0

continuous removal of product during the process. Esterification process is a reversible reaction so that it is necessary to maintain the direction of the process to the production side. In this study, this was done by overfeeding glycerol reactant to the reaction. The formation of two layers in the esterification product was caused by the finding that in the end of the reaction there was some glycerol which did not get reacted. During the esterification process, nitrogen gas was continuously flown into the flask to push the water vapor out of the flask. As water vapor was a by-product of esterification, the removal of it would lead to an optimal glycerol ester production. If it was not removed out from the reactor, the formed water vapor might hydrolyze glycerol ester back to glycerol and oleic acid. The yield and the physicochemical properties including acid number, density, viscosity, kinematic viscosity, flash point, pour point, and boiling point of glycerol ester produced were measured.

1) Yield

In this study, yield was the amount of glycerol reacted with oleic acid to result in glycerol ester. It is shown in Figure 2 that wider molar ratios resulted in fewer yields. This indicated that overfeeding of glycerol, under the esterification condition used in this study, did not result in higher glycerol ester yield. This might be caused by the fact that the purity level of glycerol was only 84% so that when it was overfed to the esterification process, more filth was found in the esterification material. These filths inhibited the formation process of glycerol ester.

Esterification done with higher amount of oleic acid (molar ratio of 0.8:1) resulted in high yield. This indicated that higher amount of oleic acid fed in the esterification process increased the possibility of the formation of ester bonds between glycerol and oleic acid.

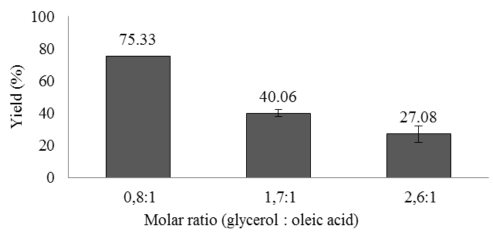


Figure 2. Effects of molar ratio on glycerol ester yield

It was also shown that molar ratio factor did not give significant effect (P>0.05) on yield. It was suggested therefore that a molar ratio of 0.8:1 be used to get high yield of glycerol ester.

2) pH

The glycerol ester sample taken from the esterification was a mixture of monooleic, dioleic, trioleic glycerols, remaining oleic acid which did not react, and MESA catalyst. pH measurement was done by dissolving glycerol ester in 30% distilled water. It was found that glycerol ester sample did not dissolve in the water but MESA catalyst did. pH measurement was taken to assess the amount of MESA catalyst found in the esterification product. Higher pH level indicated higher amount of MESA catalyst found in glycerol ester. Results of pH measurement are depicted in Figure 3.

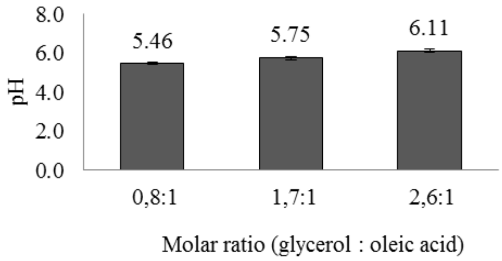


Figure 3. Effects of molar ratio on pH

It is shown in Figure 3 that a wider molar ratio or higher amount of glycerol fed into esterification led to lower pH levels. This was caused by the finding that the pH level of glycerol ester formed was in line with the pH level of glycerol. In this study, purified glycerol had a pH level of 6.24.

3) Density

Density or specific gravity is a weight of a liquid per unit volume. Density measurement was taken to assess the inter-molecule denseness in glycerol ester yielded. It is shown in Figure 4 that glycerol ester with high density was yielded in wider molar ratios. According to [9], the density level of ester of carboxylic fatty acid was affected by molecular weight and temperature. Higher molecular weight meant higher density level.

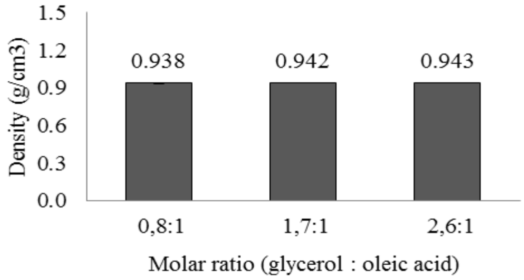


Figure 4. Effects of molar ratio on density level of glycerol ester

It was found that molar ratio factor did not give significant effect on density levels. This might be caused by the fact that each sample of esterification product contained similar main components, namely monooleic, dioleic, and trioleic glycerols. Therefore, the density level of each sample was not too different.

It was found that molar ratio factor did not give significant effect on density levels. This might be caused by the fact that each sample of esterification

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product contained similar main components, namely monooleic, dioleic, and trioleic glycerols. Therefore, the density level of each sample was not too different.

4) Acid Number

Acid number is used to assess the amount of fatty acids per gram of sample. Higher acidic number indicates higher amount of fatty acid content. Acid number shows how much (ml) KOH is needed to neutralize 1 gram of fat/oil. It is shown in Figure 5 that, in general, an increase in molar ratio led to an increase in acid number. This meant that wider molar ratio was not followed by higher yield conversion to glycerol ester leaving more fatty acid which did not react in the esterification process. As oleic acid has an acid number of 200 mg KOH/g sample, high amount of oleic acid remains which did not react in the process would lead to the production of glycerol ester with high acid number.

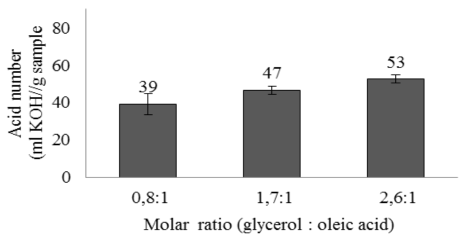

Figure 5. Effects of molar ratio on acid number of glycerol ester

It was found that molar ratio factor gave significant effects on acid number of glycerol ester.

5) Viscosity

Viscosity is a physicochemical property showing the level of thickness of a fluid. An increase in viscosity is a result of increased molecule concentration [10]. Increased viscosity of a material may also caused by increased chain length and molecular weight. Viscosity affects the flowing characteristic of a fluid; higher viscosity means lower capacity of the fluid to flow. As can be seen in Figure 6, higher amount of glycerol fed into the process led to wider molar ratio and higher viscosity level. This was attributed to the fact that the viscosity of glycerol ester yielded was always in line with the viscosity of glycerol used. In addition, as discussed above, wider molar ratio did not yield in higher amount of glycerol ester leaving more oleic acid which did not involve in the reaction. This, in turn, led to a higher viscosity level of glycerol ester.

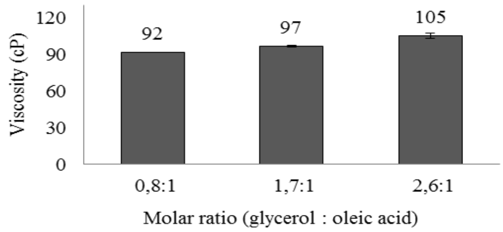

Figure 6. Effects of molar ratio on viscosity levels of glycerol ester.

It was revealed that, in general, glycerol ester yielded from the molar ratio of 0.8:1 the lowest viscosity level. This indicated that most glycerol ester was produced in the esterification process done with a molar ratio of 0.8:1. This was supported by the finding that molar ratio factor gave significant effect on the viscosity levels of glycerol ester.

6) Kinematic Viscosity

Kinematic viscosity is the measure of the resistance of glycerol ester to flow. Higher kinematic viscosity level means that it is more difficult for the substance to flow. According to [11], the value of kinematic viscosity is affected by the length of carbon chain and the position and number of double bonds of fatty acid or alcohol used in an ester synthesis. Longer carbon chain means higher kinematic viscosity level while number of double bonds has a negative relation with kinematic viscosity level. Kinematic viscosity is a function of dynamic viscosity and density; increased kinematic viscosity is resulted from higher dynamic viscosity and lower density level [8]. In this study, it was revealed that wider molar ratios gave higher kinematic viscosity level which was in line with viscosity level (Figure 7).

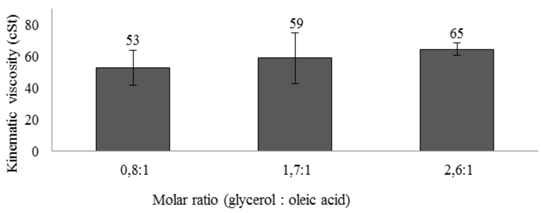

Figure 7. Effects of molar ratio on kinematic viscosity of glycerol ester

Molar ratio was found to give no significant effects on kinematic viscosity levels of yielded glycerol ester. As discussed above, esterification of glycerol and oleic acid resulted in glycerol ester in the forms of monoolein, diolein, or triolein. One of them was found to be dominant and affect their general physicochemical properties. This non-significant difference suggested that all samples share common main components in relatively similar concentration.

7) Flash Point

Flash point is the lowest temperature at which a substance starts to ignite and burn itself [1]. It is a

ISBN : 978-1-4673-7404-0

parameter affected by the content of volatile fractions (alcohol residue). According to [12], higher content of volatile fractions in an ester makes it need only low temperature to ignite. A material with low flash point is easier to get burnt and therefore needs special handling and storing. In esterification, as an alcohol, glycerol releases its hydroxyl groups and binds oleic acid to form ester. This makes the flash point of glycerol ester higher. Purified glycerol and oleic acid have flash points of 120°C and 204°C, respectively. Relatively similar component compositions found in samples make their flash points relatively the same.

8) Pour Point

According to [4], pour point is the lowest temperature at which a sample is still able to flow. Lower pour point of a material indicates that the material is able to flow at low temperatures. According to [14], the chain length and unsaturation of a molecule affect its pour point. Longer chain length increases pour point while double bonds indicating unsaturation lowers it. In this study, the pour points of all glycerol ester samples were found to be the same, namely 0°C. This showed that at temperatures below 0°C, there would be white crystals formed in the glycerol ester and it would no longer be able to flow. A fluid with low pour point is better to be used in areas with low temperature.

9) Boiling Point

Boiling point is a physicochemical property showing a temperature at which a material starts to boil. Boiling point shows intermolecular force in a fluid; stronger force means higher boiling point. According to [6], boiling point is affected by molecular weight and the existence of hydrogen bonds. In this study, as shown in Figure 8, boiling points of glycerol ester were slightly fluctuating. The highest boiling point was shown by glycerol ester yielded from the molar ratio of 1.7:1.

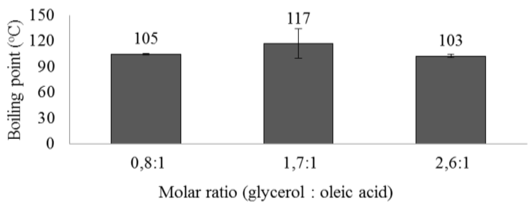

Figure 8. Effects of molar ratio on boiling point of glycerol ester

It was shown that molar ratio gave significant effects (α = 5%) on the boiling points of glycerol ester yielded. The boiling points in molar ratios of 0.8:1 and 2.6:1 were not different but they were significantly different from the boiling point of glycerol ester in molar ratio of 1.7:1. This was an indication that glycerol ester yielded in the molar ratio of 1.7:1 had the highest concentration.

After the properties of glycerol ester were analyzed, the best esterification condition was determined based on the parameters of the analysis done. First, based on the yield, the highest yield of glycerol ester was obtained from molar ratio of 0.8:1. Density level was not included in the consideration as no significant effect of molar ratio was found on it. In addition, the difference in the density levels of glycerol ester yielded in different molar ratios was negligible. The lowest acid number was found in glycerol ester yielded in molar ratio of 0.8:1. Further, glycerol ester in this molar ratio also had the smallest viscosity and kinematic levels. Low viscosity and kinematic viscosity levels indicated most preferred glycerol ester as it would be the easiest one to flow. The next parameter was flash point and the preferred glycerol ester was the one with highest flash point. A substance with high flash point is not easy to get burned making it easier to handle. As no significant difference was found flash points, glycerol ester yielded in molar ratio of 0.8:1 was then selected as the best. Similar consideration was given to pour points which were not significantly different making glycerol ester yielded in molar ratio of 0.8:1 as the best. Finally, based on the boiling point, the best glycerol ester was the one yielded in molar ratio of 1.7:1 as it had the highest boiling point. Overall, it was decided that the best esterification condition was the one done in molar ratio of 0.8:1.

IV. Conclusion

The best esterification process was obtained in molar ratio of 0.8:1. Glycerol ester produced in this condition had a yield of 75.33%, density level of 0.938 g/cm^3, acid number of 39 ml KOH/g sample, viscosity of 92 cP (30°C), kinematic viscosity of 53 cSt (40°C), flash point of 204°C, pour point of 0°C, and boiling point of 105°C.

Recomendation

It was suggested that esterification of glycerol 80% with palm oleic acid be done in molar ratios wider than 0.8:1.

Acknowledgment

Supports of facilities from SBRC LPPM IPB and finance from *Lembaga Pengelola Dana Pendidikan* (*LPDP*) were acknowledged.

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ISBN : 978-1-4673-7404-0

Selecting Part of Natural Fiber EFB which has Best Mechanical Strength through Tensile Test Analysis for Composite Reinforced Material

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Abstract—**Natural fiber of EFB which is recently still categorized as waste material is very potential to be utilized as composite reinforced material, however it is remain constrained on resulting composite strength. Many treatment has been applying to obtain better mechanical bonding, however it was costly higher rather than its result and some did not increase the strength compare with matrix material strength itself. Previous researcher described that tensile strength of EFB was not as good as other natural fibers such as bamboo, sisal, pineapple leaf, and many others, furthermore it contains residual oil and several harmful minerals which had weakened its composite, therefore it is necessary for selecting part of natural fiber EFB which has best mechanical strength. This study explored morphology of an EFB, and separating it to 3 parts, ie: upper stem, main stem, and fruit stem. Those 3 parts was examined and base on tensile strength analysis, the leaf stem has best mechanical strength, and it also shown more stiff structure compare with 2 others. Tensile strength analysis result using ASTM D3822-01 standard shown that average tensile strength of an EFB leaf stem single fiber was 152,85 MPa, while upper stem fiber and main stem fiber was 108,29 MPa and 125,13 respectively.**

Manuscript received April 30, 2015.

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I. INTRODUCTION

Indonesia is a world biggest crude palm oil (CPO) producer with a total land growth of 7.6% during 2004-2014 [6] and projected to produce 40 million tons in 2020[4]. Currently on 10.9 million hectares of land, 29.3 million tons of CPO [6] is produced by 608 units of palm oil mill spread unevenly across the major islands in Indonesia [4], and it is concentrated on the island of Sumatra, especially in Riau Province.

Oil palm empty fruit bunches (EFB) which is 21% -24% share part of the total fresh fruit bunches (FFB) has not been utilized optimally. Palm oil mill generally returns EFB into plantations to be used as fertilizer. However, because of the large numbers, and transportation costs are expensive, and not comparable with the needs of the fertilizer itself, then finally palm oil mill granted to accumulate this EFB in open fields, and this deposit potentially produces methane gas released into open air causing damage to the ozone layer.

EFB is a fibrous material that is hard and tough and it shows morphological similarities with coconut coir [26]. SEM (scanning electron microscopic) image of fiber TKKS taken from a transverse position can be seen in Figure 5 which shows the presence of lacuna like portion in the middle surrounded by a porous tubular structure [26]. The pores of fibre surface has 0.07 μm average diameter and this porous surface is useful to produce a better mechanical interlocking with the epoxy matrix material in the composite fabrication [26]. However the porous surface structure also facilitates the penetration of water into the fiber by capillary action, especially when it is exposed to water [13].

ISBN : 978-1-4673-7404-0

Fig. 1 Accumulated EFB that is waiting to be returned to the field (Source: PTPN 13)

Starch granules found in the interior of vascular bundles of EFB [16]. Silica bodies are also found in great number on fiber strand. They attach themselves to circular craters which are spread uniformly over the fiber surface. The silica bodies, through hard, can be dislodged mechanically, leaving behind perforated silica-crater, which would enhance penetration of matrix in composite fabrication [24]. High cellulose content [25] and high toughness value [9] of EFB make it suitable for composite applications. However presence of hydroxyl group makes the fibers hydrophilic, causing poor interfacial adhesion with hydrophobic polymer matrices during composite fabrication. This may lead to poor physical and mechanical properties of the composite [19]. EFB fiber also contain oil residue around 4.5% [1] that will significantly influence the fiber-matrix compatibility.

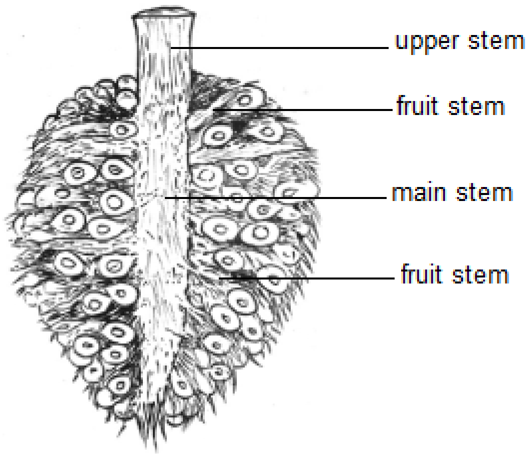

Fig. 2 EFB fiber morphology which classifies fiber according to body composition and function

The ester components of which may affect coupling efficiency between fiber and polymer matrix as well as the interaction between fiber and coupling agents [20].The fiber properties can be improved substantially through surface modifications. Chemical treatments decrease hydrophilic property of the fibers and also significantly increase wettability with polymer matrix [11]. There are number of treatment methods on EFB to improve its properties and make it compatible with polymeric matrices. Shinoj et al (2011) have studied EFB fiber and conclude that it is suitable for composite raw material. EFB containing cellulose in the range of 43% - 65% and Lignin of 13% - 25% make it compatible with several polymer raw materials such as natural rubber, polypropylene, polyninyl chloride, phenol formaldehyde, polyurethane, epoxy, and polyester.

There are several treatments to improve the properties of EFB fiber to make it suitable and coupled with its polymer matrix. Compatibility can be improved by providing an alkali treatment on natural fiber. Alkali treatment is immersing natural fiber into a 5% solution of sodium hydroxide that will increase the flexural modulus of composite materials [23]. The solution eliminates the hemicelluloses and lignin from kenaf fiber surface so that compatibility for the better. Alkali treatment on fiber flax above 10% sodium hydroxide lowers the composite tensile stress. This is caused by changes in the chemical structure of owned fiber wherein the cellulose molecule chains lose local crystalline structure due to alkali treatment [5].

It is more convenient to model the composite on a macro scale continuum level. An analogy is to model steel as a homogenous material instead of modeling the crystals and grains. The method used when determining the macro scale continuum properties from the micro scale properties, is referred to as homogenization. The macro scale properties are obtained by analyzing a representative volume element, RVE, of the composite on a micro scale. The macroscopic properties of a composite, i.e: its density, stiffness, thermal and hygro expansion etc are determined by the equivalent properties of the fibre and matrix materials. A central parameter in micro mechanical modeling is the volume fraction of the fibers and the matrix. The volume fractions are Vf and V_m for the fibre and the matrix respectively. Vf and V_m are defined such that:

$$Vf + V_m = 1 \quad (1)$$

This relation is valid if the composite is solid, i.e. it does not contain any pores.

By assuming that the strain in a RVE is homogeneous, the stiffness of a composite can be approximated by [7]:

$$\mathbf{D}c = Vf\mathbf{D}f + Vm\mathbf{D}m \quad (2)$$

where $\mathbf{D}_c$, $\mathbf{D}_f$ and $\mathbf{D}_m$ are the stiffness matrices of the composite, fiber and the matrix respectively. V_f is the volume fraction of the fibers and V_m the volume fraction of the matrix. Equation 2 is referred to as the Voigt approximation, the rule of mixture (ROM) or the parallel-coupling model. The

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approximation might be more familiar in its one-dimensional form:

$$Ec = VfEf + VmEm \qquad (3)$$

where E_c, E_f and E_m are the E-modulus of the composite, the fibre and the matrix respectively.

If the stress field is assumed to be homogeneous, the compliance matrix can be approximated according to [7]:

$$\mathbf{C}c = Vf\mathbf{C}f + Vm\mathbf{C}m \qquad (4)$$

and its one-dimensional form:

$$\frac{1}{Ec} = \frac{Vf}{Ef} + \frac{Vm}{Em} \qquad (5)$$

which is referred to as the Reuss approximation or the series-coupling model.

It should be mentioned that both the Voigt and Reuss approximations are incorrect on the micro scale level. Assuming a uniform strain field of the RVE leads to that the tractions at the boundaries of the phases cannot be in equilibrium. Similarly, if the stress field is assumed to be uniform, the matrix and the reinforcement material cannot remain bonded.

Refer on above explanation, it is known that the strength of composite materials in receiving mechanical loads can be improved by using fiber reinforcing material which has high mechanical strength and stiffness, and also improves wettability to increase interfacial bonding between resin-fiber. Therefore used EFB fiber raw materials must have as high strength and uniformity as possible, since the out coming strength of composite is significantly determined by it. In addition, the fiber treatment process is proposing to improve wettability, and not to weaken the strength of the fiber itself, accordingly it needs to be controlled to obtain optimal conditions.

So far, some recent literatures that have been reviewed showed that previous research has not been sorting EFB fiber in part by part, but in integral part. It is predicted in because of preparation process in separating it into parts is quite hard to do, and many researchers obtain the raw EFB material fiber instantly from preparation machinery that has been processed by large-scale factory, and it is without any prior sorting process. This could be resulting strands of fiber with high variance strength level. Based on this study, the goal of this research is founding the part of EFB fiber which has best mechanical strength through tensile test analysis for composite reinforce material by selecting it each part by part as illustrated on Figure 2.

2. METHOD

Sampling of palm oil EFB conducted in PTPN VIII Business Unit 1 owned palm oil mills (PKS) at Cikasungka Plantation – Bogor Regency. EFB sorting was separation process between the main stem and fruit stem by slicing method using conventional blade. Fiber preparation process was done mechanically to get single fiber, while eliminating water, oil, and dirt clinging to each part of the EFB.

Fig. 3 EFB sorting process by separating between the main stem and fruit stem

Instead of main stem and fruit stem, the other EFB part that will be analyzed is upper stem which have biggest diameter. Based on the early hypothesis, upper stem which is closest to the palm oil tree sustains the heaviest load of fresh fruit bunch (FFB); therefore testing will be focused to the upper stem of FFB which is closest to the tree. Based on the above hypothesis anyway, it also conducted sampling of the upper stem that is left at land. When harvesting, most of farmer generally cuts perfectly near to a FFB (≤ 5 cm) to lower down the size and weight [2], and left upper stem on the tree or cut it before transport and left it on land. Thus it is possible for upper stems are left on land has the best mechanical strength since it pays the load of FFB which some can have weight up to 50 kg.

Fig. 4 Main stem and fruit stem which have been separated

Physical properties testing of untreated EFB carried out in the laboratory of Bio Material LIPI -

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Cibinong. EFB single fiber diameter is measured by Optical Microscope Zeiss Axio Imager type with 50 times magnification. Three types of fiber samples (BA;upper stem, BU;main stem, and BB;fruit stem) water content were measured with a dry basis, and then those samples are taken randomly each 50 pieces to be measured. This measurement is intended to generate value of cross sectional area A, and then the tensile strength values can be formulated as follow:

$$\sigma UT = \frac{F}{A} \qquad (5)$$

σ_{UT} = Ultimate tensile strength
F = Peak force when fiber broken off while tensile test in Newton
A = Cross-sectional area in mm^2

Figure 5 ~ 7 are fiber strand illustrations of each part of EFB. Each fiber section is coded as BU (main stem), BB (fruit stem), and BA (upper stem). Photos are taken by using a microscope with a magnification of 50 times.

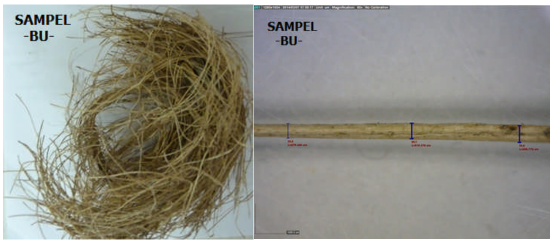

Fig. 5 Main stem fiber strand (BU)

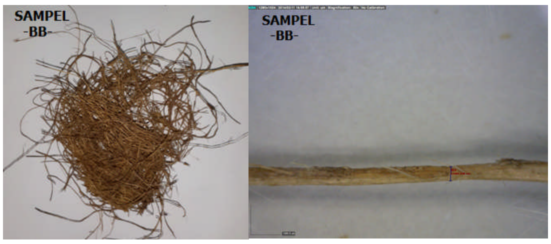

Fig. 6 Fruit stem fiber strand (BB)

Fig. 7 Upper stem fiber strand (BA)

2.1. Specimen Making

Tested specimens were made by using ASTM 3822-01 standard. Fibers were dried to achieve moisture content <40%. Specimens were prepared are 50 pieces of each fiber parts, bringing the total to 150 specimens. Figure 8 below shows how the fiber is prepared before the tensile test.

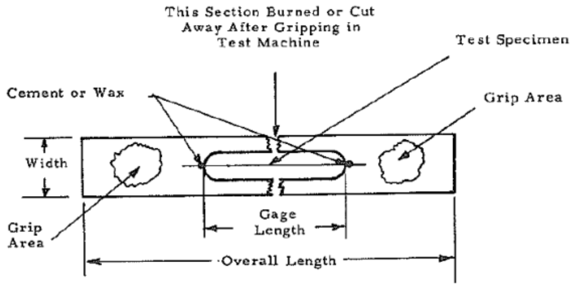

Fig. 8 Ilustration of fiber tensile test model

Every single piece of fiber specimen takes two sheets of 200 grams cardboard and was formed using a paper cutter. Fiber then attached using epoxy glue to provide a good grip. Figure 9 illustrates some of the specimens that have been made.

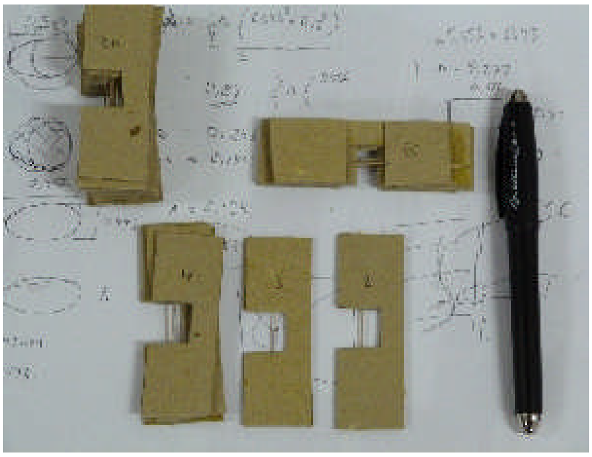

Fig. 9 Fiber strands that were ready to be tested

Specimens were left for ± 24 hours for perfectly glue curing to prevent fiber slippage during testing and fibers pull out. Fiber slippage may affect on test results, especially related to modulus of elasticity value.

2.2. Testing Procedure

Tensile test procedures were firstly attached the load cell in UTM (universal testing machine) with a maximum load 1kN, then the specimen was placed on the center of vise jaw, and then locked to prevent shifted from its original position. In order to left single fiber only, we cut Paper on specimens with scissors. To provide real fiber strength data, we need to enter the diameter value of the fiber under test into UTM software, and then press the start button to begin tensile testing process. When the fibers began to be pulled, the graph on the screen will start to be seen, showing that the fiber tensile stress began to be detected.

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Fig. 10 Load cell were used on fiber tensile testing

Fig. 11 Tensile test preparation process

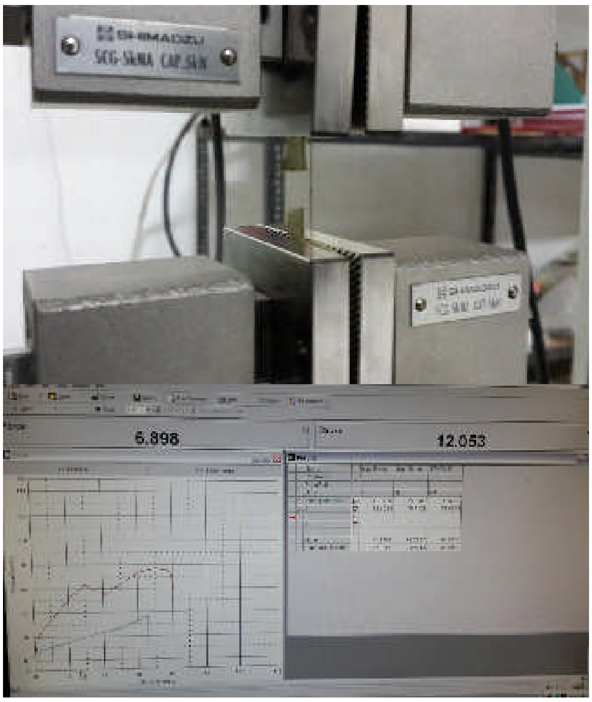

Fig. 12 Tensile loading mechanism and tensile test graphs

3. RESULTS AND DISCUSSION

Post boiled EFB which had been threshed has moisture content of approximately 67% [28], so in order to complete the mechanical properties test data, test specimens also conducted testing of the physical properties. It was expected to get as much as possible the fiber under test to represent the current state of the fiber that will be fabricated as composite materials. One of the three fiber specimen which was measured its density, fruit stem (BB) density was the lowest, and showed uniqueness.

TABLE I
PSYSICAL PROPERTIES OF EFB FIBER

No.	SAMPLE	MOISTURE CONTENT (%)	DENSITY (g/cm^3)
1.	Main stem	19.03 +3.68	1.07+0.04
2.	Upper stem	19.01 ±7.35	1.03+0.03
3.	Fruit stem	16.00.+ 4.14	1.02+0.03

Chemical properties of EFB samples were also tested as a reference, but in generally the results are almost similar with previous research. However, there are again a uniqueness shown by fruit stem EFB fibers (BB), which showed lowest lignin content than other parts of EFB fiber, which is 13.53%. This indicates that the fruit stem fibers expect to be easier in pre-treatment process to remove lignin content due to lesser content of lignin, and this is a value added when it is used as composite materials.

TABLE II
CHEMICAL PROPERTIES OF EFB FIBER

NO	T EST	Fruit Stem		Upper Stem		Main Stem		Standard Method
		RESULT *(%) Dry Base*	Standar Dev	RESULT *(%) Dry Base*	Standar Dev	RESULT *(%) Dry Base*	Standar Dev	
1	Water Content	10,91	0,099	5,983	0,064	7,173	0,037	TAPPI TM T412 OM94
2	Ethanol-Benzene Extractive content	2,696	0,007	3,007	0,035	2,956	0,014	TAPPI TM T204 OS76
3	Klason Lignin	13,53	0,047	19,8	0,231	17,26	0,248	TAPPI TM T222 0M88
4	Holo-Cellulose	49,5	0,385	62,07	0,465	60,15	0,145	TAPPI TM T203 OM93
5	α-Cellulose	30,28	0,669	38,22	0,408	36,14	0,107	TAPPI TM T429 CM01
6	Hemicellulose	19,49	0,669	23,52	0,408	24,11	0,107	By difference

The next discussion will be tensile test result that will test 50 samples per each part. It will be drawn at random a number of 15 pieces which still meet the population standard samples are permitted. This was because in each 50 pieces of samples per part, there

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were several damaged, and ignored. The damage was mainly caused by imperfectly gluing process and caused slippage when fibers were pulled. The error indicated by ambiguous graph which was showed abnormal condition on fiber material.

The main stem EFB fiber (BU) showed unfavorable results, although these fibers are the longest part of EFB fibers. Furthermore tensile graphic presentation of test results are presented in Figure 13,14, and 15.

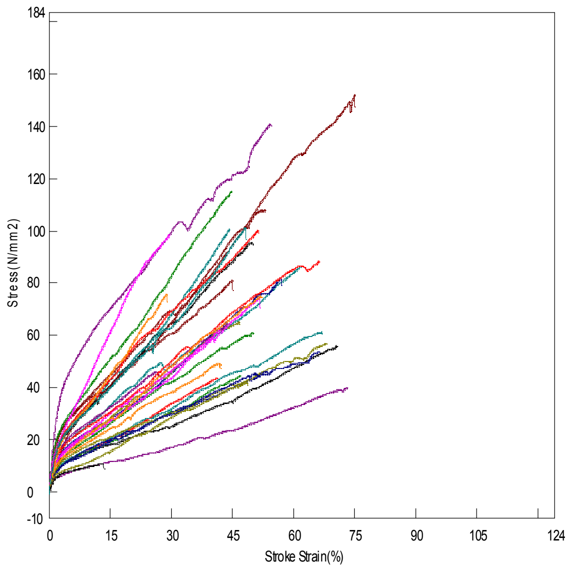

Fig. 13 Stress-strain graph for testing main stem fiber (BU) with 50 population

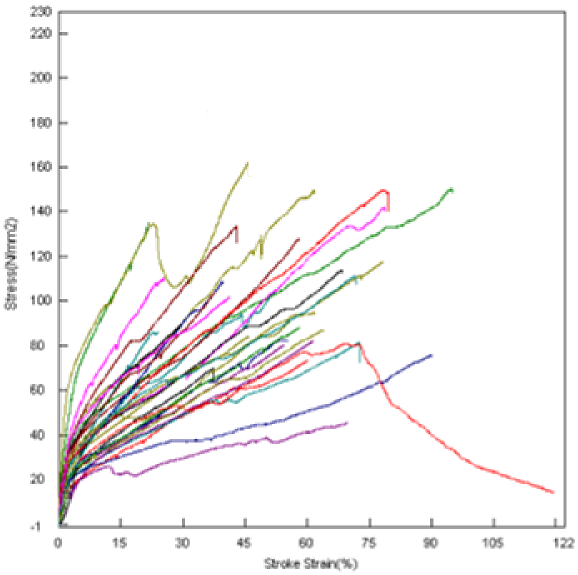

Fig. 14 Stress-strain graph for testing upper stem fiber (BA) with 50 population

Visual observation showed some samples had abnormal tensile test graph (Figure 14). This indicated the possibility of slippage on the fiber during testing. These cases are common in natural fibers that cause high standard deviation if abnormal sample result is calculated and put into the statistical calculations. In case of natural fibers, the stress-strain graph obtained is very random so difficult to determine the value of the modulus of elasticity that truly reflect the characteristics of the material. Elongation (ε) obtained is not worth the constant and very varied and changed very diverse. As for displayed value (stress, strain, and modulus of elasticity) derived from software processed UTM (Universal Testing Machine).

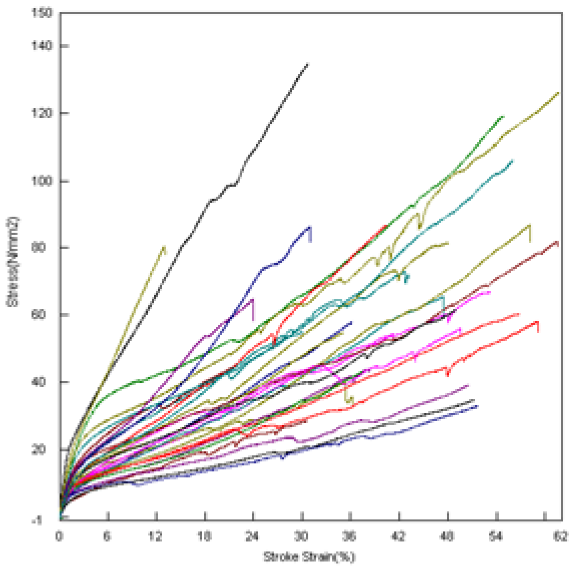

Fig. 15 Stress-strain graph for testing fruit stem fiber (BB) with 50 population

All of tensile test results generated by UTM using Shimadzu AG-IS 1 kN, with software Trapezium 2; 2003, which was operator's role was limited to input testing the sample data include: the dimensions (width, length, thickness, diameter, etc.), number and shape, the type of testing (tensile, pressure, bending, shear), and data output (tensile strength, modulus of elasticity, strain, force, displacement, and charts). If raw data is needed, the output data will be only force, displacement and time with 0.05 seconds of interval. As for tensile strength, elongation, and modulus of elasticity output, it is needed to entered data of dimensions and tensile strength equation (Force / A (area)). Whereas elongation and modulus elasticity result data was determined by the machine.

It is commonly understood that the tensile strength of the material has a transition pattern, which are elastic area, semi-plastic and plastic that is clear and mapped. Then (σ) = Eε, and understood the value of the modulus of elasticity (E) is proportional to the tensile strength (σ) with the assumption that the value of ε is constant. In this case, it appears a postulate that if tensile strength is high, then modulus of elasticity is also high, and vise versa. This is actually cannot be generalize in all type of materials, but as for the fiber almost commonly accepted.

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TABLE III
MECHANICAL PROPERTIES OF EFB FIBER

No.	SAMPLE	TENSILE STRENGTH (MPa)
1.	Main stem	125.13
2.	Upper stem	108.29
3.	Fruit stem	152.85

Table 3 informs the average yield statistics on tensile test data. These results indicate that the fruit stem fiber has highest tensile strength. This is also break the early hypothesis that the upper stem EFB fiber has highest strength due it sustains fresh fruit bunches that can weigh up to 50 kg. Furthermore, even the main stem has longest fiber, it turns tensile strength is not as good as the fruit stem.

This is a positive result due in chemical testing showed that the lignin content in fruit stem fiber turns the lowest compared to other parts EFB fiber. It is certainly easier for us to do a lignin removal treatment process to improve the compatibility of EFB fruit stem fiber with matrix material, particularly of polymeric material.

In the mean time the results of physical properties testing are also quite positive, because the density of the fruit stem of EFB fiber turns lowest. It is encouraging composite maker since produced material will be lighter.

4. CONCLUSIONS

Fruit stem fiber is a part of the palm oil EFB fiber which has highest tensile strength and the best compared with two others ie; main stem and upper stem. It is also a part of the EFB fiber which has a lowest lignin content compared with two others. In addition, this fiber also has lowest density. Based on initial analysis, it was concluded that fruit stem EFB fiber was part of the EFB which is most suitable for being used as a reinforcing material for FRP composite material with a polymeric matrix.

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EFFECT OF ETHYL METHANE SULFONATE (EMS) ON GROWTH RATE, CELL SIZE, FATTY ACID CONTENT AND ANTIOXIDANT ACTIVITIES OF *Dunaliella* sp.

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ABSTRACT

***Dunaliella* sp. has great potential to be used as food and energy commodity, thus makes it a prominent waters commodity. But there is also a constraint faced which is lack of production of microalgae biomass crops. To increase the production, certain techniques are required that can be applied to the microalgae. One technique is mutagenesis by using Ethyl Methane Sulfonate (EMS). The purpose of this study was to analyze the effect of EMS on the rate of growth, cell size, fatty acids and antioxidant activity of microalgae species Dunaliella sp. The method used is by adding EMS concentration of 0.1 M and 0.5 M in the early stages of cultivation of microalgae. The analysis conducted to determine the effect of the addition of EMS were observation of cell size, cell density, proximate characteristics, characteristics of fatty acid and antioxidant activity microalgae species of *Dunaliella* sp. The results showed that the concentration of 0.1 M EMS has a cell size three times larger than the controlled cell size and have a higher percentage of fatty acids. While, the added EMS treatment had lower growth rate and antioxidant activity compared to the control treatment.**

Keywords: Antioxidants, fatty acids, *Dunaliella* sp., Ethyl Methane Sulfonate, growth rate, Microalgae

INTRODUCTION

Microalgae are microscopic living creatures that can grow well in freshwater and seawater. This organism is the most primitive plants are better known as phytoplankton. Pigment chlorophyll in microalgae is able to perform photosynthesis like other higher plants, so microalgae acts as producers in the waters. In addition, a marine microalgae is marine organic matter that can be used as one component of the formation of petroleum on the seabed [1].

Manuscript received May 5, 2015. This work was supported by Research Institute of Science and Technology (RIST-POSCO) South Korea.
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Dunaliella sp. is microalgae which belongs to class of green algae, its movement is motile with two flagella of the same length. Generally, the cell shape of *Dunaliella* sp. is rounded to the width of 4-15 µm and length of 6-25 µm, depending on the phase of growth or environmental conditions. In general, cell shape *Dunaliella sp.* is radially bilateral symmetrical and partly shaped, flat, curved top or slightly asymetrical. [2]. *Dunaliella sp.* can be found in fresh water and sea water and some high-salinity lakes throughout the world. Temperature, salinity and nutrients are limiting factors for the growth and development of *Dunaliella sp.*

Microalgae *Dunaliella sp.* has great potential to be used as feed or food ingredients that can be used as an alternative waters commodity. Most species of microalgae produce distinctive products such as fatty acids, antioxidants and carotenoids [3]. *Dunaliella sp.* is one of the microalgae are quite widely studied because of its carotenoid content and high glycerol. Chemical contents such as proteins, amino acids, vitamins, polysaccharide and carbohydrates extracted from microalgae have been used for food material. In addition to the feed and food, microalgae can be used as a producer of alternative fuels or biofuels.

Until now, researches are still conducted to get the type of microalgae are able to produce high biomass to support the next stage of the process. One technique that is widely used to increase the biomass of microalgae is by mutagenesis techniques. Mutagenesis techniques are divided into two, namely physical and chemical mutagens. Physical mutagen used is the x-rays and gamma rays, while the chemical compound is colchicine, ethyl methane sulfonate (EMS), and ethylene oxide. EMS is a mutagen compounds most commonly used in chemical mutagenesis because it has a mutation effectiveness and mutagenic properties can be lost after a hydrolysis reaction with water [4]. Therefore, this study was conducted in order to analyze the effect of the provision of EMS on microalgae species *Dunaliella sp.*

MATERIAL AND METHOD

Microalgae Cultivation

Cultivation is done on a laboratory scale with a ratio of 1: 3 as many as 100 ml of *Dunaliella sp.* inoculant added to 300 ml of sterile sea water, and walne fertilizer. *Dunaliella sp*. cells cultivated in 500 ml Erlenmeyer and placed in culture shelves and areated and lighting of 1000 lux light for 24 hours.

ISBN : 978-1-4673-7404-0

EMS Mutagenesis

After the age of cultivation reached logarithmic phase, microalgae samples were taken to be mutated using 0.1 M and 0.5 M ethyl methane sulfonate (Sigma, USA) and stably shaken with a magnetic stirrer for 60 minutes. After the sample has been given EMS, microalgae rinsed 3 times replications with sterile sea water to remove the remaining EMS on microalgae. Furthermore, the sample is added with the walne fertilizer and separatied for each treatment (EMS 0.1 M, 0.5 M and controls EMS) into 10 ml test tube. Microalgae are maintained for 7 days and cell density was calculated before selected. Selected tubes then cultivated back on a larger scale (scaling up).

Harvesting the Microalgae

Harvesting was done when the age of microalgae reached stationary and death phase by filtration using a vacuum pump and a 90 mm whatman paper. Filtered microalgae biomass dried using oven temperatures below 105°C for ± 1 hour.

Fat Extraction

Dry samples were weighed as much as 1-2 grams, wrapped in a sleeve which previously included fat-free cotton. Then the samples were inserted into the Soxhlet tube and add the chemical hexane as the extraction solvent for 6 hours [5]. The fat extract was distilled using a Soxhlet, then oven fat extracted with a temperature of 105°C for approximately 1 hour and then weighed to get fat.

Cell Density Calculation

Dunaliella sp. cell density calculation in each treatment was performed every day by using a microscope and a haemocytometer. Each calculation is done by counting the 5 visual field with 4 repetitions each. Cells that have be counted subsequently calculated using the following formula:

$$\text{Cell density (cell/ml)} = n \; x \; \frac{25}{5} \; x \; 10^4$$

Where:
n = Amount of observed cells

Determination of Moisture Content (AOAC 1995)

Dry the porcelain cup used for 1 hour in an oven at 105 ° C, then cooled in a desiccator, and weighed. A total of 2-3 grams of sample was weighed and put into the cup to be dried in the oven for 4-6 hours at a temperature of 105 ° C. Furthermore, the cup is cooled in a desiccator, and weighed.

Determination of Ash Content (AOAC 1995)

The sample was weighed as much as 2-3 grams and put in a porcelain cup of known weight. After that, the cup was inserted into the electric furnace at a temperature of 600 ° C for 4-6 hours until perfect ashing was achieved. Then the sample was removed and cooled in a desiccator and weighed to a constant.

Determination of Crude Protein Content

Weigh 0.51 gram of sample and place in a 100 ml kjeldahl flask. Add 2 grams of a mixture of selen and 25 ml of concentrated H_2SO_4 and then heat over an electric heater or burner flame for about 2 hours until boiling point is reach and the solution color become clear greenish. Cool the sample, then dilute and insert it into a 100 ml volumetric flask, align to mark the line. Pipette 5 ml of solution and incorporated into the refiner and add 5 ml of 30% NaOH and some PP indicators. Distill it for 10 minutes, as a container use 10 ml of 2% boric acid solution that has been mixed indicator. Then titrate with 0.001 N HCl solution.

Esterification

A total of 2 grams of fat extracted using hexane that has been saponified with 25 ml of 0.5 M NaOH methanol. Then, 300 mg of saponified fat samples were reacted with 8 ml of BF3-methanol and heated for 3-4 minutes. After that, 2-3 ml petroleum ether (60°C) was added to separate the ester. Samples was added with NaCl to float fatty acid compound to the top of the flask and then analyzed by means of GC-MS [6].

Gas Chromatography– Mass Spectrometry (GC-MS) Method

Gas Chromatography–Mass Spectrometry (GC-MS) analysis was conducted using kromatografi gas Shimadzu QP2010 gas chromatography that has been equipped with DB-5 ms silica coloumn (30 m in length ; 0.25 mm in inner diameter; and 0.25 µm film layer thickness) and helium as booster gas. Gas chromatography has a detection limit of 0.001 ppb. Gas chromatography use split injection mode with a ratio of 1: 200. The gas chromatograph oven temperature was programmed to 80°C are held constant for 2 minutes, then raised 210°C at a speed of 10°C / min are held constant for 1 min, then increased again to 280 ° C with a speed of 6°C / min are held constant for 5 minutes. GC-MS conditions is the ionization potential / electron energy 70eV, ion source temperature of 250°C and 280°C temperature interface. Full mass of data recorded between 50-400 Dalton every second. Retention time is from 0 to 32.67 minutes. Then the data were recorded and analyzed by GC-MS Real Time Analysis and GCMS Postrun Analysis softwares.

Antioxidant Activity Test

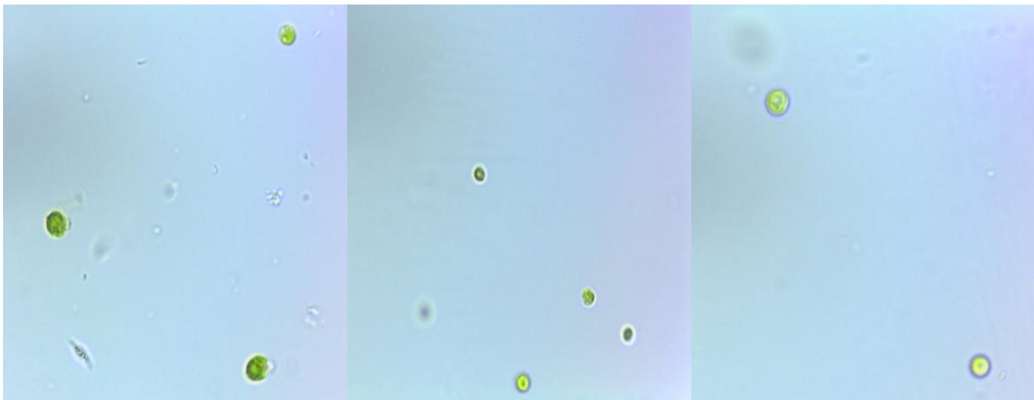
Solution of DPPH (2,2-diphenyl-1-picrylhydrazyl hydrate) was prepared by dissolving 0.004 grams of DPPH in 100 ml of methanol [6, 7]. 1 ml of microalgae were centrifuged at a speed of 10000 rpm at 4°C for 15 minutes, then the precipitate was extracted with 1 ml of ethanol and then vortex at a steady pace. Extract was settled at 4 ° C for 4 hours and add 2 ml of DPPH solution. Then the mixture was incubated for 30 min at room temperature in the dark room. Blank sample (ethanol solution) is the control. Calculate the absorbance at a wavelength of 517 nm using a spectrophotometer.

ISBN : 978-1-4673-7404-0

RESULT AND DISCUSSION

Mutagenesis Cells

In this study, cultivation of microalgae combined with the addition of EMS was successful. EMS concentrations given at each treatment affects the size of the cell from the culture results and the chemical content of microalgae. Effect of chemical compounds Ethyl Methane Sulfonate (EMS) to microalgae *Dunaliella sp.* qualitatively can be seen from different cell sizes. The cell size of each treatment is presented in Figure 1.



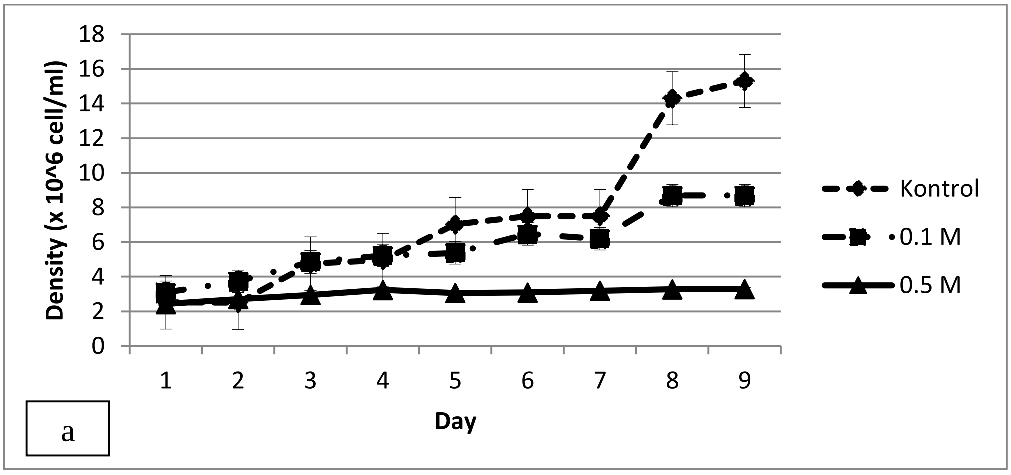
a b c

Figure 1. Size cell *Dunaliella sp.* with 1000x magnification on cultivation (a) EMS 0.1 , (b) EMS 0.5 M, dan (c) Control

Figure 1 shows microalgae cell observation using an electron microscope with a 1000x magnification. *Dunaliella sp.* from control treatment is 4:08 µm in size, EMS 0.1 M size is 10:09 µm, and EMS 0.5 M size is 3.89 µm. Addition of 0.1 M EMS to the cultivation of *Dunaliella sp.* can produce larger microalgae cell size than the other two treatments. This correspond to research conducted by Aranez [8], where, microalgae species *Scenedesmus* cells which was given EMS treatment cell size twice and three times that of normal cells. EMS additions to the microalgae can produce a larger cell size twice or three times the size of round or oval cells more than normal cells.

Dunaliella sp. Growth Rate

The rate of growth is the increase in the number of cells. Each treatment has a growth rate that is different. EMS treatment had a lower growth rate compared to the control treatment. *Dunaliella sp.*cell density is presented in Figure 2.



ISBN : 978-1-4673-7404-0

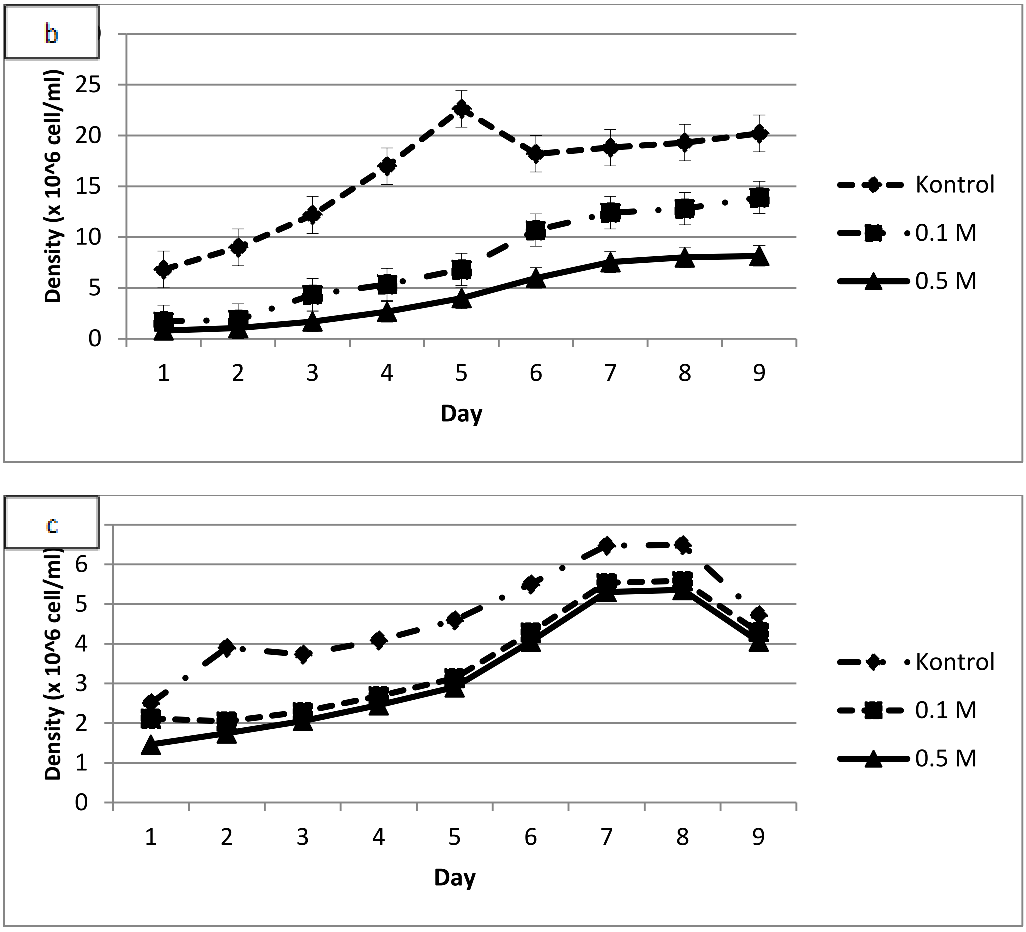


Figure 2. *Dunaliella sp.* growth rate in the culture medium (a) 10 ml, (b) 400 ml, and (c) 20 L

10 ml cultivation scale is an early stage of the culture process of microalgae *Dunaliella sp.* 10 ml scale cultivation chart explains that low cell density in EMS 0.5 M treatment, it is presumably because when the induction of EMS 0.5 M was carried out, the amount of microalgae cell death heightened up to 60%. This is presumably due to the nature of EMS is very acidic compounds that can lower the pH and characterized by a change in culture medium color to white. In the process of incubation, cell numbers tend to be increased or decreased so that it can be concluded that the state of the microalgae are in the dormant phase. The addition of EMS can affect the degree of acidity (pH) in early cultures. The rate of photosynthesis will be limited by carbon reduction and high pH values. Accordingly, EMS treatment at 0.5 M went through a phase of dormancy, so it can inhibit cell growth.

Scale up is done in every microalgae culture stage to the 8th day. Scale up aims to obtain greater yields. At the time of the addition of 400 ml scale cultivation, the control treatment had a higher cell density compared to the of EMS addition treatment. Low cell density treatment was in EMS 0.5 M treatment. The density of the control treatment cell has a peak cell density on day 4 with 22.6×10^6 cells / ml, whereas the cell density of 0.1 M EMS treatment continues to increase with the highest peak density on day 5 of 10.68×10^6 cells / ml. Chaturvedi and Fujita [9] states that mutant microalgae species has a growth rate that is lower than the density of native species (wild type). In this study prior to scale up, initial pH control treatment and EMS is 7 while the 0.1 M 0.5 M EMS is 2.

In this study, the addition of 20 liters volume scale can reduce the amount of cell density of species of microalgae *Dunaliella sp.* This is presumably because during the 20 liters scale cultivation, seed of microalgae *Dunaliella sp.* used was in the death phase. One factor that determines the length of the adaptation phase is the age of the culture used as an inoculum [10]. Research results from Doan and Obbard [11] showed that the number of deaths control cell culture by 0.8% and would grow along with the addition of EMS concentration. The amount of cell death in EMS 0.5 M and 1 M are for 67.3% and 92%, respectively, while the EMS 1.2 M concentration will cause death in microalgae cells *Nannochloropsis sp.*

Characteristics of *Dunaliella* sp.

Characteristics of microalgae can be seen from the content of protein, carbohydrates, fats, vitamins and minerals. Each species of microalgae have the chemical characteristics that vary and are influenced by environmental factors. These environmental factors include light intensity, temperature, salinity, pH,

 ISBN : 978-1-4673-7404-0

aeration, and nutrients. Results of the proximate analysis of microalgae species *Dunaliella sp.* in each treatment were measured on two different days is the stationary phase and death phase, the results of the analysis can be seen in Table 1.

Table 1. Characteristics (%) of microalgae species *Dunaliella* sp

Characteristics (%)	Control		EMS 0.1 M		EMS 0.5 M	
	D7	D8	D7	D8	D7	D8
Water Content	82.05	88.01	85.51	90.22	84.15	85.64
Ash Content	8.27	5.70	7.83	4.26	7.82	6.45
Fat	1.95	9.85	1.19	15.80	1.45	1.17
Protein	14.52	19.15	14.24	22.92	13.99	16.46

[a]D7 : Harvest on Day-7 (stationery phase), D8 : Harvest on Day-8 (death phase)

Table 1 shows the highest percentage of water content found in death phase of 0.1 M EMS with 90.22%. It is much different from the results Yudha [12] that *Dunaliella* sp. water content amounted to 65.22%. The value of high water content, presumably because the microalgae sample that would be analyzed still contains a lot of water, so that the weight of the initial weighting will tend to be larger. The water content in a material can determine the quality, freshness and durability of the material.

Analysis of ash content indicates mineral content of *Dunaliella sp.* Ash content either in original species or EMS on the stationary phase is higher than the death phase. The highest ash content contained in stationary phase control treatment that is equal to 8.27%. High and low ash content is influenced by the condition of the environment so that the intake of minerals that are absorbed by each individual will vary.

The highest fat content contained in the death phase of 0.1 M EMS treatment is 15.80%. This is consistent with Doan and Obbard [11] which showed that total fat of mutant *Nannochloropsis sp.* species either in exponential phase and stationary phase will be higher 1-2 times compared with original species. Differences in the levels of fat in each treatment are caused by nutrients contained in each cultivation. Microalgae can produce more fat when experiencing stress [13].

Protein plays an important role in the formation of microalgae cells. From these results, *Dunaliella sp.* has a protein content of 13-14% (dry weight) on the stationary phase and 16-30% (dry weight) on the death phase. However, when compared with the research Yudha [12], the percentage of protein in *Dunaliella sp.* do not differ greatly in the amount of 18:12% (dry weight).

Fatty Acid Compound of *Dunaliella* sp.

Fatty acids results of *Dunaliella sp.* in each treatment were detected by gas chromatography– mass spectrometry, identified by comparing the spectra value with wiley libraries. Table 2 shows the concentration of highest unsaturated fatty acids is hexadecanoic acid (methyl palmitate) were observed in all treatment cultivation. Cultivation conditions are different in each treatment will lead to different compounds of fatty acids formed during cultivation [14].

Table 2. Fatty acid compounds of *Dunaliella* sp.

Fatty acid compounds	Stationery phase (%)			Death phase (%)		
	C	E1	E5	C	E1	E5
Hexadecanoic acid methyl ester	22.81	23.87		16.57	11.41	19.36
Hexadecenoic acid methyl ester	4.4	2.79		1.67	1.81	
Octadecanoic acid methyl ester	5.80	5.13	6.88	4.62	2.47	8.57
Octadecadienoic acid methyl ester		15.65	11.36	6.73	8.67	6.63

[b]C: Control, E1: EMS 0.1 M, E2: EMS 0.5M

The results showed that the highest percentage was found in 0.1 M EMS, such as Hexadecanoic, Octadecadienoic and Octadecatrienoic. This is consistent with the research by Augustine et al. [15], that stated 0.1 M EMS treatment on the species *Nannochloropsis sp.* gave higher percentage of fatty acids when compared to the EMS concentration of 0.5 M. Culture conditions, growth phases, and environmental factors are factors that affect the fat content and fatty acid nature [16].

Fatty acid calculation of algae biomass is one procedure to indicate which fat that is suitable to be converted into biodiesel. An effective selecting phase of high oil content and harvesting methods are needed to produce bioediesel from microalgae [17]. Hexadecanoic or more commonly known as palmitic acid is a fatty acid contained in many biodiesel and have a percentage of 23.7% of the total fatty acids in microalgae *Dunaliella salina* [18]. From this research result, hexadecanoic stationary phase has a value more than the death phase. The high content of saturated fatty acids have good value and oxidative stability for biodiesel. Octadecanoic acid (stearic acid) in

 ISBN : 978-1-4673-7404-0

Dunaliella salina is higher than *Botryococcus braunii*, *Chlorella vulgaris* and *Scenedesmus sp.* [19].

Antioxidant Activity in *Dunaliella* sp.

Antioxidants serve as an antidote to free radicals that can damage body tissues of living creatures. Currently, many marine microbiology organisms have been used for their antioxidant content. *Dunaliella sp.* is a green microalgae with high carotenoid content. *Dunaliella sp.* beta-carotene reached 4% dry weight [20].

The antioxidant activity test can be done both qualitatively (color reaction) and quantitatively (absorbance). Qualitative results are demonstrated by looking at the color reaction that occurs between DPPH solution with the compound tested. When a compound able to reduce DPPH solution that has purple color, then the compound has the power to reduce free radicals. Based on the results of the study, treatment control has a green color and and 0.1 M EMS treatment has a yellow color. This proves that qualitatively microalgae *Dunaliella sp.* control and EMS 0.1 M treatment have the free radicals reduction power against DPPH. In the treatment of EMS 0.5 M, when the solution is added DPPH color becomes purple. Qualitatively *Dunaliella sp* 0.5 M EMS treatment does not have the power to reduce free radicals against DPPH. Figure 5 shows the color change that occurs when testing the antioxidant activity *of Dunaliella sp*. Observation on free radical reducing using DPPH method used spectrophotometric method with the reaction time of 30 minutes and a wavelength of 517 nm.

Figure 3. Antioxidant activity test on *Dunaliella sp.* using DPPH method

Table 3. Antioxidant activity (%) microalgae *Dunaliella* sp.

Phase	Control	EMS 0.1 M	EMS 0.5 M
Stationery	84.33	54.78	24.63
Death	77.76	66.72	59.70

Table 3 shows the control treatment had high absorbance values when compared with the 0.1 M and 0.5 M EMS treatments. Absorbance value determines the level of reducing free radicals. According Amrun and Umyah [21], a decrease of absorbance showed increased DPPH free radical, which means that the higher the concentration gives high of the antioxidant activity.

CONCLUSSION

Addition of Ethyl Methane Sulfonate (EMS) with certain concentration can affect the microalgae species *Dunaliella sp*. In this study, 0.1 M EMS concentrations is the concentration that can affect microalgae species *Dunaliella sp.* 0.1 M EMS has higher percentage of fatty acid than the control treatment. EMS treatment has the growth rate and lower antioxidant activity compared with control treatment. Besides the higher concentration of EMS, it causes death in microalgal species *Dunaliella sp.*

ACKNOWLEDGEMENT

Acknowledgements is dedicated to the Research Institute of Science and Technology (Research-Posco) South Korea's top research grants and Surfactant and Bioenergy Research Center (SBRC) to facilitate this research.

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ISBN : 978-1-4673-7404-0

Identification of *phenol red* as *Staphylococcus aureus* indicator label

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Abstract

Staphylococcus aureus is one microorganism which caused food-borne disease. This bacteria contamination is very easy due to it exists in air, dust and contaminated equipment. Food contamination can occur during or after handling process such as on meat products, chicken, milk, fermented food items, vegetables, fish products and etc. The bacteria can cause food poisoning, so it is necessary to detect the growth of this bacteria in the food and food product before it is consumed. *Staphylococcus aureus* on food products can be detected using label indicator by the label color changing. The label was attached inside the food package. Many potential media can be used as label material. One of them is mannitol salt agar (MSA). MSA can give information *Staphylococcus aureus* growth on product by color changing from red to orange and yellow. This changing is irreversible. The color changing occur due to volatile acid and mannitol fermentation on MSA by *Staphylococcus aureus* result on pH reducing of the media, and then, once it will change *phenol red* color containing in MSA turn to orange and then yellow. The objective of research was to identify MSA media as *Staphylococcus aureus* detection label. The examination was conducted on petri dish approximately 2 cm from *Staphylococcus aureus* culture. The capability of label on detection *Staphylococcus aureus* growth was starting from 516 per gram of colony. The color change from red (R (red) 55, G (Green) 44 dan B (Blue) 41) to orange (R (red) 47, G (Green) 38 dan B (Blue) 34).

Key word : *Staphylococcus aureus*, color indicator, mannitol salt agar (MSA)

1. Introduction

Smart or intelligent packaging is a package that monitors the condition of the packed food to provide information about the quality during storage, transportation and distribution (Kuswandi *et al* 2011). The intelligent systems monitors the quality of the food product or its surrounding environment to predict or measure the safe shelf-life better than a best-before-date (Jong *et al* 2005). Some of smart or intelligent packaging have conducted such as smart packaging of erpa indicator (Nofrida *et al* 2013), smart packaging of natural or synthetic color (Warsiki and putri 2012), smart packaging of monitoring fishery spoilage (Pacquit *et al* 2007), smart packaging to monitor spoilage (Napwinyouwong *et al* 2010). Smart or intelligent packaging was being developed is color indicator to detect pathogen bacteria. Smart or intelligent packaging use label that can give information about microbial growth by color change. Label color will change as a result of the reaction between color compound in label to bacteria metabolites produced. This kind of label is potential to be applied for meat and meat product which spoil sensitive to microbial growth such as *Staphylococcus aureus.*

Staphylococcus aureus is Gram positif bacteria. It survivals at low aw (0.83 to 0.86), high salt concentrations up to 20%, and within a wide pH (from 4 to 10, with an optimum of 6 to 7), and temperature range (6 to 48,5^{o}C, with an optimum of 35 to 41^{o}C). That characteristic cause *Staphylococcus aureus* easy to growth in all of conditions. Growth of *Staphylococcus aureus* on food products can be detected using label indicator by the label color changing. The label was attached inside the food package.

Many potential media can be used as label material. One of them is mannitol salt agar (MSA). MSA is selective media and differential to *Staphylococcus aureus* growth. MSA contain *phenol red* as color indicator, mannitol and protein that to be nutrition of *staphylococcus aureus* growth. MSA also contain high salt concentration so can inhibit other microbial growth (Kateete *et al* 2007). *Phenol red* can change MSA color from red (alkali) to yellow (acid) due to pH change. The ability of color change MSA needs to be examined in its ability to detect pathogen microbial.

This paper used MSA as label component which was tested in *staphylococcus aureus* culture TSA (*tryptone soya agar*) medium by using MSA as pathogen indicator. This label will detect base in decrease of pH due volatile metabolite gas that produced by *staphylococcus aureus* and label contaminated by *staphylococcus aureus* so mannitol label fermented to acid, and then change the color of label.

2. Material and Method

2.1. Material

Material was mannitol salt agar (MSA) as label material, *tryptone soya agar* (TSA) as inoculant medium and *Staphylococcus aureus* isolate at 3.10^5-

ISBN : 978-1-4673-7404-0

3.10^8 concentration. Isolate made by dilution method base on McFarland 1 standard.

2.2. Method

2.2.1. *Phenol red* label producing

Label was produced by dissolving 27.75 g mannitol salt agar into 250 mL aquadest, then it was heated at 50^{O}C until 90^{o}C. Then it was sterilizated at 121^{o}C for 15 minutes, cooled and formed 2 cm × 3 cm size. There were two different treatment of the label i.e. packed and unpacked. Packed label was done by inserted the pieces of label into LDPE (*low density polyethylene*) plastic and sealed. Before it is used, label was be sterilized by UV for 15 minutes to get phenol label indicator free from contamination. Packed and unpacked label were then ready to be tested further.

2.2.2. *Phenol red* label testing

Phenol red label was attached inside the petri dish lid. Each petri dish has *staphylococcus aureus* by various concentration.

The distance between label and inoculants was ± 2 cm. Petri dish was storage at room temperature for 2 days, and the color change of the label and *Staphylococcus aureus* growth were observed. Dilution control was done by streak method on *phenol red* label. Control was conducted to observe the effect of color change label due to *staphylococcus aureus* contaminated.

2.2.3. Color label measuring

Measuring of color was done by color analyzer RGB 1002. Sensors was placed on the label surface and the measuring was done 3 replicates. The number that appears on the screen was recorded as result of measurement.

2.2.4.*Staphylococcus aureus* number determination

Staphylococcus aureus grow in TSA was white round and then it was measured.

3.Result and discussion

Below was the result of *phenol red* label testing. It can be seen that the color of the label was gradually changing (Table 1. and Tabel 2. for unpacked label, Table 3. and Table 4. for packed label).

Tabel 1. Color change of label unpacked to amount *staphylococcus aureus* growth

	colony	0 hour	colony	3 hours	colony	7 hours	colony	11 hours	colony	15 hours	colony	31 hours
MSA5 control	0		0		171		532		TBUD		TBUD	
L5	0		40		53		160		302		TBUD	
MSA6 control	0		0		0		113		258		1068	
L6	0		48		75		108		320		452	
MSA7 control	0		0		0		132		201		592	
L7	0		15		18		63		189		304	
MSA8 Control	0		0		0		4		173		372	
L8	0		0		8		12		98		106	

note : L (label), 5 (dilution of 10^5), 6 (dilution of 10^6), 7 (dilution of 10^7), 8 (dilution of 10^8), TBUD (can not calculated)

Based on result that color label change from red to yellow. The color changing was shown at label in *staphylococcus aureus* from 302 to more 592. The value of color changing was 30 (R), 94 (G) and 64 (B) to 76(R), 70 (G) and 52(B) and clearly read from Table 2.

Tabel 2. The R-G-B of label color for *staphylococcus aureus* growth

Color of sample	0 hour			3 hours			7 hours			11 hours			15 hours			31 hours		
to hpur	R	G	B	R	G	B	R	G	B	R	G	B	R	G	B	R	G	B
MSA 5 control	041	032	034	047	037	036	060	054	042	044	035	033	044	040	034	064	060	044
L5	035	031	030	049	039	036	062	052	046	046	040	035	043	039	030	055	056	042
MSA 6 control	041	031	030	047	035	034	052	043	035	041	032	030	038	032	030	045	043	034

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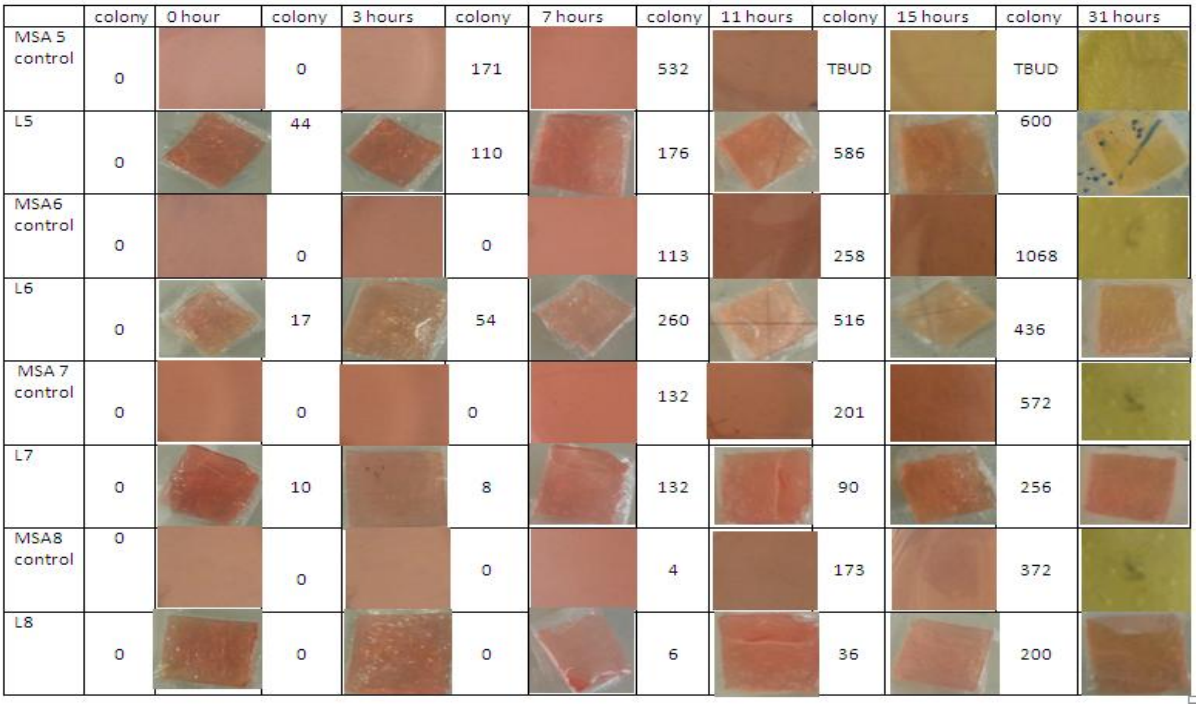
L6	036 029 028	053 042 041	054 041 037	049 040 037	083 070 059	067 060 037
MSA 7 control	040 030 030	045 032 030	055 044 038	043 031 030	038 030 029	056 053 036
L7	040 028 028	053 042 040	057 042 041	058 047 044	051 039 037	076 070 052
MSA 8 control	040 031 030	051 038 036	058 040 039	050 040 036	044 036 034	060 055 039
L8	037 029 028	053 040 036	056 042 036	054 045 042	056 047 044	066 046 044

note : L (label), 5 (dilution of 10^5), 6 (dilution of 10^6), 7 (dilution of 10^7), 8 (dilution of 10^8)

Tabel 3. Color change of packed label to *staphylococcus aureus* growth



	colony	0 hour	colony	3 hours	colony	7 hours	colony	11 hours	colony	15 hours	colony	31 hours
MSA 5 control	0		0		171		532		TBUD		TBUD	
L5	0		44		110		176		586		600	
MSA6 control	0		0		0		113		258		1068	
L6	0		17		54		260		516		436	
MSA 7 control	0		0		0		132		201		572	
L7	0		10		8		132		90		256	
MSA8 control	0		0		0		4		173		372	
L8	0		0		0		6		36		200	

note : L (label), 5 (dilution of 10^5), 6 (dilution of 10^6), 7 (dilution of 10^7), 8 (dilution of 10^8), TBUD (can not calculated)

On label packed, color change start from colony 516-600. The color change 39(R), 26 (G), and 27(B) to 92(R), 76(G) on 64 (B). the data on the Tabel 4.

Tabel 4. The value of packed label during *staphylococcus aureus* growth

Warna sampel per Jam	0 hour R G B	3 hours R G B	7 hours R G B	11 hours R G B	15 hours R G B	31 hours R G B
MSA 5 control	041 032 034	047 037 036	060 054 042	044 035 033	044 040 034	064 060 044
L5	043 037 036	091 061 052	086 062 054	068 052 048	049 042 034	092 076 064
MSA 6 control	041 031 030	047 035 034	052 043 035	041 032 030	038 032 030	045 043 034
L6	084 068 058	107 084 069	087 068 058	085 072 064	047 038 034	100 081 071
MSA 7 control	040 030 030	045 032 030	055 044 038	043 031 030	038 030 029	056 053 036
L7	056 040 038	082 049 044	080 047 043	059 045 043	054 040 038	097 073 070
MSA 8 control	040 031 030	051 038 036	058 040 039	050 040 036	044 036 034	060 055 039
L8	045 042 040	180 134 108	142 108 087	056 046 043	052 044 040	085 060 056

note : L (label), 5 (dilution of 10^5), 6 (dilution of 10^6), 7 (dilution of 10^7), 8 (dilution of 10^8)

RGB is an abbreviation for Red-Green-Blue. RGB is a base color for color combination (Saini dan Chan 2013, Binnar *et al* 2014). The value of combination for red and green produce yellow (Nishad dan Chezian 2013). The result show that the increase in red value (R) and green (G) occurring at 31 hours. The color change to yellow due to reaction between *phenol red* and metabolite produced by *staphylococcus aureus*. *Phenol red* is one of indicator color, it usually used to quantitative analysis. *Phenol red* has red color at alkali (pH 8.0) and yellow at acid (pH 6.6). The color will change, if the condition change to acid or alkali. The color change mechanism of *phenol red* label are by volatile and mannitol fermentation.

The volatile was produced by *Staphylococcus aureus* on TSA. TSA (*tryptone soya agar*) is a general medium which contain casein pepton and soya peptone that carbon, nitrogen, vitamins and minerals source to *staphylococcus aureus* growth. Casein pepton contains high tryptophan, while soya pepton contains polypeptide, dipeptide and others amino acid (Bahri *et al* 2009). Casein and amino acid was breakdown by *staphylococcus aureus* to acetic acid volatile, dimethyl sulfide and methantiol (Carbonero *et al* 2012, Filipiak *et al* 2012). Volatile compounds binding *phenol red* molecule on label so it changes character of *phenol red* to yellow. Ability of label to detect *staphylococcus aureus* affected by amount of *staphylococcus aureus* growth in media.

Mannitol fermentation happen, when *Staphylococcus aureus* contaminate label. *Staphylococcus aureus* grow in label, it fermented mannitol to acid in label. Acid changed pH label, then pH change color of *phenol red*.

Label unpacked has detection ability from s.*aureus* at 302, while label packed at 516. It was caused by the barrier between volatile compounds or bacteria and label. Label packed use LDPE (*low density poly ethylene*) as its packaging. Packaging use in label to prevent contamination for product due to label. Pore size of LDPE about 1.4 μm (Wendorf *et al* 1999), while size of volatile gas about 0.1-1nm and *Staphylococcus aureus* 1 μm (1000 nm). It causes plastic used can be penetrated by volatile gas and *Staphylococcus aureus*.

4. Conclusion

MSA (mannitol salt agar) is one of selective medium to microbe identification, it contains *phenol red* can used as label indicator. The color change label mechanism by volatile and acid from mannitol fermentation. Volatile and acid react with *phenol red* in MSA. Using LDPE as label packed can be used to detection *staphylococcus aureus*. The application, label can applicated to *staphylococcus aureus* easy contamination product by.

5. Suggestion

The weakness of label is label compositon have not been halal or not halal for muslim to application in food, so it needs new halal formulation which can work base on MSA (mannitol salt agar) work principle.

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ISBN : 978-1-4673-7404-0

ISBN : 978-1-4673-7404-0

Enhancing Ethanol Tolerant of *Escherichia coli* Recombinant by Glutamate Addition under Aerobic Conditions

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***Abstract*—Enhancement of *Escherichia coli* recombinant cell growth in high ethanol culture conditions by the addition of glutamate as osmoprotectant was investigated under aerobic condition. It was also supported by analysis of dry cell weight (DCW), glucose uptake, and acetate accumulation. *Escherichia coli* cells were grown under aerobic conditions with ethanol and glutamate addition in the culture time of t = 6 h. In the culture of *E. coli* recombinant in high ethanol culture conditions (20 g/l ethanol) for 24 hours, DCW and glucose uptake reached in 0.91±0.14 g/l and 13.23±0.89 g/l, respectively. These values were lower than the culture conditions with 2 g/l glutamate additions (1.8±0.03 g/l DCW and 17.75±0.43 g/l glucose uptake). This glutamate addition, also suppressed the accumulation of acetate from 6.27 g/l to 3.29 g/l, indicating that glutamate addition redirect central carbon metabolism from acetate accumulation to tricarboxylic acid (TCA) cycle.**

Key words: *Escherichia coli*, ethanol tolerant, glutamate.

I. INTRODUCTION

One of the problems which are faced by many countries is energy crisis. Energy crisis is due by rising of fuel demand which is not appropriate to the availability of fuel. The Solution to face energy crisis and negative impact of greenhouse gasses from fossil fuel is ethanol [1] as the alternative fuel. In America 1990, first time they produced ethanol from corn starch by using *Saccharomyces cerevisiae* [2]. However, using corn starch as ethanol substrate will compete with food requirements. So that, using lignocellulose from agricultural and forestry waste as substrate could replace corn starch [3][4]. Accordingly, it is needed microorganisms which consume lignocellulose to produce ethanol. Table 1 shows development producing ethanol research from kind of microorganisms.

Genetic engineering has proved that *E. coli* can improve ethanol production through insertion ethanol gene from *Z. mobilis* [5]. The ability of *E. coli* in consume more kind of simple sugar, especially

TABLE 1
DEVELOPMENT OF ETHANOL PRODUCTION RESEARCH

Microorganism	Culture condition	Ethanol (g/l)
Zymomonas mobilis [6]	- Medium : Luria broth - Carbon source : Glucose - Condition : anaerobic	25.7
Saccharomyces cerevisiae [7]	- Medium : Luria broth - Carbon source : glucose - Condition : anaerobic	100
Escherichia coli [8]	- Medium : Luria broth - Carbon source : Glucose - Condition : anaerobic	58
Escherichia coli [8]	- Medium : Luria broth - Carbon source : Xylose - Condition : anaerobic	42
Escherichia coli [8]	- Medium : Luria broth - Carbon source : Lactose - Condition : anaerobic	52

 ISBN : 978-1-4673-7404-0

pentose and hexose which are main block of lignocellulose structure molecule support ethanol production [8]. Otherwise, the ability are not had in *Z. mobilis* and *S. cerevisiae*, they only consume hexose [1]. Thus, the huge amounts of lignocellulose make *E. coli* as very potential microorganism in using ethanol production.

In Table 1 show, producing ethanol through anaerobic condition decrease cell growth and produce lactate. Accumulation lactate leads to activation of lactate dehydrogenase (LDH) [9]. Consequently, the ethanol yield is lowered. Meanwhile, in aerobic condition LDH inactivate because of oxygen sensitivity that impacts the yield of lactate [10]. It was reported that aerobic condition can change flux carbon through TCA cycle with NADH addition for respiration and result high cell growth [9]. In addition, high cell growth will increase ethanol production, then make cell *E. coli* osmotic stress. Therefore, we need strategy to help *E. coli* response in osmotic changing. In this study, we describe that glutamate addition will increase cell growth in stressful of ethanol.

II. MATERIALS AND METHODS

A. Bacterial strain and plasmids

E. coli BW25113 and its *pta* deficient mutant (JW2294) were gained from The National Bio-Resource project (National Institute of Genetics, Japan) (11). Plasmids which contain *adhB-pdc* and *fdh* enzyme are inserted and donated as *E. coli* BW25113*Δpta*/pHfdh/ pTadhB-pdc. Transformation was conducted with $CaCl_2$ and heat shock, respectively by using ampicillin 50 ppm as antibiotic. Cell mutant was saved in glycerol 50 % as stock.

B. Cell cultures

Pre-culture cells in liquid LB medium for 12 h at 37 ^{o}C with shaking at 120 rpm until OD_{660} = 1-1.5 were inoculated into test medium. The test medium contained 40 g glucose, 4 g sodium format, 5 g yeast extract, 10 g NaCl, and 10 g Polypepton, per litter of deionized water. For antibiotics, were used ampicillin (50 mg l^{-1}), chloramphenicol (34 mg l^{-1}), and kanamycin (15 mg l^{-1}) and added together with 0.5 mM IPTG for inducing recombinant protein. The initial pH of medium was kept steady at 8.0 by using NaOH and $CaCO_3$ (20 g l^{-1}) which included in medium to avoid pH drop in course of culturing. The cultures were placed at rotary shaker 250 rpm at 37 ^{o}C. The test medium was supplemented by ethanol 20 g l^{-1} and sodium glutamate with different concentration (2, 4, and 6 g l^{-1}) at t = 6 h. Then, course of culturing were continued until 24 hour.

C. Analyses

For dry cell weight (DCW) was conducted according to [12]. Glucose analysis was assayed by enzymatic method using F-Kit 716251 (Roche) with necessary modification according supplier's instructions. The concentrations of organic acid were measured through high performance chromatography (HPLC) with column ZORBAX SB-Aq 883975-914 and mobile phase 99% NaH_2PO_4 20 mM pH 2.0, 1% ACN. The data experiment were represented as means ± standard deviation (SD) and obtained from 3 times test, except in HPLC analysis. Data processing used T-test in *Microsoft office excel* 2007.

III. RESULTS AND DISCUSSION

A. Effect of Ethanol

Figure 1 compares the ethanol addition and dry cell weight of *E. coli* BW25113*Δpta*/pHfdh/pTadhB-pdc strains. Increasing of ethanol concentrations from 0 to 15 g/l did not provide the significant effect to cell growth, but it was ethanol 20 g/l which decreased cell growth from 1.27 ± 0.06 to 0.9 ± 0.14 g/l. This trend indicated that cell mutant *E. coli* underwent growth retardation at ethanol 20 g/l, it was appropriate to [13] result that ethanol 10 g/l addition in culture medium would inhibit growth rate of cell *E. coli* K12 in anaerobic condition. Moreover, ethanol passed through membrane by diffusion which caused disturbed in production of cross-linked peptidoglycan structure that reduced strength of membrane peptidoglycan [14]. Hence, ethanol had been confirmed that high ethanol concentration could destruct cell wall integrity with subsequent inhibition growth rate cell *E. coli* in aerobic condition.

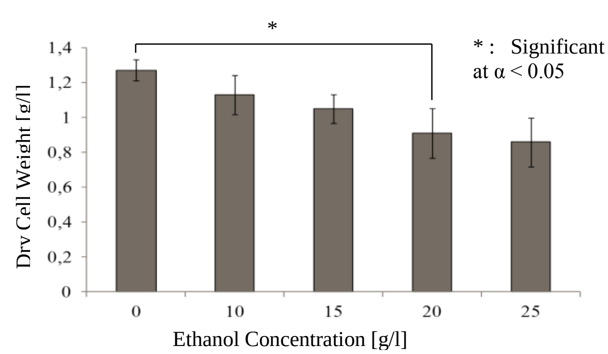

Fig.1. DCW of *E. coli* BW25113Δpta/pHfdh/pTadhB-pdc was at different ethanol concentration in medium culture conditions. The addition of ethanol was at 6h, and the cells were cultured for 24 h.

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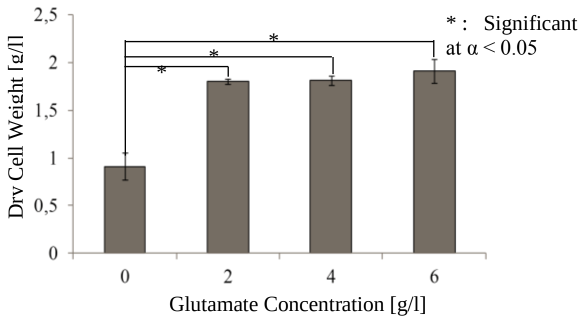

Fig.2. DCW of *E. coli* BW25113*Δpta*/pHfdh/pTadhB-pdc was at different glutamate concentration and ethanol 20 g/l in medium culture conditions. The additional glutamate and ethanol was at 6h, and the cells were culture for 24h.

B. Impact of Glutamate on dry cell weight and glucose consumption

To solve ethanol effect toward growth rate cell was conducted in this experiment with glutamate supplement. D-glutamate is important amino acid for building block of peptidoglycan in cell wall which is resulted by L-glutamate conversion. The conversion will be catalyzed by glutamate racemase (MurI) [15]. D-glutamate which is formed will bind to UDP-N-acetylmuramil-L-alanine on peptide bond. Then, it combines to mes-diaminopimelic acid, D-alanyl, and D-alanine until form peptidoglycan monomer [16]. The ability of glutamate in cell wall strength has been represented from previous study which demonstrated that cell growth of *E. coli* WM335 decreased when cell removed from medium rich glutamate to lower glutamate and peptidoglycan became lysis [17].

As shown in Figure 2, increased glutamate concentration helped boost DCW in ethanol 20 g/l medium, aerobic condition. However, glutamate concentration 2 g/l gave a significantly different effect on increased DCW which nearly doubled from treatment without glutamate addition, that was compared to others glutamate concentrations. Growth rate enhancement indicated that glutamate supplement had role in peptidoglycan so cell wall became resistant to ethanol 20 g/l. To classify effect of glutamate addition to DCW enhancement was conducted with analysed glucose consumption which it as carbon source. The more increasing glutamate concentration, the more glucose is consumed (Fig. 3). At 2 g/l glutamate addition caused glucose consumption dramatically increased 4.5 g/l from treatment without glutamate addition. Therefore, it could be stated that increased DCW resulting of glutamate supplementation was also caused by increased glucose consumption.

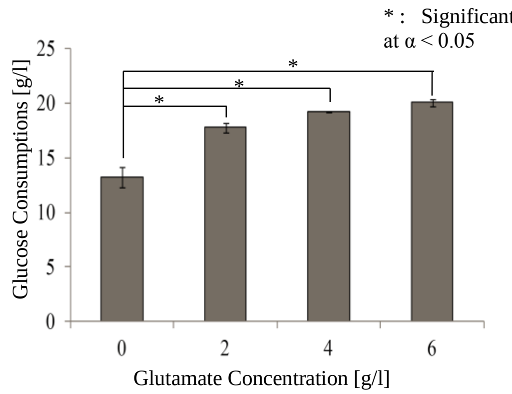

Fig.3. Effect increased glutamate concentration to glucose consumptions of *E. coli* BW25113*Δpta*/pHfdh/ pTadhB-pdc. The cells were cultured for 24 h, followed by additional ethanol 20 g/l and glutamate at t = 6 h.

C. Glutamate action on acetate production

Although glucose consumption could raise DCW, it was used for produced by product such as acetate. According to [18] that acetate forming could lead to growth rate lowering, so we looked for acetate formation profile in *E. coli* metabolism. As seen in Figure 4, the cell *E. coli* in without glutamate and glutamate supplementation had a different acetate production. Acetate which was formed in addition 2 g/l glutamate decreased almost doubled from treatment without glutamate, namely it was from 6.27 g/l to 3.29 g/l. The low production of acetate in the treatment with addition of glutamate confirmed that increasing glucose consumption directed to increasing cell growth.

In general, the formation of acetate indicated over metabolism in *E. coli* because of over condition, such as oxygenation level or glucose concentration [19]. Under aerobic condition or high oxygenation level, cell used NADH for respiration. Respiration

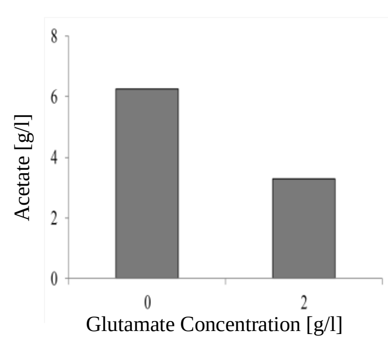

Fig.4. Acetic acid production of *E. coli* BW25113*Δpta*/pHfdh/ pTadhB-pdc was cultured for 24 h. The additional ethanol 20 g/l and glutamate at t = 6 h.

ISBN : 978-1-4673-7404-0

oxidized NADH to NAD^+ which was used for increased glycolysis and TCA cycle activity. Increased glucose consumption which affected TCA cycle would result accumulation of NADH. NADH would become allosteric inhibition for citrate synthase as main enzyme toward TCA cycle. That situation made flux carbon to TCA was lower so acetate was produced [19][20]. Accordingly, the high aerobic condition and glucose consumption had effected acetate production.

Furthermore, the formation of acetate in effect of glutamate associated with TCA cycle activity. TCA cycle is part of metabolism pathway of *E. coli* as form glutamate and other product from citrate [21] [22]. Glutamate synthesis from TCA would be used for keeping tenacity of cell wall. Besides, growth cell and ATP synthesis were also affected by TCA activity [23]. Increasing flux carbon into formation of acetate would lead to few carbons to TCA, with subsequent inhibition growth rate cell. Nevertheless, glutamate addition in media culture would be kept steady and increased growth rate, indeed.

Central carbon metabolism in *E. coli*, as shown in Figure 5 under high oxygenation and high glucose could be assumed that glutamate which was added, would role as maintenance of peptidoglycan and it had changed regulation system that flux carbon flew to TCA cycle. Glutamate also as osmoprotectant that used as osmosis balancer was caused by stress condition [24]. Otherwise, without glutamate supplementation resulted low growth rate, because flux carbon was not direct to TCA cycle, whereas to form acetate.

According to different resulted between effect of glutamate and without glutamate in *E. coli*

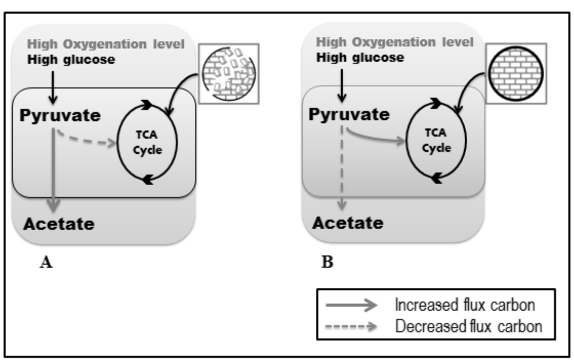

Fig.5 Scheme for central carbon metabolism in *E. coli* BW25113*Δpta*/pHfdh/pTadhB-pdc resulted in glutamate supplementation. (A) Without supplementation of glutamate, (B) With supplementation of glutamate.

BW25113*Δpta*/pHfdh/ pTadhB-pdc, had been clarified that regulation metabolic had changed. Added 20 g/l ethanol, proved decreasing growth rate cell and glutamate was able to recovery. It was confirmed that growth rate increase dramatically when 2 g/l glutamate was added.

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ISBN : 978-1-4673-7404-0

In Vitro Potential of Antibacterial Marine Microalgae Extract *Chaetoceros gracilis* toward *Staphylococcus epidermidis* Bacteria

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***Abstract*— Acne is common skin disease which can be found in society. Antibiotic was a treatment that always used to be solved this disease. Utilization of antibiotic has been facing a problem. Resistance of bacteria toward antibiotic has become one problem in acne treatment. Antibiotic resistance can be prevented through using new antibiotic compound. Marine microalgae *Chaetoceros gracilis* can be used as new antibiotic resources in acne treatment. The aim of this research was to determine in vitro antibacterial activity of C. gracilis toward *Staphylococcus epidermidis* bacteria. Antibacterial activity was tested by inhibition index and cell membrane leakage. Cultivation of marine microalgae biomass produced yield was 0.12 g/L. Yield of microalgae *C. gracilis* extract which obtained was 47.40%. Extract capable inhibited the growth of *S. epidermidis* based on the highest antibacterial activity. Minimum inhibitory concentration (MIC) value of extract was 0.4 mg/mL and have caused the cell membrane leakage. The leakage of genetic material was more higher than protein in bacteria cell membrane. Active compounds contained in extract were alkaloid and steroid.**

Key words: antibiotic resistance, *C. gracilis* extract, *S. epidermidis*, inhibition index, MIC

I. INTRODUCTION

Acne is one skin disease which can be found easily in society. Clinical diagnose of acne is more easy than prevent. One of cause acne is infection of bacteria such as *Propionibacterium acnes* and *Staphylococcus epidermidis*. Antibiotic and chemical compound is common treatment which always using to solve acne [1]. Utilization antibiotic and chemical compound in acne has make some problems such as side effect (irritation, dry skin and painful), infection of upper respiratory tract and increasing bacteria resistance [2][3]. Current research show that occurred increasing of skin bacteria resistance. In South Korea, occurred increasing of acne bacteria from isolation 100 acne patient. Resistance of *P. acnes* increasing about 36.7% and *S. epidermidis* about 69.4%. The highest resistance toward antibiotic is shown by *S. epidermidis* [4]. This result show that *S. epidermidis* has high resistance to antibiotics and also become common acne bacteria in human skin [5].

Prevention acne bacteria resistance can be solved by using alternative bioactive compound such as microalgae. Microalgae is a potential antibacterial resource which can be used as a solution to solve acne problem. Some microalgae has antimicrobial activity, one of that is *Chaetoceros* spp. *C. muelleri* which is extracted by supercritical fluid extraction (SFE) can damage and kill cell membrane *E. coli* ATCC 11775 and *S. aureus* ATCC 25293 [6]. Except that, *C. gracilis* also show antibacterial activity toward *Vibrio harveyi*. *Listeria monocytogenes* ATCC feld stem and *Bacillus cereus* ATCC 13901 [7]. Those results show potential marine microalgae *C. gracilis* as a new alternative resource in bioactive.

Measurement an anti-acne active compounds carried through several stages consist of antibacterial activity, anti-oxidant and anti-inflammatory. The first stage of anti-acne was checked by measured of antibacterial spectrum. Antibacterial activity was tested by inhibition and cell membrane leakage. Antibacterial compound of *C. gracilis* can be obtained via ultrasound-assisted extraction (UAE). Combination with UAE aimed to damage cell wall of *C. gracilis* which contained silica. Utilization of *C. gracilis* extract using UAE to inhibit *S. epidermidis* growth has never been done before. In addition, mechanism of cell membrane leakage *S. epidermidis* by using *C. gracilis* extract is not clear. Measurement of bacteria cell membrane leakage will describe the

 ISBN : 978-1-4673-7404-0

process of bacterial cell membrane damage from *C. gracilis* extract and its potential in pharmacy sector.

II. MATERIALS AND METHODS

A. Sample preparation

Pure cultures of *C. gracilis* were scaled up from 2 L to 50 L in medium aquarium supplied with aeration and illumination. Vitamins, trace metals, Na_2EDTA, Na_2HPO_4, F medium and $Na_2SiO_2.5H_2O$ were used as fertilizers. At the logarithmic phase, microalgae cell were harvested by filtration. The harvested microalgae were stored in jar bottle and refrigerated to maintain freshness during one day. Drying of microalgae cell used freeze drying with temperature about -82 ^oC and pressure on 0,001 bar. The biomass powder was kept in 4 ^oC refrigerator until extraction.

B. Ultrasound-Assisted Extraction (UAE)

In the current work, ultrasound-assisted extraction (UAE) was applied for extraction of biomass. The ultrasound extraction was carried out under the following experimental condition: time (15 min), solid to solvent ratio (1:10 g/mL), amplitude 100% and sonication power (20 KHz). After sonication done followed by stirring using magnetic stirrer during 24 hour at room temperature 30 ^oC. The extracts were filtered and the solvent was removed using rotary evaporator. Ethanol was used as the solvent and extraction was performed in duplicate.

C. Antimicrobial activity

Antimicrobial activity was checked by disc diffusion method. The cultures were grown in nutrient broth and incubated at 37 ^oC for 24 h. After incubation period is over, the OD of the culture was adjusted to 0.5-0.8 with sterile nutrient broth. Mueller-Hinton agar medium mixed with bacteria culture then poured into sterile petri plates and allowed to solidify. The disc (6 mm diameter) impregnated with some concentration 0.5, 1 and 2 mg/mL were placed on the surface of petri plates. The plates then were incubated at 37 ^oC for 24 h. after incubation period the zone of inhibition was measured.

D. Minimum inhibitory control (MIC)

Minimum inhibition concentration (MIC) were used by dilution method. Nutrient broth was used about 5 mL and extract has some concentrations 0.1, 0.2, 0.3, 0.4 and 0.5 mg/mL respectively and control, then added with bacteria culture about 5 µL. Medium and inoculum (tested microorganism) were used as positive control meanwhile medium and extract used as negative control. Sample were incubated at 37 ^oC and 24 h. MIC were determined by optical density value. OD was measured with wavelength 600 nm at 18 h and 24 h. The MIC was defined as the lowest concentration of the compound to inhibit growth of microorganism by OD value.

E. Analyze of cell membrane leakage

The culture about 10 mL was centrifuged for 20 min at 3500 rpm followed by washed with phosphate buffer saline pH 7.0 duplicate then re-suspended pellet by 0.1 M phosphate buffer saline pH 7.0 about 8 mL and also added extract concentration 1 and 2 MIC. Sample followed by incubated in rotary shaker 150 rpm at 37 ^oC for 24 h. After incubation, bacteria suspension was centrifuged for 20 min at 3500 rpm. Supernatant and pellet were filtered by Whatmann 0.42 µm. The absorbance of the supernatant obtained was measured using a UV-visible spectrophotometer at 260 nm and 280 nm to analyze the nitrogen content of nucleic acids and protein, respectively.

F. Phytochemicals screening

Phytochemicals screening were tested refers to analyze active compounds in extract. In this work, active compounds were tested consist of alkaloid, flavonoid, phenol, steroid, tannin and saponin.

III. RESULTS AND DISCUSSION

A. Biomass and extract *C. gracilis*

In this research, biomass was cultivated at 50 L in medium aquarium. Wet biomass was obtained 59.74 g then followed by drying. Freeze drying used as method to dry wet biomass to save bioactive compound such as sterol and unsaturated fatty acid. These component was sensitive to heat process. Dry biomass obtained 5.96 g and yield 0.12 g/L. This result show that yield of cultivation process was small. One factor contributed to yield of cultivation added of CO_2 at cultivation process. In this study, there was no added of CO_2 while cultivation. CO_2 sources was only came from aeration so that biomass obtained only in small capacity.

Dry biomass was extracted by UAE combination with stirring. Crude extract of *C. gracilis* was obtained has green brown color, sticky and paste appearance. Green brown color was expected from chlorophyll and carotenoid pigment. Yield of extract was obtained about 47.40%. This result show that extraction process have the impact to yield. Sonication makes cell wall of *C. gracilis* damage and active compound from cell wall come out to solvent [8]. Moreover, stirring also increased damage of microalgae cell wall and mass transfer and interaction between solvent and material occurred. This process caused some active compound was still left in cell

ISBN : 978-1-4673-7404-0

wall come out and dissolved with solvent. Crushed solvent and cell component will powerful caused by particles pounding by stirring [9].

B. Antibacterial activity

The results obtained from the present study concerning the antibacterial effects of algal extracts against *S. epidermidis* were recorded in Table (1). It was concluded that the diameter of inhibition zone depend on difference of concentration extract. Concentration 2 mg/mL was the highest spectrum of antibacterial activity.

Table 1. Inhibition *S. epidermidis* bacteria

Test	Zone inhibition (mm)	Inhibition index
Ethanol	0.00	0.00
Clindamycin	26.50	4.42
Extract 0.5 $^{mg}/_{mL}$	4.25	0.71
Extract 1 $^{mg}/_{mL}$	6.50	1.08
Extract 2 $^{mg}/_{mL}$	9.50	1.58

According to inhibition index, this concentration has strong capability to inhibit growth of *S. epidermidis*. Capability of inhibition *C. gracilis* extract was more smaller than *Aquilaria crassana* leave extract. Inhibition zone diameter of *A. crassana* leave extract in 2 mg/mL was 12 mm and higher than *C. gacilis* extract 9.5 mm [10]. In other that, capability of *C. gracilis* extract also more smaller than clindamycin because its purity. Clindamycin was an antibiotic compound lincosamide class which obtained from *Streptomyces lincolnensis* bacteria through purification process sot that clindamycin has strong antibacterial spectrum than *C. gracilis* extract [11].

C. Minimum inhibitory concentration (MIC)

MIC value in this study was obtained from two different time, 18 h and 24 h. OD value was decreased with increasing of concentration (Table 2). This result was appropriate with basic theory that increasing antibiotic concentration will decrease bacteria growth. Inhibition extract showed by comparison of OD from control and sample. At 18 h, control value more higher than sample which means that bacteria growth was inhibited. OD value at 18 h became determined inhibition character of *C. gracilis* extract. OD value at 24 h increased higher than od value at 18 h. This result show that effectiveness extract was decreased but inhibition bacteria growth still occurred looked from value of OD control higher than sample.

Table 2. MIC *C. gracilis* extract

Test	OD 18 h	OD 24 h
Control	0.363	0.558
0.1 $^{mg}/_{mL}$	0.029	0.042
0.2 $^{mg}/_{mL}$	0.029	0.040
0.3 $^{mg}/_{mL}$	0.027	0.040
0.4 $^{mg}/_{mL}$	0.019	0.030
0.5 $^{mg}/_{mL}$	0.012	0.030

Increasing OD value show that *C. gracilis* extract only inhibited bacteria growth and can't killed bacteria, so that this extract has bacteriostatic character. MIC value in this study was obtained at extract concentration 0.4 mg/mL. From classification of MIC value which classified refers to [12] this concentration was categorized as medium spectrum of antibacterial activity.

D. Cell membrane leakage

The value of cell membrane leakage was analyzed by reading the absorbance value at a wavelength of 260 nm and 280 nm. Wavelength of 260 nm can detect the presence of purine compounds and pyrimidine, meanwhile the wavelength of 280 nm can detect the presence of tyrosine and tryptophan compound belongings to the proteins class [13]. Results showed absorbance reading absorbance 260 nm values higher than 280 nm (Figure 1). The high reading absorbance values shows that the genetic material of bacteria cell membrane of *S. epidermidis* was more dominant damage than protein.

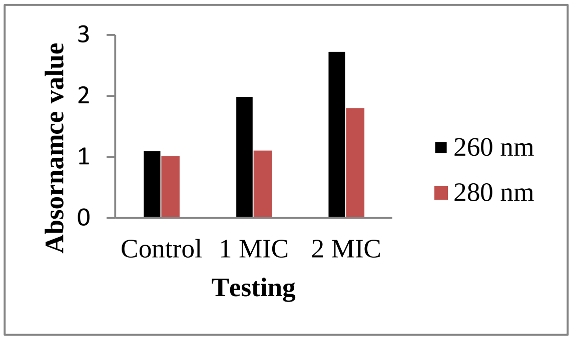

Fig. 1 Cell membrane leakage of *S. epidermidis*

Measurement absorbance of cell membrane leakage also showed changes value of leakage at each concentration. Changes in absorbance values of each treatment has a difference. High concentration was effected to cell membrane leakage become higher than less concentration. Change of absorbance values was resulted a breakdown of bacteria cell membrane. Bacteria cell membrane of *S. epidermidis* was damaged by *C. gracilis* extract effected to release of genetic material and proteins [14].

E. Phytochemical screening

Crude extract from *C. gracilis* which extracted by ethanol were contained alkaloid and steroid. Those compounds were secondary metabolite compound which has capability as antibacterial. Alkaloid was offend peptidoglycan component in cell membrane. Antibacterial character from steroid was offend translation which effected in disorder of transcription process [15]. This process have the impact to synthesis of bacteria protein. Steroid compound in this study was suggested as the main antibacterial compound. This result was analyzed from FTIR test of *C. calcitrans* extract [16].

IV. CONCLUSION

The present study has reported the screening phytochemical, antibacterial activity, MIC and cell membrane leakage from *C. gracilis* extract. Extract exhibited strong anti-bacterial activity toward *S. epidermidis* growth. Mechanism of action extract also was reported. Leakage of material genetic was higher than protein component in cell membrane. Antibacterial component in extract were suggested alkaloid and steroid. From this study, extract *C. gracilis* which could be useful in the treatment of acne disease.

ACKNOWLEDGEMENT

This work was supported by the General Directorate of Higher Education of Republic of Indonesia (Student Creativity Program) and Tanoto Foundation (Tanoto Research Student Award).

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ISBN : 978-1-4673-7404-0

The Potential Applications of Modified Nagara Bean Flour through Fermentation for Innovation of High Protein Analog Rice

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Abstract**--**Rice is the staple food for most Indonesian people and the rate of rice consumption is increasing every year, eventhough government should go import. The source of carbohydrates not only from rice, but there are many other materials such as cereals, tubers that have not been threated optimally. Similarly, the occurrence of a shortage of protein in some communities in Indonesia are still being found. Therefore, the strategy of this problem is with food diversification to substitute or replace the rice needs by using rice analog from Nagara beans (*Vigna unguiculata* ssp *Cylindrica*). Nagara beans have high carbohydrate content about 50-60% and 20-25% protein. Nagara beans contain amino acid dominant aspartic acid 0.913%, glutamic acid 2.182% and histidine 0.826%. Grits size produce flour yield, protein content, water absorption capacity, and the swelling volume greater than others. Fermentation time up to 120 hours tend to lower flour yield and protein content, while the water absorption capacity tend to increase up to 96 hours fermentation and swelling volumer tends to be stable up to 96 hours fermentation periods.

Keywords : nagara bean flour, spontaneous fermentation, protein, water absorption capacity

I. INTRODUCTION

One alternative in achieving national food security is the food diversification. But the culture of Indonesian people “it feels not full before eating rice” makes the process of diversification has not run smoothly. Therefore, we need an alternative food that resembles the staple food of Indonesia, namely rice. The food resembling rice is called analog rice. Analog rice generally processed from cereals or tubers with a dominant carbohydrate content, but on the other hand there are actually several types of legumes that contain carbohydrates dominant one of it which grow in swampy areas.

Nagara bean (*Vigna unguiculata* ssp. *Cylindrica*) is one of the local bean which grow in South Kalimantan, especially in Hulu Sungai Selatan area. The largest component in the in the Nagara bean is carbohydrate and implies almost the same as cowpea and green beans which ranges from 62%. On the other hand, Nagara bean is also one source of vegetable protein. Protein content ranged from 22.7 to 27% (Noor 1993), it is higher than green bean and cowpea.

According Niba (2003) limitations legume characteristics can be improved by fermentation and bioprocessing techniques. The fermentation process was known as one method that can modify starch structure and physicochemical properties of a material (Chinsamran *et al*. 2005), where the fermentation can affect the solubility, the development of granule, and viscosity of starch (Abia *et al.*, 1993; Nche *et al.*, 1994; Yadav and Khetarpaul, 1994) the specific characteristics is very instrumental on subsequent product processing. Prinyawiwatkul *et al*. (1997) assess the functional properties of bean flour were influenced by soaking, boiling and fermenting fungi, and Yadav and Khetarpaul (1994) on *Phaseoulus* mungo fermentation process at a temperature of 25-30 ºC for 12 and 18 hours was able to increase the digestibility of starch from 57% to more than 88%.

The process of fermentation with soaking is a technique that is easy to modify starch, and on the other hand it is able to improve in vitro starch digestibility 17-23% after 12 hours of soaking. With longer soaking treatment, it is expected to increase digestibility of starch and contribute to the declining of antinutrition such as phytic acid and polyphenols which can inhibit the activity of α-amylase (Desphande and Cheryan 1984).

Material that has been fermented legumes are digested significantly faster than the legume is not fermented. This is possible because of the loss of structural integrity of the starch granules, changing the interaction between starch and fiber because inactivation of some antinutrien (such as phytic acid).

Natural fermentation process is simple and inexpensive method to reduce and eliminate oligosaccharides. Zamora and Fields (1979) states that fermented cowpea will reduce stachiosa and raffinose, this is caused by the ability of lactic acid bacteria to use oligosaccharides for metabolism. Lactic acid is the dominant role in the process of fermentation include *Lactobacillus casei, Lactobacillus leichmanni, Lactobacillus plantarum, Pediococcus pentosaceus and Pediococcus acidilactici.*

This study was aimed to assess the modification processof Nagara bean flour through spontaneous fermentation process to produce flour with optimal characteristics as a raw material rice analog formulations.

II. MATERIAL AND METHODS

Materials

Nagara bean take from Hulu Sungai Selatan districts exactly Nagara area, South Kalimantan Indonesia

Methods of Spontaneous Fermentation

Nagara beans soaked with water at a ratio of 1: 4 (w / v). Spontaneous fermentation with some variation wet fermentation periods (24 hours, 48 hours, 72 hours, 96 hours and 120 hours), by changing the soaking water everyday and form a fermented material that are whole bean (with skin), and grits. The fermented beans are cleaned from the peel, dried at a temperature of 60 ° C for 48 hours, then powdered and sieved to 80 mesh size. Nagara beans tested amino acid composition using HPLC. Flour obtained by testing the moisture content (oven method) protein content (method Kjeldhal) Kamba density, water absorption capacity, swelling volume and solubility.

Bulk Density

Bulk density was measured using a measuring cup. Samples to be measured, weighed as much as 10 g. Then put in a 50 ml measuring cup and readable volume. Bulk density is calculated as the ratio of the sample weight by volume of the sample read on the measuring cup.

$$\text{Bulk density (g/cm}^3) = \frac{\text{weight sample (g)}}{\text{volume(cm}^3)}$$

Water absorption capacity

Centrifuge tube filled with 2 g of flour samples were weighed and the weight of the sample tube (a), then added 9 mL of distilled water and vortex. Furthermore allowed to stand for 30 minutes and then centrifuged at 3000 rpm for 15 minutes, decanted and weighed (b).

Water absorption capacity (% db)

$$\text{Water absorption capacity (\% db)} = \frac{b-a}{ms\ (1-mc)} \times 100\%$$

a = weight of sample + weight sentrifuge tube (g)
b = weight of wet sample + weight sentrifuge tube (g)
ms = weight sample
mc = moisture content

Swelling volume (g/g db)

Swelling volume is determined by weighing as much as 0.35 g of flour are then added water to 12.5 mL centrifuge tube. Furthermore the solution have been vortex and then heated in a water bath with a temperature of 92.5 ° C and vortex once every 5 minutes for 10 minutes. Furthermore, the solution was cooled in ice water for 1 minute and at 25 ° C for 15 minutes. Then the solution was centrifuged at a speed of 3600 rpm for 15 minutes. Gel that is formed is measured in volume and is expressed as a swelling volume in unit g / g (db). Solubility is obtained by pouring the resulting supernatant into a cup that has been known weighed and dried at 110 ° C for overnight. Solubility is calculated by the following formula :

$$\text{Solubility (\%db)} = \frac{w1}{wdm} \times 100\%$$

$$\text{Water swelling volume (g/g db)} = \frac{w2}{ms\ (1-mc)}$$

w1= weight of supernatant (g)
w2 = weight of formed gel (g)
wdm= ms(1-mc)
ms = weight sample
mc = moisture content

Statistical Analysis

The data are analyze by using analysis of variance (ANOVA) and if there is real effect then continued with Duncan test (DMRT) at a rate of error of 5%.

III RESULT AND DISCUSSION

Composition amino acid in nagara bean

Nagara bean is one type of bean with high carbohydrate and protein. Quality protein in a material can be seen from the composition of amino acids in it. The results showed that Nagara bean contain amino acids glutamate (2,183%), amino acid composition are presented in Table 1.

Table 1 Amino acid composition in nagara bean

Amino acid	Total (%)
Aspartic acid	0.913
Glutamic acid	2.182
Serin	0.578
Glisin	0.258
Histidin	0.826
Arginin	0.584
Threonin	0.282
Alanin	0.116
Prolin	0.196
Tyrosin	0.218
Valin	0.734
Methionin	0.791
Sistin	0.321

 ISBN : 978-1-4673-7404-0

Amino acid	Total (%)
Isoleusin	0.393
Leusin	0.775
Phenilalanin	0.417
Lysin	0.438
Tryptofan	-

The **c**haracteristics of Nagara beans flour can be better obtained either by way of a natural modification through a process of spontaneous fermentation. Spontaneous fermentation is fermentation which does not add inoculum or starter from the outside, and the process is very influenced by the length of fermentation which is done. During fermentation, it is expected to occur fragmentation of starch granules that will affect the characteristics of the resulting flour. During fermentation, lactic acid bacteria grow and produce organic acids especially lactic acid. Subagio (2006) stated that during the fermentation of starch, there are changes in characteristics such as solubility, rehydration value, aroma and color. In this study, the fermentation is done spontaneously by soaking Nagara bean in the form of whole beans and grits with a long fermentation time 24 hours to 120 hours. The test results are presented in Table 2.

Table 2 The characteristics of spontaneous fermented nagara bean flour

Treatments		Parameter						
Size	Fermentation periods (hours)	Yields (%)	Moisture content (%)	Protein (%)	Bulk density (g/cm^3)	Water absorption capasity (% bk)	Swelling volume (% g/g bk)	Solubility (% bk)
Whole grain	24	57.0±7.0	7.9±0.2	22.6±0.9^{ab}	0.46±0.0	142.2±8.2^{a}	553.6±11.2	24.4±2.0^{d}
	48	58.0±14.1	6.8±0.9	22.7±1.9^{ab}	0.50±0.0	177.4±14.8^{b}	522.1±69.9	16.9±7.7^{d}
	72	57.5±3.5	6.8±1.7	24.2±0.6^{b}	0.49±0.0	200.5±11.6^{cd}	518.1±5.6	10.6±1.3^{cd}
	96	45.5±7.7	5.9±0.6	23.1±1.0^{ab}	0.50±0.0	204.6±6.2^{cd}	530.8±72.3	7.1±0.0^{ab}
	120	40.0±2.8	5.2±1.1	22.6±0.2^{ab}	0.51±0.0	193.4±5.1^{bcd}	711.1±33.8	5.9±0.6^{ab}
Grits	24	60.5±4.9	6.3±0.2	24.3±2.5^{b}	0.50±0.0	186.5±5.9^{bc}	552.5±80.4	12.0±2.2^{c}
	48	59.5±12.0	6.3±0.3	23.9±0.7^{b}	0.52±0.0	201.1±3.1^{cd}	554.7±116.0	8.3±3.3^{bc}
	72	53.5±2.1	5.9±1.9	21.0±0.9^{a}	0.51±0.0	202.1±3.3^{cd}	541.9±38.3	6.5±0.9^{ab}
	96	51.5±0.7	5.8±0.5	22.2±0.8^{ab}	0.49±0.0	208.8±2.7^{d}	554.1±16.6	6.5±0.3^{ab}
	120	51.5±0.7	5.3±0.0	21.5±0.2^{a}	0.50±0.0	190.3±8.7^{bcd}	693.5±49.7	5.2±0.0^{a}

*numbers followed by the same letter are not significantly different (α 5%)

Yields

In a process, determining the yields are very important as a measure of the performance of processes. The result of variance analysis (α 5%) showed that the size of bean and periods of fermentation had no significant effect on yield of Nagara bean flour. In the process of spontaneous fermentation Nagara bean, the average yield is 53.45% which produced flour yield of grits size is relatively higher than the size of the whole, and the longer of the fermentation flour yield will decrease. It was caused by the longer of contact time, the process of absorption of water into the matrix of Nagara bean is increased, so did the performance fragmentation of lactic acid from lactic acid bacteria in degrading cellulose structure is intensified. So it makes the texture of Nagara bean increasingly softened, and the washing process will lead to losses. The process of softening Nagara beans is larger after fermentation periods 72 hours. In whole bean sizes, after the fermentation process, the skin was stripped, after 72 hours of fermentation the beans have tender texture, very soft, so when there were washed, the beans will be destroyed and lot of starch dissolved in water. While in the grits size, the skin already partially separated from the beans, the emphasis on beans to remove the skin is relatively small, and has lower structural damage, so the loses of it is smaller.

Moisture Content

The determination of moisture content was aimed to determine the water content in the fermented nagara bean flour. Nagara bean flour moisture content ranging from 4.42 to 8.04% with an average value of 6.20%. The result of variance analysis (α 5%) showed that the size of bean and periods of fermentation had no significant effect on water content produced nagara bean flour.

On the whole size beans, flour moisture content ranges from 5-7.5% while the grits size ranges from 5-6% water content. The size of bean which are still intact beans are covered by the skin so that the rate of diffusion of water into the bean will be slower than bean in the form of grits. Size grits expand the surface area so contact between the beans with water and organic acids will degrade performance granular structure easier, so that the water content in the drying process easily evaporated. If fermentation process so longer, so the process of fragmentation of granules is

ISBN : 978-1-4673-7404-0

getting bigger, so during the drying process, the water content of flour will decrease.

Crude Protein Content

The crude protein content of fermented Nagara bean flour is high enough range 21.02 to 24.20%. Bean in general are a source of protein, with the fermentation process through soaking, it will be possible for protein hydrolysis become simpler components namely peptides so that its availability will be higher. The lactic acid produced from lactic bacteria that grow spontaneously will accelerate the process of hydrolysis of proteins.

The result of variance analysis (α 5%) showed the interaction size bean and periods of fermentation significantly affected protein content of modified Nagara bean flour. The highest protein content generated on the grits were fermented for 24 hours (24. 29%) and did not differ with whole bean with a fermentation time 72 hours (24.20%). The size of grits is suspected hydrolysis or breakdown protein by proteolytic enzymes and acids that occurs faster than the size of the whole. On grits size, the media of fermentation decrease faster, on 24 hours fermentation it reaches pH 5, while on the whole size, on 24 hours fermentation it reaches pH 6-7.

Supposedly on grits size allows lactic bacteria grow rapidly due to the availability of nutrients from the beans and more easily obtained compare with whole size bean.

Bulk Density

Bulk density is needed to determine the weight of material per unit volume. Modified Nagara bean flour had a softer texture than unspontaneous modification. Bulk density of modified Nagara bean flour ranges from 0.46 to 0.52 g /cm^3. The result of variance analysis (α 5%) showed Nagara bean size, fermentation periods and interaction of both have not significant effect on the density of the Nagara bean flour. Smaller bulk density of material will facilitate the packaging process and transport.

Water Absorption Capasity

Starch granules which are the main components can be inflated by soaking in cold water. In cold water, the water absorption capacity is limited, but when starch is heated, the thermal energy will break the hydrogen bonds so the surface area for absorption of water become larger and starch granules will absorb more water.

The result of variance analysis (α 5%) showed that the interaction size nagara bean and fermentation periods significantly affect the water absorption capacity of the Nagara bean flour produced. The highest rate of water absorption is obtained in the 96 hours fermentation of grits size and relative no different with fermentation periods 48 and 72 hours. Supposedly greater water absorption is due to the fragmentation of the starch and protein during spontaneous fermentation process so that the binding of water becomes greater. According Etudaiye *et al*. (2009), during fermentation, the proteolytic activity of the microorganisms cause additional polar groups on the starch granules, and the addition of polar groups will increase flour hidrofility.

Differences in the absorption of water is caused due to differences in surface area, that is broken bean and protein content (Sabularse *et al*. 1991). Water absorption capacity tends to increase in fermentation time up to 96 hours, while at fermentation periods 120 hours tend to lower water absorption. Grits size at 24-hour fermentation had grater water absorption capacity than the size of the whole, it is presumably because the larger surface area. Fragmentation of starches and proteins occur more quickly so that the absorption of water more quickly too.

Swelling Volume

Swelling volume indicates the level of development of starch granules when interacting with water, the more water is absorbed, the rate of granule development will be even greater. The result of variance analysis (α 5%) showed that the fermentation periods significantly affect swelling volume of the fermented bean flour. Swelling volume is likely to increase up to 120 hours fermentation periods. Leach *et al.* (1959) stated swelling volume is influenced by the strength of the bond between the granular network. Lactic acid bacteria produce amylase will attack amorphous areas of starch granules, the performance is affected by hydrolytic enzymes and organic acids produced during fermentation. During heating in water, the starch granules occur gelatinization and will expand and partially dissolved causing a viscous solution. Rigid structure that would be difficult to expand because the matrix is still strong so the water absorption becomes limited.

Solubility

The solubility of the modified Nagara bean flour ranges from 5.15 – 24.38 % db. The result of variance analysis (α 5%) showed that the interaction of nagara bean and fermentation periods have significant effect on the solubility of flour. On the size of grits solubility in water flour is relatively lower than full size and the longer of the fermentation, the smaller of the solubility flour. Swelling of the starch granules above the gelatinization temperature is accompanied by washing polisaccharides soluble. Amylose which is polar, if much amylose component out of the granules, the solubility increases. With the longer the fermentation, suspected amylose exposure is reduced so that the solubility decreases. The amount of dissolved amylose is a function of the organization's internal granular starch (Walter *et al*. 2000).

ISBN : 978-1-4673-7404-0

IV CONCLUSION

Treatment of grits size produce flour yield, protein content, water absorption capacity, and the swelling volume greater than others. Fermentation time up to 120 hours tend to lower flour yield and protein content, while the water absorption capacity tend to increase up to 96 hours fermentation and swelling volumer tends to be stable up to 96 hours fermentation periods.

ACKNOWLEDGMENT

We wish to thank Directorate General of Higher Education, Ministry of National Education Indonesia for the research funding through Hibah Pekerti.

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ISBN : 978-1-4673-7404-0

Studies on the Characteristics of *Pasayu* (Pasta of Cassava Waste) Fortification as a New Product Development

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***Abstract* - Development of local flour-based food product is a new inovation to provide solutions on food security conditions in Indonesia today. *Pasayu* (pasta of cassava waste) is high in nutrients fortified with vitamins B1, B2, B6 and zinc, made of raw starch composite consisting of cassava waste mixed with corn flour and mung bean flour in the form of pasta-type *fettuccine*. The shape of pasta *fettuccine* was selected to provide an alternative staple food variations. The purpose of this study was to obtain *Pasayu fettuccine of* corn and mung beans that fortified by certain vitamin and mineral with the best characteristics and protein content and fiber higher than commercial *fettuccine*. The method used was Explanatory Descriptive Method against two best formulations, *ambu* (waste-cassava) : corn flour 20: 80 and *ambu* : mung bean flour 70: 30, fortified respectively with vitamin B1 (0.45 mg), vitamin B2 (0.50 mg), vitamin B6 (1.00 mg) and mineral zinc (0.102 mg), followed by t difference test to determine whether there is an influence differences between the two samples that were not interconnected. The best results that obtained in this study was corn *Pasayu fettuccine* fortified with vitamin B2+Zn and mung bean *Pasayu fetuccine* that fortified with vitamin B1 + Zn. Corn *Pasayu fettuccine* has the characteristics of the protein content 11.21%, water content 10,43%, raw fiber content 3.58%, fat 6.30%, carbohydrates 74.00%,, ash content 2.15%, hardness 272.27 gF and rehydration power 148.47%. While mung bean *Pasayu fettuccine* characterized by the protein content 12.78%, water content 12.66%, raw fiber content of 5.36%, fat 6.94%, carbohydrate 67.82%, ash content 4.28%, hardness 1362.20 gF and rehydration power 115.45.**

Keywords: *Fettuccine*, Fortification, *Pasayu*, Pasta

1.Introduction

Food is a basic human need therefore it should always be available, sufficient, safe, quality, nutritious, and diverse with an affordable price and does not conflict with religion, beliefs, and culture. Food condition in Indonesia is still weak, as indicated by the high dependency of people only on certain food commodity, rice. Indonesian Center Bureau of Statistics (BPS) stated (2011) that rice consumption reached 139.15 kg/capita with the rice demand is currently around 34 million tonnes of rice/year. Furthermore as of August 2011, *BPS* recorded that Indonesia's rice imports from various countries reached 1.62 million tons. These conditions put the Indonesian people as the highest consumers of rice compared with Asean countries such as Thailand, Vietnam and Malaysia in the range of 65-70 kg/person/year. The issue of national food security is closely related to the high dependence on consumption of rice in the people's food consumption patterns, reaching of up 113 kg/capita/year [1].

Food diversification probably is the only solution to overcome the highly dependence on rice. It is supported by the fact that Indonesia has a wide variety of food sources, especially agricultural-based carbohydrates. Diversification of food consumption should be directed to increase public awareness and to develop a diverse pattern in food consumption, with nutrition balanced, safe and in accordance with the potency and local wisdom.

Courage to change the pattern of food consumption is essential in order to have the national food security through food diversification strategy. In Indonesia, more than 30 types and varieties of tubers are commonly grown and consumed by the people. Tubers have a number of advantages compared with rice, such as much cheaper price, much easier and cheaper to be cultivated. In addition, the carbohydrate content of tubers is also equivalent to the rice. Cassava, one of the tuber type, is the most important food after rice, corn, and soybeans [2]. The selection of cassava as a staple food commodity to substitute rice is a prospective breakthrough, because it can improve the image that cassava is no longer a commodity inferior. In addition, these commodities are easily grow even in the less fertile area and are well known by the entire community as a plant source of carbohydrates. Cassava in industrial scale, is used as raw material in tapioca manufacture. Tapioca industries however, produce solid waste that often cause problems if not handled properly, giving a bad impact on the environment. One possible solution is to process the solid waste becomes a food product. through scientific and technological approaches the solid waste can be transform into staple food product with the advantages of adequate protein, healthy and safe for consumption. Tapioca solid waste product still has potential nutritive foods. It contains around 74.78 g/100g carbohydrate in the form of starch and approximately 11.92 g/100 g fiber [3]. Every 250 kg of

ISBN : 978-1-4673-7404-0

cassava flour produced from 1 ton of cassava, there are as many as 114 kg of solid waste that has not been reprocessed and is only used as animal feed.

Waste-cassava product known as *rasi* (the Indonesian abrev.of waste-cassava) has long been consumed by an indigenous people living in Cireundeu Village, South Cimahi, West Java as their staple food for almost a century. The solid waste has to be processed first into starch (*rasi*) and cooked as rice before ready to be consumed. They consume *rasi* not because they do not afford to buy rice, but because of following a local wisdom inherited from their ancestor. Although *rasi* or *ambu* (the term used in this paper) contains high carbohydrate, it has low protein content so that *ambu* needs an additional protein from corn flour and mung bean flour. An appropriate ratio of mixed waste-cassava product (*ambu* flour), corn flour and mung bean flour, fortified with vitamins B1, B2, B6 and mineral Zn, through technology engineering and extrusion processes will produce a new product of nutritious, high fibrous in a form of pasta of *fettuccine* type, introduced as *Pasayu* (pasta waste-cassava).

2. Objectives

The aim of study is to obtain *pasayu* of *fettuccine* type, fortified with vitamins B1, B2, B6 and mineral Zn with the best characteristics of chemical and physical that preferred by consumers.

3. Materials and Equipments

The main materials used was *ambu* : corn flour 20:80 and *ambu* : mung bean flour 70:30. Supporting materials consisted of supporting material consists of eggs, salt, olive oil, and water. Vitamin B1 (Thiamin), vitamin B2 (riboflavin), vitamin B6 (pyridoxine) and mineral zinc (Zn) as fortificants. Chemicals used for the analysis include distilled water, concentrated H_2SO_4, HgO, H_3BO_3 3%, NaOH 1N, H_2SO_4 1N, HCl 0,02N, K_2SO_4, HCl 4M, enzyme alpha-amylase (termamyl), sodium phosphate buffer, pepsin, ethanol 95%, ethanol 78%, acetone, methyl blue and red indicator, red litmus paper, blue litmus paper, and solution of iodine.

Equipments used included molding machine pasta (pasta bike), cabinet dryer, disc mill, sieve 80 mesh, analytical balance, thermometer, consumable materials and stove. The tools used for chemical analysis were Kjeldahl flask, beaker glass, filter paper, furnaces, Erlenmeyer flask, measuring flask, measuring cup, Rapid Visco analyzer, Soxhlet, burettes, test tubes, rod stirrer, oven, desiccator, boiling flask, volume pipette, bulb pipette, hot plate, funnel glass, pipette, and *krustang*.

4. Method

The research method used was descriptive experimental method against the two best samples ambu : corn flour 20 : 80 and ambu : mung bean flour 70: 30 respectively, which were fortified with vitamin B1 (0.45 mg), vitamin B2 (0.50 mg), vitamin B6 (1.00 mg) and each was added by the mineral zinc (0.102 mg). Analysis was carried out four times. After having been analyzed, the test was continued by conducting t difference test, unpaired to determine whether there is an average difference between the two samples that not interconnected. Experiments were carried out with the two formulations, corn *Pasayu fettuccine* and mung bean *Pasayu fettuccine*. Fortification with 3 kind fortificant was given for each *fettuccine* formulations of *Pasayu*.

- Mung bean *Pasayu* (the best formulation)
  Fortification with 0.45 mg vit.B1 + 0.102 mg Zinc
  Fortification with 0.50 mg vit. B2 + 0.102 mg Zinc
  Fortification with 1.00 mg vit.B6 + 0.102 mg Zinc
- Corn *Pasayu* (the best formulation)
  Fortification with 0.05 mg vit. B1 + 0.102 mg Zinc
  Fortification with 0.50 mg vit. B2 + 0.102 mg Zinc
  Fortification with 1.00 mg vit. B6 + 0.102 mg Zinc

Analysis of t difference test, unpaired was then carried out by comparing the effect of the formulation on the variety of additional types and the quantities of fortificant.

5. Results and Discussion

Current paper is a continuation of the study that has previously been presented in VB Food Net Conference, 2013 held in Hanoi, Vietnam [3]. The objective of previous study was to determine the best formulation by using composite flour of *ambu* (cassava waste), corn and mung bean as raw materials. The best formulation obtained was, *ambu* : corn flour = 20 : 80 and *ambu* : mung bean = 70 : 30. Characteristics of each formulation is shown in Table 1.

Table 1. Chemical and Physical Characteristics of Composite Flour per 100 gram Material

PARAMETER	FORMULATION	
	***AMBU* : CORN FLOUR 20 : 80**	***AMBU* : MUNG BEAN FLOUR 70 : 30**
Protein (%)	9.2	12.3
Water (%)	9.5	8.97
Starch(%)	62.39	33.2
Amylose (%)	32.62	23.5
Fat (%)	6.84	5.03
Carbohydrate (%)	72.8	69.32
Calorie (Cal)	389.56	371.47

 ISBN : 978-1-4673-7404-0

Table 1. Chemical and Physical Characteristics of Composite Flour (Continued)

PARAMETER	FORMULATION	
	AMBU : CORN FLOUR 20 : 80	*AMBU* : MUNG BEAN FLOUR 70 : 30
Ash (%)	1.60	4.45
Raw Fiber (%)	3.57	4.45
Rehydration Power (%)	73.38	149.23
Texture (gF)	208.74	1543.52

Analyses results of chemical, physical and microbiological for the products of corn *Pasayu fettucine* and mung bean *Pasayu fettuccine*, fortified with vitamins B1, B2, B6 and mineral Zn is shown in Table 2.

Table 2. Data Summary of the Chemical, Physical and Microbiological Characteristics of Fortified, Corn *Pasayu Fettuccine* and Mung Bean *Pasayu Fettuccine*

Chemical and Physical Composition of Fortified *Pasayu Fettucine* (*Ambu* : Corn and *Ambu* : Mung Bean)							
Chemical, Physical and Microbiological Component	*Ambu* : Corn (20:80)			*Ambu* : Mung Bean (70:30)			USDA
	+ Vit B1+ Zn	+ Vit B2+ Zn	+ Vit B6+ Zn	+ Vit B1 + Zn	+ Vit B2 + Zn	+ Vit B6 + Zn	
Chemical							
Protein (%)	11.21 (a)	11.22 (a)	11.12 (a)	12.78 (a)	12.34 (b)	12.02 (b)	13.04
Carbohydrate (%)	74.00 (c)	78.31 (a)	76.39 (b)	67.82 (b)	67.86 (b)	72.63 (a)	80
Starch (%)	56.64			48.68			-
Water (%)	9.72 (b)	9.50 (ab)	9.19 (a)	9.51 (a)	9.22 (a)	9.19 (a)	-
Ash (%)	2.15 (a)	1.89 (b)	1.99 (ab)	4.28 (a)	3.93 (b)	3.45 (c)	1.9
Raw Fiber (%)	3.58 (a)	2.41 (b)	1.81 (b)	5.36 (a)	5.63 (a)	4.36 (b)	3.6
Fat (%)	6.30 (b)	5.52 (a)	5.76 (a)	6.94 (a)	6.61 (b)	5.03 (a)	5
Energy (cal)	427.5			405.3			361.33
Physical							
Hardness (gF)	272.27 (a)	241.44 (a)	223.48 (a)	1362.2 (a)	1036.1 (b)	1138.57 (a)	831.69*
Rubberiness (gF)	3986.2 (a)	3899.5 (a)	3549.7 (a)	5432.4 (b)	4677.0 (c)	5698.97 (a)	6057.10*
Rehydration Power (%)	148.47 (a)	130.30 (b)	136.90 (b)	115.45 (b)	121.18 (a)	110.75 (b)	-
Vitamins and Mineral							
Vitamin B1 (mg)	0.132	0.018	0.515	0.045	0.015	0.046	0.06
Vitamin B2 (mg)	0.008	0.006	0.502	0.0432	0.076	0.055	0.07
Vitamin B6 (mg)	0.024	0.116	0.568	0.095	0.013	0.156	0.05
Mineral Zn(mg)	0.307			0.325			0.0 - +0.1

note: Summary of the data before it is statistically processed

(b) Values followed by different small letters have significantly different values based on t-test

(*) Analysis results conducted in 2013

Fortification of corn *Pasayu fettucine* and mung bean *Pasayu fettuccine* with 0.45 mg of Vitamin B1, 0.5 mg Vitamin B2, 1.0 mg vitamin B6 and 0.102 mg Zn on 3 formulations of *ambu* : corn flour and 3 formulations of *ambu* : mung bean flour, generally indicates a decrease in the amount of vitamins B1, B2 and B6.

The addition of nutrients to foodstuffs or food fortification in this study is a response from the desire to create new products as an alternative staple food that

ISBN : 978-1-4673-7404-0

filled up with the added value of vitamin B1 (thiamine), B2 (riboflavin), vitamin B6 (pyridoxine) and zinc mineral. The stability of vitamin relatively varies in the different kind of processing conditions, vitamin B6 group as pyridoxine is stable to warming, strong alkali or acid, but is sensitive to light, particularly ultraviolet rays, when in the alkaline solution. Riboflavin is very sensitive to light and the destruction speed will increase with an increasing pH and temperature. This vitamin however, is stable to heat in dry form or in acid solution.Thiamine seemed not to be destructed when boiled in acid conditions for a few hours, but there will be loss of up to 100% when boiled in conditions of pH 9 in 20 minutes. This compound is not stable in the air, especially at higher pH value and will be damaged during the process of autoclaving, sulfitation and in alkali. Thiamin is not easily damaged during the drying and milling.

Protein Content of *Pasayu Fettuccine*, Fortified with Vitamins B1, B2, B6 and Mineral Zn

Analysis of t difference test on the value of protein content in corn *Pasayu fettuccine* and mung bean *Pasayu fettuccine*, fortified with vitamins B1, B2, and B6 and mineral Zn, is displayed in Table 2.

The data shows that the fortification of vitamins B1, B2, and B6 with Zn did not make a significant different influence on the protein content of corn *Pasayu fettuccine*. This is not the case with mung bean *Pasayu fettuccine*, where each additional vitamin B1, B2, and B6 make a significant different effect on the protein content, although the difference is very small (0.374%). mung bean *Pasayu fettuccine* with fortification of vitamin B1 and Zn have the highest protein content of 12.77%. The protein content is influenced by its functional properties when exposed to heat [4]. Protein denaturation occurs when the dough reaches a temperature of 60ºC - 75ºC [5], in which the termination of peptide bond occurred [6]. The peptide bond rupture causing the severance of nitrogen bond, amino groups of amino acids that binds to the carbonyl group (CO) of other acids [7]. The process of steaming and drying during the processing *Pasayu fettuccine*, caused denaturation of proteins that affect the protein content.

Protein content of *spaghetti* pasta according to Indonesian National Standard [8] minimum is 9% and 13.04% for pasta *fettuccine* [9] Protein content of corn *Pasayu fettuccine* ranged from 11.18 to 11.22%, while mung bean *Pasayu fettuccine* ranged from 12.02 to 12.77%, higher than the protein content of spaghetti according to National Standard [8], but was still lower than USDA 100425 [9]. It can be ascertained that *fettuccine Pasayu* fortification of corn and mung bean produced contain protein that was good to be recommended as an alternative staple food of waste-cassava based.

Water Content of *Pasayu Fettuccine*, Fortified with Vitamins B1, B2, B6 and Mineral Zn

Based on the t difference test on the value of the water content of each treatment corn *Pasayu fettuccine* and mung bean *Pasayu fettuccine*, fortified with vitamins B1, B2, B6 and mineral Zn, obtained the following results (see Table 2):

It shows that the fortification of vitamins B1, B2, B6 and mineral Zn did not give a significant different influence on the water content of corn *Pasayu fettuccine* and mung bean *Pasayu fettuccine*. This is due to, the time and temperature used for steaming and drying in each *Pasayu fettuccine* either corn or mung bean, were the same. The water content of fortified corn *Pasayu fettuccine* ranged from 9.19% to 9.72% and the water content of fortified mung bean *Pasayu fettuccine* ranged from 9.19% to 9.51%, both of which are already meet the water content of pasta (*spaghetti*) according to ISO 01-4454-1998 at maximum of 12.5%. Thus, the quality of corn *Pasayu fettuccine*, fortified with vitamins B1, B2, B6 and mineral Zn and mung bean *Pasayu fettuccine* in terms of water content has been fulfilled. As it has been well known that the water content in food is very important, that furthermore, the water can affect the appearance of the texture and the taste of food [10], so that it can be expected the quality of both *fettucine* pasta product are good and having a long shelf life.

Carbohydrate Content of *Pasayu Fettuccine*, Fortified with Vitamins B1, B2, B6 and Mineral Zn

Table 2 shows that the fortification of vitamins B1, B2, B6 and mineral Zn gave a significant different effect on the carbohydrate content of corn *Pasayu fettuccine*. Fortified, corn *Pasayu fettuccine* has carbohydrates content, ranged of 74% - 78.31%. Corn *Pasayu fettuccine*, fortified with vitamin B1 has the lowest carbohydrate content of 74.0%. At mung bean *Pasayu fettuccine* that fortified with vitamin B6 gave significant different influence on carbohydrate content compare with mung bean Pasayu fortified with vitamin B2 and B6, but the fortification of vitamins B1 and B2 have the same carbohydrate content, based on the results of t-difference test. Fortified *Pasayu fettuccine* with vitamin B6 and mineral zinc has a significantly high carbohydrate content of 72.63%. Carbohydrate content of pasta (*spaghetti*) according to USDA amounted to 74.4% (in 100 g), while fortified mung bean *Pasayu fettuccine* contain carbohydrates that ranged from 67.82 to 72.63%, nearly meets the appropriate content of carbohydrate according to the USDA. However, in the fortified corn *Pasayu fettuccine*, carbohydrates content that ranged from 74.00% - 78.31% have not been able to match the levels of carbohydrates according to the USDA (80%).

Effect of roasting on carbohydrates commonly associated with the occurrence of hydrolysis. For example, the heating will cause gelatinization of starch which will increase its digestibility values. On the other hand, the role of simple and complex carbohydrates in

ISBN : 978-1-4673-7404-0

the Maillard reaction can reduce the availability of carbohydrates in the products of roasting. The difference between corn and mung bean *Pasayu fettuccine* in the carbohydrate content, are caused by differences in the raw materials used. Carbohydrate content of mung bean is 62.93% (Purwani, et al), while maize 77.86%, and ambu 86.5%, therefore, the levels of carbohydrates in corn *Pasayu fettuccine* is higher than mung bean *Pasayu fettuccine*.

Raw Fiber Content of *Pasayu Fettuccine*, Fortified with Vitamins B1, B2, B6 and Mineral Zn

Based on the result of t difference test, on the value of raw fiber content for each treatment of corn Pasayu fettuccine and mung bean Pasayu fettuccine that fortified with vitamins B1, B2, B6 and mineral Zn, obtained the following results (see Table 2).

Measurements were made on the basis of raw fiber that usualy used in the proximate analysis of foodstuffs. Raw fiber content does not show the total fiber content in the food, so that the fiber content of hydroxide has a greater ability to hydrolyze the components of food compared to the digestive enzymes. But according to Scala (1975) about a fifth to a tenth of crude fiber serves as dietary fiber [10].

Based on the results of t difference test in Table 2, fortification of vitamin B1 provided a significant different influence on the fiber content of corn Pasayu fettucccine compared with corn Pasayu that fortified with vitamins B2 and B6. However, fortification of vitamins B2 and B6 on corn *Pasayu fettuccine* have the same fiber content, based on the results of t difference test. Corn *Pasayu fettuccine* fortified with vitamin B1 and Zn has the significantly highest raw fiber content 3.58%.

Mung bean *Pasayu fettuccine* that fortified with vitamin B6 gave a significant different effect on fiber content compared with mung bean *Pasayu* that fortified with vitamins B1 and B2 that having the same fiber content based on the results of t different test. Raw fiber content of mung bean *Pasayu* fortified with vitamin B6 and mineral Zn was significantly lower at 4.36%, but it meets the commercial fiber content (*spaghetti*) according to the USDA by 3.6%. Therefore mung bean *Pasayu fettucine* that contains raw fiber content, ranging from 4, 36% - 5.62%, meets the criteria of USDA standard. Unlike the corn *Pasayu fettuccine*, only *Pasayu* that fortified with vitamin B1, already meets the fiber content according to the USDA of 3.58% .

Overall, based on the observations on fiber content of *Pasayu fettucine* before fortification on both selected corn and mung bean formulation, did not give significant changes with after being fortified. This proves that the processing only give small influence on the fiber content in the foodstuffs tested [4].

Fat Content of *Pasayu Fettuccine*, Fortified with Vitamins B1, B2, B6 and Mineral Zn

Based on t difference test on the value of fat content for each treatment corn *Pasayu fettuccine* and mung beans *Pasayu*, fortified with vitamins B1, B2, and B6 and mineral Zn, it obtained the following results as shown in Table 2, Fortification on corn *Pasayu fettuccine* with vitamin B1 gave a significant different effect on the fat content of *Pasayu fettuccine,* fortified with vitamins B2 and B6, but the fortification of vitamins B2 and B6 have the same fat content (not significantly different) based on the results of t difference test. Corn *Pasayu fettuccine* fortified with vitamin B1 and mineral Zn has the most significant fat content as high as 6.30%. It differs with mung bean *Pasayu fettuccine*, where each fortification of vitamins B1, B2, and B6 provided a significant different influence on the fat content. Mung bean *Pasayu fettuccine* with fortification of vitamin B1 and Zn has the lowest fat content of 5.03%, and the highest fat content is 6.94% on mung bean *Pasayu fettuccine*, fortified with B1 and Zn. Fat content in corn *Pasayu fettuccine* or mung bean *Pasayu fettucine* is higher than the fat content in pasta (*spaghetti*) of the USDA that is equal to 1.5%. High levels of fat content in *Pasayu fettuccine* either corn or mung beans were influenced by the raw materials used.

Corn starch has a fat content of 3.9%, while mung bean starch is 1.3%, and egg yolk that contain fat is 31.9% (Directorate of Nutrition, Department of Health, 1981). It also can be caused by the high protein content on corn and mung bean *Pasayu*. Protein has the functional properties as emulsifiers which can lead to the binding of fat [6], therefore the larger the protein content, the higher the fat content contained on *fettuccine*. Heating will accelerate the movement of fat molecules, so that fat molecules inter molecules distance become wider and will simplify the process of removing fat. The process was influenced by temperature of heating and its duration. The results showed that the temperatures used in roasting Pasayu fettuccine still can not damage the fat so that the fat content is still relatively the same with *Pasayu* before fortified.

Ash Content of *Pasayu Fettuccine*, Fortified with Vitamins B1, B2, B6 and Mineral Zn

Ash content in *Pasayu Fettuccine* of corn and mung bean indicated the total mineral content derived from composite flour and the addition of materials used. Data in Table 2 shows that the corn *Pasayu fettuccine*, fortified with vitamins B1, B2, and B6, did not give a significant different effect on the ash content based on the results of t difference test. Unlike mung bean *Pasayu fettuccine,* each fortification of vitamins B1, B2, and B6 has significantly different on ash content. Thus, it can be said that the fortification on mung bean *Pasayu fettuccine* gave an effect on ash content.

Ash content that meets the quality requirements pasta (spaghetti) according to SNI 01-4454-1998, is 0.85%, and is 0.9% for USDA. Fortified, corn *Pasayu fettuccine* that has ash content ranging from 1.89% - 2.15% and mung bean *Pasayu fettuccine* that has ash content ranging from 3.45% - 4.28%, have already met or even exceed the standards of good ash content according to SNI 01- 4454-1998 and USDA. High content of ash in *Pasayu fettuccine* either corn or mng

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bean can be influenced by the raw materials used. Mung bean flour has ash content of 3.11%, corn flour of 0.27% and ambu as raw material, has an ash content of 1.9% (Agency of Counseling and Development of Agricultural Human Resources, 2008). Other materials such as eggs, olive oil and salt were responsible for the higher ash content.

Ash is an inorganic residue remaining after full combustion or oxidation of organic compounds in foodstuffs [11]. Ash content can also be regarded as a total mineral content of food [12]. The three types of processing that do not cause significant different in ash content, probably is due to the heat treatment did not affect the total mineral existing in the sample. In general, mineral salts do not affected significantly by the chemical and physical treatment during processing [4]. The presence of oxygen can lead to the possibility of some minerals were oxidized to higher valency minerals, but did not affect its nutritional value. Although some food components were damaged in the process of roasting food, the process did not affect the mineral content of foodstuffs. Ash content that exceeds the requirements will not be dangerous because many minerals will beneficial to the body, but it will affect the physical characteristics of *fettuccine*, because the mineral is one of the parameters that correlated to the color [13]. The greater the ash content, the darker the appearance of the resulting color.

Hardness Level of *Pasayu Fettuccine*, Fortified with Vitamins B1, B2, B6 and Mineral Zn

Table 2 also shows that the fortification of vitamins B1, B2, B6 and mineral zinc did not provide significant different influence on the level of hardness of corn *Pasayu fettuccine*. It indicates that the fortification of vitamin B1, B2, and B6 did not affect the level of hardness of corn *Pasayu fettuccine*. This is not the case with mung bean *Pasayu fettuccine*, where fortification of vitamin B2 provided significant different to the level of hardness of mung bean *Pasayu fettuccine*, fortified with vitamin B1 and B6, that has the same level of hardness based on the results of t difference test. Mung bean *Pasayu Fettuccine* with fortification of vitamin B2 and Zn has the lowest level of hardness of 1036.131 gF. The value of hardness illustrates that the higher the value, the harder the food product. Hardness level of commercial *fettuccine* is equal to 831.69 gF. Corn *Pasayu fettuccine* has the hardness value ranged from 223.48 - 272.28 gF, lower than the level of hardness of a commercial product. It can be said that the texture is more fragile than commercial products. Mung bean *Pasayu fettuccine* has a hardness that ranged from 1036.131 to 1362.21 gF, higher than the commercial product, it means that the texture of mung bean *Pasayu fettuccine* is harder than the commercial products.

The hardness is caused by proteins that will undergo denaturation during drying, when the protein is denatured, reactive groups will open and then re-bonding will occur between adjacent reactive groups, so that the amount of the bonding can be more powerful [14]. It can be seen from the protein content of mung beans *Pasayu fettuccine* that ranged from 12.02% - 12.78%, higher than protein content of corn *Pasayu fettuccine* of 11.11% - 11.22%. It is also influenced by the amylose contained in the food product. Product that made of high amylose starch will be tighter distance, harder, and less expands radially when extruded [15]. The presence of amylose fractions in the starch granules will limit the development of granules and will maintain the integrity of the granules. The higher the amylose starch content, the stronger the intermolecular bonding, so that when the expansion did not occur optimally, it will produce a hard final product. Amylose content of ambu flour is 18.1% [16], amylose flour of mung bean is 28.8% [17] and amylose flour of corn starch. *Fettuccine* 25%. *Pasayu fettuccine* that contains higher amylose will have a tougher texture.

Rubberiness Level of *Pasayu Fettuccine*, Fortified with Vitamins B1, B2, B6 and Mineral Zn

Fortification of vitamins B1, B2, B6 and mineral Zn did not leave a significant different on the level of rubberiness of corn *Pasayu fettuccine* after boiling (Table 2). It shows that the addition of vitamins B1, B2, and B6 did not affect the level of rubberiness of corn *Pasayu fettuccine*. In mung bean *Pasayu fettuccine*, however, each fortification of vitamins B1, B2, and B6 gave significant different on the level of rubberiness. Mung bean *Pasayu fettuccine*, fortified with vitamin B6 and mineral Zn has the highest level of rubberiness at 5698.97%. Rubberiness level illustrates that the higher the value, the more springy the food product. The rubberiness level of commercial *fettuccine* is equal to 6057.10 gF. *Fettuccine* rubberiness values of corn *Pasayu fettuccine* ranged from 3549.73 - 3986.23 gF, still did not meet the rubberiness level of commercial products, as well as with mung bean *Pasayu fettuccine*, were a little closer to the value of the rubberiness level of commercial products that ranges from 4677.03 gF - 5698. 971 gF. This rubberiness was caused by the content of amylopectin in the pasta and the process of gelatinization, when the starch granules swell and heating was continued, amylose diffused out of the starch granules filling cavities between amylopectin and forming a uniform matrix. The chain structure of amylopectin that branched, stimulates the expansion and development power so that rubberines in *fettuccine* will be formed. Amylopectin content of corn is 75%, amylopectin of mung bean is 71.2% [17], and amylopectin content of *ambu* is 81.8% [16]. Based on the formulations of *Pasayu fettuccine* of *ambu* : corn (20: 80) and ambu: mung bean (70: 30), then fortified mung bean *Pasayu fettuccine* has a higher amylopectin. Therefore, the rubberiness level in the fortified mung bean *Pasayu fettuccine* was higher than the rubberiness level of corn *Pasayu fettuccine*. In addition, the level of rubberiness was also influenced by the proteins contained in mung bean, they are albumin, globulin, prolamin, and glutelin. Prolamin and glutelin contained in green beans, is a type of protein that are similar to wheat protein [13]. Prolamin similar to gliadin that brings extensive nature and glutelin is similar to glutenin that brings the chewy nature.

At the time of the mixing process, the protein will interact with water. Some proteins that soluble in water, albumin and prolamin, initially will form sticky mass of protein, then will form solid fiber structure with other proteins that were insoluble in water, globulin and glutelin. Mixing processes cause the structure of the protein fibers are wrapped in starch resulting in a flexible texture, smooth, and supple after rehydrated. This theory is in accordance with the results of analysis where mung bean *Pasayu fettuccine* fortified with vitamin B6 has the highest rubberiness value of 5698.97 gF.

Rehydration Power of *Pasayu Fettuccine*, Fortified with Vitamin B1, B2, B6 and Mineral Zn

Rehydration power or water absorption is the ability to absorb water again after a drying process [18]. Based on the results of t difference test in Table 2, fortification of vitamin B1 gave a significant different influence on the rehydration power of corn *Pasayu fettuccine* compared with corn *Pasayu fettuccine* with fortification B2 and B6. However, fortification of vitamins B2 and B6 on corn *Pasayu fettuccine*, has the same rehydration power based on t difference test. Corn *Pasayu fettuccine*, fortified with vitamin B1 and mineral Zn has the highest rehydration of 148.47%. At mung bean *Pasayu fettuccine*, fortification of vitamin B2 has a real different rehydration power with mung bean *Pasayu fettuccine* that fortified with vitamins B1 and B6, based on the results of t difference test. Rehydration power of mung bean *Pasayu fettuccine* fortification vitamin B2 and mineral Zn is real the highest of 121.18%. Process of rehydration occurs when gelatinization process, the starch granules absorb water that previously were outside the granule and moves, now in grains of starch and can not move because it has formed the irreversible matrix [18].

The difference in the rehydration power level on corn *Pasayu fettuccine* and mung bean *Pasayu fettuccine* werre influenced by the ability to absorb water and the ability to develop starch. The absorbtion of product water is affected by the total of amylose content and amilopectin. A great ability to absorb water in starch because the starch molecules have a very large number of hydroxyl group [10]. Amylose with the straight chain would have a hydroxyl number greater than amylopectin having branched chains [19]. The greater the number of hydroxyl groups in the starch will increase the the ability of water absorption. Amylose content of *ambu* flour is 18.1% [16], mung bean flour is 28.8% [17] and amylose content of corn flour is 25%. By looking at the ratio of *ambu* : corn (20 : 80) on corn *Pasayu fettuccine* and the ratio of *ambu* : mung bean (70 : 30) on mung bean *Pasayu fettuccine*, corn *Pasayu* that has higher amylose content will have the rehydration power higher. In addition, it is also influenced by the size of the starch granules. Mung bean has the size starch granules of 7 - 26 μm [20], while cassava starch granules have the size of about 20 μm [21], and corn starch granules have the size of about 5 - 25 μm [10]. Capability of starch development that affected by the size of the starch granules was one of the factors that affect rehydration power. The greater the starch granule development, the greater the ability of the starch granules to absorb water, it will be even greater when dried, make the starch porous and having a high rehydration power. Protein also has a role in the power rehydration of ingredients (pasta). The higher the protein (formulation *ambu*: mung beans) indicates the lower the power rehidration, this is interpreted that protein denaturation occurred, terminating the hydrogen bonds, so that the ability to bind water decreases.

Conclusions

Based on the description above, it can be concluded as follows,

1. Corn *Pasayu Fettuccine*, fortified with Vitamin B2 + Zn was the best product. Whereas mung bean *Pasayu Fettuccine* that fortified with Vitamin B1 + Zn was the best product.
2. Both new product in the form of pasta *fettuccine* have some advantages, because the levels of protein and raw fiber were higher than the commercial pasta, furthermore, these pasta product contain adequate vitamins B1 and B2 and mineral Zn that are essential for human health.
3. This pasta *fettuccine* was the only pasta made of waste-product from cassava that can be aligned with wheat-based pasta product, which is actually imported products.

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ISBN : 978-1-4673-7404-0

Optical and Particle Size properties of *Sargassum sp* chlorophyll as dye-sensitized solar cell (DSSC)

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Abstract

A study on optical and particle size properties of chlorophyll solution of *Sargassum sp* as an active agent of dye-sensitized solar cell (DSSC) device was conducted. Samples were extracted from *Sargassum sp* by acetone and distillated water method. The extract chlorophyll was tested by light absorption and the characteristics of extract particles were investigated by particle size analyzer. Analysis results indicated that light absorption by chlorophyll solution had light absorption spectrum that generally observed at the peaks of λ1 = 406 nm and λ2 = 665 nm. This confirms the effectiveness of chlorophyll solution of *Sargassum sp* extracted by acetone solution. The measurement of particle sizes indicated a value of 159.25 nm. The distribution of particle sizes according to intensity, volume, and number were found to have average value of 215.42 nm, 201.08 nm, and 36.21 nm, respectively. The obtained particle size of chlorophyll extract was near to the maximum nano particle size (1-100 nm). The combination of both optical properties and particle size indicated that the chlorophyll of *Sargassum sp* had the potential for DSSC and organic solar cell applications. In the present study, we utilized chlorophylls from samples of the brown alga *Sargassum sp* as sensitizer in DSSC. The dye, extracted by frozen seaweeds and used without any chemical purification, showed a very good fill factor (0.6). Even the photelectrochemical parameters if compared with the existent literature are very interesting.

Keywords: chlorophyll, *Sargassum sp*, optical, particle size, DSSC

INTRODUCTION

Organic solar cell is an alternative device to convert solar energy into environment-friendly electrical energy. Commercial solar cells commonly use inorganic materials such as silicone (Si) and germanium (Ge). The silicone-based and germanium-based solar cell types have energy efficiency at about 14%-17% with cell active time for 25 years, but the cost of the raw materials and expensive production cost have resulted in relatively high selling prices in the market for solar cells [1].

Based on these, researchers begin to find new breakthroughs by using organic materials. The use of low-cost materials and easy production technique are believed will produce low-cost solar panels. DSSC is a dye-sensitized solar cell developed as an alternative concept of conventional solar cell devices. Recently, many studies have been conducted to evaluate the DSSC potentials as a solar cell [2]. Dye extracts or plant pigmentsare used as photosensitizers, one of them is chlorophyll [2] or anthocyanin [3].

Chlorophyll is a main pigment effective as photosensitizer in photosynthesis process of green plants, having a maximum absorption at 670 nm, that make it as an interesting component as a visible part of photosensitizer [2]. There are several chlorophyll types encountered as photosynthetic products, but the commonly found type in higher plants are chlorophyll a and b [4]. Chlorophyll has a

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chemical structure as shown in Figure 1. Both of the chlorophyll types, chlorophyll a and chlorophyll b, have light absorption at two wavelength areas: at 400 nm – 490 nm and 620 nm – 680 nm ranges.

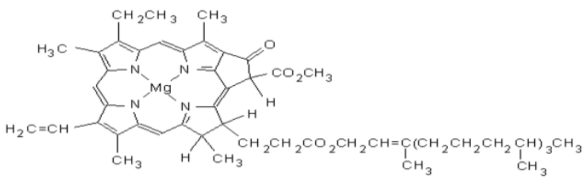
Figure 1. Chlorophyll has a chemical structure

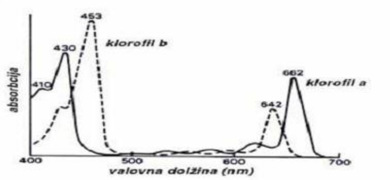

Figure 2. Absorption spectrum of chlorophyll a dan chlorophyll b [6].

In chlorophyll absorption, the blue and red lights from sunlight are the most effective wavelengths to produce electron excitation. These absorption spectrum also indicated that only certain wavelengths of light can be active in photosynthesis process. The active part of light radiation in photosynthesis process is called Photosynthetic Active Radiation (PAR), namely at wavelength range of 400 nm to 700 nm [4].

This paper analyzed the relationship between chlorophyll concentration and absorption spectrum and the particle sizes characteristics for optimization in obtaining chlorophyll solution from *Sargassum sp* appropriate for DSSC device optimization.

EXPERIMENT

The used chlorophyll samples in this study were derived from brown seaweed *Sargassum sp*. The chlorophyll collection from this natural source was conducted by extracting *Sargassum sp* using acetone and distilled water, as pigment solvent. Next, the solvents were evaporated to obtain purer chlorophyll extract, and then dissolved again in acetone according to Hakeim *et. al.* method [10]. Test samples were then characterized for optical properties and particle sizes. The isolated chlorophyll from three samples were measured for their light absorption using spectrometer UV-Vis at wavelength of 300-800 nm.

Analysis procedure for optical properties of Sargassum sp chlorophyll as dye-sensitized solar cell (DSSC)

Current–voltage curves were recorded by a digital Keithley 236 multimeter connected to a PC and controlled by a homemade program. Incident irradiance was measured with a Si-based pyranometer. Incident photon-to-current conversion efficiency (IPCE) and relative photo action spectra of sealed DSSC were measured by a IPCE station. The photoanodes thickness was measured by using a DektakXT profilometer (Bruker) equipped with a diamond-tipped stylus (radius of 2 lm) and selecting a vertical scan range of 65 lm with 8.0 nm resolution, a programmed scan length of 6000 lm, and a stylus force of 1 mg. Each measure was verified by acquiring different runs with different start positions, by rotating or translating the sample.

And the particle sizes of solution pigment were analyzed by VASCO *Particle Size Analyzer*.

RESULTS AND DISCUSSION

Characteristics of Pigment Extract
Particle Size of Extract

The chlorophyll pigment solution was prepared by immersing the dried alga powder in 90% acetone at ratio of 1:10 for 4 hours. The color of the produced pigment solution was

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deep green. The extract particle average size was investigated by using VASCO Particle Size Analyzer and found to be 159.25 nm with polydispersity index of 0.4350. Particle sizes were explicitly depicted in Figure 1:

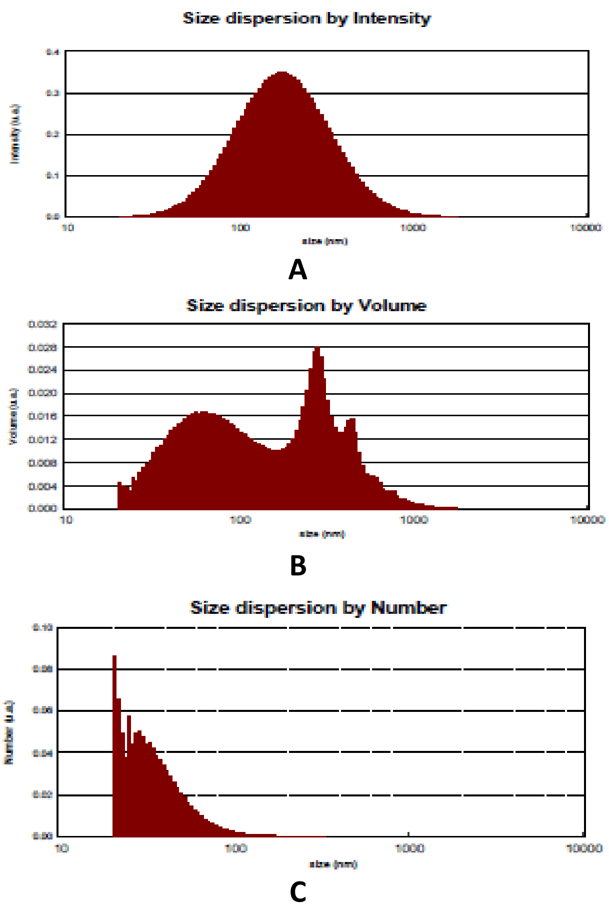

Figure 3: Distribution of particle size of the pigment in 90% acetone by intensity (A), volume (B), and number (C).

Distribution of particle sizes by intensity, volume, and number were known to have average value of 215.42 nm, 201.08 nm, and 36.21 nm, respectively. The obtained particle size of chlorophyll extract was near to the maximum nanoparticle size (1-100 nm), but the normal distribution of solution particle size was very wide that it was not evenly distributed. The wide particle size distribution is known to have poor stability and easily aggregated due to Van Der Waals bond[9].

Absorption Wavelength of Extract

Chlorophyll has two main absorption colors at visible light, namely red (Qy band) and blue (Soret band)[4]. Absorption wave of extracts is depicted in Figure 1.

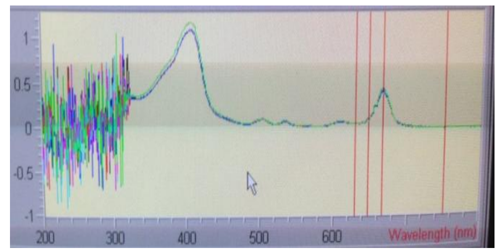

Figure 4: Maximum absorption wavelength of chlorophyll pigment solution in 90% acetone.

Maximum absorption wave of read and blue for chlorophyll *a* were was observed at 662 and 430 nm, respectively, with Soret and Qy band ratio (A_{soret}/A_{qy}) was 1.23. Whereas forphaeophytin*a*it was observed at 409.5 and 665 nm with Soret and Qy band ratio (A_{soret}/A_{qy}) of 2.26 in acetone solution [12]. Characteristics of phaeophytin*a*pigment as a derivative of chlorophyll *a* pigment, can be considered similar to those of investigated pigment solution wave absorption.

The absorption wavelength of extract was measured by spectrophotometer UV-Vis with wavelength of 200-800 nm. The maximum wavelength value for pigment extract in 90% acetone ranged from (Soret and Qy) 405-406 nm and 664-665 nm. The Soret and Q absorbance ratio (A_{soret}/A_{QY}) of the pigment solution was 2.6907.

Phaeophytin *a* is a derivative of chlorophyll *a* without magnesium atom in the center of the chlorophyll porphyrin ring. Phaeophytin has a similar appearance to chlorophyll in relation to its brownish-green color [11]. The release of magnesium atom in chlorophyll can occur in extraction process when the liquid in plant

 ISBN : 978-1-4673-7404-0

clorophlast has low pH, resulting in the formation of phaeophytin. In addition, in normal pH condition, the formation of phaeophytin can be accelerated by the presence of sunlight exposure [9]. The following is the reaction of phaeophytin formation according to Florkin and Stotz (2014):

The nitrogen atom in porphyrin ring in chlorophyll binds to magnesium atom in its center. The bond is very weak and unstable in acid condition and in sunlight exposure, so that it can be detached easily to form phaeophytin [9].

Optical properties of Sargassum sp chlorophyll as dye-sensitized solar cell (DSSC)

Concerning the IPCE measurement (see Fig. 6) we found very low values (2% in the Soret peak region and 1% in the Q band red region). The presence of other species which absorbs in the red region around 700 nm.

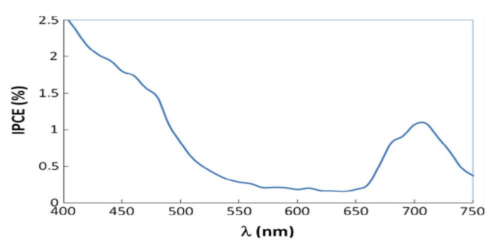

Figure 5. IPCE curve photoaction spectra on DSSC of

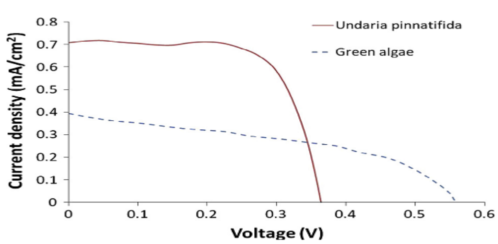

Figure 6. Comparison of current_voltage curve for U. pinnatifida and green algae curve from Taya et al. [12].

The experimental data obtained by our photoelectrochemical studies are reported in Fig. 7 where it is showed the acquired I_V curve characterized by the following parameters: Voc of 0.36 V, Jsc of 0.8 mA/cm2 and efficiency of 0.178%. More importantly, for the raw *Sargassum sp* based DSSC, we found a very good fill factor of 0.6. It's worth to note that this value is higher than that reported by Wang et al.[11], obtained by using purified *Sargassum sp* as sensitizer dye. Furthermore, taking into account the increasing photo electrochemical obtained by these authors with increasing dye concentration [11], improved performances (in terms of current density and efficiency) are expected also for a DSSC based on a higher raw *Sargassum sp* dye content.

CONCLUSION

Chlorophyll was found to be present in *Sargassum sp* extract, which was detected using UV-Vis spectrophotometer at λmax = 430 nm for chlorophyll a and 662 nm for chlorophyll b. The obtained particle size of chlorophyll extract was near to the maximum nano particle size (1-100 nm), but the normal distribution of solution particle size was very wide that it was not evenly distributed.

The optical properties of *Sargassum sp* exhibited the efficiency of around 0.178% whereas for the cell based green algae the best values reported by other researcher are 0.397 mA/cm2, 0.559 V, 0.44 and 0.1% for Jsc, Voc, fill factor of 0.6 and solar efficiency respectively, which are lower than our results.

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ISBN : 978-1-4673-7404-0

Alkaline Pre-Treatment of *Gelidium latifolium* and *Caulerpa racemosa* for Bioethanol Production

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Abstract **- Bioethanol production from *Gellidium latifolium* and *Caulerpa racemosa* begin with a specific pre-treatment to breakdown sulfated groups and lignin, to facilitate the hydrolysis process and increase the yield of reducing sugar. This research aimed to raise the yield of reducing sugar from the hydrolysis of both types of seaweed through alkaline pre-treatment. *G. latifolium* after alkaline pre-treatment contained 19.65% w/w carbohydrates and 27.29% crude fiber. *G. latifolium* which was submerged in 0.1 N NaOH solutions produced the highest reducing sugar of 5.26% w/v, compare to the ones which submerged in water (3.05%w/v), 0.05 N NaOH (4.05% w/v), and control without pre-treatment (2.20%w/v). Fermentation process of the hydrolysates from the best alkaline treatment generated 0.43% ethanol content. *C. racemosa* from the best alkaline treatment contained 36.69% carbohydrate and 40.87% crude fiber. The highest reducing sugar which obtained from the one submerged in water was 7.67% w/v and had 0.70% ethanol content after fermentation.**

***Keyword*: *G. latifolium*, *C. racemossa*, bioetanol, alkaline pre-treatment, NaOH**

I. Introduction

Macroalgae is a potential source of biomass to produce bioethanol because it's high content of carbohydrate. Moreover, coastal area potential for macroalgae cultivation in Indonesia is abundance which is 1.1 million ha, while until 2003 the utilization was only 222,180 ha or about 20% [1]. Macroalgae also has a short life cycles, it only takes 45 days to be harvested without requiring fertilizer or nitrogen-based additives [2].

Polysaccharides of macroalgae have different characteristics compare to terrestrial plants. It has a crosslinked polysaccharide with sulfate, lignin and various types of salt. To facilitate the hydrolysis process of polysaccharides, a pre-treatment technique that can be used is submersion in alkaline solutions.

Seaweed submersion in a NaOH solution can remove impurities that solubles in alkaline [3]. This technique is capable to dissolve lignin, so that the material structures become more amorphous after lignin separated from cellulose and hemicellulose. *Sargassum sp.* which was submerged in 0.5% NaOH solution can increase the yield of reducing sugars up to 46% [4]. Similarly, alkaline submersion of *Gracilaria sp.* can increase galactose content from 39% to 56.4% [5]. The increase of reducing sugar means that more sugar available for fermentation by yeast for bioethanol production. Acid hydrolysis of *Euchema cottonii* resulted on high reducing sugars (11.34%, w/v) and low hydroxymethyl furfural content, while ethanol yield was 2.49% (v/v) [6]. Hereinafter, hydroxymethyl furfural abbreviated as HMF.

G. latifolium is red alga and *C. racemossa* is green algae, both have a high carbohydrate content of 67.85% and 23.63%, respectively, so that they could be the potential raw materials for bioethanol production. Sulfuric acid is more suitable for hydrolysis of *G. latifolium* than hydrochloric acid [7]. As explained previously, the polysaccharides of seaweed is different from terrestrial plant, so it requires special techniques to degrade its chemical linkage of monosaccharides into fermenting sugar. Therefore, this research aimed to evaluate the effect of alkaline pre-treatment on the characteristics of hydrolysates and the yield of reducing sugar after hydrolysis of *G. latifolium* and *C. racemosa* in order to increase bioethanol production.

II. Materials and Method

A. Raw Materials

G. latifolium and *C. racemossa* collected from Pari Island-Thousands Islands, Indonesia. AL IX for ethanol fermentation is a yeast of *S. cereviceae* (IPBCC) which slowly adapted on seaweed hydrolysates. Chemicals for treatment and analysis were HCl, NaOH, NPK, urea, Yeast-Malt-Peptone Glucose medium abbreviated as YMGP medium, PDA (Potato Dextrose Agar) media, DNS (3,5 dinitrosalisilic acid) reagent, fenolftalein, Luff Schoorl reagent, KI, H_2SO_4, 5% fenol solutions, 0.5% starch solutions and $Na_2S_2O_7$.

B. Alkaline Pre-Treatment

A hundred grams of each type of macroalgae was submerged in 5 liters of water, 0.05 N and 0.1 N NaOH solutions, respectively. Submersion was done for three days. Then, seaweeds were washed, cut ±1 cm long, and dried for two days. Seaweeds from alkaline pre-treatment were analyzed their proximate parameters include water, ash, carbohydrate, crude fiber, fat, and protein content. Fiber composition did by Van Soest method.

C. Acid Hydrolysis

Fifteen grams of each macroalgae were added by 100 ml of 1% H_2SO_4 solution. Acid hydrolysis was carried out on autoclave at a temperature of 121ºC for 45 minutes. Neutralization was performed by 10% NaOH solution until pH 5-6. Hydrolysates were then filtered using a vacuum pump with filter paper Whatman 41 to obtain neutralized acid hydrolysates. Hydrolysates was analysed on reducing sugars with DNS reagent [8] and total sugars with Phenol-Sulfur reagent [9].

D. Culture Preparation

Two loops of *S. cereviceae* IPBCC AL IX isolate grown on PDA medium for 3 days was inoculated into 10 ml of YMGP medium, then incubated for 24 hours at 30°C. This culture was referred as working culture or starter for fermentation process.

E. Fermentation Process

Ninety mililiters of acid hydrolysates was put into 250 ml erlenmeyer flask, and then pasteurized at 70-80ºC for 15 minutes. After hydrolisate was cool, urea, NPK and culture starter were added aseptically. Fermentation process lasted for 4 days at room temperature. Distillation was done to separate bioethanol from fermentation broth. Distillate was measured its density by Density Meter Anton Paar DMA 4500M and calculated for bioethanol concentration.

III. RESULT AND DISCUSSION

A. Raw Material Characteristics

Alkaline pre-treatment was conducted to break sulfated groups bound on monosaccharides chain. Release of sulfates was expected to increase the yield of fermentable sugar. This technique also did to breakdown the lignin (delignification) and remove impurities generally found in macroalgae. In addition, alkaline treatment caused swelling on macroalgae that can increase the surface area of acid absorption.

Alkaline treatment on *G. latifolium* led to an increase of water content, due to swelling during the submersion process. Water was absorbed and trapped in the structure of polysaccharides chain, so it was difficult to evaporate. Similarly, the crude fiber content was increased in materials after alkaline treatment caused by a release of soluble components into water during submersion. In contrast to the moisture content and crude fiber, submersion techniques actually reduced salt or other minerals which were calculated as ash content. Submersion also caused a decrease in carbohydrate content of *G. latifolium* which could be caused by partially released of soluble polysaccharides into alkaline solution. Salts, other minerals, polysaccharides and impurities which dissolved during the immersion process caused the lower yield of macroalgae (Table 1).

Table 1. Compositions of *G. latifolium*

Chemical Compositions	Pre-treatment with water	Pre-treatment with 0.05 N NaOH	Pre-treatment with 0.1 N NaOH	Without Treatment [10]
Yield (%db)	85.80	82.20	83.20	100
Water (%)	8.90±0.12	9.90±0.16	11.77±0.26	9.66±0.02
Ash (%db)	8.74±0.99	9.07±0.10	11.54±1.95	11.91±1.07
Fat (%db)	0.53±0.02	0.09±0.001	0.69±0.007	0.13±0.02
Protein (%db)	9.00±0.06	8.73±0.37	6.45±0.39	9.32±0.25
Carbohydrates (%db)	21.95±0.64	19.59±0.76	19.65±0.39	23.81±1.08
Crude Fiber (%db)	26.49±1.27	28.29±1.16	27.29±1.46	16.34±0.10

Table 2. Compositions of *C. racemosa*

Chemical Compositions	Without Treatment	Pre-treatment with water	Pre-treatment with 0.05 N NaOH	Pre-treatment with 0.1 N NaOH
Yield (%)	100	79.80	79.90	78.00
Water (%)	12.35 ± 0.01	15.69 ± 0.16	12.39 ± 0.10	12.90 ± 0.08
Ash (%db)	16.83 ± 0.02	10.57 ± 0.01	12.81 ± 0.13	15.73 ± 0.48
Fat (%db)	11.71 ± 0.05	10.22 ± 0.23	8.50 ± 0.65	9.31 ± 0.34
Protein (%db)	0.75 ± 0.003	0.61 ± 0.06	0.30 ± 0.32	0.27 ± 0.07
Carbohydrates (%db)	30.45 ± 4.39	36.69 ± 0.40	36.12 ± 0.79	38.97 ± 0.00
Crude Fiber (%db)	39.88 ± 0.04	40.87 ± 0.32	44.50 ± 2.42	46.73 ± 2.82

ISBN : 978-1-4673-7404-0

For *C. racemossa*, immersion technique also led to an increase of water content and crude fiber. Ash content was significantly declines with the water immersion which causes the lower yield than control without submersion, that is 79.80% db. The best alkaline treatment for *C. racemosa* obtained from submersion with 0.1 N NaOH solutions with 38.97% carbohydrate content (Table 2). The addition of Na^+ from NaOH will increase the mineral content of the material which is counted as ash content.

B. *Fiber Composition of G. latifolium*

Analysis of fiber composition by Van Soest method show that the NDF and ADF value of materials which submerged with 0.1 N NaOH solutions was lower than other treatments (Table 3). Neutral Detergent Fiber (NDF) is the biggest part of plant cell walls consist of cellulose, lignin, silica, hemicellulose, and some proteins. While Acid Detergent Fiber (ADF) is part of the cell wall which is insoluble and composed of cellulose, lignin, and silica. Difference between the NDF and ADF are known as hemicellulose. ADF digested in H_2SO_4 at 15°C for three hours and then filtered. Solids were filtered weighed as cellulose. The residue remained after washing and drying were weighed, then made into powder. The powder showed silica content, while the reduced weight during the formation of the silica powder calculated as insoluble lignin in acid solutions [11].

Submersion with a higher concentration of alkaline will dissolve hemicellulose and causing lower NDF values. Due to the low value of hemicellulose, lignin and cellulose content rose because both components were more resistant to alkaline. Seaweed which submerged with water and 0.05 N NaOH had higher levels of hemicellulose, lignin, and cellulose compared to controls without submersion. This could be due to seaweed without alkaline treatment contains other components or impurities which could reduce the percentage of NDF and ADF values.

Cellulose is the structure of all plant cell walls [12]. The cellulose content in the cell walls of higher plants is about 35-50% db. The lowest cellulose content derived from control without alkaline treatment of 20.10%. While the highest cellulose content obtained from macroalgae which was submerged in 0.1% NaOH solution that is 37.20%.

Table 3. Crude fiber composition of *G. latifolium*

Fiber Compositions	Pre-treatment with Water	Pre-treatment with NaOH 0.05 N	Pre-treatment with NaOH 0.1 N	Control Without Treatment [12]
NDF (%db)	82.42	86.10	73.64	-
ADF (%db)	30.64	31.69	59.27	-
Cellulose (%db)	23.03	24.87	37.20	20.10
Lignin (%db)	7.29	6.43	25.29	4.41
Hemicellulose (%db)	51.78	54.41	14.37	43.96

Gelidium sp. is a marine biomass which has low lignin content, so that the pretreatment steps can be relatively easier compared to cellulosic biomass [13]. Lignin has a complex, irregular, and random stucture. Therefore it is difficult to be broken. Alkaline submersion expected to break down lignin compounds (delignification) so that the hydrolytic enzyme can reached hemicellulose and cellulose. Thus, more sugar is formed and can be used by yeast during the fermentation process. Delignification performed with NaOH because it can damage the lignin structure and separate lignin with cellulose and hemicellulose [14].

The lowest lignin content was obtained from treatment without submersion (4.41%) compared to water submersion (7.29%), 0.05N NaOH (6.43%) and 0.1N NaOH (25.29%). This can be due to the presence of other non-lignin carbohydrate and cutin which was count as lignin. Delignification need a proper alkaline concentration to be able to breakdown the lignin structure [15].

Hemicellulose stucture consist of D-glucose, D-galactose, D-mannose, D-xylose, and L-arabinose. It was similar to cellulose which could be hydrolyzed by dilute acid into mannose and galactose. But, hemicellulose dissolves easier in acid and alkaline, so that the lowest levels of hemicellulose was obtained from macroalgae submerged in 0.1 N NaOH (14.37% db).

C. *Fiber Composition of C. racemossa*

The highest content of hemicellulose obtained from treatment of water submersion (71.64%), while the lowest was from submersion with 0.1 N NaOH (10.10%) (Table 4). These results indicated alkaline treatment caused a decrease in hemicellulose content because this compound easily dissolved in alkaline solution. Hemicellulose molecules were easily absorb water, more flexibles, and had a larger contact surface between molecules compared to cellulose [16].

ISBN : 978-1-4673-7404-0

Table 4. Crude fiber composition of *C. racemosa*

Fiber Compositions	Control Without Treatment	Pre-treatment with water	Pre-treatment with NaOH 0.05 N	Pre-treatment with NaOH 0.1 N
NDF (%db)	80.80	83.58	80.78	77.05
ADF (%db)	72.49	11.94	36.68	66.95
Hemicellulose (%db)	8.31	71.64	42.10	10.10
Cellulose (%db)	47.31	3.78	19.99	43.46
Lignin (%db)	24.18	7.86	18.66	19.34

D. Acid Hydrolysis of *G. latifolium*

Acid hydrolysis aimed to break down macroalgae polysaccharides into monosaccharides that can be used by yeast in bioethanol fermentation. *Gelidium sp.* polysaccharides consists of a complex fibrin (cellulose) and agar (galactans) consisting of glucose and galactose as a monomer. Agar structure consists of two main components, which is agarose and agaropektin in varying amounts [17].

Acid hydrolysis of *Gelidium sp.* in a batch system with an autoclave will produce D-galactose, 3,6-anhydro-L-galactose (3,6-AHG), and D-glucose as the main product. Among these products, galactose and glucose classified as monosugars that can be fermented by yeast while 3,6-AHG as sugar that can not be fermented [18].

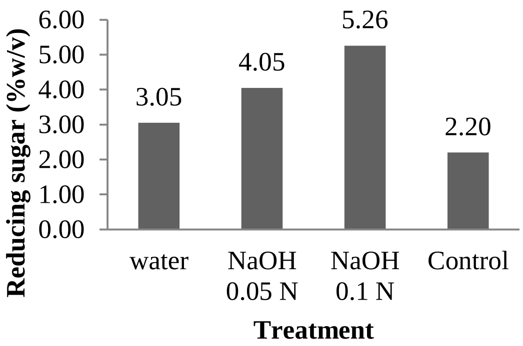

Fig 1. Reducing sugar of acid hydrolisates of rinsed *G. latifolium* after alkaline submersion

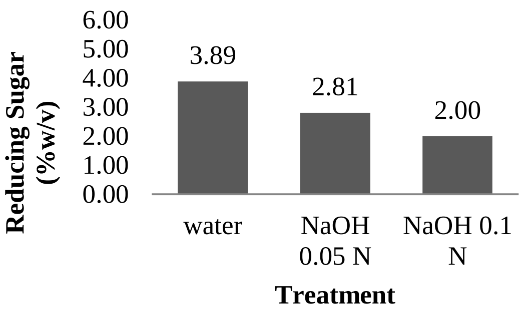

Fig 2. Reducing sugar of acid hydrolisates of *G. latifolium* without rinsing after alkaline submersion

The highest reducing sugars obtained from *G. latifolium* submerged with 0.1 N NaOH (5.26% w/v) compared to 0.05 NaOH (4.05% w/v), water (3.05% w/v) and control without submersion (2.20% w/v). *G. latifolium* which was submerged with 0.1 N NaOH solutions had the lowest hemicellulose but the highest reducing sugar. Immersion treatment with high concentration of alkaline was able to break down the sulfated groups of macroalgae polysaccharides, thus resulted in lower hemicellulose content. Lignin decomposition made polysaccharides easier to hydrolysis. Therefore the reducing sugar content was higher than other treatment. Control without submersion and water submersion having a high hemicellulose content but low on reducing sugars because the sulfated groups can become an obstacles in acid hydrolysis. Thus it can be concluded that the alkaline submersion can increase reducing sugars on acid hydrolysate of macroalgae.

Rinsing with clean water after alkaline treatment of macroalgae was very affected to the yield of reducing sugar. Reducing sugar content of acid hydrolisates from *G. latifolium* which was rinsed after alkaline pretreatment was higher than without rinsing (Fig 1 and 2). Rinsing the macroalgae with water can dissolve the remains of alkaline material, so that when the hydrolysis took place, acid solutions were not neutralized by alkali. Thus, the acid hydrolysis run effectively and raised the yield of reducing sugars.

Total sugar was the overall sugar content in the form of monosaccharides or oligosaccharides and this number didn't linearly related with the ethanol content from hydrolysates after fermentation. This was because the sugar content which was measured not only reducing sugars but also non-reducing sugar.

Seaweed hydrolysates treated with alkaline submersion had higher total sugar content than controls (Fig 3), but lower than water submersion. This maybe because there were polysaccharides components that decomposed and dissolved in alkaline, such as hemicellulose. Total sugar was a mixture of reducing and non reducing sugars produced from seaweed hydrolysis.

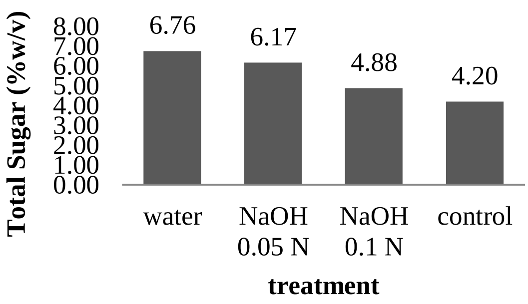

Fig 3. Total sugar of *G. latifolium* acid hydrolysates

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E. Acid Hydrolysis of C. racemosa

As *G. latifolium*, acid hydrolysis of *C. racemosa* showed the lowest reducing sugars present in the *C. racemosa* without submersion while the highest reducing sugar obtained from submersion in water (Fig 4). Submersion treatments using NaOH and water capable to break down the bond between hemicellulose, cellulose and lignin and increase the surface area of hydrolysis by acid solutions.

Although the carbohydrate content raised with increase of NaOH concentration, the reducing sugars level of the macroalgae which were submerged with water was the highest (7.67%, w/v). This was due to the alkaline material still remained on macroalgae and slightly neutralized the acid solutions in the hydrolysis process. The amount of impurities and minerals that were still present in the control without submersion alleged to inhibit hydrolysis process so that the sugar yield from the controls was the lowest one (4.70% w/w).

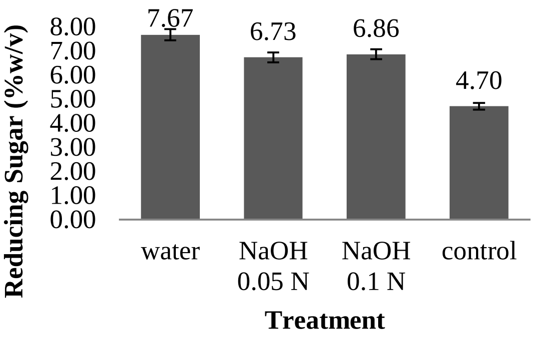

Fig 4. Reducing sugar of *C. racemosa* acid hydrolisates

Rinsing with clean water after alkaline treatment also affected the yield of reducing sugar. The highest reducing sugars obtained from macroalgae which were rinsed after water submersion (Fig 5). Alkaline submersion without rinsing will leave the remains of alkaline in the material and lead to higher pH value. The addition of 1% H_2SO_4 solutions during hydrolysis will neutralize the sample before break down seaweed polysaccharides.

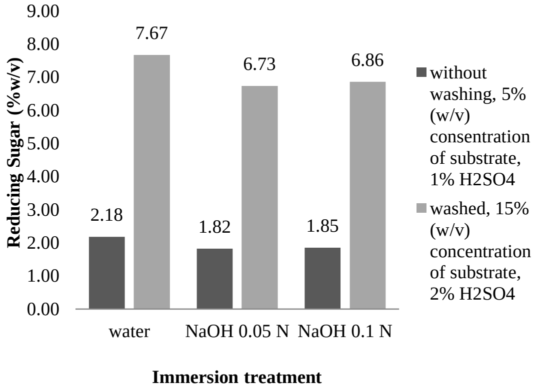

Fig 5. Reducing sugar content of *C. racemossa* acid hydrolysates with different washing treatment, subsbtrate and acid concentration

In addition to rinsing step after submersion, acid concentration and the amount of macroalgae also affected the yield of reducing sugar after hydrolysis. The higher solid concentration for acid hydrolysis mean more polysaccharides available to converted into monosugars. However, increase of macroalgae concentrations should be folowed by an increase in acid concentration. Sulfuric acid concentration of 2% (v/v) was the optimum concentration for macroalgae hydrolysis at 15% (w/v) total solid concentration.

F. Fermentation of G. latifolium Acid Hydrolysate

One of the parameter observed during fermentation process was the changes in reducing sugar level. It already known that reducing sugar level of hydrolysates will decrease at the end of fermentation which showed the sugars consumption by yeasts. The highest sugar consumption found at submersion treatment with 0.1 N NaOH solutions, while the lowest one was control or without submersion (Fig 6).

Galactose was the dominant monosaccharides produced from the hydrolysis of macroalgae polysaccharides. This type of monosaccharide was a non-conventional nutrition for yeast. Galactose metabolism in yeast was done with the help of specific enzymes in the Leloir pathway, namely galactose mutarotase, galactokinase, galactose-1-phosphate uridiltransferase, UDP 4-epimerase and phosphoglucomutase. Most organisms including *Saccharomyces cerevisiae* has the special enzyme. When galactose is available in the media, these enzymes would change the D-galactose into D-glucose 6-phosphate [19].

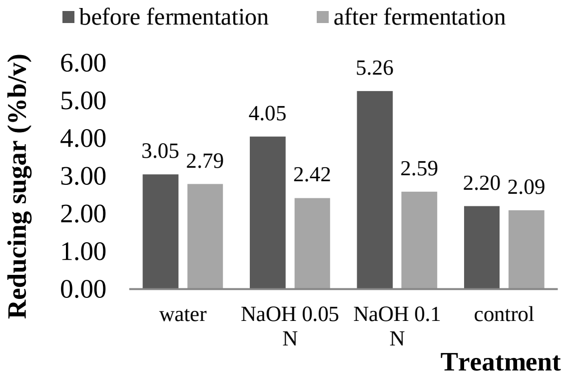

Fig 6. Reducing sugar levels of *G. latifolium* hydrolyzate before and after fermentation

Ethanol content referred in this study (% v/v) was the volumes of ethanol contained in the fermentation broth. The highest ethanol content found from submersion treatment with 0.05 N NaOH solutions, whis was 0.63% v/v. Control which has the lowest sugar consumptions also had the lowest ethanol content of 0.30% v/v (Fig 7).

Efficiency of substrates described the amount of sugar consumed by yeast during fermentation. As can be seen on Fig 8, alkaline treatment with 0.1 N NaOH

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has the highest efficiency of substrate (50.82%), but had the lowest ethanol content (0.43% v/v. One of monosaccharide compound in red algae was 3,6-anhidro-L-galactose. Although it has similar structure to D-galactose, this sugar can not be metabolized by *S. cereviseae* due to the lack of enzymes in yeast cells that capable to consume this sugar. The 3,6-anhidro-L-galactose can be act as a growth medium, but can not be converted into an ethanol product [20]. This lead to low ethanol content although high levels of sugar was being consumed.

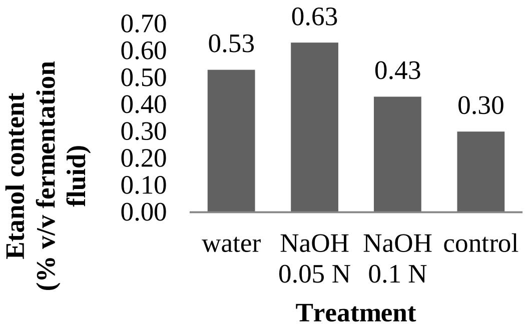

Fig 7. Ethanol content of fermented *G. latifolium* hydrolyzate from various alkaline pre-treatment

Efficiency of fermentation shows a comparison between the actual ethanol production and theoretical ethanol which was calculated based on the amount of reducing sugars in the hydrolysate and the coefficient of sugar conversion into ethanol (0.51). Submersion with water has the highest efficiency of fermentation of 22.75%, followed by 0.05 N NaOH (21.94%), control without alkaline treatment (18.89%) and 0.1 N NaOH (12.04%). Submersion with 0.1 N NaOH has the lowest efficiency of fermentation due to lower ethanol production although it has high sugar consumption. High salt content in the hydrolyzate were allegedly become an obstacle in the bioethanol production.

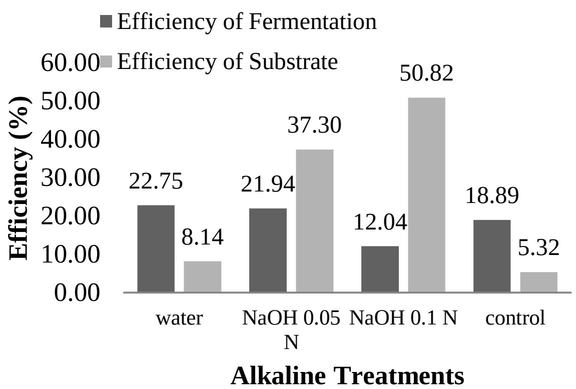

Fig 8. Efficiency of fermentation and efficiency of substrate of *G. latifolium*

G. Fermentation of C. racemosa Acid Hydrolysate

Reducing sugar analysis of *C. racemosa* hydrolysate by DNS method showed decreased on level of reducing sugars after fermentation. The highest sugar consumption derived from alkaline treatment with 0.05 N NaOH is about 1.81% w/v (Fig 9). While the highest ethanol content obtained from water submersion was about 0.70% (v/v) (Fig 10) with efficiency of fermentation of 17.26% and efficiency of substrate of 15.41% (Fig 11).

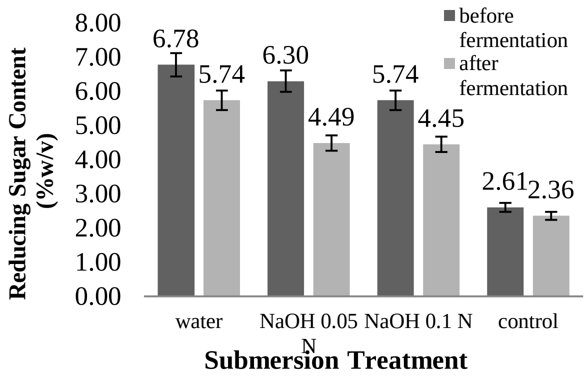

Fig 9. Reducing sugar levels of *C. racemosa* hydrolyzate before and after fermentation

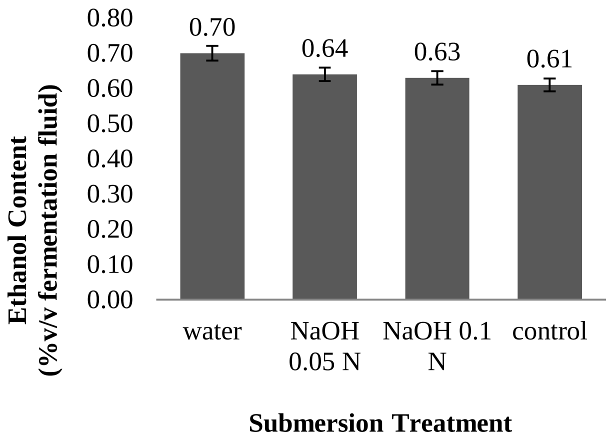

Fig 10. Ethanol content of fermented *C. racemosa* hydrolyzate from various alkaline pre-treatment

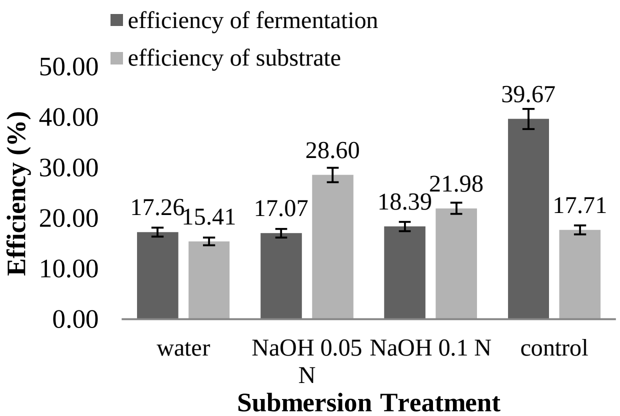

Fig 11. Efficiency of fermentation and efficiency of substrate of *C. racemosa*

C. racemosa without submersion treatments had the highest efficiency of fermentation (39.67%) compared to another treatment (Fig 13). This is due to the macroalgae wich was submerged with NaOH solutions had twice additions of alkaline, that was when submersion treatment and neutralization after acid hydrolysis. Neutralization of macroalgae acid hydrolysates with 10% NaOH solution cause the formation of salts which can increases the salinity of hydrolyzates and potentially inhibits the bioethanol production by microorganisms [6]. Therefore, more alkaline compounds are added, more salt could formed and inhibit the performance of yeast and cause lower ethanol content.

The highest efficiency of substrate was obtained from 0.05 N NaOH submersion treatment (28.60%) (Fig 11). Nevertheless, the ethanol content was lower than the submersion with water. This might be because not all sugar were consumed by yeast converted into ethanol. Allegedly, sugar consumption used by yeast to adapt with salt and toxic compounds in the hydrolyzate before being used for ethanol production.

IV. CONCLUSION

Submersion technique with water and alkaline decreased carbohydrate and ash content of *G latifolium*. However, alkaline treatments for *C. racemosa* increased ash content. Submersion treatment with 0.05 and 0.1 N NaOH solutions were able to dissolve hemicellulose but didn't not work for lignin content in both types of seaweed. Alkaline pre-treatments raised the yield of reducing sugar on hydrolysate of *G latifolium* significantly but not with *C. racemosa*. Rinsing with clean water after alkaline submersion affected on the yield of reducing sugar. Increase of substrate concentration should be followed by an increase on acid concentration at hydrolysis process. The highest ethanol content of *G. latifolium* obtained from immersion treatment with 0.05 N NaOH (0.63% v/v), which has substrates efficiency of 37.30% and fermentation efficiency of 21.94%. While for *C. racemosa*, the highest ethanol content obtained from water submersion (0.70% v/v) with efficiency of substrate was 15.41% and efficiency of fermentation was 17.26%. Submersion of *G latifolium* with water or alkaline solution was able to raised reducing sugar content in the hydrolyzate and lead to a higher ethanol conversion and efficiency of fermentation. But the use of higher alkaline concentrations will increase salt content in the hydrolyzate and disrupt yeast activity in the bioethanol production.

V. REFFERENCE

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New Trends in Industrial Environmental Engineering and Management

ISBN : 978-1-4673-7404-0

Formulating a Long Term Strategy for Sustainable Palm Oil Biodiesel Development in Indonesia: Learning from the Stakeholder Perspective

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***Abstract*— Indonesia, the largest producer of palm oil, has been developed palm oil biodiesel as renewable energy in the last decade. Indonesia biodiesel development policies aim to increase domestic value added of palm oil product and reduce the reliance on fossil fuel. Indonesia has embarked on a comprehensive palm oil biodiesel program since 2006 and targeted the 20% biodiesel blend (B20) in 2016. This article explores the strategy formulation by accommodate the stakeholder perspective in the problems and the solutions. This research analyzes the information from in depth interview with biodiesel stakeholders (government, industry and researcher) in Indonesia by combine Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis with a Multi Actor Analysis approach. The results show the problems of biodiesel development are mainly on the high production cost due to high price of raw material, production technology and distribution infrastructure. The government policy, technology development and raw material supply are the driving forces of the biodiesel development in Indonesia. In the long term strategy, government of Indonesia should secure the biodiesel raw material, develop an environmental friendly technology in biodiesel processing, and accommodate any improvement idea from other stakeholders.**

I. INTRODUCTION

Since 2008, Indonesia is net importer of petroleum. The national production capacity of petroleum cannot fulfill the national demand. In the 2013, the total consumption of petroleum is 72 million kiloliter (diesel fuel: 34 million kiloliter). In the supply, the import number of petroleum reach 32 million kiloliter (diesel fuel: 11 million kiloliter), then 44 % of the petroleum supply in Indonesia is imported.

The government sees the opportunity to reduce petroleum import by utilize biofuel. The government promotes bioethanol to substitute gasoline and biodiesel to substitute diesel fuel. In the progress, the development of bioethanol is stagnant. It was caused by Indonesia is lack of glucose and starch as raw material of bioethanol. Only biodiesel is success in the development because Indonesia has adequate Crude Palm Oil (CPO) as raw material.

In the first step of the biofuel program, the Indonesia Government through National Biofuel Team formulated a regulation on the biofuel mixing up to 5% (B5). The regulation is Presidential Regulation No.5/2006 on National Energy Policy, calling for 5% biofuels in the energy mix by 2025. And then, government established by the National Team for Biofuels Development to coordinate industry expansion (July 2006). On the biofuel, National Team for Biofuels proposed development of Bioethanol from sugar cane or cassava and Biodiesel from palm oil or *Jatropha Curcas*. Until now, only palm oil biodiesel has been developed on industrial scale.

For the raw material supply, palm oil plantation in Indonesia is 7.9 million hectare, produce 26.5 million ton of CPO (exported: 18.1 million ton, domestic use: 8.4 million ton) – the biggest in the world. As listed in Ministry of Energy and Natural Resources, there are 26 biodiesel companies with the total national capacity about 5.6 Million kiloliter/year. Those regulations successfully got the attention from the investor.

In the demand side, the government regulated mandatory blending of biodiesel, believing it will generate domestic demand for biodiesel that will encourage the growth of the biodiesel industry. In 2006, the government target of biodiesel mandatory blending is 5% (b5). So the total demand of biodiesel will reach 1.3 Million Liter, Considering the target 5% biodiesel blending and the national demand of diesel fuel (26 Million Liter).

In 2013, government increase the biodiesel mandatory blending to 10% because the government wants to save the petroleum import budget. Central Statistics Agency (Badan Pusat Statistic - BPS) recorded the Indonesian trade balance during January 2013 a deficit of 430.6 million U.S. dollars, which is derived from the value of exports 14.48 billion U.S. dollars and imports amounted

Manuscript received July 20, 2015. This work was supported in part by the Ministry of Industry of Indonesia.

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ISBN : 978-1-4673-7404-0

to 14.92 billion U.S. dollars, one reason is the increasing imported fuel oil by the government to meet domestic demand. Based on BPS data, one of the triggers of the trade deficit in the early years due to high oil and gas imports to reach 3.55 billion U.S. dollars, while exports of oil and gas is only 2.49 billion U.S. dollars. To solve the trade deficit, the government is trying to reduce the value of imports by substitution with goods produced in the country. Thus the government is trying to reduce imports of diesel fuel by using biodiesel blends, which Indonesia has a huge palm oil production as a raw material for biodiesel. One of government action was increase the biodiesel mandatory blending of 5% to 10%.

II. LITERATURE STUDY

A. Biodiesel Development Policy

The aims of the biofuel development were to improve energy security, boost economic growth, create employment and reduce poverty in rural areas [1]. The objectives have similarity with other developing countries in South East Asia like Malaysia, Thailand and Philippines. The main objective of the biofuel development policy was to reduce the dependence on oil import as a socio-economic concern, but also to increase employment and income generating opportunities in the rural areas. Climate change is currently not the primary motive of these countries to pursue biofuel development policies [2].

Biodiesel is made from biological resources such as vegetable oils or animal fats. The main compound of biodiesel is a *methil ester* compound. Biodiesel can be made from the *transesterification* of fatty acids. Fatty acids, from vegetable oils, are mixed with fatty esters and alcohol to produce by products such as *glycerine*. In the market, *glycerine* has a high economic value.

Biodiesel has been widely used as a substitute for diesel fuel. Biodiesel feedstock development depends on the natural resources of a nation, for example canola oil in Germany and Austria, soybean oil in USA, palm oil in Malaysia and Indonesia, coconut oil in the Philippines[3].

The national team of biofuels provided a biodiesel development roadmap in 2006. They targeted to use 10% biodiesel from total consumption of Automotive Diesel Oil (ADO) in 2006 – 2010 and then increased until 20% in 2016. The target of biodiesel usage from total usage is ambitious [4]. Increasing mandatory blending is one of the policies to increase biodiesel usage [5], but the problem of palm oil biodiesel continue from the plantation until distribution. The government should provide a set of effective regulation in the biodiesel supply chain [6].

In 2014, the government targeted to increase biodiesel mixing to 10% (B10) that was stated in Minister of Energy and Mineral Resources Regulation No: 20/2014. This regulation targeted to utilize the biodiesel in Transportation, Industry and Power Plant sector.

B. Policy Analysis in Multi Actor

In Indonesia, biodiesel development was conducted by government with the support from industry, academics, research center and palm oil grower. This means the biodiesel development policy is multi actor policy. In this condition, every problem in the formulating and the implementation of the policy is become complicated. Different actor has their own view on the problems and also on the solutions.

The model of policy analysis in multi actor organizes the stakeholder in the network rather than classic hierarchy. This means the desired solutions is products of cooperation among the actors [7].

The policy analysis in multi actors system starts with problem formulation. Every actor provides problem and solutions according their perspective. And then the analysis divided into three methods:

1. System Analysis
   The system analysis provides conceptual framework of the system, the area of research, and also identified the means, external factors and criteria. The steps in system analysis are problem demarcation, specify object and criteria, identify the means and map the main causal, and the last is provide of the problem area using a system diagram.
2. Actor Analysis
   Identifying the problems of biodiesel could start by analyzing the role of the stakeholders. The stakeholder definitions depend on the interest, role, power and impact. Knowing who the key actors are, their knowledge, interests, positions, alliances, and importance related to the policy allows policy makers and managers to interact more effectively with key stakeholders and increase support for a given policy or program [8]. Furthermore, failure to attend to the information and concerns of stakeholders clearly is a flaw in thinking or action that too often and too predictably leads to poor performance, outright failure or even disaster [9].
   Understanding the stakeholder will provide a firm base to develop the strategy. In case of biodiesel development in Indonesia, how far the government understands the issues and shows concerns for the stakeholder interest is questionable. The blueprint of biodiesel development was developed with limited involvement from stakeholders such as the uncertainty [4].
   Stakeholder input was sought only when the final draft was released. In this stage, the government of Indonesia was unable to involve the key stakeholders in the biodiesel development and this condition generated many problem and obstacles in the policy implementation.
3. Scenario Analysis
   Scenario analysis provides the alternative of the future according to the present issue. The future is hard to predict but the scenario analysis of alternative can be used to predict the future. The main activity is determining the contextual factors in the present and then finds the driving forces. According to the driving forces impact and the scenario of the policy in the future can be predicted

Multi actor analysis utilizes the above analysis to provide recommendation to improve the policy and also provide alternative strategy in the implementation of the policy.

 ISBN : 978-1-4673-7404-0

C. Sustainable Development

Sustainable development has caught the researcher spotlight lately. Many organizations like profit, non-profit, public, government and NGO have promoted the label sustainable development. Sustainable development, although a widely used phrase and idea, has many different meanings and therefore provokes many different responses. In broad terms, the concept of sustainable development is an attempt to combine growing concerns about a range of environmental issues with socio-economic issues [10].

The separation of environment, society and economy often leads to a narrow techno-scientific approach, while issues to do with society that are most likely to challenge the present socio-economic structure are often marginalized, in particular the sustainability of communities and the maintenance of cultural diversity [11].

Sustainable development analysis of palm oil biodiesel is sequenced steps started with defining the system boundary biodiesel and then followed by identifying the kinds of impacts (economic, environmental, and societal). This impact would accrue as a result of the biodiesel development, then identifying, selecting, and prioritizing the indicators to be used to evaluate the alternative routes for sustainability evaluation. Comparison of the indicators data will lead to a decision on which of the alternatives is more sustainable [12].

In term of sustainability of bioenergy, there are some approaches to guarantee the sustainability of biodiesel in Indonesia. In the supply side, the palm oil plantations and palm oil mills has to certify by ISPO (Indonesia Sustainable Palm Oil) as the implementation of RSPO (Roundtable Sustainable Palm Oil). In biofuels, The Global Bioenergy Partnership (GBEP) established the GBEP Task Force on Sustainability to promote sustainable production and use of bioenergy. GBEP members are 27 countries (include Indonesia) and 12 International Organizations and institutions and further GBEP partners reach 23 countries and 14 international organizations and institutions.

The 24 indicators of sustainable bioenergy development were grouped in three pillars, i.e.: environmental, social and economic [13]. The indicators are starting points from which policy-makers and other stakeholders can identify and develop measurements and domestic data sources that are relevant to their nationally-defined needs and circumstances.

In the future, all the strategy of biodiesel development in the aspect of supply raw material and demand of biodiesel usage have to acknowledge the sustainable development criteria. The sustainability is the most important in the policy decision. For example in the supply of raw material, the future raw material of biodiesel must be environmental friendly, accepted socially and feasible economically.

The connection between sustainable development and entrepreneurship depend on many factor, for example: business sector, industry structure and the dynamics of its interplay, and also depend on trade off among competing economic, social and environmental aspects [14]. Biodiesel sustainable development in Indonesia is to be made the responsibility of the entrepreneur. The condition of economic side of biodiesel business is not profitable. The biodiesel development is government initiative to increase the value added of palm oil product and reduce the dependency to petroleum import [6]. In the result, the government is the main driver of sustainable development of biodiesel in Indonesia.

Biodiesel development program has been executed for 9 years. The government has made some change on the policy many times. Those changes were decided by the government to catch the opportunity to grow the economic by utilizing biodiesel industry, but the government did not give the attention to the problems and solutions of the stakeholder. This condition made the implementation of biodiesel development policy did not effective. This research is approaching the stakeholders perspective to formulate the problem, provide the scenario of future, and recommend the long term strategy to sustain the biodiesel development in Indonesia.

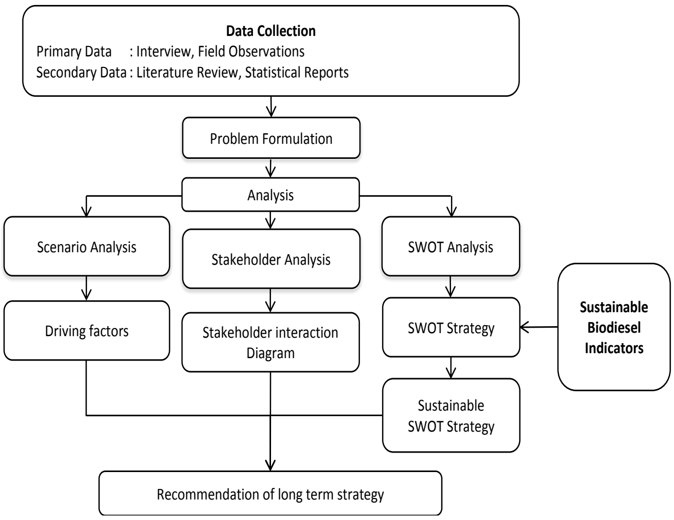

Figure 1 Research frameworks

III. RESEARCH METHOD

A. Data Collection

The research was conducted through a case study methodology with the qualitative approach. The research is conducted by using data from Indonesia palm oil biodiesel experts. The criteria of expert come from their activities in the biodiesel development in Indonesia. The supply chain of biodiesel product in Indonesia starts with palm oil plantation then continues through to distribution at the gas station. The research framework is illustrated in figure 1.

An interview script that had open-ended questions was used. The semi-structured interviews were conducted and recorded, mostly about 30-60 minutes for each respondent; a series of notes was made during the interviews. The respondents were the head of divisions and directors of each company. Data of field observation were also collected.

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B. Data Analysis

Thematic analysis was used to analyze the result of the interviews. Firstly, all interviews were audio recorded on tape, then listen repeatedly, transcript and coded as proposed by Creswell [15]. After the coding of the material, some nodes were created and categorized following the already established framework from the literature reviews [16].

Problem formulation is the early step in multi actor policy analysis, continued by scenario analysis and actor analysis by using stakeholder analysis. The stakeholder analysis is conducted to analyze the interest, power and relation among the stakeholders.

SWOT is an acronym for Strength, Weaknesses, Opportunities, and Threats. As the name implies, SWOT analysis is used to identify the strengths, weaknesses, opportunities and threats. It is used to decide on the actions to be taken after the elements of SWOT have been determined [17].

IV. RESULTS AND DISCUSSION

A. Problem of Biodiesel Development

From the industry side, the problems faced by the biodiesel industry are similar to the problems faced by the industry at large in Indonesia. The problems associated with the distribution of goods in Indonesian infrastructure. A case in point is Dumai, as a city that has the largest biodiesel industry in Indonesia. Dumai sea port has a small capacity for handling CPO and biodiesel. This resulted in the duration of loading and unloading at the port that increased cost of the port.

Furthermore, in terms of raw material, biodiesel in Indonesia relies heavily on palm oil, as palm oil is the only raw material that is successfully developed in Indonesia. Initially, raw material for biodiesel that is developed there are several including *Jatropha curcas*, *Reutealis trisperma (Blanco) Airy Shaw*, used cooking oil, and palm oil, but only palm oil growing up at industrial scale. For biodiesel industry which has an oil palm plantation, availability of raw materials not crucial problem, but for industries that do not have oil palm plantation, availability of raw materials is the dominant issue they face each year.

CPO supply in the future can also be a problem for the biodiesel industry as CPO also used by other industries such as food and cooking oil. And the food industry has a higher profit margin than the biodiesel industry. Large scale Biodiesel companies also produce many palm oil product for food, cosmetic, pharmaceutical and biodiesel. If biodiesel product does not provide feasible profit, the management change their production focus on the others product.

The next problem of the biodiesel program is the lack of standard rules in the selling price of biodiesel in Indonesia. PERTAMINA as the sole purchaser of biodiesel submit a pricing mechanism to the government, but until now the standard price that should be used is still unclear. In Indonesia, there are three standard selling price of biodiesel is

1. MOPS (Mean of Plats Singapore) standard, biodiesel price depend on petroleum price
2. Export Price Standards, biodiesel depend on the global biodiesel price.
3. Production Cost Standard, biodiesel price depend on the biodiesel production costs.

Third standards above have fluctuating prices, respectively, and the government should immediately set the standard prices prevailing at PERTAMINA. The quality of biodiesel produced by each uncontrolled biodiesel industry, in particular small and medium-scale industry that does not have complete testing facilities. Poor quality of biodiesel will lead to problems on machines that use biodiesel. The last problem is the environmental issues. As the only raw material, palm oil still has homework related to deforestation, land acquisition, and greenhouse gas emission.

Overall, the problems in biodiesel development in Indonesia are:

- High Cost production due to price of CPO, production technology and infrastructure of distribution
- Different pricing standards
- Biodiesel Standardization: low quality control
- Environment issue: deforestation, fire, GHG Emission and social problem
- Biodiesel depends on palm oil supply

The biodiesel development faced obstacles in Technical, Financial, Regulation, Social and Market [6]. Those obstacles are arising until now, even though government has revised the biodiesel policy. The government should accommodate the solutions offered by the other stakeholders.

B. Factors that drive the Biodiesel Development

The available data indicate that the realization of the absorption of biodiesel in 2010 and 2011 respectively by 20.73% new and 27% of the target set. Based on the information Indonesia Biofuel Producers Association (APROBI), pricing policies are the main cause on business and not optimal absorption of biofuel in Indonesia.

The government has issued several regulations related to business and the use of biofuel. The increase in oil prices was high enough in 2005 to force the government to raise subsidized fuel prices. This is the driving factor for the development and utilization of biofuel for domestic interest.

During its development, the use of biofuels as mandated in the Minister of Energy and Natural Resource did not run consistently. Based on existing data, almost 100% biodiesel usage is made by the transport sector. However, the policy also mandates that the biodiesel has to be utilized by the industrial sector, commercial, and power plants. However, after eight (8) years after the implementation of these regulations, there is still no biodiesel use by non-transport sector like industry and power plant.

ISBN : 978-1-4673-7404-0

TABLE 1
Driving Forces of Biodiesel Development

No	**Driving forces & Contextual Factors**
A	**Government Policy**
	Biodiesel demand on fuel
	Biodiesel demand on industry and power plant
	Price of Biodiesel
	Government incentive
	Government Subsidy
	Biodiesel & CPO Tax policy
	Biodiesel Standardization
B	**Technology Development**
	Technology development in biodiesel production
	Technology development in Biodiesel Usage
	Technology development in CPO usage
	Technology development in other renewable energy
	Environment issue
	Customer acceptance
C	**Raw Material Supply**
	Supply of CPO
	Price of CPO
	Supply of other biodiesel raw material
D	**Infrastructure**
	Biodiesel distribution infrastructure
	Biodiesel blending facility
E	**International Factors**
	Biodiesel production
	Export Biodiesel
	Price of Petroleum
F	**Economic Feasibility**
	Demand of CPO in food product
	Profitability of Biodiesel
	Profitability of Food product

According to the contextual condition above, each of contextual factors will be analyze to determine the driving forces of each contextual factor. The detail contextual factors and driving forces provide in table 1.

The driving factors of biodiesel development in Indonesia are government policies, technology development, raw material supply, infrastructure, international factors and economic feasibility. In recent condition, government policies and raw material supply is the main driving forces. In the future, technology development and economic feasibility can be the main driving forces.

C. Long Term Strategy of Biodiesel Development

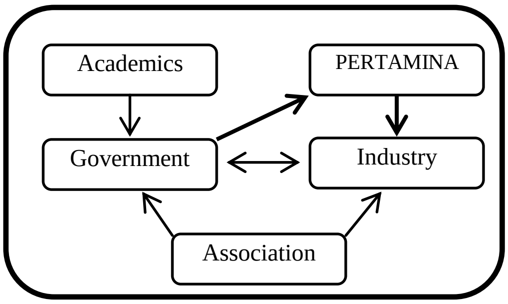
From 2006 until 2015, biodiesel program has developed to supply the domestic market and global market. The focus of formulated strategy is on the domestic market. Government has targeted to use 20% biodiesel blending in 2016. SWOT analysis will provide the current position of the biodiesel program implementation and then draw the strategy to sustain the development of biodiesel program.

SWOT Strategy Analysis

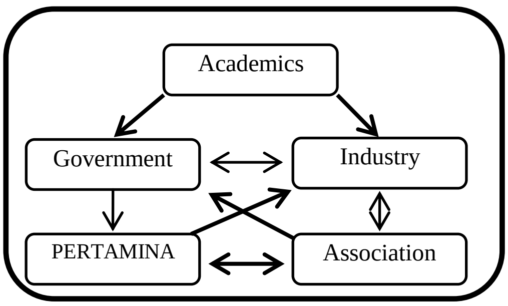
- Strength**:** Adequate supply of raw material and support from the governments.
- Weakness: low support in technology, Quality issue, and the resources depend on CPO.
- Opportunity: Economic growth, Industrial collaborative issue, Increasing demand in industrial and power plan sector.
- Threat: Food vs Fuel issue of CPO product, environment issue, and public acceptance of high biodiesel blending (B20).

On the long term strategy, the government should focus on the strength of biodiesel program to get the opportunity. The strength of this program is stakeholders support and adequate source of biodiesel raw material. In Indonesia, Government is the main actor of the Biodiesel Development, so the long term strategy that should be taken by government in support the research in development of new raw material and the development of biodiesel technology, for both in the production technology and also usage technology in vehicle, industrial machinery and power plant.

The implementation of the long term strategy depends on the interaction among stakeholders. According to Caroko et al. (2011), there are 9 key stakeholders in biodiesel development according to the interest and motivation but in this research we focus on specific biodiesel stakeholder without the stakeholder of CPO.



a. Recent Stakeholders Interactions



b. Improved Stakeholders Interactions

Figure 2 Biodiesel stakeholders interactions

From the figure 2, the current interaction of biodiesel stakeholders is only dominated by government. The bold arrow shows a high influence on the biodiesel program. The government has high influence to PERTAMINA in case of biodiesel blending. Same condition is happening from PERTAMINA to the industry. The influence of PERTAMINA to the biodiesel industry is very high because PERTAMINA is the only buyer of biodiesel in Indonesia. The government develops the biodiesel development policy with their own knowledge. The academics influence to the government is low, their opinions on the biodiesel development is neglected by the government.

V. CONCLUSION AND RECOMMENDATION

Developing of new raw material of biodiesel is the first key of sustainable biodiesel development in Indonesia. The criteria of new raw material are environmental friendly, accepted socially and feasible economically. According to GBEP report (2014), the current issue of sustainable CPO and Biodiesel industry in Indonesia are Green House Gas (GHG) emission, water pollution and habitat loss and the impact in biological diversity.. The GHG emission coming from from forest fire, peat decomposition and fermentation of palm oil mill effluent (POME),

The first key of long term strategy in biodiesel development is guarantee the sustainable raw material of biodiesel especially CPO. The government should secure the supply of CPO as raw material of biodiesel by providing sustainable palm oil plantation exclusive to biodiesel.

The second key of sustainable biodiesel development is technology development. The government should support the research on the development of biodiesel production technology. The latest technology in biodiesel development is bioprocess by using enzyme. The bioprocess technology will reduce the production cost and infestation cost. The technology in the biodiesel utilizations also should be developed. Until now, the maximum biodiesel blending on the standard engine is 20%, higher biodiesel blending will make some problem to the engine and fuel pump. The latest technology that has been developed is Catalytic Hydrocracking Technology. This technology claimed that able to use 100% of biodiesel. Some automotive manufacture company has started the development of this technology.

In formulating long term biodiesel strategy, government should accommodate the idea from other stakeholders like Academics and Association. In the stakeholder relationship, the biodiesel experts including academics, researcher, and industrial consultant should has more knowledge power to influence the government in the formulating biodiesel policy. The academics and biodiesel industry should create a joint research in biodiesel technology, because both of them have different knowledge that will be very useful to share

This research was conducted in small number of stakeholders and the interview question cannot explore the stakeholder perspective in detail. The bigger sample will provide better identification of motivation, interest and connection to all the biodiesel stakeholders. The next research should identify the supply and demand of the biodiesel in detail. Further research should explore the cost and benefit analysis of biodiesel in the future.

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ISBN : 978-1-4673-7404-0

Quality Improvement of Polluted River Water Used as Raw Water in Clean Water Supply by Using Biofiltration

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Abstract — The river water pollution prevails in many parts of Indonesian region, due to the industrial, commercial, residential and farming activities. In many areas the quality standard of raw water has even been violated. This leads to the increased water treatment costs as well as public health risks. The use of biofiltration system can be an effective means to overcome these problems. The technology is able to eliminate various types of raw water contaminants and therefore reduces overall treatment costs. This paper demonstrates the technical and financial benefits of applying this technology as a pre-treatment step prior to conventional coagulation and flocculation processes. The experiments showed that bioreactor filled with "honeycomb" type matrix can reduce COD levels from 122-173 to 42-92 mg/L depending on the hydraulic retention time applied, while that filled with quartz sand can reduce COD levels from 128 to 32-43 mg/L. The biofiltration systems also demonstrated the ability to reduce TSS from 56 to 5 mg/L or equivalent to 90% reduction in the case of quartz sand matrix, while honeycomb-type matrix showed slightly inferior performance. The decrease in TSS will reduce coagulant consumption in the subsequent water treatment processes. It was also observed that nitrification also took place in the biofiltration system, indicated by removal of 55-75% ammonium concentration. This will eventually reduce chlorine required for disinfection. Based on these results, an estimation of potential cost saving from the use of the biofiltration process is derived.

Key words: polluted raw water, biofiltration, pretreatment, raw water quality improvement

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I. INTRODUCTION

The river water pollution prevails in many parts of Indonesian region, due to the industrial, commercial, residential and farming activities. In many areas the quality standard of raw water has even been violated, in terms of physical (turbidity, color, solids), chemical (organic matters, nutrients, detergents, pesticides, and heavy metals), and biological contaminations (total coliforms, *Escherichia coli*, and other pathogens). Moreover, today's trend shows an increase in communities attention not only on pollutants commonly known as toxics (pesticides, heavy metals), but also to the increased levels of organic matters in the raw water that have potential health implications. The organic materials may trigger the formation of by-products, such as trihalomethane ($CHCl_3$) compounds in the water treatment plants that are applying chlorination for disinfection purposes. These byproducts are considered as carcinogenic compounds causing cancer [1] - [3].

The problem of river water pollution has to be resolved, especially considering that in many areas, the water is used as source of water supply for drinking water. In addition, there are urgent demands from the public suggesting the government (central or local) to increase the capacity and quality of water supply, as stated in the targets of MDG's (Millennium Development Goals). The development of an effective technology to address these challenges is needed.

Innovative technology of biofiltration can be considered as an effective solution to reduce problems in the water supply, especially in improving the quality of raw water and thus the treated water, and reducing treatment costs. Biofiltration process (known also as packed bed biofilm reactor) is a technology that utilizes microbial activity, in which solid materials are used by microorganisms as a matrix for growing, forming biofilm and consuming pollutants from the treating water as their energy source [4], [5].

This system allows prolong microorganism residence time relative to its hydraulic residence time. This provides the microorganisms to have opportunity to adapt to environmental conditions and types of

 ISBN : 978-1-4673-7404-0

pollutants in the system, and to establish the type and concentration of certain enzymes needed to eliminate a variety of pollutants, including recalcitrant compounds, such as pesticides and other synthetic organic compounds. These favorable conditions increase the effectiveness and stability of the system in eliminating various types of contaminants from the treating raw water. The biofilm process performance is determined mainly by two parameters, namely the surface characteristics of the support material (matrix) and biofilm thickness, which affect substrate and oxygen supply from the liquid phase [4], [6], [7].

Biofiltration system has been reported to be used for various purposes, such as for advanced wastewater treatment (tertiary wastewater treatment) [8] - [10], for the elimination of pesticides [11], and for the elimination of toxic compounds [12] - [14]. These studies are mostly geared to treat highly polluted wastewaters and partly for advanced wastewater treatment for the elimination of nutrients (nitrification, denitrification and phosphate elimination). More recently, Rattier et al. [15] studied removal of micropollutants during tertiary wastewater treatment by biofiltration with the focus on the role of nitrifiers and removal mechanisms.

Development of biofiltration system for eliminating organic matters, suspended solids and low concentration of organic pollutants found in the raw water has not been widely reported, despite of the urgent need for removal of these pollutants. There is also tremendous need to improve the quality of raw water and thus treated water at reduced treatment costs.

An increased level of organic matters in surface water sources in many parts of the world has encouraged the development of various technologies, such as the oxidation process using O_3/H_2O_2, O_3/UV, UV/H_2O_2, TiO_2/UV, H_2O_2/catalyst, Fenton, and photo-Fenton process [1]. However, these processes require high investment and operating costs, so its commercial scale application in developing countries is limited.

This paper presents the results of a preliminary study on pre-treatment of polluted river water as raw water of drinking/clean water supply using biofiltration system. The system performance is evaluated by its ability in reducing the level of water contaminants covering COD, turbidity, TSS, and ammonium. The potential technical and financial benefits derived from the technology are then analyzed.

II. METHODOLOGY

Feed Water. Water of Cihedeung River located nearby IPB Campus was used throughout the experiments. The river water has been used for the campus water supply. The river water characteristics vary depending on weather conditions. Table I shows the variation of water characteristics during rainy and dry seasons. At rainy season, the value of TSS, turbidity, color of the river water is much higher than that in dry season. The water pH is very low (acidic) in rainy conditions (pH ≈ 4.5) and nearly neutral in dry season.

TABLE I.
PHYSICAL PROPERTIES OF THE RIVER WATER DURING THE SEASONS

Parameter	Unit	Rainy condition	No rain condition (bright)
TSS	mg/L	148	39
Turbidity	FTU	160	60
Color	PtCo	550	283
pH	-	4.5	6.9

Biofiltration system. The reactors are made of plastic filled with a honeycomb type of plastic media and quartz sand as the matrix. Total volume of the reactors was 24 liters. Schematic diagram of the biofiltration system can be seen in Fig. 1. It consists of a) valves, b) recirculation pumps, c) effluent pipe, d) raw water inlet, e) matrix, and f) diffuser. The biofiltration system were filled with honeycomb-structured plastic (plastic type "Bee Nest") and quartz sand matrices, and operated in continuous mode with upflow mode of water and air flow. The flow rate (hydraulic residence time or Empty Bed Contact Time) was regulated through the aperture of installed outlet valve.

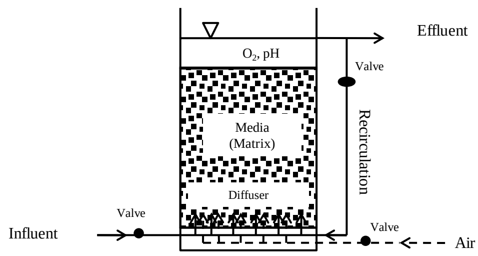


Fig. 1. Schematic diagram of biofiltration system used in the experiments

Acclimatization. Microbial acclimatization was done by operating the reactor continuously at 4 hour HRT. During acclimatization influent and effluent values of COD, turbidity, TSS and ammonium were monitored.

Experimental works. Experiments were carried to evaluate the performance of two types of matrix media, namely quartz sand and honeycomb-structured plastic. The bioreactors were operated at different loads (effected by adjusting flowrate and pollutant concentration). The observed parameters cover pollutants removal efficiency, effluent quality, and system stability against shock loads.

Jar Test. Jar test using a standard 1000 mL of 6 beaker glass was performed to determine the optimum dose of coagulant PAC (Poly Aluminum Chloride) at

ISBN : 978-1-4673-7404-0

various levels of raw water turbidity and TSS. One beaker was used as a control, and the five other beaker were added with different doses of PAC. The coagulation was conducted by stirring at 120 rpm for 1 minutes and then allowing the samples to settle for 30 minutes. The jar test results were used as a basis for evaluating the financial implication from the use of the bioreactor system, by determining the relationship of pre-treated water quality (TSS and turbidity levels) against the reduced needs of coagulant (PAC).

Laboratory analysis. Samples were taken directly from the inlet and outlet of packed bed reactor and then analyzed for organic substances (COD), turbidity, TSS, and ammonium. The organic material was analyzed according to SK SNI M-72-1990-03, Ammonium (NH_4^+) was analyzed in accordance with APHA procedure (2005) [16], and was measured using the absorbance of light by using spectrophotometer type DR/2000 at a wavelength of 810 nm. Turbidity was examined by similar method with TSS measurement only differ in wavelength. Color was measured using spectrophotometer DR/2000 with a wavelength of 450 nm, while the pH was measured by pH-meter electrically.

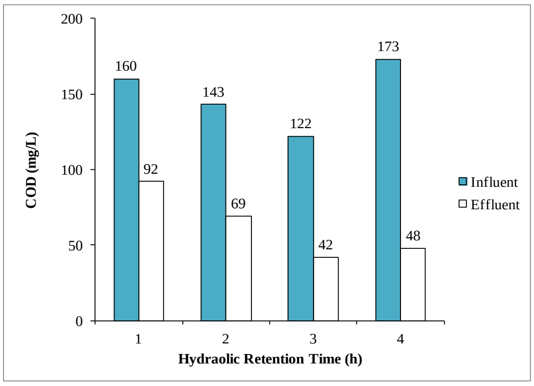
III. RESULT AND DISCUSSION

A. Pollutants Removal

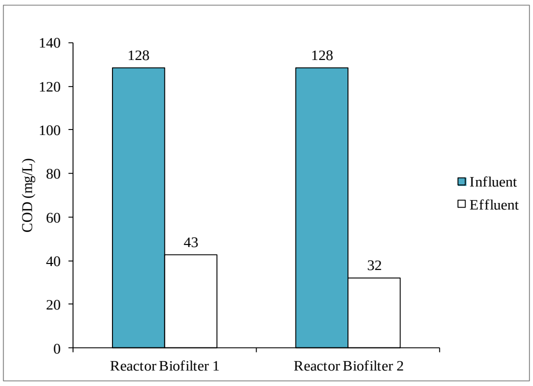
Acclimatization. Acclimatization was intended to grow microorganisms in the media, forming a layer of biofilm by utilizing the available substrates and nutrients in the fed water and to get them adapted to the environmental conditions. Microorganisms that grow attached on the media surface play a key role in degrading the organic materials or adsorbing the inorganic suspended solids. Biodegradation activity increases with the increase of the number and concentration of microorganisms. The end of the acclimatization is characterized by the achievement of pseudo-steady state conditions, indicated by a stable level of pollutant reduction and residual concentration in the effluent. The longer the time of operation, the better the microorganisms getting adapted to its environment and thus the higher the rate of pollutants elimination. In this experiment acclimatization took about a month.

Degradation rate of pollutants. After the formation of biofilm on the media during the acclimatization phase, experiments were performed to observe the influence of the contact time (hydraulic residence time) on the reduction of various types of water pollutants. Results showed that the reduction of organic matters, turbidity, TSS, and ammonium increased with increasing hydraulic retention time. The rate of pollutant degradation varies depending on the type of pollutant. Soluble materials are more easily degraded biologically than suspended materials. The degradation rate of organic matters was faster at the first three hours contact time and decreases with increasing contact time. The remaining pollutants with longer contact time are considered as biologically-difficult-to degrade substances. With increasing the adaptation time and the concentration of microorganisms (biofilm thickness), the degradation rate is expected to be improved and the remaining residual pollutants can minimized.

COD is an important parameter that indicates the concentration of organic materials in the water samples. By using biofiltration system filled with honeycomb-structured matrix (plastic type "Bee Nest"), COD can be reduced from 122-173 mg/L to 42-92 mg/L depending on the hydraulic retention time applied, while the biofiltration system filled with quartz sand can reduce COD of 128 mg/L to 32-43 mg/L. Fig. 2 shows the influent and effluent COD of the biofiltration system filled with plastic type "Bee Nest" (a) and quartz sand (b) matrices.



(a) "Bee Nest" matrix



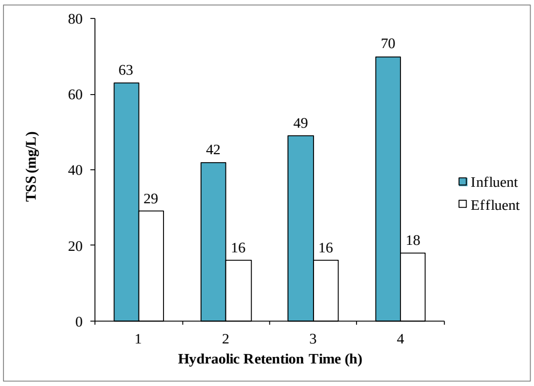
(b) Quartz sand matrix

Fig. 2. Influent and effluent COD of the biofiltration unit filled with "Bee Nest" type (a) and quartz sand (b) matrices

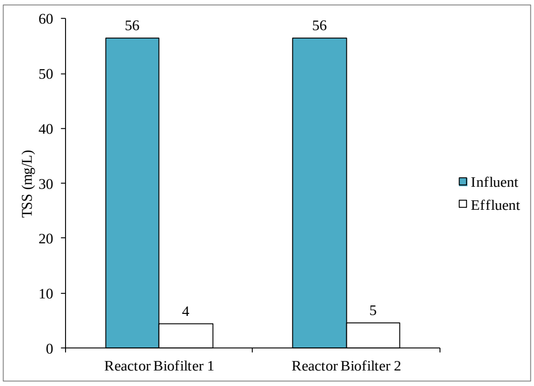
TSS can be reduced significantly using biofiltration system filled with honeycomb plastic or quartz sand (Fig. 3). In term of TSS reduction, biofiltration system filled with quartz sand was better than that with honeycomb plastic matrix because the former has an additional physical effect on TSS removal in addition to the biological effects (biodegradation by biofilm). The biofiltration system filled with quartz sand was

ISBN : 978-1-4673-7404-0

able to reduce the TSS from 56 mg/L to 5 mg/L, equivalent to 90% reduction. The decrease in TSS will reduce water turbidity and coagulant consumption in subsequent water treatment processes. The relationship between TSS and the required coagulant and its relation to the financial implication are discussed in Section B.



(a) “Bee Nest” matrix



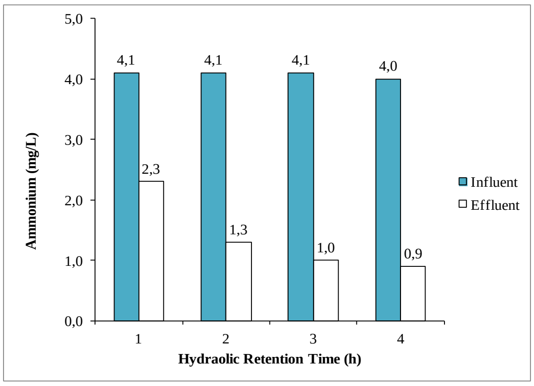
(b) Quartz sand matrix

Fig. 3. Influent and effluent TSS of the packed bed reactor with “Bee Nest” (a) and Quartz sand (b) matrices

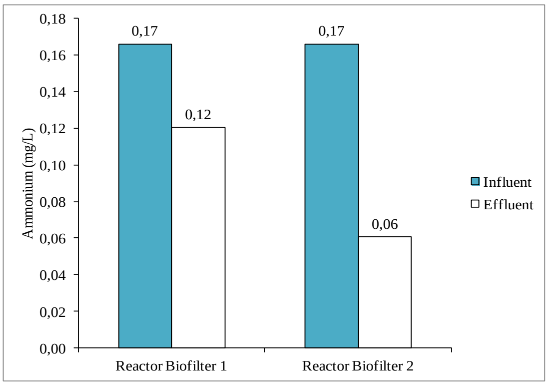
Besides elimination of dissolved organic matter (COD) and TSS, it was observed that nitrification also took place in the biofiltration system, indicated by a decrease in ammonium concentration (Fig. 4). In a technical context, a reduced level of ammonium results in reduced chlorine required for disinfection in the water treatment process. The ammonium removal of 55-75% could be achieved depending on the type of matrix used as shown in Table II.

B. Benefits Analysis

The following paragraphs discuss the technical and financial benefits of biofiltration system for the pre-treatment of raw water from the polluted river water. The analysis is based on the experimental results, where the use of biofiltrations has decreased TSS and ammonium levels that lead to reduced consumption of coagulant and chlorine. TSS is one of the most important parameters of raw water quality, where the higher the level of TSS in the water, the higher the turbidity. Fig. 5 shows the linear relationship between TSS level and turbidity as well as color.



(a) “Bee Nest” matrix



(b) Quartz sand matrix

Fig. 4. Influent and effluent ammonium of the packed bed reactor with “Bee Nest” (a) and quartz sand (b) matrices

TABLE II.
PERCENT OF POLLUTANTS REMOVAL (AT 3 HOUR HRT)

Parameter	Matrix material	
	Plastic type “Bee Nest”	Quartz sand
TSS	70	90
Turbidity	65	80
COD	65	75
Ammonium	75	55

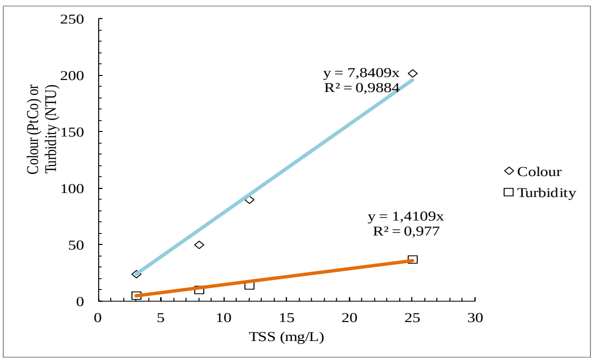
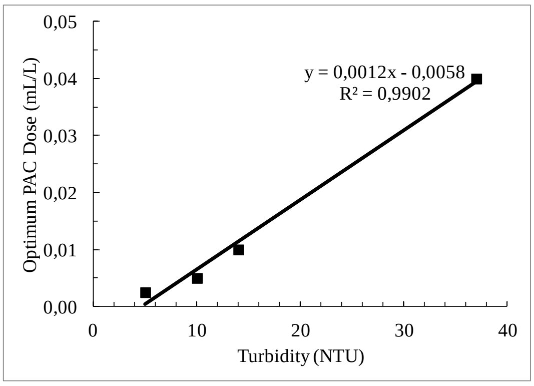


Fig. 5. The relationship between TSS level and color and turbidity in raw water

ISBN : 978-1-4673-7404-0

In water treatment, the levels of TSS and turbidity determine the amount of coagulant requirements. The higher the levels of TSS and turbidity of the raw water, the higher the amount of the coagulant needed for water treatment. Fig. 6 shows the relationship between turbidity and TSS in the raw water with the optimum dose of PAC. Although the quantitative relationship is influenced by the characteristics of the water, the relationship is useful for indirect estimation of the potential saving of coagulant. With help of Fig. 6 it is estimated that a reduction of TSS from 25 mg/L to 8 mg/L results in a reduction of PAC requirement from 0.04 to 0.005 mL/L or equivalent to a saving of PAC by 87 percent.



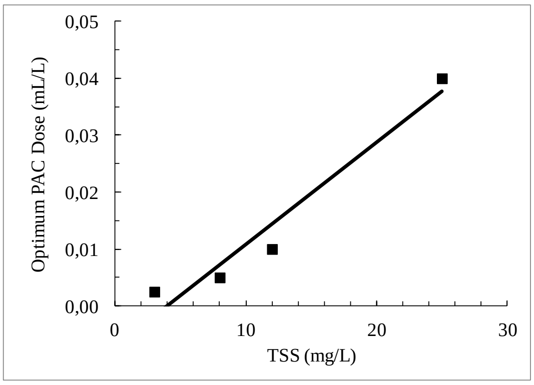


Fig. 6. The relationship between turbidity (upper) and TSS in the raw water (lower) with the optimum dose of PAC in the water treatment (liquid PAC with 10% activity)

Ammonium in the raw water cannot be effectively eliminated using a conventional water treatment system, so that ammonium would remain in the treated water. The remaining ammonium reacts with chlorine (Cl_2) and therefore increases the disinfectant requirement in the water treatment according to the following chemical equation [17]:

$$NH_4^+ + Cl_2 + 2HOCl \rightarrow NCl_3 + 2H^+ + Cl^- + 2H_2O$$

Ammonium in the raw water can be oxidized to nitrate (nitrification) in the biofiltration system. Reduced level of ammonium means also reduction of chlorine for the disinfection process. As per the above chemical equation, one mole (18 g) of ammonium requires one mole (71 g) of chlorine. This means that a reduction of 18 g ammonium in raw water lead to a saving of 71 g chlorine.

From the above discussion, it is clear that both TSS and ammonium in raw water affects the chemicals requirement in the water treatment process. In other words, reductions of TSS and ammonium can reduce the need for chemicals, both coagulant (PAC) and disinfectant (chlorine). This preliminary study showed that the biofiltration systems reduced the level of TSS from 56.4 to 4.5 mg/L, which is equivalent to a decrease in the use of liquid PAC from 0.079 to 0.006 mL/L (jar test result). At the same time, the ammonium level can be removed from 1.5 to 0.5 mg/L, which is equivalent to a reduction in chlorine requirement from 6.3 to 2.1 mg/L (stoichiometric calculation). Assuming the price of liquid PAC is Rp 4,500,- /L and chlorine Rp 5,200,-/kg, a water treatment plant with capacity of 100 L/s equipped with biofiltration can save Rp 1,017,007,488,- /year from coagulant (PAC) and Rp 67,550,569, -/year from chlorine consumption.

C. Application of biofiltration

From the description above, it is obvious that pre-treatment of polluted water using biofiltration system would improve the quality of raw water and the quality of treated water, or improve the water treatment plant capacity. Fig. 7 shows the recommended set up of biofiltration unit within the typical series of unit operation of water treatment processes. The addition of this unit will not interfere with the design and operation of the existing water treatment systems significantly.

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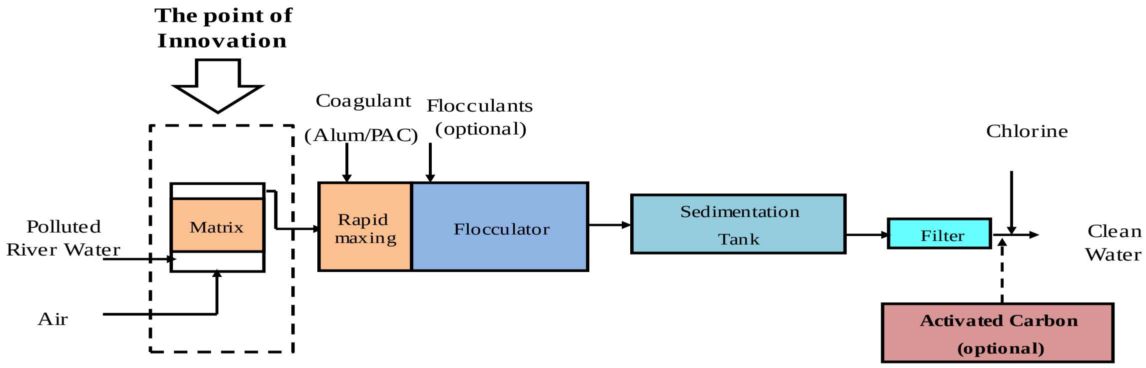

Fig. 7. The recommended setup of water treatment facility equipped with biofiltration unit

Results of the experiments shown in this preliminary study concluded that this technology has potential technical and financial benefits in the overall water treatment system. This technology will have a significant contribution in the context of ever increasing intensity of river water pollution and the high variation of pollution load. However, further thorough investigation on the applicability of the pre-treatment of raw water is still needed at a larger scale and longer period of time. Comprehensive studies are currently taking place in our laboratory. The studies are focused on the further development of biofiltration for the treatment of polluted river water as raw water in water supply in order to exploit these advantages optimally, includes aspects of the degradation characteristics of various types of pollutants (including non-conventional pollutants and new / emerging pollutants), such as trace elements from pesticides, herbicides, medicines, cosmetics, shampoo, soap, heavy metals, and detergent, testing the stability of the system against shock loads, mode of operation (upflow, downflow), process optimization, and determination of design and operating parameter values of the biofiltration system with various types of filter media, as well as a comprehensive analysis of techno-economic aspects.

IV. CONCLUSIONS

Biofiltration systems can remove various pollutants in raw water significantly, such as organic substances (COD), turbidity, color, TSS and ammonium. The increased raw water quality can reduce water treatment cost and the risk to public health. The biofiltration systems as pre-treatment unit also function as equalizer to the high variation in organic pollutant load of influent. Besides the technical benefits, use of biofiltrations has been shown to result in cost saving due to reduced consumption of coagulant and chlorine. Further development of biofiltration for the treatment of polluted river water as raw water in water supply is still needed in order to exploit these advantages optimally, includes aspects of the degradation characteristics of various types of pollutants (including non-conventional pollutants and new / emerging pollutants), testing the stability of the system against shock loads, mode of operation (upflow, downflow), process optimization, and determination of design and operating parameter values of the biofiltration system with various types of filter media, as well as a comprehensive analysis of techno-economic aspects.

ACKNOWLEDGMENT

The authors thank Nurhidayanti, Mega Ayu Yusuf and Bunga Cahyaputri for their contribution in laboratory works, as well as PT. Multi Screen Indonesia for providing sample of honeycomb plastic for conducting a part of this experiment, and Ministry for Research, Technology, and Higher Education for the financial support through Competency Grant (HIKOM) Scheme for further development of the biofiltration system.

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ISBN : 978-1-4673-7404-0

An Empirical Investigation of the Barriers to Green Practices in Yogyakarta Leather Tanning SMEs

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Abstract— This study identifies factors that inhibit green practice implementation in the leather tanning SME industry in Yogyakarta, Indonesia. These external and internal barriers were identified during interview with representatives from a number of leather tanning SMEs and industry experts. The results show that SMEs in this sector adopt only a limited level of environmental practices. Internal barriers to green adoption included insufficient resources and infrastructure, low-skilled human resources, poor financial capability, low awareness, and poor organizational strategies. The external barriers are significant; however, inadequate law enforcement and government support, a small and limited market segment, and the lack of green chemicals contribute also toward these poor practices. To deal with these problems, this research proposes eight strategies to tackle the obstacles that prevent the implementation of leather tanning green practices.

I. INTRODUCTION

Yogyakarta is a provincial region in Indonesia located on Java Island. The economic structure of Yogyakarta is dominated by trade (21%), services (18%) and agriculture (16%). Yogyakarta's development is significant and includes two leading industries - leather manufacturing and wood processing. These two industries contribute significantly toward the GDP, employment, investment, and development potential of the Province with multiplier effects to related industries in other provinces. The focus of this research is on leather tanning. Although this industry is well developed, there are significant waste management environmental problems.

According to the Indonesian Tannery Association, around 75% of the leather industry firms are small and medium enterprises (SMEs). These SMEs have limitations which hinder their waste management environmental protection efforts. Previous studies have found that SMEs tend to be more harmful to the environment compared to larger corporations due to their poor production techniques [7]. Other studies have found that leather tanning SMEs in developing countries face significant solid waste disposal problems with many being closed for not meeting the required standards [8]. This situation is similar in Indonesia where there is a low level of adoption of leather tanning green practices ("Badan Lingkungan Hidup" (BLH)).[1]

Increasing Indonesian consumer environmental awareness has begun to pressure the leather tanning industry to be more responsible. In this regard, the Indonesian Government is looking to clean up "dirty" industries by introducing industry green policies (e.g., National Regulation 3, 2014).[2] Consequently, leather tanning SMEs need to upgrade their existing practices and find better ways to solve their challenges while developing better competitive advantages. Many Yogyakarta SMEs, however, claim that they are challenged in implementing green practices, though there is no empirical evidence to support these claims.

In response to this lack of empirical evidence, this research aims to reveal the barriers that inhibit green practice implementation in Yogyakarta leather tanning SMEs and formulates strategies to tackle these barriers for better implementation of green practices.

II. LITERATURE REVIEW

A. *A glimpse of the Indonesian leather industry*

Leather is a most promising Indonesian industry as evidenced by the upward trend of international demand toward its leather products (Table 1). Yogyakarta SMEs generate significant export and local tourism sales.

Although the economic benefits of the industry are important, it has a negative environmental impact [16]. During the manufacturing process, pollution occurs through the generation of toxic liquids and solid wastes which emit repulsive smells. Only one-fifth of the raw hides/skins are converted to products; the rest are

Manuscript received May 10, 2015. This work was supported in part by the Ministry of Industry of Indonesia.

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[1] The BLH is an environmental agency in Yogyakarta which has identified that most leather tanning SMEs have not met the required environmental standards.

[2] A green industry is defined as an industry which prioritizes efficiency and effectiveness in the resource utilization of its processes to align industrial development with the preservation of the environment while providing benefits to the community.

 ISBN : 978-1-4673-7404-0

discharged as waste or by-products. The tanning process produces 45-50m^3 of waste water per ton of raw hides/skins [8]. Tanning wastewater is a serious threat to the environment due to its content of strong alkali, bio-waste, and heavy metals.

Table 1. Export value of leather products 2009-2013
Source: Indonesian Ministry of Trade

Year	Export value (million USD)	Destination country
2009	178,4	US, Japan, Germany, Italy, Malaysia, Belgium, UK, Russia Federation, Egypt, Morocco, India, Taiwan, Canada, Australia, Georgia, Singapore, Algeria, Ecuador, France, South Africa
2010	246,4	
2011	292,1	
2012	324,7	
2013	338,1	

B. SME barriers to green practice implementation

SMEs are focused on generating profits to keep their businesses operating. They are preoccupied with reducing resource use and waste in order to achieve short term goals; however, this is not a priority if they do not gain associated benefits [4]. SMEs see environmental innovation as a financial burden and they do not recognize the contribution to performance of environmental best practice [21]. Thus, poor environmental practices exist because SMEs tend to focus on day-to-day activities [19] with their resources restricted to issues related to the business core [2] rather than green practices. Therefore, SMEs tend to be more reactive in tackling environmental problems. It is the larger companies that tend to be more proactive [1], [7]. SME reactive strategies focus more on compliance than sustainability [7]; they are not willing to contribute voluntarily. However, SME non-compliance is acknowledged and considered serious only if there is a threat of prosecution [21].

A range of studies have examined the barriers to green practice implementation. Most of these classify barriers into internal and external (refer Tables 2 and 3). There have been none that focus on leather tanning in Yogyakarta. For this reason, we investigate the Yogyakarta leather tanning industry and generate the propositions that appear in Table 4.

Table 2. Identified *internal* barriers

Internal barriers	Authors
Insufficient resources and infrastructure	Rojsek (2001); Brammer, Hoejmose & Marchant (2012); Tilley (1999); Murillo-Luna, J. L., Garcés-Ayerbe, C., & Rivera-Torres, P. (2011)
Inadequate technical knowledge and skills (human factor)	Hillary R. (2004); Rojsek (2001); Zilahy, G. (2004); Moors, E. H., Mulder, K. F., & Vergragt, P. J., 2005; Murillo-Luna, J. L., Garcés-Ayerbe, C., & Rivera-Torres, P. (2011)
High cost of environmental technologies (financial factor)	Hillary R. (2004); Rojsek (2001); Tilley (1999); Shi, H., Peng, Liu, & Zhong, (2008); Zilahy, (2004), Murillo-Luna, Garcés-Ayerbe, & Rivera-Torres, (2007); Zutshi, & Sohal, (2004); Moors, Mulder & Vergragt, 2005; Massoud, Fayad, El-Fadel, & Kamleh, (2010); Murillo-Luna, Garcés-Ayerbe, & Rivera-Torres, (2011)
Low awareness	Wilson, Williams & Kemp (2012); Tilley (1999); Zilahy, (2004).
Lack of organizational strategy	Murillo-Luna, Garcés-Ayerbe, & Rivera-Torres, (2007); Zilahy (2004), Moors, Mulder, & Vergragt, 2005; Massoud, Fayad, El-Fadel, & Kamleh, (2010)
Aversion to innovation	Murillo-Luna, Garcés-Ayerbe, & Rivera-Torres, (2011)

Table 3. Identified *external* barriers

External barriers	Authors
Market segment for green product is too small	Rojsek (2001); Zilahy (2004)
The 'green' supplier support is insufficient	Rojsek (2001); Murillo-Luna, Garcés-Ayerbe, & Rivera-Torres (2011)
Poor environmental legislation	Rojsek (2001); Wilson, Williams & Kemp (2012); Brammer, Hoejmose & Marchant (2012); Shi, Peng, Liu, & Zhong (2008); Revell & Rutherfoord (2003); Moors, Mulder, & Vergragt (2005)
Limited government support	Massoud, Fayad, El-Fadel, & Kamleh (2010)

Table 4. Proposition 1 details

RQ: What are the barriers that inhibit the implementation of green practices in Yogyakarta leather SMEs?
Proposition
Internal barriers
Proposition 1a: Insufficient resources and infrastructure
Proposition 1b: Human factor
Proposition 1c: Financial factor
Proposition 1d: Low of awareness
Proposition 1e: Organizational strategy factor
Proposition 1f: Aversion to innovation
External barriers
Proposition 1g: Market segment is too small
Proposition 1h: Insufficient "green" supplier support
Proposition 1i: Poor environmental legislation
Proposition 1j: Limited government support

A. Strategy formulation using SWOT analysis

A SWOT analysis is commonly used as a means to diagnose the internal and external environments of an organization. It summarizes the most important factors in both environments as a base of the strategic formulation for the organization's future [9]. In this study, a SWOT analysis informed by previous research is used as the key tool to develop strategic plans for improved environmental performance of leather SMEs in Yogyakarta.

A variety of studies have identified various recommendations. For example, reference [20] found that better environmental practices can be achieved through more extensive environmental education and training, stronger regulatory frameworks, financial assistance, and better management guidance from stakeholders. Other study also proposed training and communication as key to addressing SME green practice barriers [24]. Government and policy makers also need to play a role in policing environmental regulatory breaches [17]. For example, reference [18] found that enhancing technical progress and applying stricter environmental regulations are crucial. In addition, previous study argued that SMEs are capable of making themselves greener by making strategic and organizational changes [10]. Based on these studies, additional propositions were developed (refer Table 5).

 ISBN : 978-1-4673-7404-0

Table 5. Proposition 2 details

What strategies can be proposed to tackle existing barriers?
Proposition 2a: Intensifying education and training program
Proposition 2b: financial assistance
Proposition 2c: Provide environmental management guidance
Proposition 2d: Stricter environmental regulation
Proposition 2e: Encouraging the organizational change process

III. RESEARCH METHOD

Data was collected using interviews with select academic, business, and government representatives, supplemented by observational evidence. Interview durations ranged between 45-90 minutes. All interviews were recorded and transcribed for analysis. The participants were purposively sampled based on their experience and knowledge:

a. Participant A (RA): The owner of AA enterprise, Yogyakarta leather SME
b. Participant B (RB): The owner of BB enterprise, Yogyakarta leather SME
c. Participant C (RC): Head of Division, Centre for Leather, Rubber and Plastics (CLRP), Yogyakarta
d. Participant D (RD): Head of the Indonesian Tanneries Association
e. Participant E (RE): Lecturer in the Academy of Leather Technology, Yogyakarta

Table 6 provides details of the participant SMEs.

Table 6. Profile of SME company participants

AA enterprise
Production capacity: 40.000-60.000 sqft/month
Number of workers: 50
Products : Finished leather
Process: Starts from pickle, not rawhide/skin
Established: 1991
Customers: Most local with some demand from Japan, USA, etc
BB enterprise
Production capacity: 10.000-20.000 sqft/month
Number of workers: 20
Products: Finished leather and leather products
Process: Starts from pickle, not rawhide/skin (majority) though is a limited process that starts from beamhouse
Costumers: Most local with some demand from other countries

Data was analysed using descriptive and interpretive analyses. A SWOT analysis was used as the basis for the strategy formulation.

IV. FINDINGS AND DISCUSSION

A. Characteristics of Yogyakarta leather SMEs

Typically, the Yogyakarta SME leather tanning process starts with “pickling” not from raw hide/skin treatment. The industry argues that commencing the process with pickling is more efficient and can reduce waste and odours and sludge. For example, participant B said, *“The reason (for starting with pickling) is environmental. This location is already configured as a leather factory site but it is still close to population centers. And their focus is the smell of the waste”.* Also, in the words of participant A, *“If you don’t want to have a longer process, and don’t want to have a problem with the community, don’t start the process from processing the raw hides/skins”.* However, while there is a realization that environmental considerations will be a challenge in the future, these are not a priority because there is little pressure from regulatory bodies or customers to comply. For example participant A said, *“It will affect the environment if the effluent is not treated.”* However, participant A also said, *“As long as there are no complaints …. I do not think there is a problem”.* While participant B declared, *“Personally, I do not want to deteriorate the environment. But, a consequence of the industry is to generate waste. I have tried to minimize the waste but as long as the cost is reasonable”.*

These types of comments suggest that the Yogyakarta SME environmental leather problems are unresolved. These SMEs have no special treatment for solid and gas waste, nor for waste water. Critically, they do not regularly monitor and/or evaluate treatment results. Regulatory enforcement is an issue because of insufficient staff to enforce laws and there is customer apathy toward green practices since most customers are local and focus on quality and price - not environmental issues. Thus, SMEs do not focus on preventive pollution management.

B. Identification of green practice barriers

This study reveals a number of barriers that impede Yogyakarta leather SMEs from adopting green waste management practices. These barriers, based on participant responses, appear in Tables 7 - 16.

Table 7. Proposition 1a Internal Barriers

Sub Topic
Insufficient resources and infrastructure
Participant Quotes
RB: There is a technological problem. I use my own ways to treat waste; maybe it has not perfect yet. In our treatment, we do not use aeration. We just put the waste into the basin and hope that the effluents have been neutralized.
RD: There is a plan to build an integrated waste treatment. But inadequate government infrastructure becomes an impediment.
RE: Cost constraints, equipment and land are impediments.

Some participants considered “insufficient resources and infrastructure” as one factor that hinders green practices. This is consistent with previous research [3], [14], [18], [20]. Limited infrastructure and resources negatively impact efforts to protect the environment. Most of the SMEs use only simple treatments, simple chemicals, and no biological treatments for waste. With limited staffing, they cannot focus on environmental aspects only day-to-day activities [19].

Table 8. Proposition 1b Internal Barriers

Sub Topic
Human factors
Participant Quotes
RA: The barriers are technology and financial; the competency of human resources is low
RB: SMEs have limited knowledge about waste. Therefore, if there is special training and assistance for SMEs it would help
RC: They have not mastered how to manage the waste. They do not capable to treat the waste. The point is that they do not know how to operate waste treatment processing. Competency of the operator in the waste treatment unit is still low.
RD: They have very limited human resources. But, I believe that if there is a requirement that forces them, they would be able to adapt quickly.

Most participants identified staff as a key factor that hinders green practice implementation. This is consistent with prior studies [6], [14], [18]. Low-skilled human

ISBN : 978-1-4673-7404-0

resources have prevented positive organizational change. A previous study found that human factors are one of the most cited SME barriers to adopting green management and that green businesses require high levels of human resource competency because of the need to develop innovation-focused environmental initiatives [10]. Thus, the enhancement of human resource competency should be investigated in Yogyakarta leather SMEs.

Table 9. Proposition 1c Internal Barriers

Sub Topic
Financial factors
Participant Quotes
RA: Barriers are technology and financial. And the competency of the human resources is low. **RB**: We considered building large pipelines to separate the waste … but it was costly needing billions of dollars for 3 km. **RC**: The problem is related to the cost of the waste processing. If these costs are included, it will reduce profits **RD**: Financial factors hinder SMEs; therefore, they need communal waste treatment **RE**: Cost constraints, equipment and land are impediments.

Participants agreed that financial factors are an important barrier; thus, it is a challenge for SMEs to innovate [5]. Environmental innovation is seen as a financial burden [21] and is not considered a priority [4].

Table 10. Proposition 1d Internal Barriers

Sub Topic
Low awareness
Participant Quotes
RB: Personally, I don't want to deteriorate the environment. I'll try to eliminate the waste, but it should be reasonable. **RC**: SMEs are aware … they treat the waste to avoid complaints from the locals but they have not used the best waste treatment **RD**: SMEs have not considered environmental management as important. But, they realize there will be an obligation for them someday to take part in environmental protection efforts. **RE**: They focus on customer demand, ignoring the environment.

Consistent with previous study, SME awareness varies with some not seeing green as important [20].

Table 11. Proposition 1e Internal Barriers

Sub Topic
Organizational strategy factors
Participant Quotes
RA: If I need to comply with the environmental requirements, I will look for a way to comply. But, for now, I do not want to. As long as there is no problem from customers, it will be fine ... No need for additional costs, additional human resources. **RB**: We do not want to be bothered. If there is integrated waste processing which is handled by the government, we will pay for it. It would greatly relieve us than to treat our own waste. **RC**: This really depends on their customers. SMEs are happy as long as they get profits. **RE**: As long as there is a requirement from customers, there is no other choice for SMEs. For example, what SMEs have done to avoid complaints from the community, they start to be aware about environmental issues

Table 11 results confirm previous studies that SMEs adopt reactive strategies rather than proactively contribute to environmental protection efforts [2] and focus on compliance rather than sustainability [7].

Table 12. Proposition 1f Internal Barriers

Sub Topic
Innovation factors
Participant Quotes
Although the level of SME innovation is low, no participant considered this factor a principal barrier

Table 13. Proposition 1g External Barriers

Sub Topic
Market segment is too small
Participant Quotes
RB: Most of our customers are locals **RC**: There is a demand for green products from customers abroad but local customers only consider price and product appearance **RD**: The issue of green products has not been relevant yet with SMEs because most of their customers are local.

Table 13 results suggest that SMEs focus on customer requirements. Since most customers are local which do not require any environmental aspects and only focus on the appearance and price, SMEs feel that it is not necessary to implement green practices. This finding is consistent with previous study [18], [23].

Table 14. Proposition 1h External Barriers

Sub Topic
Insufficient "green" supplier support
Participant Quotes
RD: In order to achieve the criteria related to green product customers, we have to use chemicals mostly from Europe. Local suppliers provide only common chemicals. **RE**: We depend so much on the imported chemicals for both, the common and environmentally-friendly chemicals

Raw material prices are a sensitive issue for SMEs. If they have a choice between the environment and the economics, the economics dominate. With limited finances, SMEs ignore environmental considerations. Most of the imported green chemicals are more expensive compared to the local chemicals that are commonly used. In the words of participant D, "*The consequence of producing green products ... is a significant price increase*." This is consistent with previous research [14], [18].

Table 15. Proposition 1i External Barriers

Sub Topic
Poor environmental legislation
Participant Quotes
RC: Supervision from the BLH environmental agency needs to be improved - there is no strict punishment applied. Therefore, the industry does not need good environmental management. **RE**: The government needs to provide either punishment or solutions. If they give SMEs strict regulation without a solution, it will be turned into a problem such as unemployment.

According to previous study, pollution preventive management and waste management to protect the environment have not worked in many countries [11]. The reasons are poor regulation and an industry view that environmental protection is an added cost. In Indonesia, a developing country, the regulations are not strictly enforced. This causes SMEs to have no obligation to adopt green practices. This is consistent with study which found that SMEs have poor awareness of compliance issues [21].

ISBN : 978-1-4673-7404-0

Table 16. Proposition 1j External Barriers

Sub Topic
Limited government support
Participant Quotes
RB: We need training about leather industry but the training is not intended to judge the industry. **RC**: Unlike Garut and Magetan, in Yogyakarta, there is no integrated waste treatment installation for the leather industry **RD**: There is a plan to build integrated waste treatment .. but inadequate infrastructure from the government is an impediment. **RE**: The most effective and efficient solution is government needs to take over all of the environmental management

The Table 16 results are consistent with a previous study [12]. Most participants considered that SMEs need government support related to communal waste water treatment installation.

C. Strategy Process Development

Strategy development was aligned to the previous results and those identified in Tables 17-19.:

Table 17. Proposition 2

What strategies can be proposed to tackle the existing barriers?
Sub topic
Intensifying education and training program
Participant Quotes
RA: We need training but with real experts in the field **RB**: SMEs have limited knowledge about waste. Therefore, if there is a special training and assistance for the SMEs it would help a lot **RC**: Give them knowledge through training **RE**: I think it is necessary to promote green technology to the industry
Sub topic
Financial assistance including the provision of infrastructure
Participant Quotes
RA: We need free waste water treatment installation from the government. As long as there are no complaints from the community and customers there is no need to add the cost related green facilities. **RB**: The industry really does not want to be bothered. If there is an integrated waste processing plant which is handled by government …it will greatly relieve the factories **RC**: Government need to provide communal waste treatment facilities **RD**: The industry expects support from the government **RE**: The most effective and efficient solution is government to take over the environmental management.
Sub topic
Provide environmental management guidance
Quote
RB: Industry needs guidance from the CLRP or BLH to assist the industry on best waste management practices **RC**: Strengthen the environmental management system so SMEs can analyze the impact of their processes.
Sub topic
Stricter environmental regulations
Quote
RC: Supervision from the BLH needs to be improved due to there being no strict punishment applied. **RE**: Government needs to provide either punishment or solution.
Sub topic
Encouraging the organizational change process
Quote
RC: Give them a reward program such as PROPER. **RD**: It needs stakeholder participation such as CLRP to give SMEs information about the problem and how to solve it. It is difficult if we wait for SMEs because there is no requirement from their customers

Using the participant interviews, a SWOT analysis was conducted to identify possible strategies to tackle the barriers to current environmental practices (Table 18). Strategies formulated appear in Table 19.

Table 18. SWOT analysis

STRENGTHS
(S1) Have a localized land area for leather tanning (S2) Competent and experienced in producing good quality products
WEAKNESSES
(W1) Inadequate data and low-skilled human resources in environmental management (low in competency, knowledge, and commitment) (W2) Inadequate facilities, machinery, and funding (W3) A focus on end-of-pipe treatment c.f. preventive management (W4) Limited access to more environmentally-friendly chemicals
OPPORTUNITIES
(O1) Increasing trend of leather product demand (O2) Availability of actors concern with the leather industry such as government(CLRP), association (APKI) and academician (ATK) (O3) Substitution products of chromium as a tanning agent
THREATS
(T1) Future demands directed to green products (T2) Environmental regulations will be increasingly strictly enforced (T3) Have not found cost-effective environmentally-friendly technology

The details of the SWOT analysis are as follows:

S1: The government has provided a localized land area for the leather tanning industry that is located in Sitimulyo, Yogyakarta. This area is intended to integrate the waste management for the industry, especially to help the SMEs which have a financial limitation to minimize the impact of the process to the environment.

S2: Although most of the customers are locals, the SMEs are proven have enough experience to produce a good quality of product to fulfill the demand from other countries such as Japan, USA, etc.

W1: Human resources is the most cited SME barriers to adopting green management [10]. It prevents positive organizational changes due to inadequate knowledge, competency and commitment to contribute to the environmental protection efforts.

W2: Although the government provided localization area, the SMEs still limited in the facilities and machinery and needed to be supported.

W3: Focus of the SMEs still on the treatment after generated the waste. A prevention management needs to be developed.

W4: Indonesia leather tanning industry depends on the imported chemicals. Local suppliers are limited to provide green chemicals. In addition, the SMEs focus on profit that leads them to minimize production cost by avoiding higher price for environmentally friendly chemicals.

O1: Export demand for leather products has continuously increased each year (table 1). Aware of the emergence of green consumerism can be a good step forward to capture a new market segment.

O2: Availability of other stakeholders in Yogyakarta in greening the environment is a good opportunity for the SMEs. Some previous study have found that SMEs need stakeholder support to green their businesses since the use of stakeholders enhance environmental management practices is crucial [20], [22].

O3: There is an opportunity to produce substitution products to replace the predominance of chrome as a tanning agent. A lot of studies have been conducted and found new tanning agent although still cannot compete chrome as a superior tanning agent.

T1: It cannot be ignored that the emergence of green consumerism has begun, i.e., European countries. It can be a serious threat for the SMEs in the future, if they ignore this market trend.

T2: As a developing country, the regulation is not strictly enforced. But there is a tendency an increased green product demand from the customer.

T3: A range of studies has been conducted to found a better technology in the leather tanning process. But, in industrial scale, the environmentally friendly process need more expensive chemicals during the process which increases production cost.

Table 19. Strategy formulation

SO strategies (use strength to take advantage of opportunities)
1. (S2O1) Product development in meeting future market demand
2. (S2O2) Develop stakeholder partnerships to enhance SME competency
3. (S2O3) Develop low-cost green technology through R&D activities
WO strategies (take advantages of opportunities by overcoming weaknesses)
1. (W1O2) Develop stakeholder partnerships to enhance SME competency
2. (W1O2) Promote best practice to increase environmental performance
3. (W2O2) Collaborating with stakeholders, provide facilities/machinery
4. (W3O2) Promote the adoption of proactive and innovative strategies
5. (W3O2) Develop best practice guidance
6. (W4O2) Working with government, identify green chemical suppliers
ST strategies (use strength to avoid threats)
1. (S2T1)&(S2T3) Collaborate with stakeholders to support research activities associated with innovative environmentally-friendly technology
2. (S2T2)&(S2T4) Facilitate stakeholder networks to assist developing good environmental management systems
WT strategies (minimize weaknesses and avoid the threats)
1. (W1T1) & (W3T1) Intensify knowledge transfer of good environmental management (through training, guidebook, technological assistance)
2. W2T1) & (W2T2) Develop environmental assistance partnerships with government, academia, and the local industry association
3. (W2T3) Collaborate with government: Integrated waste treatment facility
4. (W4T1) Collaborate with government: Local green chemicals suppliers

Table 20 summarizes the strategies developed. These are classified into internal and collaborative. Table 21 discusses these in more detail. Collaborative strategies suggest that SMEs need stakeholder support to green their businesses since the use of stakeholders enhances environmental management practices [20]. However, stakeholders are not always ready to assist [13]. Thus, for greater effectiveness, both internal and collaborative strategies should be adopted.

Table 20. Strategy Classification

Internal strategies
1. Encourage product development process
2. Promote proactive and innovative strategies within SMEs
Collaborative strategies
1. Develop low-cost green technology through R&D activities
2. Develop best practice guidance and promote implementation
3. Provide adequate facilities and machinery
4. Provide green suppliers to supply the green chemicals
5. Intensify knowledge transfer of good environmental management
6. Establish a punishment and reward system

Table 21. More detailed discussion of strategies

Strategy 1 *Encourage product development processes*: The issues of pollution prevention, waste minimization, and pollution control require an innovative approach to production processes and product development becoming greener[5]. It is inevitable that SMEs must become aware of the emergence of green consumerism.
Strategy 2 *Promote proactive and innovative strategies*: SMEs need to shift from reactiveness to proactiveness and develop innovative strategies. SMEs with high innovation capabilities are associated with progressive green management practices (Noci and Verganti 1999).
Strategy 3 *Develop low-cost green technology through R&D activities*: Technological innovation is challenging. There needs to be collaboration between SMEs, government, and research institutions [10].
Strategy 4 *Develop best practice guidance and promote its implementation*: SMEs can make themselves greener through organizational change[10]. There should be collaboration, with the government providing guidance on best practice [20].
Strategy 5 *Provide adequate facilities and machinery*: Government should investigate providing communal waste treatment facilities.
Strategy 6 *Provide suppliers to supply green chemicals*: Internal and external stakeholders to enhance green management practices are essential. Local suppliers to be encouraged to provide green chemicals.
Strategy 7 *Intensify knowledge transfer of good environmental management*: Environmental training programs should be conducted to assist SMEs change their attitudes and behaviors toward green practice.
Strategy 8 *Establish a punishment and reward system*: A stricter environmental regulation approach needs to be enforced [18].

D. Limitations and future research directions

A limitation of this pilot research is related to the small sample size and the purposeful sampling adopted. Thus, caution should be exercised in generalizing the results of this research. Future studies may consider embracing a larger and more randomly selected sample.

E. Summary

This study used purposeful sampling to examine waste management problems associated with Yogyakarta leather producing SMEs. These SMEs face a range of limitations and need assistance to adopt green management practices.

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ISBN : 978-1-4673-7404-0

PRELIMINARY STUDY FOR CO_2 MONITORING SYSTEM

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Abstract : Global warming is becoming a very important issue. The impacts of climate change are the occurence of natural disasters and the uncertainty of the season. It is revealed that one of the main causes of climate change is the increase in greenhouse gas concentrations that exceed the limits of the earth's ability to neutralize them. Various studies have been conducted in several countries, CO_2 is a greenhouse gas that significantly contributes to climate change with emissions of 8230 metric tons in 2006. According to this fact, we plan to build a CO_2 monitoring system which can monitor CO_2 concentration in particular area. In order to evaluate the suitability of this whole system. The main discussion in this paper is analyzing data CO2 concentration several countries to recognize pattern CO2 spreading. From this analysis, we will develop a model that represents the CO2 growth.

1. Introduction

Recently, Global warming has becoming very important issue. The consequences of global warming are the rise of the earth's temprature and the increase of evaporation and precipitation, thus melting the glacier and ice. This results in the increase of sea level[1]. This is caused primarily by rapid industrial development and greenhouse gas emission. According to Carbon Dioxide Information Analysis Center (CDIAC), CO_2 emission is increasing from 3 metric ton in 1751 to 8230 metric ton in 2006 GISS. Surface Temperature Analysis showed positive anomalies for global temperature between 1980—2014[2].

Furthermore, Monitoring of carbon dioxide(CO_2) becomes very important to people, companies and governments due to heatlh risk[3]. For instance, people that stays in an underground unit can be exposed by sweating, dim vision, headache caused by long exposures of the high CO_2 concentration for a long time[4].

Various papers on mapping, visualization, real time information and predictions regarding the CO_2 have been pulished a lot considering the CO_2 problem has become a global concern of the world community [5]. In data gathering, many studies are done to find a way in which one of them is predictions of GOSAT CO_2 data by utilizing IR to see the number of people who live at a certain point and comparing it to the surface or intensity of human activities[6].

The importance of CO_2 information initiates research by installing CO_2 sensors at several public places. Then, the results were posted to social media in real time [7]. In addition, there is also a research on the prediction of the CO_2 by using genetic algorithm[8]. Therefore, we used the CO_2 data from various places as the input for the knowledge and consideration for important decision.

In this paper, we propose the design of match algorithm for processing and predicting the data of CO_2. We compared various algorithm including linear regression(LR), Multilayer Perceptron(MLP) and Decision Tree(DT) in the interest of finding the most efficient algorithm for CO_2 data predicting. At this point of time, various algorithms must be evaluated to verify potentials of the algorithms in predicting the system.

This paper provides discussion and analitics using three different algorithm through open data set of CO_2. In the end, the result of this paper will be used for our next research as our implementation tool to predict CO_2 concentration data in several places.

2. Design Architecture

2.1 Research Stages

This paper is a part of a big research project about monitoring CO_2 system through wireless sensor network. The current stage is marked with a red circle in Fig 1. More systematically, the projet consist of three phases in which each phase is done in a period of 1 year. As mentioned before, this paper is in the first phase of the research.

In the first stage, the preliminary study will begin by analyzing CO_2 concentration data in several places to recognize patterns and grooves spreading. From this analysis, a model that represents the CO_2 cycle will be developed.

2.2 Data Aquissition Module

Teh data aquisition module performs three sensor module : CO_2 sensor, GPS and temperature and humidity sensor. After collecting data the sensor that was attached to arduino sensor CO_2 and GPS will send the

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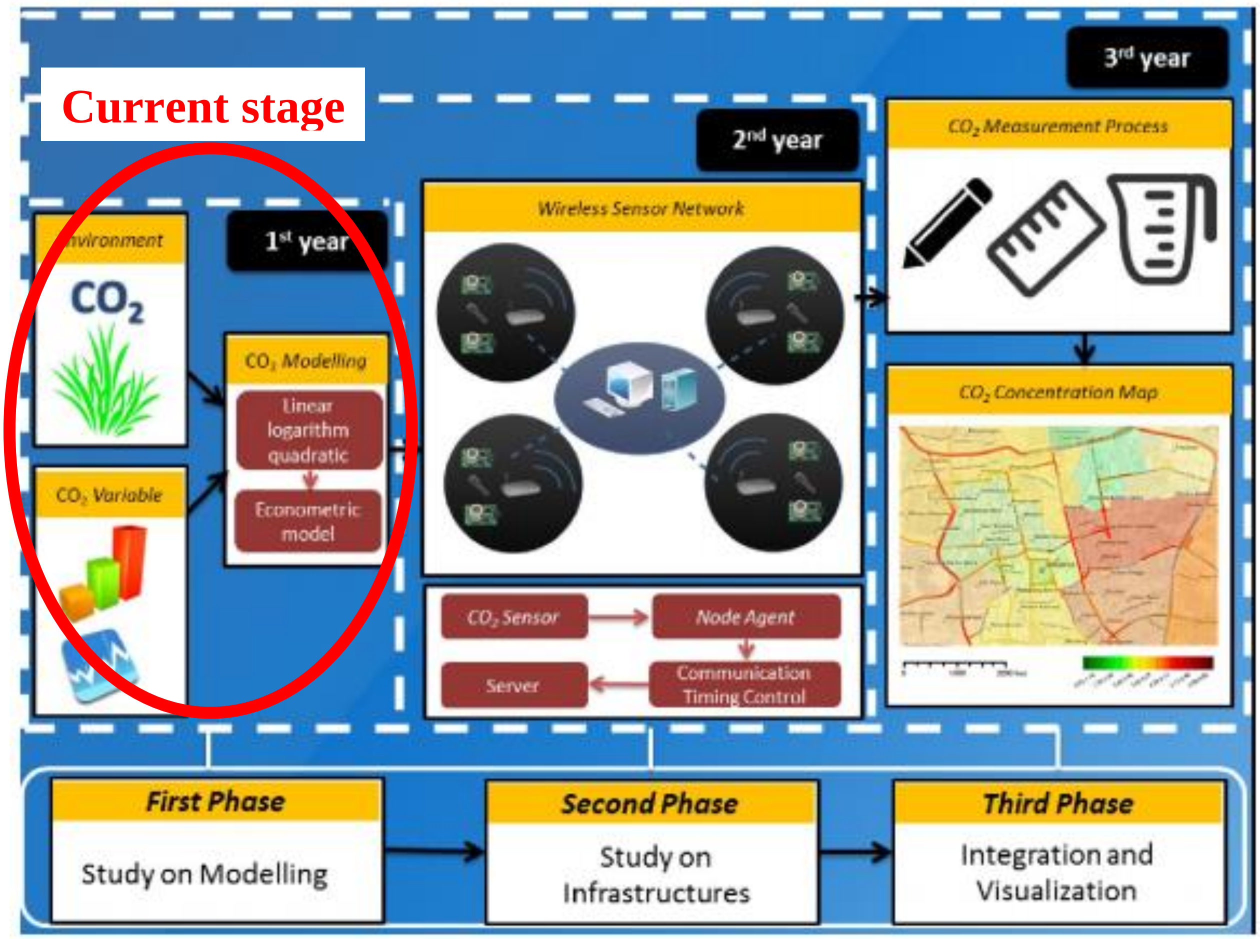

Fig 1 Research Project

data through serial port while temperature and humidity sensor send data directly to Raspberry.

The Raspberry will be the main board That stores data and information inside a directory.

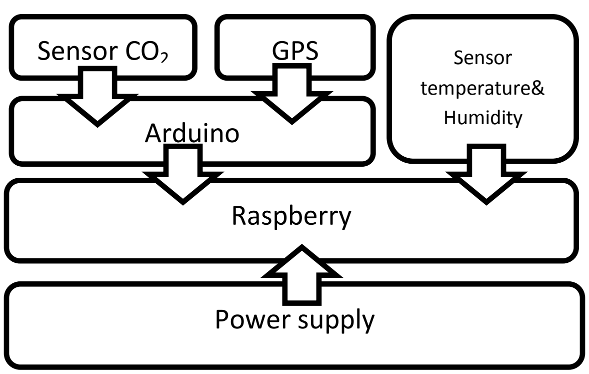

Fig 2 Architechture diagram

As shown in Figure 2, arduino directly communicates with raspberry using usb port. This because the Raspberry will be the main board thats stores the data in a directory.

2.3 Control Module

Control module consists of a microprocessor and a microcontroller. The microprocessor that is attached to the raspberry is 700 MHz Low Power ARM1176JZFS Applications Processor, 512 Mb RAM and 8Gb of external memory. The microcontroller that is attached to Arduino UNO is 16 MHz ATmega328 with 2 KB of SRAM and 1 KB of EEPROM

2.4 Sensor Module

The two sensor modules that is attached to the arduino is CO_2-Cozir and GPS. For the temperature and humidity we use GrovePi humidity and temperature sensor. Ultra Low Power Digital Output NRID CO_2 Gas Sensor COZIR that has ultra low power of 3.5mW, Measurement 0-5000ppm with accuracy 50ppm +/- 3% reading[4]

GPS shield provides longitude and latitude coordinate of the tools. We used arduino GPS shield that uses UART communication protocol and Baud Rate type 38400 bps.

2.5 Power Supply Module

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The power energy module provides energy for the entire system. Since the Raspberry works in 5V and 2A, We used uninterruptible power supply(UPS) PRO1200SV that provides 1200VA with volatge that ranges 140-300V +-5%.

Since we have different voltage, we used an adaptor from power to microusb that is common for smartphone.

2.6 Software Design

The compiling of system software used python language on the raspberry and ino language from Arduino IDE. It includes main program, communication process, CO_2 sensor handler, GPS handler, temperature and humidity handler, data processing and data display. The main program for Arduino is shown in Fig 3.

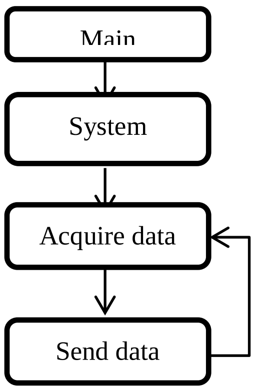

Fig 3 Arduino main program

The Arduino simultaneously sends the data the GPS and CO_2 data through the usb port. The Raspberry, as the main board, is responsible for two sources of data, arduino and GrovePI. First, the Raspberry connect to the CO_2 sensor and the GPS from arduino port through usbtty serial communication. Next, the raspberry pi connects with the humidity and temperature sensor through GrovePi ports. As the main board the raspberry will combine that two pieces of data into one and add a timestamp value. Finally, it ill be stored on a file as database for every single second.

The example of test result of program from the raspberry are shown in table 1 above.

3. Algorithm

3.1 Linear regression

Linear regression is a data modeling between one or more explanatory variables (or independent variable)[9].

Given n input columns of m linear output, regression will generate the output function in linear model form[10].

$$y = f(x) = a + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_n x_n$$

3.2 Multilayer Perceptron(MLP)

This a common algorithm in machine learning using a that network consists of multiple layer of computational unit. The MLP networks are the mostly used by the researchers to approximate any non-linear function to a high degree of accuracy.

Each layer has directed connection to the next layer. The units of the networks consists of sigmoid function or linear function as an activation function. It is also called as multi-layer feedforward neural network. It consists of three types of layers. The first layer is the input layer and corresponds to the problem input variables with one node for each input variable. The second layer is the hidden layer witch provides non-linear relationship path to output. The last layer is output layer[11].

3.4 Decision Tree(DT)

Decision tree is one of the most commony used machine learning algorithm. In general the data structure data of decision tree is shown in Figure 4.

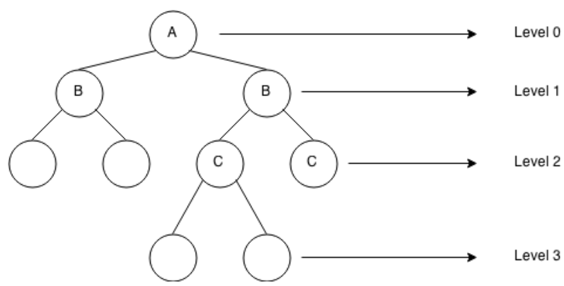

Fig 4 Decision tree architecture

Decision tree consists of 2 types of nodes, decision node and decision leaf. Decision node represents checking process based on an attribute and a leaf node represents a class in which data are grouped. Decision tree algorithm do not use distance vector to classify objects. It is used based on a list of attributes and values[12].

4. Data Source

We use the data set that we took from NOAA Earth System Research Laboratory[13]. NOAA provides various data set of CO_2, which is the data that is take with flask or directly method. If we choose the directly method, then NOAA provides two types of data set which is taken from surface or tower.

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Table 1 Data gathering

Temp (C°)	Humid (%)	CO_2 (ppm)	Longi-tude	Latitt-ude	Time
28.7	68.0	<400	-6.8534487	106.832405	04/20/2015 18:42:27
28.7	68.0	<400	-6.8534487	106.832405	04/20/2015 18:42:28
28.7	68.0	<400	-6.8534487	106.832405	04/20/2015 18:42:29
28.7	68.0	<400	-6.8534487	106.832405	04/20/2015 18:42:30

NOAA provides data measurements directories. These directories contain atmospheric Carbon Dioxide (CO_2) Dry Air Mole Fractions from quasi-continuous measurements at Barrow, Alaska (BRW); Mauna Loa, Hawaii (MLO); American Samoa (SMO); and South Pole (SPO), 1973-2013.

We used NOAA's CO2 data that were taken directly from the surfaces. We choose the directly method from the surfaces data because it is similiar with the next step of our research that will measure the data directly from surfaces.

5. Simulation Result

5.1 Preprocessing

In this stage, CO_2 data is preprocessed to remove error values that is caused by errors from the sensors. The value of error can make fatal effect for the learning.

5.2 Result

Table 2 Sensor location

Site	Code	Long	Lat
Barrow, Alaska	BRW	71.323	-156.6114
American Samoa	SMO	-14.2474	-170.5644
Mauna Loa, Hawaii	MLO	19.5362	-155.5763
South Pole, Antartica	SPO	-89.98	-24.8

As we can see in the table 2, each of the sensor placed in diferent area.

Table 3 Accuration result

Data-set	Linear Regression (LR)	Multi-layer Perceptron (MLP)	Decision Tree(DT)
BRW	73.5409	69.2872	**97.673**
SMO	90.9305	93.7758	**97.7142**
MLO	87.2583	89.4243	**97.4158**
SPO	92.9055	97.0713	**98.361**

In this paper, for processing the data we used Weka 3.7.11.0 using ten times cross validation and for error rate we used error from root relative squared error. From this point we could see that the DT learning is the most accurate compared to the LR and MLP algorithm.

5.3 Visualization

The chart below Fig 5-8 includes data training from 1980-2013 training set and 2014-2030 prediction. On the following visualization, we used four lines, blue line with dots are actual value, red line for regression linear, green line for MLP and the purple line for DT.

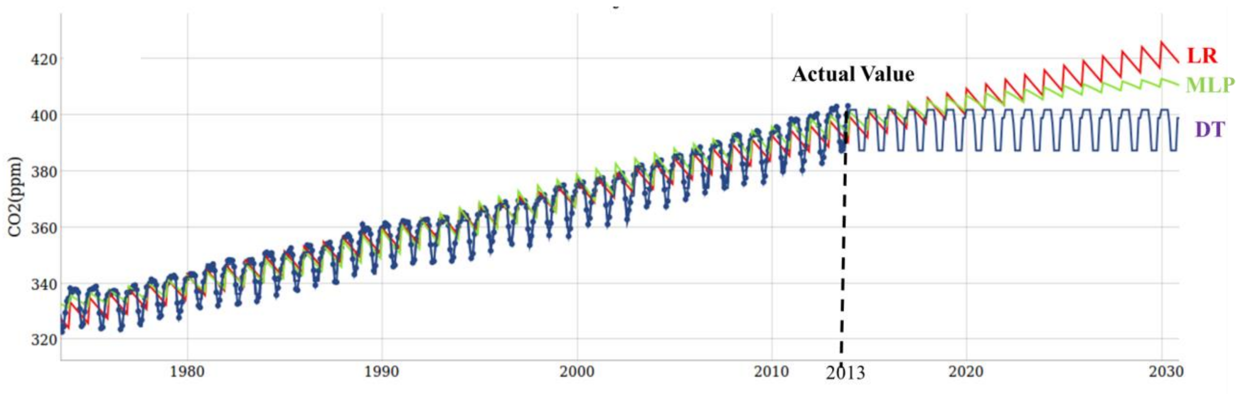

Fig 5 comparative prediction algorithm chart at BRW

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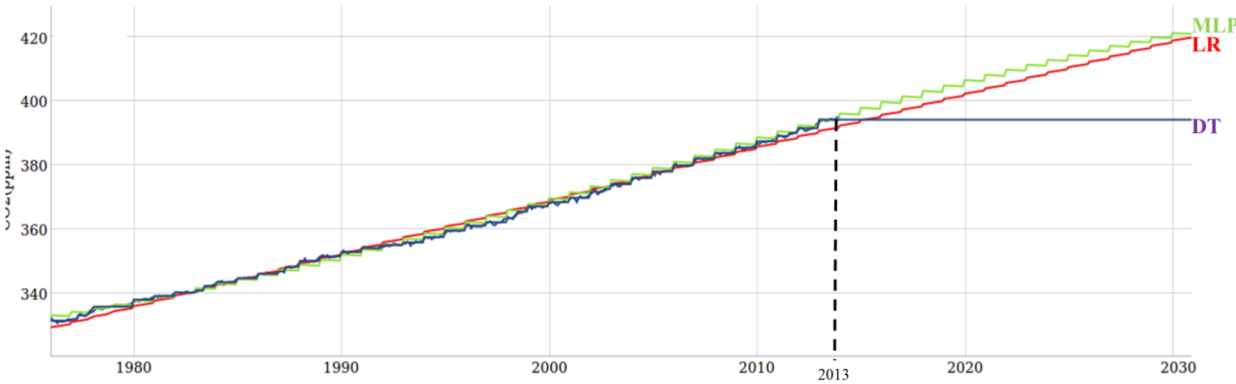

Fig 6 comparative prediction algorithm chart at SMO

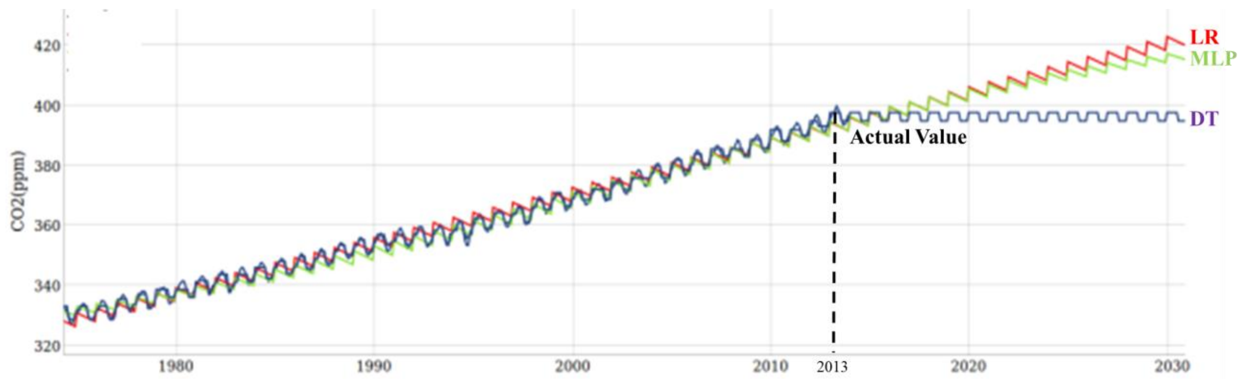

Fig 7 comparative prediction algorithm chart at MLO

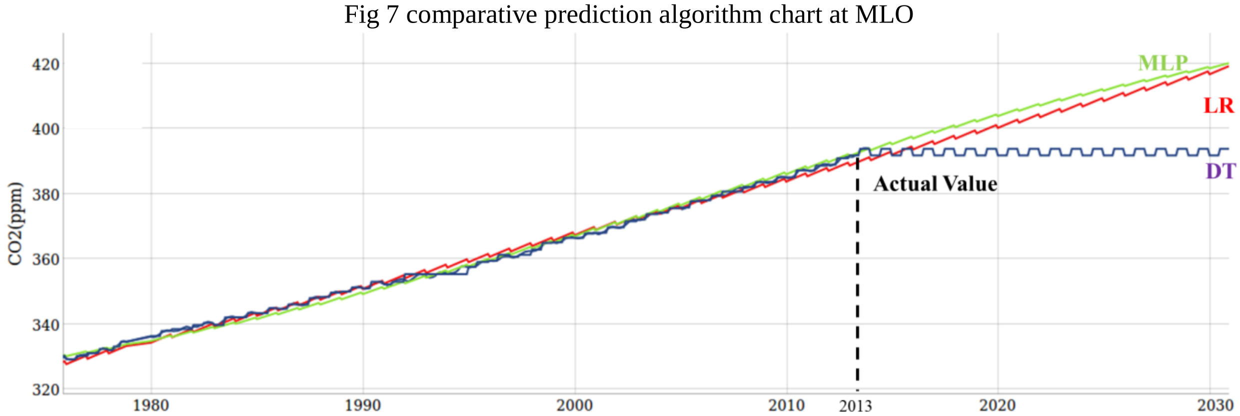

Fig 8 comparative prediction algorithm chart at SPO

In the simulation result, we used hourly data, but in the visualization section, we visualized the data from the monthly average of the hourly Data that were provided by NOAA. Because the hourly data are too big. It can’t be visualized clearly as itis too tight tight with one and another.

Fig 5 shows comparative variation result of CO_2 concentration value that were measured simultaneously from 24 July 1973 – 31 December 2013 in Barrow, Alaska alongside with predicted values of LR, MLP, DT algorithms. Moreover, the predicted values of three algorithm continue to predict the CO_2 concentration from 31 December 2013 – 2030.

Fig 6 is similiar to Figure 5. The difference lies in the place, which is American Samoa with higher population density and value measured begin from 1 January 1976.

Fig 7 shows CO_2 concentration value from 17 May 1974 – 31 December 2013 in Mauna Loa, Hawaii alongside with with LR, MLP and DT from 17 May 1974 – 31 December 2030.

Fig 8 the place is in the South pole and the measurement value showed from 25 November 1975

ISBN : 978-1-4673-7404-0

– 31 December 2013 alongside with 25 November 1975 – 31 December 2030 prediction with algorithm.

The actual value only occurs on begining till 2013. That is provided by NOAA. The begining – 2013 is used for training set by the algorithm. Then we used the model that was generated from training session for 2014 -2030 data.

6. Conclusion

From the result we can see that DT has stronger ability in data set learning better than the other two algorithms, but it was discovered that DT has overfitting problem. In fact, better learning algorithms, such as conjugate gradient, can furthermore lead to worse generalization[11]. So, in this preliminary study, we could not use DT as a prediction algorithm in our future work. Considering that LR and MLP, MLP relatively more accurate based on the results of the comparisons

7. Future Works

In the future, we will use the result of this evaluation of prediction algorithm for implementing CO_2 data prediction. Hybrid concept will be considered for better learning system accuracy improvement. Models that have been formed later will be modified to add the factor of algae as biological CO_2 absorbent.

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 ISBN : 978-1-4673-7404-0

Designing a Collaboration Form to Overcome Innovation Resistance in Waste Management Practices in Lampung Tapioca Industry

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***Abstract*—Waste management is an important innovation in environmental management. It has significant role for minimizing the effect of industrial activities. Unfortunately, this practice has not been fully adopted in Lampung tapioca industries. The purpose of this paper is to analyze innovation resistance among Lampung tapioca and industry in adopting waste management practices. This research offers collaboration form to overcome these barriers. According to Ram and Sheth's theory, five barriers namely usage, value, risk, tradition, and image barriers were used to investigate the impediment. A case study methodology were conducted with eight respondents which represent stakeholders in Lampung tapioca industry (academics, government, and tapioca firm). The data were collected through semi-structured interviews, field observation, and internal documents. The findings show that the awareness about waste management practices have been risen among stakeholders. It indicates with positive attitude toward usage barrier and value barrier. However, risk, tradition and image are the intense barriers to adopt waste management practices. They have found difficulties in technical and management aspect to implement waste management. This research has practical implications to decision maker and innovators in collaboration strategies to overcome resistance to innovations like waste management practices are discussed.**

Keyword: waste management, innovation resistance, tapioca industry, innovation adoption.

I. INTRODUCTION

LAMPUNG Province is well-known as the largest tapioca producer in Indonesia with 66 tapioca factories and 8.059.287 tonnes of tapioca starch production [1]. This industry has a significant positive impact on the regional economy; however, the tapioca industry discharges large amounts of waste from its processing that contributes significantly to environmental degradation. Mai [2] identifies the forms of waste that is generated from tapioca starch processing. This includes resource consumption, wastewater, solid waste, and air pollution. Tapioca waste treatment needs a large area for waste processing, and it creates a foul smell that can disturb residents [3].

Some strategies have been developed by key stakeholders (academics/research and development institutions, government, and local firms) to solve these environmental issues. For example, the Indonesian Environmental Compliance Public Disclosure Program (PROPER) was developed by the Government [4] which was informed by research activities from academics and research and development institutions [2,5]. However, the implementation of research innovation and environmental regulation compliance is still low. Based on PROPER assessment results in 2014, there were only 14 of the 66 Lampung Province tapioca processing plants that met the necessary compliances [6].

These failures are the result of a lack of information about environmental regulations and the research results that are available [4]. In Lampung Province, there are several parties that have knowledge and information about waste management practices; however, each stakeholder works independently which leads to overlapping roles and inefficiencies in the innovation adoption process and information sharing.

In order to find the best approach to overcome this situation, the decision maker must understand the impediments that may prevent tapioca industry for adopting waste management practices. The aim of this study is to explore the resistance of innovation in waste management practices in Lampung tapioca industry, while creates a collaboration form among stakeholders. First, the innovation resistance theory is explained. Second, the development of interviews and data collection are transcribed. Thereafter, the presentation of the results. Finally, the conclusion is drawn.

II. LITERATURE STUDY

A. *Waste Management Practices in Tapioca Industry*

The tapioca processing industry generates a considerable amount of waste and by-products. The environmental impact arises from the processes of cleaning, peeling, and extracting. According to Mol and Dieu [7], $10m^3$ – $20m^3$ of waste water that contains high levels of biodegradable organic materials is released per ton of tapioca starch processed. Moreover, Mol and Dieu [7] analyzed the characteristics of wastewater from tapioca processing with values of 55-200 kilograms of BOD, 130-500 kilograms of COD, 40-140 kilograms of suspended solids, 0.2-0.6 kilograms of phosphorus, and 3-10 kilograms of nitrogen. To produce tapioca starch, roots are peeled, washed, chipped, pressed, grounded or milled, dried, and then sieved. The tapioca starch produced contain around 15 – 19 % moisture content [8]. Fresh cassava roots are then transported to the cassava mills. Several processing stages are involved in the cassava starch extraction process. The tapioca processing stages are shown in Figure 1.

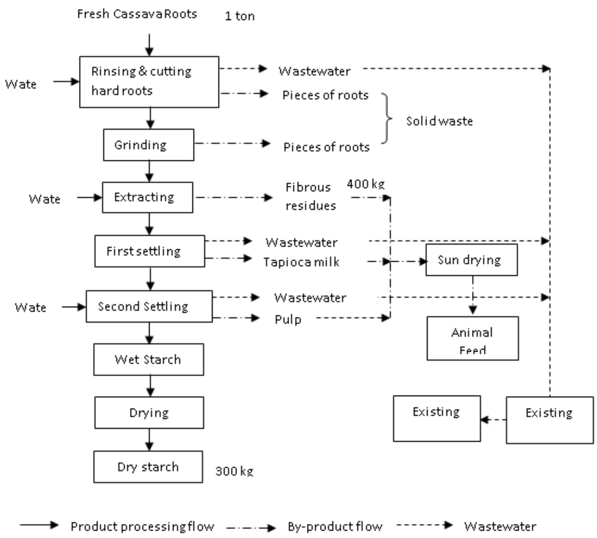

Figure 1 Process in tapioca mills [7].

The study variables include the reuse and recycling of water, use of biogas from wastewater, and technology modification for efficiency in the production process. A systematic methodology was adopted to analyse the implementation of cleaner production. The research methodology consists of four steps:

(1) Analyzing the current situation and collecting information associated with four key factors (water consumption, electricity consumption, fuel oil consumption, and starch loss)

(2) Evaluating and measuring the four key factors by calculating material mass and water mass balances

(3) Selecting an appropriate approach for minimizing the amount of waste generation based on four key factors calculation, and

(4) Designing and implementing potential clean technology options for the tapioca starch plants.

The result of this study show that clean technology implementation in the eight selected tapioca starch processing plants can successfully reduce water consumption and enhance wastewater energy recovery. However, the clean technology approaches that have been offered were only based on material mass and water mass balance calculations. This is more about the technical issues. There were limitations and weakness in this study. For example, the study did not mention the process of clean technology implementation in tapioca starch plants that involves the implementation process and clean technology adoption.

B. *Barriers in Innovation Adoption*

Some studies identify that many organisations experience challenges in adopting innovative products or technologies [9-11]. Users consider innovation as a new way for implementing changes. However, resistance to change is a common response from customers before the adoption of innovation begins [10]. For example, see the study by Laukkanen et al. [10] which investigated innovation resistance among mature consumers in mobile banking. This research followed Ram and Sheth [12] "Innovation Resistance Theory". An internet survey was conducted with 1525 respondents, of which 370 respondents represented mature costumers (over 55 years) and 1155 respondents represented young customers. Based on Ram and Sheth's [12] framework, the Innovation Resistance Theory is divided into five categories:

- Usage barrier
  The usage barrier is associated with the utilization of innovation. These barriers arise when an innovation is not well-matched with customer requirements, in term of habits or practices.
- Value barrier
  The value barrier is related to comparing performance with price. It occurs when an innovation does not show great performance-to-price compared with other products.
- Risk barrier
  Uncertainty is always attached with innovation; therefore, risk cannot be avoided by customers. The risk barrier refers to the consequences that customers may be exposed to should they accept an innovation [10].
- Tradition barrier
  The tradition barrier occurs when innovation gives effect in daily routines. Consumers may be reluctant with an innovation because it changes their daily lives. Therefore, not all consumers have an interest with a new innovation.

- Image barrier
  The image barrier is linked with stereotyped thinking, it can be brand or certain identity of the product.
  By using this framework, Laukkanen et al. [10] suggests that the value barrier is the most significant barrier to mobile banking adoption for both elderly and younger users. However, the elderly have higher degrees of risk barriers to the use of mobile banking. This is due to more mature people not trying an innovation because it is complicated to use. Hence, banks need to develop promotional campaigns for demonstrating the advantages of mobile banking compared with conventional financial services.

III. RESEARCH METHOD

A. Data Collection

This study adopted a case study methodology with field observations and interviews for the data collection process. Field observation was conducted by visiting the tapioca processing plants to understand the natural process production of tapioca. Then, individual explorative interviews with a representative from the actor groups were arranged for identifying major themes. Semi-structured interviews were arranged with non-participant observation, supported by internal documents where possible. The semi-structured interview began with broad and open questions while exploring each respondent's story to get more insight into the topic. An interview guide was prepared based on the main research questions and keeping the interviews on track. A total of eight (8) interviews were organized, recorded, and transcribed. Each lasted between 45-60 minutes. Three tapioca processing plants represented business, two research institutions and one university represented academics, and two province councils represented government. In the next chapter, individual actors are identified by following codes: Tpp1-Tpp3 for tapioca processing plants, Aca1-Aca3 for academics, and Gov1-Gov2 for a government. Secondary data from institution internal documents was also collected to support the findings.

B. Data Analysis

The collected data was transcribed and organized based on research questions and themes. Standard techniques for a case study were followed Yin [13]. First, the interviews were transcribed with the Indonesian language, to get more understanding and minimize misperceptions. Second, data was clustered to produce more general codes and to identify themes. A coding method was used to organize interview data into a limited number of issues around the questions. Data from the field observations are also compared with the data from the interview. Third, data are divided into specific themes, in a term to capture different perspectives and interpretations. Therefore, it can answer the research questions. Fourth, the data analysis involved translated the interviews into English.

C. Validity

To support the validity of the findings, multiple sources of data were used based on Yin's [13] suggestions. Interviews, non-participant observations, and secondary data were used as data. These data resources were triangulated, and from an analytical standpoint, only those results are presented which are supported by multiple streams of evidence.

IV. RESULTS AND DISCUSSION

A. Current Waste Management Practices

From the data analysis, the main topic that occurs is the nature of waste management practices in the tapioca industry. According to the interviews with the key tapioca industry actors, simple waste management practices have been implemented in a tapioca processing plant, especially with reuse and recycling activities for solid waste. According to Sriroth et al. [14], the cassava slurry contains a high starch content (about 68% based on dry weight) and fiber (about 27% based on dry weight). Because of this high starch concentration, an animal feeder industry uses cassava slurry as a raw material. Another development in solid waste treatment is the utilization of cassava peel as biofertilizer. Cassava peel consists of two elements, an outer covering brown layer and an inner covering of parenchymatous. Both are lignocellulolytic components [15]. By using a particular fermentation process, the tapioca industry can produce biofertilizer from cassava peel. These following statements support the reuse and recycling practices in solid waste management:

In the words of Gov1: "It is true that the tapioca industry produces some waste from the process production. But, they can sell their solid waste to the market. Usually, cassava peels are used as raw materials for animal feed or compost, and the acid citrate industry needs cassava slurry as their primary material". Tpp1 adds: "20% of our cassava slurry production has been used as feed for waste water treatment, and we have sold the rest to the market. Another factory need cassava slurry as a material for traditional sauce, and cassava peel as a material for animal feed".

While solid waste treatment provides a positive trend, a different situation emerges in waste water treatment in the tapioca industry. The Majority of actors in the Lampung Province tapioca industry persist with conventional lagoon treatments, rather than using applied biogas reactors for further benefits. According to Gov1, only 10-20 tapioca processing plants from 66 factories are going further with new technology by converting methane from wastewater into biogas (a renewable energy resource). In the words of Aca1: "Most of them (tapioca processing plants) are using conventional lagoons like a big pond

 ISBN : 978-1-4673-7404-0

with long time detention, at least 3-5 months for processing treatment". However, some of the tapioca processing plants have implemented or modified their waste water treatments to get more benefit from waste water. Tpp1 says: "Nowadays, lagoon treatment is used in our factory. But, we have modified this treatment with a mixing tank reactor. Tpp2 adds: "Before 2012, we were using lagoon treatment for our waste water. But since 2012, a biogas plant is now effectively used in our factory".

B. Innovation Resistance in Waste Management Practices

Rogers [16] assumes that all innovations are accepted and adopted by users. However, innovation means change for users, and this could result in resistance as a response to change before the adoption process begins. The tapioca industry actors may have their reasons for resisting innovation for their products. Based on innovation resistance theory [12], some factors are identified as potential impediments to Lampung Province innovation adoption of waste management:

- Usage barriers
  The usage barrier commonly relates to service utilization and consumer requirements. From the interviewee feedback, it seems that usage barriers are not the main obstacle to adopting good waste management practices. All the stakeholders have an interest in implementing new technology. Tpp1 says: "Now, we use conventional lagoons for our wastewater treatment, but since we have heard of the success stories from another factory, we decided to install a biogas converter". On the other hand, the respondents may have found difficulty in the first implementation of new waste management practices. As mentioned by Tpp3: "when the first time we tried the biogas reactor, there were so many trial and error experiences. We are a little bit afraid of using this technology".
- Value barriers
  The value barrier relates to a comparison of performance-to-price to substitutes. Some respondents feel that the relative advantage of waste management practices is high from their point of view, since they get added value from waste. Ramsey, Ibbotson and Mccole [11] states that firms are profit driven, therefore firms compare benefits and costs of technology use before making a decision in adopting a technology. The new trend shows that waste does not become a burden for cost production but can give benefits, such as additional income from selling cassava peel and cassava slurry, and energy from wastewater. Nevertheless, some interviewees revealed that a financial burden is a barrier for implementing the innovation production. In the words of Aca2: "Basically, they (the tapioca processing plants) understand the advantages of good waste management practices, but we cannot deny that the investment for new technology in waste management is expensive". This research suggests that some respondents felt that high investment in waste management implementation is the main issue against innovation adoption.

- Risk barriers
  The risk barrier refers to the risk that users are exposed to when using innovative technologies. Laukkanen et al. [10] stated that inventors should notice that risk is a user perception rather than a product characteristic. Some tapioca processing plants fear that they might make mistakes when applying new technology for the first time, especially for SMEs. Sometimes SMEs do not have the financial or technical resources to adopt innovation [9]. For an SME tapioca processing plant, human resources are a key problem in the innovation adoption process. These firms have high dependencies with the owners for adopting new innovations. In the words of Tpp3: "as an owner, I have to know everything about this factory. This includes knowledge about how to manage our waste. I come to a workshop or sometimes the Government invites me so I can learn new things, then I can share it with my workers. Most of my workers only graduate from high school; they do not have any idea about how to manage waste". These practices increase the risks even though the owners have supervised the innovation adoption transfer from their thoughts to their workers. However, these risks can be minimized by employing a consultant or having a discussion with experts. In the big tapioca processing plants, innovation adoption runs more smoothly and there is less risk because the larger firms have better infrastructures and human resources.
- Tradition barriers
  The tradition barrier implies the change caused by innovation in daily routines. Johnson [9] explains that the adoption of technology is a gradual process and it is time consuming. Adopting new waste management practices mean changing daily routines. For example, by implementing a biogas reactor, Tpp2 and Tpp3 have to change their production lines and train their workers to get used to the technology. Based on the situation in Tpp2, this requires training for workers not only for introducing the technology but also for changing their attitudes toward technological innovation. Studies have reported that technology adoption will succeed if there is support from top management [11]. As several interviewees affirm, "management policies become important issues".
- Image barriers
  The image barrier refers to stereotyped thinking that can hamper innovation adoption. The image barrier in waste management practices emerges from waste management behaviours. On the one

 ISBN : 978-1-4673-7404-0

hand, the tapioca processing plant operators perceive the implementation of waste management to be too complicated to apply because they have to change their organizational habits. Tpp1 reports: "Before we have our kick start in new waste management next year, we have to change our installation system, habits, and perspectives. It is not an easy job, big homework for the company". On the other side, the adoption of waste management practices will lead to good reputations for the company since the awareness of environmental issues has risen recently.

Other than five barriers based on innovation resistance theory, this research has found other obstacles to the adoption of waste management practices. From the interviews, the researcher noticed that there was an emerging problem related to joint research activities among stakeholders. As regards funding issues, the R&D institutions point out disagreement about the ownership of intellectual property. Aca1 says: "There may be disagreements occurring over the ownership of an innovation product that has been produced from research activities. They want to own that product for free and do not want to pay for the intellectual property for our researcher". This situation may appear because of unclear contractual agreements between the two sides.

C. *Collaboration Form of Innovation Adoption*

One aspect that researchers believe encourages the innovation adoption process in waste management practices is the collaboration of stakeholders. They feel that stakeholder interactions will improve if the role of stakeholders and form of collaboration are clearly defined. In Lampung Province, collaboration involves several parties such as the tapioca processing plants, government, and academics or R&D institutions. Each stakeholder has its role description that is listed in the regulations or legislation, especially for Government, academics,or R&D institutions. However, problems can emerge during the information sharing process.

According to Regulation of Lampung Governor No. 33/ 2010, the Environmental Monitoring Agency has a role in coordinating, facilitating, mentoring, and reviewing environmental management in Lampung Province. These roles include providing technical assistance and consultancy about environmental issues for the industry and society. However, it is found that a coordinating role has not worked in the field. Another organization that has involvement in the innovation adoption process is the Regional R&D institution. The Regional R&D institution has a role in developing technical policies for research and development; and providing advice to the local government based on scientific studies. Nevertheless, the presence of this institution is not perceived well by another stakeholder. Aca2 says: 'There is a poor role from the Regional R&D institution to coordinate and manage the innovation in this province. They do not even have a database for innovation'. For this reason, the tapioca firms had difficulties getting information about innovation.

Academics and R&D institutions have roles as a center of knowledge. In Indonesia, academics have three main roles that are called "Tri Dharma". Tri Dharma defines the three main roles of universities: Education, research and development, and community service. The R&D institution also has a role for conducting research and development activities. These situations raise a problem in the overlap of innovation products. It is often found that R&D institutions and academics organize almost similar research, especially for the most demanding topics such as alternative energy sources from tapioca waste water. Aca2 mentions: 'It happened with us. A few years ago we arranged research about biogas in Pesawaran district, then we got information that the R&D institution from the Ministry of Energy and Mineral Resources did the same research in another tapioca plant'. It indicates lack of information sharing among stakeholders.

Another issue in cross-actors information sharing is business competition among the tapioca plants themselves. It prevents them from sharing information about new waste treatments. Nowadays, many international organizations give funds or grants for carbon markets. Each tapioca plant makes a proposal to get funding by creating waste management strategies. Therefore, they keep information from competitors.

Based on the description of the role of stakeholders, the collaboration form among stakeholders can be arranged as seen in Figure 2.

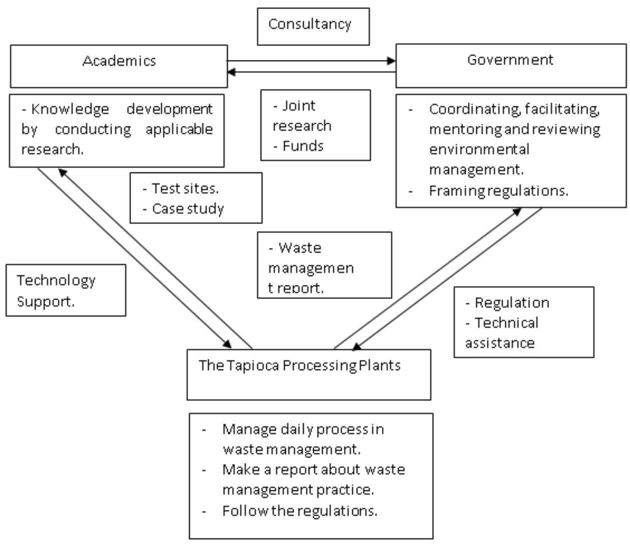

Figure 2. The Collaboration Form of Innovation Adoption in Waste Management

ISBN : 978-1-4673-7404-0

V. CONCLUSION AND RECOMENDATION

When majority of research have discussed about the success of innovations and factors driving to adopt, the innovation resistance theory explains the reasons that impede adoption of innovation. Waste management represents one of the recent innovations in the environmental issues. Today, companies realize by adopting waste management, they reduce not only pollution but also gain benefits from waste [17]. However, the adoption rates of waste management in Lampung tapioca industry are significantly low. Environmental Compliance Public Disclosure Program (PROPER) result in 2014 has reported that there were only 14 tapioca processing plants out of 66 tapioca processing plants that met regulation compliances.

The initial findings found that stakeholders have concerns about waste management practices. The results showed that the usage barrier and value barrier are not the reason for tapioca industry for not adopting waste management. They are understand about this issues and have interest to adopt waste management practices into their daily process. Tapioca processing plants in Lampung Province aware about the benefits and value that they will get from the tapioca waste. For example, waste water for biogas, and tapioca slurry as raw material for biofilm. Though, risk, tradition and image barriers are significant barrier to waste management adoption among Lampung tapioca industry. This means that innovation users consider that the innovation is uncertainty process of trial and error, and time consumed. In this respect, stakeholders could develop collaborative action among stakeholders by sharing the role in innovation adoption process, based on the fact that innovation is an inter-disciplinary proccess. Government plays role as mediator and innovation broker by framing regulations, and controlling and monitoring waste management practices. Academics as an innovation producer can provide their experts through coaching or mentoring to help tapioca processing plant in adopting new innovation. While the tapioca processing plant itself become innovation user or funds provider. They have role to manage daily operation of waste management and to share the experience on the field.

The scope of this study was limited which leads to typical findings due to it is difficult to be generalized to other cases. However, the result would be important to provide the foundation for future research in the development of innovation adoption strategies. As a suggestion for further improvement, the study needs to use more respondent. For primary data collection, a quantitative method such as survey or questionnaire can be used to get more representative respondents. More detailed in process production will be needed in the background to get more understanding about the nature of tapioca industry. Another actor should be involved as a respondent to get their perspective.

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ISBN : 978-1-4673-7404-0

Pollution Reducing Opportunities for a Natural Rubber Processing Industry: A Case Study

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***Abstract*— One of the problems associated with natural rubber processing is the environmental problems created by the use of large amounts of water, together with energy and chemicals that pollute the environment. An environmental innovation is considered as a strategy to address the environmental impacts better than a conventional end-of-pipe treatment. This research aims to explore the opportunities of pollution prevention that have not been implemented yet in a natural rubber processing industry. This study used a Case Study approach on a small and exploratory scale, with data collected from interviews and observations. The results show that the environmental issues that are related to factory's daily operation that consists of water usage, accumulation of unprocessed material, the use of ammonia and the use of inorganic fertilizer. Some preventive strategies to overcome the environmental issues namely: reuse of the wastewater, efficiency of water usage, material substitution, and good housekeeping. The results of this study suggest the recommendation to overcome some specific environmental issues of a particular natural rubber industry that could be an appropriate template for broader study.**

I. INTRODUCTION

Indonesia is the second largest natural rubber producer in the world after Thailand [1] with approximately 26 % of the world's natural rubber needs is supplied by Indonesia [2]. The main types of natural rubber products in Indonesia are: crumb rubber, rubber sheet (Ribbed Smoked Sheet or RSS), concentrated latex, and crepe [3]. As one of the main commodities of the agricultural sector, Indonesia's natural rubber industries create attention with respect to the magnitude of potential wastewater, solid waste, as well as odor emissions resulting from the production processes chain [4].

Compliance with environmental laws in a country is one of the factors driving innovation opportunities within a company. It is intended to encourage the company and all its elements to use the technology, materials and processes that are more environmentally friendly [5]. Therefore, it is necessary to improve the environmental management performance through an innovation [6]. Innovation that aims to reduce environmental impacts is called environmental innovation [7]. The innovation could be on the process, product, marketing or organization [7]. While based on the approaches are used, the environmental innovation can be distinguished into two types i.e. reactive and preventive strategies [8]. Even though an end-of pipe treatment facility is able to comply with the effluent standards, the type of environmental strategy is seen as an uneconomic treatment and cannot anticipate changes in environmental issues in the future [9]. Therefore, it is necessary for industry to start looking for proactive strategies replacing the conventional waste management with the pollution prevention efforts at the sources.

Given the situation, the purpose of this study is to explore the opportunities for pollution prevention practices in a natural rubber company. Therefore, the research question that posed in this study is:

"What are the pollution prevention strategies to innovate the existing environmental practices?"

This question intends to explore the opportunities for environmental practices improvement based on the identified environmental impacts and company's situation.

II. POLLUTION CONTROL FOR NATURAL RUBBER INDUSTRIES

Some characteristics of the waste or pollution associated with the processing of the intermediate

Manuscript received 20 July, 2015.
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ISBN : 978-1-4673-7404-0

products of natural rubber are: 1) high concentration of biochemical oxygen demand (BOD), chemical oxygen demand (COD) and suspended solids (SS) in the wastewater, 2) acidic effluent, 3) high concentration of ammonia and nitrogen compounds, 4) high level sulphate, and 5) high level of odor [10]. The untreated wastewater from natural rubber production can contaminate ground water and surface water [11]. In addition to water pollution, environmental impact is also caused by air pollution, for the example, odor and smoke particles from the production process of the RSS rubber [12]. In addition to air pollution from the production process, air pollution also comes from anaerobic wastewater treatment system due to the release of methane as a greenhouse gas [13]. With the strict environmental requirements and sanctions system from the Ministry of Environment, some medium and big business implement waste management systems. The wastewater that is discharged from the treatment facility must meet the quality of Ministry of Environment’s Decree No. 51 Year 1995 [14]. To comply with the regulation, the company must provide a sewage treatment unit to meet the required standard [15]. However, majority rubber industries in Indonesia are using conventional lagoons system to treat their wastewater, that requires long retention times and large area [16].

III. Pollution Prevention

Some environmental approaches to deal with environmental pollution in industries include: (1) the end-of-pipe approach, (2) pollution prevention or total quality management (TQM), (3) product stewardship, and (4) sustainable development [17], [18]. A company is said to be environmentally innovative if they meet one of the several criteria such as the integration of environmental criteria into the design process or product, improvements in waste management and recycling process for either internal or external [19]. The shifting from reactive into pollution prevention strategy show higher level of proactivity in terms of environmental management strategy in a company. This includes an environmental innovation in process [20]. Pollution prevention is reduction or elimination of pollutants creation at the sources, not when the waste is already formed [21], [22]. Some activities that are categorized as pollution prevention include the substitution of raw materials, spill and leak prevention, modification processes and equipment, modification of products, and so forth [23].

IV. Data and Methodology

A. *Conceptual framework and case study*

In seeking the innovative environmental strategies, it is necessary to conduct the identification and prioritization of key environmental issues for the determination of the resources and actions required [24]. After that, a more detailed examination of the status and performance of environmental management are required. Thus, to determine the areas and corrective actions, it is necessary to review the existing environmental management system in the company. This review may consist of the amount of natural resources used during production processes, and the amount of waste that is formed along with the potential environmental impacts that may result.

Hence, research on innovative strategies and opportunities for environmental improvement will be done in a natural sheet rubber processing factory using the fumigation method. A case study approach was used to understand the findings [25], [26]. This approach also was taken due to the specific conditions of a company that leads to difference environmental impacts, environmental management [27] and relationship with the local environmental institution. The stages in this study consist of identification the source of pollution and practices that are not environmentally friendly, obstacles to pollution prevention efforts, and possible environmental innovations in achieving environmental improvements in the plant. This research was in a rubber processing company in Central Java Province, Indonesia which is called company X. The company manufactures quality rubber products such as RSS (ribbed smoked sheet) and cutting (pieces of rubber from the sorting process). This company employs 1,447 employees. Ribbed smoked sheet (RSS) is one of the processed products made from rubber plantations in Indonesia that occupies the second largest rubber products after crumb rubber or SIR (Standard Indonesian Rubber). The process of RSS rubber through smoking is more complicated than the manufacturing of crumb rubber that consist of nine stages [28].The stages in the RSS production from field latex are: raw materials handling before arrive at factory, reception of latex in the factory, dilution latex, coagulation, milling, draining, drying with fumigation, sorting, and packaging.

B. *Data Collection*

- *Literature Study*

By studying data from books, journals, research report, publications and documents that are relevant for this study. The documents that were studied include environmental regulations, the company's monthly production reports, and job training reports.

- *Interview*

The interview aims at generating primary data from source persons, who were selected through purposive method sampling [29]. The interviewees were selected based on their expertise in the rubber industry and

 ISBN : 978-1-4673-7404-0

environmental management. Therefore the total participants are 11 that consist of:

1) Two representatives from Ministry of Industry who handle agricultural industry and green industry policy.
2) Two representatives from environmental agency at the provincial level
3) Two representatives from R & D Agency pollution prevention
4) Two representatives from R & D Agency of natural rubber
5) Three representatives from the selected factory (includes director, technical manager, and employee)

The interview is a semi-structured interview, in which the main research questions were explored and combined with derivative questions from primary research questions, following the context of this study and the roles of the participants. The interviews with experts were held for thirty to sixty minutes which then recorded and transcribed.

- *Observation*

This stage focused on the performance of existing environmental management, to identify sources of pollution and their causes. Direct observation was performed at every stage of the production process to identify the practices that are inefficient and potentially cause environmental impacts in the company. At this stage a checklist was used during the observation process, which consists of the data about raw material consumptions; production process, numbers of employees, waste management system; and additional qualitative information as needed.

C. Data analysis

To support reliability of data, this study used a triangulation method from multiple sources that contributes to the confirm-ability of research findings [26], [30]. The key interviews and sections of interviews were transcribed and categorized [31]. Then the data analysis used explanatory approach with supporting literature and evidence [32].

V. Results and Discussions

A. Identification of potential environmental impacts

From the processing of smoked rubber products (RSS) and by-products (brown crepe rubber) in the company, the wastes that were generated are wastewater and solid waste. The liquid wastes are generated from water residue and washing equipment. While the solid waste consist of solid rubber and wood chips.

The environmental review aimed to take into the environmental effects associated with firm's activities in order to identify the most significant ones [33]. Data of the materials used for production are shown in the Table 1.

The potential environmental effects that can be identified in this rubber company namely:

1) Pollution by wastewater resulting from the production process that uses large amounts of water. The effluent of rubber wastewaters have negative impacts on the sediments, water body receiver and macroinvertebrate due to the content of pollutants such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), heavy metals and conductivity [34].
2) Air pollution that comes from burning wood to the rubber latex curing process. Burning the rubber firewood can cause smoke particles pollution if there are no proper ventilation systems [12]. It also has effect to the local residents. However, this concern is not significant because from the air monitoring results, it shows that the air quality still meet the regulatory standards.
3) Bad smell due to the accumulation of raw material that has not been processed yet in the secondary product unit. The odor is usually caused by organic matter in the raw materials and the amount of water that causes the decay process. As for odor control in factory environments can be performed by using liquid smoke, but it is still less optimal because it has not eliminated the source of the smell.
4) The use of ammonia. Ammonia is used to prevent coagulation latex at the time of collecting the latex, and prevent contamination of the latex [35]. Ammonia has a pungent odor, toxic, and corrosive to some materials [36]. With these characteristics, ammonia will impact on the health of the respiratory system of workers [12].
5) The use of inorganic fertilizers contributes to greenhouse gases. This is due to two reasons: 1). the process of making artificial fertilizers which is energy intensive; and 2) the application of fertilizer will release the gas N_2O [13].

TABLE I
List of material usage

No.	Material	Application	Unit	Volume
1	An organic fertilizer	Plantation	Liter	140
2	Water	Plant irrigation, production processes (dilution, coagulation, equipment washing)	m^3	69,546
3	Ammonia	Latex preservation and anti-precoagulation	Liter	475
4	Formic acid	Coagulation of latex	Liter	700
5	Rubber firewood	Smoking process	m^3	3,047
6	Electricity	Machines and equipment	kWH	53,173

B. Pollution prevention opportunities

From the identification of the existing processes and the interviews result, the improvements that are

ISBN : 978-1-4673-7404-0

required namely on the production process, handling of raw material and waste management systems. Therefore some solutions that can be proposed to prevent environmental pollution can be seen in the table 2.

Reuse of wastewater

With the quality of treated wastewater effluent that meets the Quality Standard according to the Ministry of Environment's Decree No. 51/1995 [14], there is the opportunity to use it for irrigation or secondary purposes. The end output of the wastewater treatment unit of processing of natural rubber in Thailand was reused for irrigation purposes in various rubber plantations and rice plantations through several experiments [37]. Some of these experiments used to test the impact on vegetables, rubber trees, as well as rice. They also suggest the feasibility of re-using wastewater for irrigation of cash crops plantation with the consideration of the economic value and organic nutrients contained in the effluent. However, in the context of Indonesia, the output of effluent reuse for irrigation must meet certain statutory requirements as stipulated in Government Regulation No. 82/2001 [38] on Water Management and Water Pollution Control. So, prior to its implementation, it is necessary for testing of the control plants for a year. In addition, as the company is big enough and has implemented an environmental management system, company X must consider the quality of effluent that still meets with the requirements for irrigation water quality standards issued by the Ministry of Environment.

Efficiency in water usage

Because to the large amount of water used, the company should conduct efficiency for water use. In this case it does not mean reducing the amount of water usage, but examining the efficiency of its use. This is in line with the manager's technique which is for example to warn employees to turn off the water taps when not needed. Although the boss is still a very necessary role in the supervision of its implementation, the employees show a cooperative attitude to implement management directives.

Raw material substitution

According to the engineering manager that one of the main pollutant of concern is the use of ammonia. Ammonia is used to freeze the latex. Liquid smoke is an alternative as a latex coagulant to replace ammonia. Liquid smoke is considered more environmentally friendly because it is made from a biomass through a pyrolysis process. The company has such resources given they own the rubber plantation and can utilize parts of rubber trees that have not grown to make liquid smoke. In addition, to reduce the emissions due to fertilizer, the use of organic fertilizer such as animal manure would be to replace synthetic fertilizer [13].

Good housekeeping

According to [22], good housekeeping is considered as a cost effective way to reduce pollution. Its implementation requires commitment and active participation of managers and employees. The practices consist of awareness of employees to use water, chemicals and fertilizer efficiently and carefully.

TABLE 2
POLLUTION PREVENTION OPPORTUNITIES

	Previous action and result	Change that less pollute
1	The use of chemicals such as ammonia and formic acid for latex coagulation.	Substitution of the chemicals with organic coagulant, for example with the use of liquid smoke from biomass that is more environmentally friendly.
2	Uncontrolled use of water when washing the latex freezing equipment.	The response of employees to close the water taps when not in use so as to prevent water wastage.
3	Treated wastewater flowed through the drain pipe end.	Study to reuse wastewater for secondary purposes.
4	The accumulation of unprocessed raw material in the unit byproducts causes bad smell.	Add more partitions in the fumigation chamber, to increase the capacity of curing and accelerating curing time, thereby reducing the accumulation of unprocessed material.
5	Rubber sheet drying time is for 21 days in the fumigation chamber.	Addition of drying time optimization rubber partition in the fumigation chamber, so that the drying time is faster and more products are produced.
6	The use of synthetic fertilizers in rubber plantations contributes to greenhouse gas emissions.	Cooperate with a rubber research center which has been producing organic fertilizer and fungicide.
7	The use of fertilizers in general.	Efficiency in the use of fertilizer by proper time and frequency fertilization, as well as the prevention of shedding of the fertilizer.

VI. Conclusion and Recommendation

This study examines the current situation of environmental management in a natural rubber processing company to explore the pollution prevention practices opportunities.

The prevention at the source consists of efficiency in water usage, raw material substitution, good housekeeping, and increasing production capacity.

These environmental improvement strategies cannot be generalized beyond the company where the conditions and characteristics differ by region. However, this design is an appropriate template for a broader based study. In addition, future research also needed to evaluate the effectiveness if the application of these strategies is implemented by the organization. The results of this research highlight the practical implications by optimizing employees' participation for environmental friendly practices. As the strategic implications, this research also assists the company's management in environmental decision making by conducting a feasibility study on an environmental project towards implementation. These results also suggest policy makers to assist industries in the environmental management and provide the industries with technical guide. Finally, the success of efforts to implement the pollution prevention practices requires active participation from all involved parties in the company, as well as optimization of the roles of relevant experts.

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ISBN : 978-1-4673-7404-0

Creating the Standard for Specific Energy Consumption at Palm Oil Industry

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***Abstract*— There is currently no standard for the Specific Energy Consumption (SEC) in the palm oil industry. SEC is a value that can be used as an indicator to measure the optimization level in the use of energy. Indonesia as one of the largest palm oil producing countries requires a standard for energy intensity in the palm oil industry. SEC in palm oil mill is defined in the amount of energy per unit of production (kWh/kg). The classifying method that has been used in this study is K-means cluster analysis with the measurement samples in 14 palm oil mills for 12 months of period. This study has suggested the SEC standard for Indonesian palm oil industry and it is expected to be SEC reference for other studies in the palm oil industry.**

I. Introduction

ENERGY supply crisis is now becoming a strategic issue in the national development. Growth in energy consumption as a result of increasing population, industrialization, transportation and welfare of the people is causing the imbalance between the energy demand and supply. Meanwhile, the main energy source such, as fuel oil and natural gas, has increasingly been depleted and the utilization of alternative energy yet optimized, so we need significant efforts in earnest to harness energy wisely and efficiently.

Energy conservation is the use of energy efficiently and rationally, without prejudice to the use of energy that is absolutely necessary. Efforts that we can do in energy conservation at all stages of utilization, involve the use of efficient technologies and the cultivation of energy-saving lifestyles. In practical terms the energy conservation efforts involve reducing the amount of energy used while producing the same or even better results. This effort can increase corporate profits, environmental value, national security, personnel security, and human comfort.

The initial step in the conservation of energy is the energy audit. The energy audit is a Specific Energy Consumption (SEC) among the outputs. The objective of the energy audit it self is to review the present energy consumption pattern and suggest ways and means for improving energy utilization by bringing about optimum energy balance and target for continuous improvement towards minimizing the SEC.

SEC standard formulation in this study is the result of processing the data obtained from energy audits in 14 palm oil mills throughout 2014.

II. Product Opportunity Gap

The identification of product opportunities should be the core force that drives companies. Product opportunity exists when there is a gap between what is currently on the market and the possibility for new or significantly improved products that result from emerging trends [1].

Fig. 1. Scanning SETE Factors leads to POGs

A product that successfully fills a Product Opportunity Gap (POG) does so when it meets the conscious and unconscious expectations of consumers

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ISBN : 978-1-4673-7404-0

and is perceived as useful, useable, and desirable. Successfully identifying a POG is a combination of art and science. It requires a constant sweep of a number of factors in three major areas: Social trends (S), Economic forces (E), and Technological advances (T) [2]. In this paper we added one more factor, which is Environmental impact (E).

In the early stages of an innovation journey, we must identify opportunities with SETE factors for product opportunity gap. After that, we must understand opportunities by value opportunity on product attributes / specifications. At the last stage of product planning, we must build the product concepts.

SETE factors for product opportunity gap are:

- Social trends: the trend of 'green lifestyle' which calls for the eco labeling of palm oil products
- Economic forces: how to give the value of sales in the global market with palm oil products that consume less energy
- Technological advances: trigger improvements towards energy efficient technology
- Environmental impact: setting the benchmark for the preparation of life cycle analysis (LCA)

While we get the opportunity value of the impact of societal influence connected to and addressed by the SEC standards, in which the people have environmental awareness. With the SEC reference standard, the people can identify mills that have high or low energy intensity. These SETE factors generates opportunities to set a SEC standards that can have an effect on the production process at the palm oil industry. The goal is to create an added value by identifying an emerging trend and to match that trend with the right tool.

III. Literature Review

The existing research in this area can be broadly viewed under two different perspectives of ‘plant’ and ‘process’ level. The first area, the ‘plant’ level perspective, has focused on the energy consumed by infrastructure and other high level services that are responsible for maintaining the required production conditions or environments. Examples of such energy consuming activities would be ventilation, lighting, heating and cooling within a facility [3]. Energy management systems (EMS) are commonly used to monitor these activities [4]. For example, Boyd et al. [5] utilises a statistical analysis approach to determine the manufacturing Energy Performance Indicators based on ‘plant level’ variables.

On the other hand, the research targeting the energy consumption at the process level has concentrated on individual equipment, machinery and workstations within a production system [6]. Substantial research has been targeted to document, analyse and reduce process emissions for a wide range of available and emerging manufacturing processes [7,8].

Overcash et al. [9] along with a group of other engineers are working to produce an engineering rule-of-practice-based analysis of separate unit processes used in manufacturing and the information is collated in the form of a unit process life cycle inventory (UPLCI) which would help the evaluation of manufactured products through the quantification of various parameters including: input materials, energy requirements, material losses and machine variables.

In addition, the specific energy of various manufacturing processes was previously summarized by Gutowski et al. [10]. They had develop generalised ‘equipment-level’ energy models, using average energy intensities of different manufacturing processes to evaluate the efficiency of processing lines. However, the considerations of energy flows at plant or process level cannot provide an overview of ‘‘how much energy is required to manufacture a unit product’’.

This study, though, will focus on the result of energy audit at the palm oil industry when characterizing the specific energy consumption. The approach in this research is based on a product viewpoint with the aim of representing the amount of energy attributed to the manufacture of a unit product of Crude Palm Oil (CPO).

IV. Method of Collecting Data

The audit process starts by collecting information about a facility’s operation and about its past record of utility bills. This data is then analyzed to get a picture of how the facility uses—and possibly wastes—energy, as well as to help the auditor learn what areas to examine to reduce energy costs. Specific changes—called Energy Conservation Opportunities (ECO’s)—are identified and evaluated to determine their benefits and their cost-effectiveness.

These ECO’s are assessed in terms of their costs and benefits, and an economic comparison is made to rank the various ECO’s. Finally, an Action Plan is created where certain ECO’s are selected for implementation, and the actual process of saving energy and saving money begins.

To obtain the best information for a successful energy cost control program, the auditor must make some measurements during the audit visit. The amount of equipment needed depends on the type of energy-consuming equipment used at the facility, and on the range of potential ECO’s that might be considered. For example, if waste heat recovery is being considered as in palm oil mills, then the auditor must take substantial temperature measurement data from potential heat sources.

The auditor collecting data on energy use, power demand and cost for at least the previous 12 months.

 ISBN : 978-1-4673-7404-0

Twenty-four months of data might be necessary to adequately understand some types of billing methods. However, in this study the data is collected for only 12 months of period.

Bills for gas, oil, coal and electricity should be compiled and examined to determine both the amount of energy used and the cost of that energy. This data should then be put into tabular and graphic form to see what kind of patterns or problems appear from the tables or graphs. Any anomaly in the pattern of energy use raises the possibility for some significant energy or cost savings by identifying and controlling that anomalous behavior. Sometimes an anomaly on the graph or in the table reflects an error in billing, but generally the deviation shows that some activity is going on that has not been noticed, or is not completely understood by the palm oil company.

V. Creating The SEC Standard

SEC is a value that can be used as an indicator to measure the level of optimization in the use of energy. Indonesia as one of the largest palm oil producing countries requires a standard for energy intensity in the palm oil industry. SEC in the palm oil mill is defined in the amount of energy per unit of production (kWh/kg). The classifying method that was used in this study is the K-means cluster analysis with the measurement samples in 14 palm oil mills for 12 months of period (168 data). SEC data used in this study are as follows:

TABLE I
SEC Data for Plant 1 - 7

No	SEC (kWh/kg)						
	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Plant 7
1	4.26	5.26	4.55	4.77	4.65	5.26	4.55
2	4.22	5.08	4.66	4.85	3.13	5.08	4.66
3	4.12	5.13	4.66	4.71	4.69	5.13	4.66
4	4.12	5.07	4.74	4.74	4.73	5.07	4.74
5	3.59	5.17	4.76	4.77	4.75	5.17	4.76
6	4.09	5.07	4.66	4.66	4.57	5.07	4.66
7	4.51	5.04	4.54	4.62	4.74	5.04	4.54
8	4.18	4.86	4.79	4.64	4.59	4.86	4.79
9	4.83	4.99	4.68	4.63	4.64	4.99	4.68
10	5.08	5.05	4.70	4.58	4.75	5.05	4.70
11	4.71	4.65	4.74	4.56	4.77	4.65	4.74
12	4.39	5.72	4.73	4.54	4.73	5.72	4.73

TABLE II
SEC Data for Plant 8 - 14

No	SEC (kWh/kg)						
	Plant 8	Plant 9	Plant 10	Plant 11	Plant 12	Plant 13	Plant 14
1	4.78	4.74	6.38	4.82	4.52	6.16	5.32
2	4.99	4.76	6.44	5.08	4.74	6.18	5.38
3	4.62	4.73	6.17	5.12	4.73	6.03	5.18
4	5.78	4.79	6.01	5.18	4.62	6.06	5.16
5	7.21	4.75	6.15	5.06	4.61	6.15	5.36
6	8.53	4.88	5.99	5.28	4.65	6.04	5.45
7	7.72	4.75	6.13	5.79	4.63	6.01	5.81
8	5.91	4.84	5.85	5.27	4.55	5.78	5.72
9	5.41	4.73	6.21	5.08	4.58	6.84	5.88
10	5.42	4.76	6.21	4.75	4.51	6.05	5.75
11	4.95	4.95	6.11	4.85	4.52	5.65	5.85
12	5.52	4.76	6.35	4.84	4.43	6.12	5.24

From the SEC data, we can made a scatter pattern as the following picture:

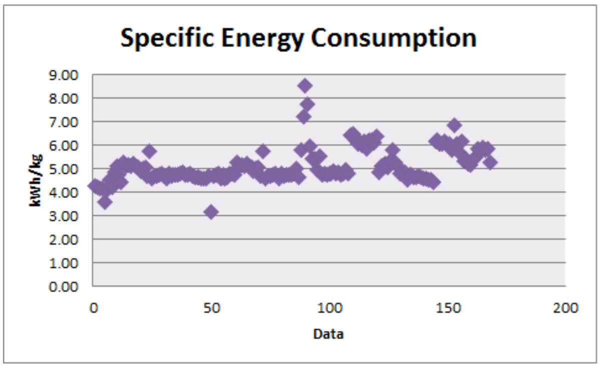

Fig. 2. SEC Scatter Pattern

With K-means cluster analysis as a classifying method, at the initial stage we classified existing data into 3 clusters with the hope there would be three levels of the SEC; those are low, medium and high level of SEC. The initial cluster centers that were obtained are as follows:

- Cluster 1: 8.53
- Cluster 2: 3.13
- Cluster 3: 5.85

After 6 times of iterating, we obtained the final cluster centers as follows:

- Cluster 1: 6.16
- Cluster 2: 4.01
- Cluster 3: 4.84

The member in the first cluster is 38 data, the second cluster is 9 data and the third cluster is 121 data. Thus we can identify the SEC standards for palm oil industry which amounted to 4.84 kWh/kg with the low-value SEC (energy efficient) at 4.01 kWh/kg and high-value SEC (energy inefficient) at 6.16 kWh/kg.

VI. Conclusion

Currently there are limited references which can be used in formulating energy conservation strategy and life cycle analysis. SEC standards in the palm oil industry are expected to be an early innovation towards the making of energy efficient technology and life cycle analysis in the palm oil industry.

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 ISBN : 978-1-4673-7404-0

Effects of Palm-Dea Non-Ionic Surfactant as an Additive in Buprofezin Insecticide on the Efficacy of it in Controlling Brown Planthopper Rice Pest

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***Abstract*—Brown planthopper or BPH (*Nilaparvata lugens*) is still regarded as a major pest in rice cultivation because the damage it causes is quite extensive and almost occurs in every cropping season. The use of pesticide is one of the measures that can be taken to control this pest. In the insecticide formula, surfactant plays a role in increasing the penetration of active compound into the host plant and the target pest and spread it all over the plant tissues. One type of surfactant potential to be used for BPH insecticide applications is diethanolamide (DEA) surfactant. This study was aimed at assessing the effects of the use of a non-ionic DEA surfactant made of palm oil methyl ester as an additive in buprofezin insecticide on the efficacy of the insecticide to control BPH pest. Results showed that the addition of non-ionic DEA surfactant gave significant effects on the efficacy of buprofezin in controlling BPH pest. A probit analysis as part of toxicity test was then done to determine the optimal concentration of non-ionic DEA surfactant to improve the efficacy of Buprofezin insecticide. It was shown that the addition of DEA surfactant of 6% was the most optimal in improving the efficacy of Buprofezin insecticide to control BPH pest.**

I. INTRODUCTION

BROWNplanthopper(*Nilaparvatalugens*) is stillregardedasa majorpestand widely distributed in all rice growing areas in Indonesia. BPH is of particular importance, because it is responsible for the transmission of rice viruses which are called grassy stunt, ragged stunt, and wilted stunt viruses [1]. The pest feeds directly on the growing plant, reducing its yield potential. If the pest density is high, the plant dies and a condition known as hopperburn result [2].

Rice breeders have made many attempts to develop resistant varieties. However, resistant breaker strains of planthoppers have easily appearedin Indonesia. As the main rice pest, planthopper is an insect with high genetic plasticity making it able to adapt to various environment in short time. This is proven by the appearance of new biotype/population that can break the resistance of rice plants to BPH [3]. This has made farmers keep relying on insecticides to control BPH. In Indonesia, MIPC(2-(1-methylethyl)phenylmethylcarbamate) and cypermethrin were tested for brown planthopper. The insect population increased more than the control when cypermethrin was sprayed [4]. Therefore, it was stipulated in the Republic of Indonesia Presidential Instruction No. 3 Year 1986 on the Development of Brown Planthopper Control in Rice Plants, that buprofezin was the effective active ingredient to be used. Buprofezin is an insecticide that interfere chitin biosynthesis process. Chitin is an important part of an insect body that is difficult to destroy. Chitin also plays an important role in the development of insects. According to Dean *et al.* (1998), the impairment in chitin of an insect might cause a death to the insect during the molting process. Insecticides containing active ingredient of buprofezin has an effective ability to control plant pests and diseasesbut a narrow spectrum.

To improve the efficacy of buprofezin insecticide, producersoften add additive materials including binder, wetting agent, homogenizer, and others. These additives are commonly made from surfactants of fossil fuel origin and imported surfactants such as etoxylate. [6]found that non-ionic DEA was another type of surfactant that could function as a binder, wetting agent, and homogenizer in an insecticide. DEA surfactant can be synthesized from palm oil through the amidation process with diethanolamide using a palm methyl ester or fatty acid path. The abundant availability of palm oil in Indonesia is a potential for the development of DEA surfactant that can be used a binder, wetting agent, and homogenizer of insecticides including buprofezin.

This study was aimed at assessing the effects of assessing the effects of the use of a non-ionic DEA surfactant as an additive in buprofezin insecticide on the efficacy of the insecticide to control BPH pest.

II. Methods

The study was conducted at the laboratory of Surfactant and Bioenergy Research Center (SBRC) IPB and Pest Laboratory of Indonesia Center for Rice Research(ICRR) in February to November 2014. DEA surfactant was synthesized from palm methyl ester olein at SBRC IPB laboratory by using a method as described in [7]. The formulation was 10% buprofezin insecticide which was mixed with Solvesso 150 solvent, synthesized DEA surfactant, and water. A single factor, namely DEA concentration in insecticide formulations, was used. DEA surfactant concentrations included 4% (formula 1), 6% (formula 2), 8% (formula 3), and 10% (formula 4). Insecticide formulation process was done by using a WiseTis HG-15D homogenizer. Stirring was done for 1.5 to 2 hours at a speed of 450-550 rpm. Insecticide formulas were then analyzed for their density and surface tension. Density measurement was done by using an Anton Paar TAAR DMA 4500M density meter while surface tension was measured by using a Spinning Drop Tensiometer TFX 500C.

Performance test and insecticide formula selection were done at Indonesia Center for Rice Research, Sukamandi. Insecticide activity was tested by using a feeding method (leaf dip/leaf residue method) [8]. Each insecticide formula with DEA inclusion was tested at water concentration of 0.25, 0.5, 0.75, 0.1, 1.25, 2.5, 5, and 10 cm^3. The performance of insecticide formulas was compared with those of two controls, namely water only and commercial buprofezin containing similar amount of active materials, namely 10% buprofezin.

The leaves of Ciherang variety rice were used. Ciherang rice seeds were grown in a seedbed for 20 days. The seedbed was placed in a green house and was covered with gauze fabric to avoid pest, especially brown planthopper, attack. After 20 days, seedlings were, one by one, taken out from the seedbed and cleaned from soil attaching to them. Every single cleaned seedling was then dipped into insecticide solutions of different concentration for 30 second before it was air dried. Thereafter, roots of every two dried seedlings were covered with tissue paper in such a way so that no crevice was found. Ten BPHs obtained from ICRR Sukamandi paddy field were placed in a reaction tube containing rice seedlings. The tube was then covered tightly with gauze fabric. The mortality rate of BPHs was observed in 24, 48, and 72 hours after application.

A completely randomized design with five replicates was used. Data were subjected to an analysis of variance (anova) and a Duncan test. The anova was conducted by using SAS statistical program package (SAS Institute 2002-2003). Probit analysis to determine LC 50 values [9] was done to select the best insecticide formula.

III. Result and Discussion

A.Properties of Formulated Insecticides

Insecticide formulas were tested for their density and surface tension properties. The results are shown in Table 1. The inclusion of DEA by 4, 6, 8, and 10% resulted in insecticides with similar density levels of 0.97 kg/m^3. Surface tension levels were found to range from 26.79 to 28.57 dynes/cm. Insecticide formula with 4% DEA had the highest surface tension (28.57 dynes/cm). Low surface tension level found in this study indicated that DEA surfactant added to insecticide formulas could function as the spreading, wetting, and thickening agents of buprofezin insecticide. Insecticides containing this type of surfactant, when they were applied in rice plants, were expected to spread evenly and attached firmly to the leaves or stems of the rice plants so that they were not easily lost or washed out by rain.

TABLE 1

DENSITY AND SURFACE TENSIONS OF INSECTICIDE FORMULAS TREATED WITH DEA SURFACTANT

Parameter	**Unit**	**Formula 1 (Buprofezin + DEA 4%)**	**Formula 2 (Buprofezin + DEA 6%)**	**Formula 3 (Buprofezin + DEA 8%)**	**Formula 4 (Buprofezin + DEA 10 %)**
Density	kg/m^3	0.97	0.97	0.97	0.97
Surface tension	dynes/cm	28.57	26.92	27.21	26.79

B.Selection and test of insecticide performance to BPH

This test was done for selection and assessing the performance of formulated insecticide. The efficacy of insecticide is shown by the mortality rate of BPHs following the application of insecticide. Results showed that there were significant effects of insecticide formulas on the mortality rate of BPHs as shown in Table 2.

TABLE 2.
MORTALITY RATE OF BPHS TREATED WITH INSECTICIDES

Formula	Dosage	Mortality (%)					
		24 hours		48 hours		72 hours	
formula 1	0.25 cc	8	bcd	28	b-g	78	c-g
	0.5 cc	6	bcd	48	abc	88	a-f
	0.75 cc	12	bcd	32	b-f	92	a-d
	1 cc	10	bcd	28	b-g	100	A
	1.25 cc	12	bcd	54	ab	92	a-d
	2.5 cc	6	bcd	42	a-e	94	a-d
	5 cc	16	bcd	44	a-d	90	a-e
	10 cc	4	bcd	48	abc	86	a-g
Formula 2	0.25 cc	4	cd	22	d-g	74	e-h
	0.5 cc	16	bcd	36	b-f	70	Fgh
	0.75 cc	16	bcd	32	b-f	82	a-g
	1 cc	18	bcd	40	b-e	76	c-h
	1.25 cc	20	bc	40	a-e	84	a-g
	2.5 cc	22	b	42	a-e	80	a-g
	5 cc	18	bcd	42	a-e	76	c-h
	10 cc	54	a	66	a	90	a-e
Formula 3	0.25 cc	2	cd	44	a-d	58	H
	0.5 cc	8	bcd	26	c-g	66	H
	0.75 cc	6	bcd	26	c-g	68	Gh
	1 cc	4	bcd	42	a-e	80	b-g
	1.25 cc	8	bcd	20	d-g	82	a-g
	2.5 cc	16	bcd	32	b-f	80	a-g
	5 cc	44	a	66	a	94	a-d
	10 cc	18	bcd	40	a-e	80	a-g
Formula 4	0.25 cc	18	bcd	48	abc	76	d-h
	0.5 cc	12	bcd	44	a-d	94	a-d
	0.75 cc	8	bcd	38	b-e	92	a-d
	1 cc	14	bcd	42	a-e	84	a-g
	1.25 cc	22	b	46	a-d	94	a-d
	2.5 cc	12	bcd	42	a-e	98	Ab
	5 cc	14	bcd	38	b-e	100	A
	10 cc	14	bcd	44	a-d	100	A
Commercia l product	0.25 cc	0	d	16	Efg	74	d-h
	0.5 cc	4	bcd	16	Efg	84	a-g
	0.75 cc	0	d	16	Fg	82	a-g
	1 cc	8	bcd	42	a-e	96	Abc
	1.25 cc	4	bcd	24	c-g	84	a-g
	2.5 cc	12	bcd	40	a-e	80	a-g
	5 cc	2	cd	42	a-e	86	a-g
	10 cc	2	cd	38	b-e	86	a-g
Control	0	2	cd	12	Fg	20	I
	0	4	bcd	6	G	22	I
	0	0	d	4	G	14	I
	0	0	d	6	G	16	I
	0	2	cd	4	G	18	I

Note: Different subscripts in the same column indicate significant differencesp<0.05)

It was shown in Table 2 that in general, insecticide formulas made in this study had better efficacy than commercial insecticide and control. Mortality rate of BPHs invested to the seedlings previously dipped into insecticide solution tended to increase as the concentration of insecticide formula increased. According to Dadang and Prijono (2008), different concentrations of insecticide give different effects on the eating activity inhibition of pests. With all pesticide formulas, eating activity inhibition tended to happen fast as the mortality rate was found to be higher than those in control and commercial insecticide since the first day of observation. High mortality rates since the first to the third day, not on the second or third day only, was an indicator of high efficacy of insecticide. This was true as the pests that were still survive on the first and second day would be able to attack the seedlings prior to their death. Meanwhile, if the death of BPHs occurred on the first day, although not 100%, it would reduce the level of pest attack or plant loss.

TABLE 3.
LC 50 VALUES OF TESTED INSECTICIDE FORMULAS

Insecticide Formula	**LC50 (cm^3/liter)**
Formula 1	0.1404
Formula 2	0.0535
Formula 3	0.1241
Formula 4	0.0551
Commercial insecticide	0.4387

A toxicity test was conducted to select the insecticide formula that could be further developed. Based on the above mortality rate of BPH, the toxicity value of insecticide formula could be measured by using an LC 50 method which was commonly known as lethal concentration (lethal dose 50%). Lethal dose 50% of a drug or chemical compound is the amount of it which causes death of 50% of the animals tested. Based on the results of probit analysis, insecticide formula 2 (Buprofezin with 6% surfactant inclusion) was the one that killed 50% of BPHs at the lowest concentration of 0.0535 cm^3/liter. It was also found that sample insecticides were more efficient in killing BPHs than did commercial insecticide. The latter killed 50% of BPHs at a concentration which was four times higher than those of sample insecticides.

DEA surfactant in insecticide formulation was found to affect the efficacy of buprofezin insecticide in killing BPHs. This was indicated by the comparison of observation results obtained from sample insecticides and commercial insecticide. The finding that DEA surfactant homogenized the insecticide solution and lowered the surface tension of insecticide making the active materials in the insecticide spread evenly on leave and stem surface of rice plants was the suggested mechanism by which DEA surfactant improved the efficacy of insecticide. This was in accordance with what was found from visual observation that drops of solution containing surfactant could penetrate and spread over fine hairs on leaf surface through capillarity. In contrast, drops of solution containing no surfactant were found unable to spread out and attached on the leaf surface only [10].

IV.CONCLUSION

The inclusion of non-ionic DEA surfactant of palm oil methyl ester significantly affected the efficacy of BPH insecticide containing buprofezin active material. The optimal efficacy improvement of BPH insecticide containing Buprofezin active material was obtained by the inclusion of 6% non-ionic DEA surfactant.

ACKNOWLEDGEMENT

Author wishes to thank Pest Laboratory of Indonesia Center for Rice Research (ICRR)Ministry of Agriculture for their kind cooperation and valuable guidance.

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Intelligent Information and Communication Technology for Adaptive Agroindustry of the Future

 ISBN : 978-1-4673-7404-0

Design of Web-Based Information System with Green House Gas Analysis for Palm Oil Biodiesel Agroindustry

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***Abstract*—The scarcity of fuel is one of the serious problems in Indonesia because it can disturb people daily activities. One way to prevent the increasing fuel usage is by providing information about biodiesel as an alternative energy source. This information is served in the form of web base information for palm oil biodiesel agroindustry with Green House Gas (GHG) analytical module. This research is aimed at providing information about data production and area of oil palm plantation, data production of biodiesel and GHG analysis module to perceive GHG emission. This information system has some main features including graph of data production, area of oil palm plantation, biodiesel data production, page editor, and shown results of GHG analysis. Using this information system, it can be decided whether an area has a high GHG emission or not. This system, therefore, can be used as a region reference for emission reduction.**

I. Introduction

THE limiting availability of fossil fuel has brought people attention to the use of plant oils as alternative sources of fuel. Biodiesel is an alternative energy people use to fulfill their energy needs for transportation, household, and industry. These need can be fulfilled easily if there is sufficient information available for public.

The need for quick, appropriate, and accurate information is an important aspect in human's life. As information develops very quickly, a better information system is needed. Designing or developing a web is a way that can be done in order to provide public with access to information.

Indonesia is a country with 98.56 million hectares of forest area (Ministry of Forestry, 2012). One of the commodities potential to develop in this country is oil palm that can be utilized as an alternative energy in the form of biodiesel. However, limited centralized information on oil palm and biodiesel has hampered biodiesel development. There are only a few websites available today providing information on biodiesel and oil palm. Latest advancement in technology has driven the use of web-based information system in which all information available is presented by using Internet medium.

Information system of biodiesel and oil palm is made to provide the public with information on oil palm production, oil palm plantation area, and biodiesel production. The development of this information system is aimed at assessing the integrated and latest information about biodiesel, oil palm, and analysis of greenhouse gas effect as a tool to determine the gas emission value resulted from the land use changes.

The aims of this study is to design web-based information system on data of oil palm production and land area and biodiesel production in Indonesia by presenting them in forms of tables and graphs depicting results of greenhouse gas effects analysis in detail as a result of land use changes..

II. METHODS

A. *Rationales*

Fuel oil scarcity is one of the serious problems faced by many countries including Indonesia. This country, however, is a developing country in which most of its land is a forest area. This area provides oil palm, a commodity that can be used to produce biodiesel as an alternative energy source.

Oil palm production is significantly increasing over years. This has created a land use change which

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ISBN : 978-1-4673-7404-0

brings a negative effect in the form of increased emission of greenhouse gasses. Providing information about oil palm biodiesel is a way that can be done to avoid fuel oil scarcity.

The advanced technology can be used to create a centralized and integrated information system. An information system designed in a web form is more accessible for public and provides information related to oil palm and biodiesel with an analysis module of greenhouse gasses in web. The concept framework of biodiesel industry management in order to optimize feedstock procurement is depicted schematically in Figure 1.

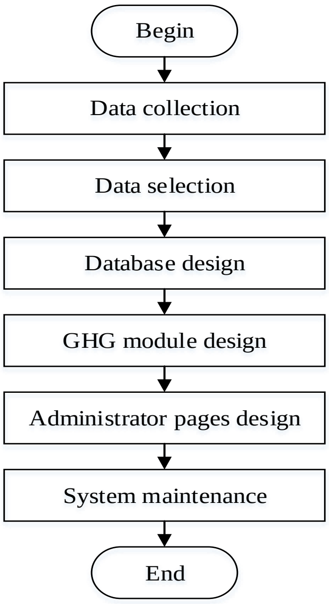

Fig. 1. Framework of thought

B. System Development

Web-based information system of oil palm biodiesel agroindustry is developed by using a System Development Life Cycle (SDLC) methodology. Stages of the development include planning, system analysis, system design, system implementation, and system maintenance (O'brien, 1999).

The advantages and disadvantages of SDLC system development are listed in Table 1.

C. Planning

System planning is done to get a description of the objectives and scope of system development, define existing problems and ways to overcome them, and evaluate strategies to be used in system development. The planning stresses on system feasibility study.

D. System Analysis

In system analysis, there are two stages done, namely analyzing and defining problems and finding solutions to the problems in an information system. In a system development, system analysis is important as it results in best solutions to problems, new needs, and improves overall system performance.

System analysis is a critical and very important stage as any mistakes made in this stage may result in other mistakes in the next stage. In general, the activity done in system analysis stage is an elaboration of feasibility study.

TABLE 1
ADVANTAGES AND DISADVANTAGES OF SDLC

No	Advantages	Disadvantages
1	Easy control	Longer time of development
2	Clear stages	System has to be defined from the beginning
3	Easy monitoring for big projects	Higher development fund
4	Good fund evaluation and work plan accomplishment	Rigid
5	Good documentation	Difficult fund estimation
6	Good definition of customer needs	Limited inputs by users
7	Easy maintenance	
8	Easy system planning and development	
9	Ability to tolerate changes in information management system	

E. System Design

There are three main activities in this stage, namely interface design, data design, and process design. System design stage is a procedure of converting logical specification to a design that can be implemented in an organizational computer system.

According to Whitten *et al.* (2001), interface design is a prototype in which a work model is designed and modified repeatedly by using feedbacks from end users. The activity in interface design focuses on interaction support between end user and computer-based application. Data design is done in database structure design that will be used by system. Process design focuses on software design in the form of proposed programs and procedures.

F. System Implementation

System implementation is a stage that takes longer time and a complex process. Activities done in this stage include software and hardware acquisition, software development, database development and testing, data conversion, and various other programming activities.

G. System Maintenance

System maintenance is the last stage in SDLC. In this stage, monitoring, evaluation, and modification are done to make repairs which are important or compatible to end user needs. System maintenance is done by an administrator who is appointed to keep the system operate well as needed.

 ISBN : 978-1-4673-7404-0

III. RESULTS AND DISCUSSION

A. Planning

This web-based information system with greenhouse gases analysis is selected as an effort to avoid fuel oil scarcity. The solution given is the provision of information about biodiesel as an alternative energy source and oil palm as a potential feedstock for biodiesel production.

Web technology is used as the basis of this information system development as the scope of this information system users is wider and centralized. Important things needed in this system development include data, time, cost, hardware, and software.

Data are one of the main things that need to be reviewed in information technology. Data utilization covers many aspects. Data describe a representation of facts composed structurally (Vercellis 2009). This information system is developed by using database as the main source of information which is presented to users. Data about oil palm are taken from the Statistic Bureau (BPS) and data about biodiesel production are taken from the Directorate of New Renewable Energy and Energy Conservation (EBTKE). In this stage, data are highly required as they are to be converted into information in the system.

The development of this information system takes time for data selection, data input, and data conversion to the form that fitted the system needs, data correction, and appearance design. Extra power and thought are also needed to get the optimum results.

The cost of this information system development consists of direct and indirect costs. According to Al-Fatta (2007), several things needed to be considered in designing an information system. These include performance analysis, information, economical value, efficiency, and service that can be given by the system. Higher measurement in economical aspect of a system is an indication that the system is worth developing.

The availability of hardware in this information system development is highly required to allow the required software operate optimally.

B. System Analysis

System analysis process in the development of an information system is a procedure done to assess any problems that may occur, develop alternative problem solutions, and develop specifications of new, proposed, or modified systems (Sutabri, 2004). System analysis is aimed at synchronizing user needs and the operational system being developed.

The information system being developed is dynamic meaning that it is able to interact with visitors of the site, it can show information originating from database, and pages on the web can change automatically (Sutisna, 2007).

World Wide Web (WWW) or commonly known as web is an information net using a Hyper Text Transfer Protocol (HTTP) that can be accessed through a simple interface. Bowo (2005) stated that a web is a component or a group of components consisting of texts, images, sounds, and animations making it as an interesting information medium.

System analysis is done through the stage of identification functional and non-functional needs. In this study, the problem found in system analysis is the finding that the availability of centralized information about oil palm and biodiesel is public functional need. This need just appears as there is a land utilization change into oil palm plantation area. This change in land function has resulted in the increased greenhouse gases emission so that the analysis of greenhouse gases emission measurement in the system is required. Meanwhile, interesting and consistent interface appearance that made it easy to use by users is found to be a non-functional need.

C. System Design

System design is a stage that describes how the system fulfills the users' need of information. System design stage plays an important role in creating a good quality system. System design consists of interface design, database design, and process design.

1) Database Design: Database is a group of data stored systematically in a computer and can be changed, deleted, erased, and added by using software to produce information. Data are stored in the form of tables and the stored tables are interconnected. Database design is affected by the sharpness of the system analysis to be produced and the result of this design will give significant effect on the resulted system (Sidik, 2005).

This web-based information system is developed to present information on oil palm production, oil palm plantation areas, and biodiesel production data in graphs or tables. The database developed for this web-based information system consists of 100 tables. The tables which are stored based on the category of the information needed by the system consist of oil palm production tables, biodiesel production tables, oil palm plantation areas tables, and values of greenhouse gases analysis tables. Each table has different identities, for example, latpb, latpr, ppb, ppr, admin, etc. Not all tables have relation one to another.

2) Process Design: The process design of this information system is made by using a contextual diagram as shown in Figure 2.

ISBN : 978-1-4673-7404-0

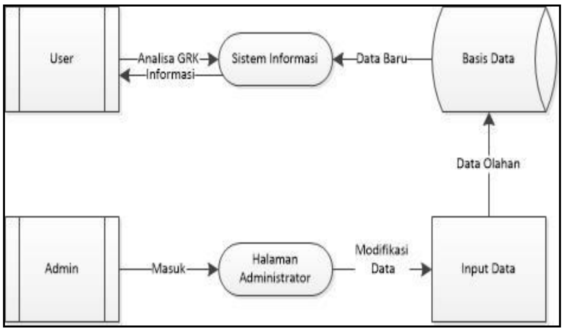

Fig. 2. Contextual diagram of process design

It is shown in Figure 2 that there is an interconnection between user and administrator. In this system, user is one who obtained information from the system and administrator is one who controlled and renewed information including the database in the information system. Users involved in this system are public.

3) Interface Design: Interface design in an information system is divided into two displays: an interface for administrator and another for users. The function of interface is to show the location of information needed by users.

The displays of each interface, user and administrator, are made as interesting as possible for their easy operation. For user interface, for example, the display is made interesting so that it would be easy for users to get the information they needed (Figure 3). Meanwhile, for administrator interface, the display is made in such a way so that it would be easy for the administrator to enter, erase, or change data.

On the user home page there are the image and logo of the information system. The navigation menu consists of Home, Oil Palm, Biodiesel, GHG (greenhouse gases), and Contacts (Figure 3). On the first user page, there are paragraphs about oil palm in both Bahasa Indonesia and English. Oil palm menu provides information on oil palm and biodiesel menu provides information on biodiesel. GHG menu is available for users who would conduct the analysis of greenhouse gases emission value.

The oil palm page provides information of data on production of state-owned, people, and private plantations, plantation areas of major estates in provinces and regencies, and number of major plantations.

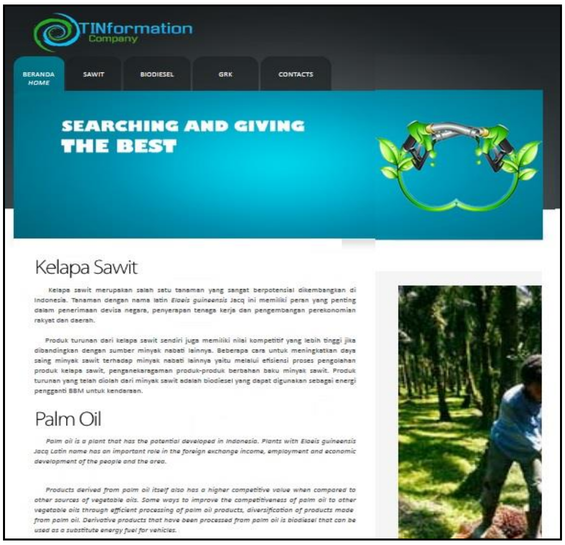

Fig. 3. User interface page

On oil palm interface page, there is a graph button that allowed users to short displays of graphs and tables according to the options of information category on oil palm interface page as shown in Figure 4. The bar graphs shown in Figure 34 are the result of jQuery plugin. jQuery is a collection of codes or Javascript functions that can be directly used to allow programmers make Javascript codes in an easier and faster way (Hakim, 2010).

Fig. 4. Oil palm interface page with information category options

The information category options on oil palm interface page can be selected by users to get more detailed information as needed. For example, detailed information on oil palm plantation areas is shown in Figure 5. On the right side there is an option menu for oil palm plantation area in the province needed.

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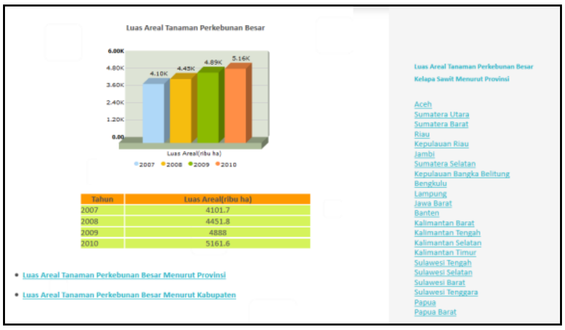

Fig. 5. Detailed page according to the information category selected by user

The displays on other pages such as those displaying production of major state-owned plantations, major private plantations, and people plantations, have similar layout and contents. There are only the data in each information category which are different. The option menu on planting areas of major plantations based on provinces is made to display data on plantation areas in provinces in Indonesia.

Biodiesel page provides information on biodiesel production and how it is made from oil palm. There are 4 options on biodiesel interface page. These contents include biodiesel making, overall and domestic biodiesel production, and biodiesel export.

Graphs and tables are also shown on biodiesel interface page to make it easier for users to get information. The graphs and tables are in the similar forms to those on oil palm interface page. Data on biodiesel production are obtained from Directorate General of New Renewable Energy and Energy Conservation. However these data are not ready for publication as there are part of the data that are not yet collected. This information system is made for EBTKE for update of data and content on the web. The availability of this web-based information system is expected to assist public and government in acquiring information.

The information on biodiesel and oil palm pages is obtained from the summary and references as the result of literature study. Palm oil production process consisting of transesterification, washing, drying, and filtration, is briefly described. Interesting information display such as biodiesel process graphs makes it easier for users to understand the content of a web page

The next page is greenhouse gases (GHG) page on which analysis of GHG emission value as a result of land use changes can be found. There are six calculation stages on this page. Each stage has its value in accordance with the options given.

This GHG analysis is the analysis of the integration result of GEF (Global Environment Facilities) calculation which is originally made in excel and then implemented in web form. The interface page of GHG analysis is shown in Figure 6 and 7.

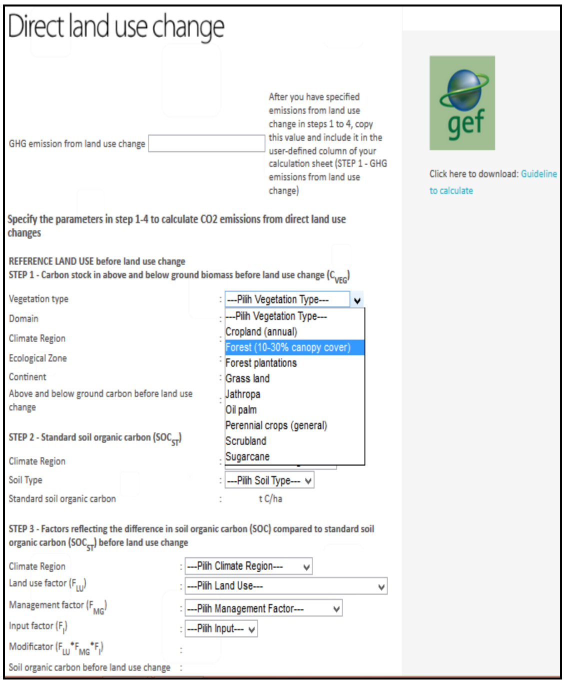

Fig. 6. GHG analysis page

As shown in Figure 6, there are 2 stages of GHG emission value analysis. In stages 1 to 4, the determination of CO_2 emission value from land direct use is done. In each stage, the option boxes are to be filled in. Each option box is provides in accordance with the rules for GFE calculator.

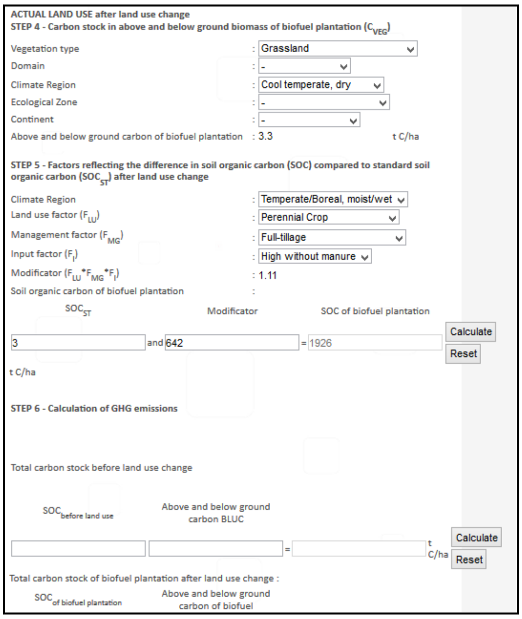

Fig. 7. Interface page of GHG-continued

In stage 5 and 6, as shown in Appendix 1, the calculation of the difference between soil organic carbon content and standardized soil organic carbon content after land use change is done. Stage 6 is the last stage in the analysis to result in GHG emission

ISBN : 978-1-4673-7404-0

value from land use change.

The next page is interface display on the administrator page. Administrator is one appointed and trusted to monitor and update data in an information system. The updated data are used as input on user pages. Prior to login to the administrator home page, an administrator has to put in an identity and password (Figure 8).

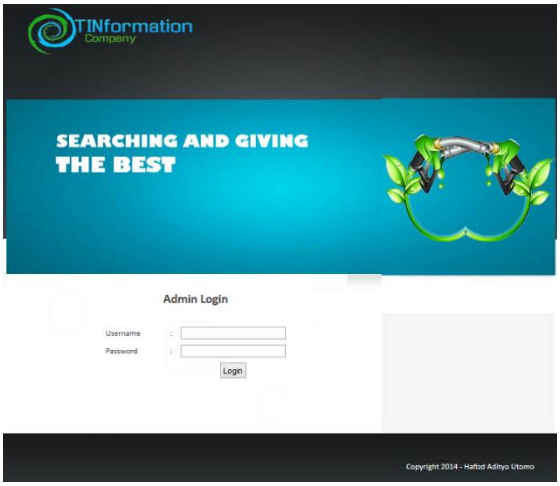

Fig. 8. Administrator login page

The administrator then selects data to be updated. Brief information about oil palm is also available (Figure 9). The category of information shown on the administrator page is synchronized with that on user page. Administrator can also select Oil Palm and Biodiesel menu to monitor or update data existing in each menu offered.

Fig. 9. Administrator home page

The display of Oil Palm menu page on the administrator page is similar to that on the user page. However, the information category here is used to select data to be manipulated (changed, erased, and added).

There are the options of the plantation areas of major state-owned plantations and major private plantations. Each is presented in provincial and regent basis. The next option is the oil palm production of major state-owned plantations, major private plantations, and people plantations and each is presented in provincial and regent basis. The displays on this page are not far different from those on the oil palm user page. The only difference is that on user page there is a "See Graphs" button which is not available in the oil palm administrator page.

Data to be updated can be changed by selecting the category available on oil palm and biodiesel administrator page. Data display can then be seen in one of the information categories as shown in Figure 10. On the right side of the table there are options of data manipulation (change, erase, add).

The Add Data button on each oil palm and biodiesel administrator page is used to update data. The box form in Add Data tables is shown in Figure 11.

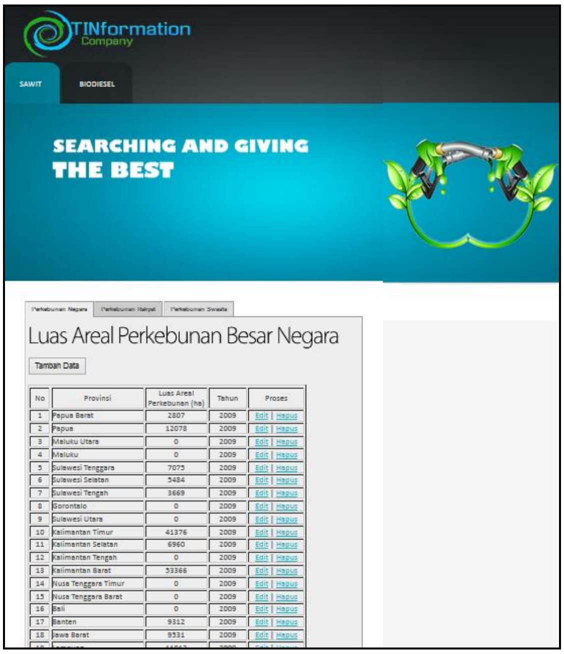

Fig. 10. Oil palm administrator page

Tables in Administrator Biodiesel menu are similar to those in Administrator Oil Palm menu. Yet, biodiesel data are taken from the whole country. Edit and Erase options in 'process biodiesel production' columns are used to modify data. This function is also available in the administrator page.

Add Data form in Figure 11 has 4 boxes to be filled in with name of province for plantation area and oil palm production on the provincial basis and name of regency and oil palm production on the regent basis. There are also Plantation Area (ha), Production (ton), and Year boxes.

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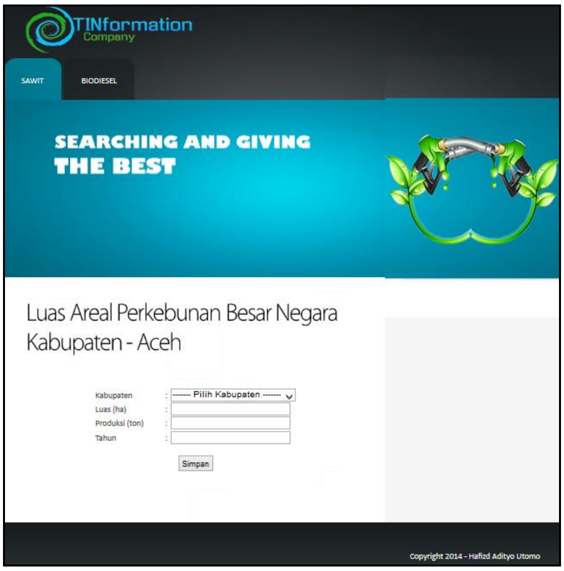

Fig. 11. Add Data form display

The Save button is used to store data that are already filled in to the Add Data form. Each table on the administrator page is connected directly to the database in the computer.

D. System Implementation

The implementation stage is a coding stage to materialize the existing design into an information system. The followings are done in this stage.

1. Software are procured to create a good web-based information system. The required software include Adobe Dreamweaver CS 6, Adobe Photoshop Portable, XAMPP 1.8.1, Microsoft Visio 2010, and Web Browser (Mozilla Firefox, Google Chrome, and Internet Explorer).

2. Coding is a programming activity to convert the whole design into a system device that fits users' need. All programming activities and database development are done on Windows 8 operating system. This web-based information system is developed by using Adobe Dreamweaver CS6 on a PHP programming basis.

3. After the coding activity is finished, the system is installed to the internet web so that the accessibility of the system can be tested. The system accessibility in Web Browser (Mozilla Firefox, Google Chrome, and Internet Explorer) is tested.

E. System Maintenance

This is the final stage in a system development system (SDLC) consisting of system monitoring, evaluation, and modification. System maintenance is done during and after the designing process.

The developed system is still in prototype form. Therefore, for system maintenance stage, only monitoring activity is done when performance test and evaluation are conducted. Modification is then done to make the developed system fits user criteria.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

This web-based information system is able to visualize tables and graphs that fit user need of an easy search for information on oil palm production, biodiesel production, and oil palm plantation area. The implementation of the analysis of greenhouse gases emission value with a land use change which has been previously integrated in the Microsoft Excel format by GEF is successfully done on a web basis.

B. Recommendations

Further studies on the development of an information system with different system approach, different information contents, and additional analysis modules of greenhouse gases emission calculation are recommended.

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ISBN : 978-1-4673-7404-0

Sequential Patterns for Hotspot OccurrencesBased Weather Datausing Clospan Algorithm

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***Abstract*— Weather is one of some contributing factors causing forest fires. A hotspot is an indicator of forest fires. Weather and hotspotsdata can generate sequential patternsof hotspot occurrencesbased on weather data. The sequential pattern can be used in making right decisions or policies to prevent forest fires. This work applied the Closed Sequential Pattern Mining (Clospan) algorithm that is avaliable in the Sequential Pattern Mining Framework (SPMF)program to generate sequential patterns on hotspots data. The data used are hotspots, precipitation and temperature that are grouped by year of events starting from the year 2001 to 2010. The sequential patterns were discovered with minimum supports from1% to 20%. The results show that the sequential patterns generated from hotspots and precipitation data indicate the first hotspot occurrence in a location with precipitation 0.03 inch per 6 hours followed by precipitation 0.20 inches per 6 hours at different times. Sequential patterns of hotspot and temperature data indicate the first hotspot occurrence in a location with temperature 28.33 °C followed by temperature 28.89 °C and temperature 29.44 °C at different times. Areas where most hotspots commonly found are those with precipitation 0.03 inch per 6 hours and temperature 29.44 °C.**
Keywords: clospan, hotspot, sequential pattern

I. Introduction

Forest fireshave bad impacts to Indonesia and neighboringcountries. Forest fires in Indonesia were influenced byhuman and weather factors. Prevention efforts can be done by monitoringweather conditions where hotspots are probably occurred in a certain location. A hotspotisan indicator of forest firesthat detectsa locationwhichhastemperaturerelativelyhigher than surroundings temperature [1].Weather data are daily recorded in weather stations. In addition, hotspots data are also regularly collected by satellites.The large collection of weather and hotspots data can be analyzed using data mining techniques in order to discover the relation between weather conditions and hotspot occurrences. Data miningis a process tofindinteresting patterns and knowledge in large data [2].One of data mining techniquesthat can be used to analyzehotspot occurrences based on weather data is sequential pattern mining.Sequential pattern miningis used tofind an occurrence ofitemfollowed by other itemsin which the sequence is based on transaction time [2]. There are two main groupsofsequential pattern mining methods.The first group is the apriori-based method whichconsists several algorithms including Generalized Sequential Pattern (GSP)andSequential Pattern Discovery using EquivalentClass(SPADE). The second group is projection-basedmethod which consists of the Prefixspan algorithm and the Closed Sequential Pattern Mining (Clospan) algorithm[3]. Clospan is better than Prefixspan because this algorithm can mine sequences in a large dataset with low minimum support without lose information [4].

This workapplied theClospan algorithm to findsequential patterns from hotspot and weather data inRiau Provincestarting fromthe year 2001 to 2010.The Clospan algorithm is available on the Sequential Pattern Mining Framework (SPMF) [5]. Weather data include precipitation and temperature that can influence sequences of hotspot occurrence in the study area. Sequential patterns of hotspot occurrences based weather data can be usedin making decisions to prevent forest fires.

II. Methods

A. Data and Data Preprocessing

Data used in this research arehotspot in the period of 2001 to 2010 and weather data including precipitation and temperature. The hotspot data in shapefile (.shp) format were collected from FIRM National Aeronautics and Space Administration (NASA). The study area is Riau Province, Indonesia. Hotspot data consist of 156703 records that have the attributes longitude, lotitude, and date.

Data preprocessing was conducted in order to prepare a task relevant data as an input for the sequential pattern algorithm. Tasks in data

ISBN : 978-1-4673-7404-0

preprocessing are data selection, data cleaning, and sequence data generation. Selection is a process to get data in the study area and attributes for further analysis. In the data cleaning, we handled the missing values and noises in the dataset. Missing values are found the precipitation data which are denoted as 99.99. In addition, the precipitation data contain the value of 0:00 meaning that value of precipitation was not measured. Such data were removed from the dataset in order to obtained valid sequences. Furthermore, asequence dataset was generated from the original dataset based on on longitude, latitude, and time of hotspot's occurrences. This step was done using the PHP programming language.

B. Sequential Pattern Mining

A sequential pattern is a pattern that describes a sequence of event's occurrences. The patterns can be discovered in the large dataset that contains successive events occurred several times [6]. Sequential pattern mining was first introduced by Agrawal and Srikant in 1995. This method is used to search for items that are followed by the appearance of other items sorted by time of transaction [2]. Sequential pattern mining is described as follows: given a number of sequences, each sequence consisting of a series of elements, and each element consists of a number of items, as well as the minimum value of support that is given by the user.

An itemset is a set of items that are not empty, denoted by $i = \{i_1\ i_2\ i_3\ ...\ i_m\}$, where i_j is an item. A sequence is a list of the order of itemsets, denoted by $s = <s_1\ s_2\ s_3\ ...\ s_n>$ where s_j is an itemset. A sequence $\alpha = <a_1\ a_2\ a_3\ ...\ a_n>$is called a subsequence of another sequence $\beta = <b_1\ b_2\ b_3\ ...\ b_m>$ denoted as $\alpha \subseteq \beta$, if there is an integer $i_1<i_2<...<i_n$ such that$a_1 \subseteq b_{i1}$, $a_2 \subseteq b_{i2}$, ...,$a_n \subseteq b_{in}$[2]. It also can be said that the sequence β is a super-sequence of the sequence α [4].

A sequence database, $D = \{s_1\ s_2\ s_3\ ...\ s_n\}$, is a set of sequences in whicheach sequence is associated with id as the sequence identifier. $|D|$ indicates the number of sequences in the sequence database D. Support α is the number of sequences in D which contains α, support $(\alpha) = |\{s \mid s \in D \text{ and } \alpha \subseteq s\}|$. Minimum support is the user defined minimum limit of a frequent itemset. Frequent pattern sequences contain all sequences that have support value not lower than the specified minimum support [4].

Clospan is an algorithm in data miningthat discover sequential patternsin a sequence dataset. This algorithm is designed for efficient search space using the concept of projected databases[4]. Post-pruningis applied in the algorithm to find patterns in the dataset using backward super-patterns and backward sub-patterns. Clospan algorithmis provided in Fig.1 [4].

Fig.1.Clospan algorithm

III. RESULTS AND DISCUSSION

This workapplies the Clospan algorithm that is available in the Sequential Pattern Mining Framework (SPMF) [5] to generate sequences of hotspots based on weather data namely precipitation and temperature. There are five categories of precipitation data retrieved for the reports that are given in Table I.

TABLE I
CATEGORY OF PRECIPITATION DATA

Category	Description
A	1 report of 6-hour precipitation
B	Sum of 2 reports of 6-hour precipitation
C	Sum of 3 reports of 6-hour precipitation
D	Sum of 4 reports of 6-hour precipitation
E	1 report of 12-hour precipitation

Because SPMF requires the integer format for items in the dataset, precipitation and temperature values are coded to integer. In addition, decimal values of longitude and latitude of hotspot data are rounded to two decimal places to obtained more hotspots in an area. Table IIand Table III show the examples of records in the sequence dataset as an input for the Clospan algorithm in SPMF. In the Table II and Table III, the longitude and latitude are considered as an identifier of an object. The events contain precipitation and temperature (see Table II and Table III, respectively) that are sorted by date to create sequences.

ISBN : 978-1-4673-7404-0

TABLE II
EXAMPLES OF SEQUENTIAL DATA OF HOTSPOTS AND PRECIPITATION IN 2002

Longitude	Latitude	Sequential Data
101.78	1.52	<(67)(1)(5)>
101.78	1.54	<(3)(1)(5)>
101.78	1.56	<(1)(5)>
101.78	1.55	<(5)>
101.79	1.57	<(5) >

TABLE III
EXAMPLES OF SEQUENTIAL DATA OF HOTSPOTS AND TEMPERATURE IN 2002

Longitude	*Latitude*	Sequential Data
101.78	1.52	<(83)(80)(81)(82)>
101.78	1.54	<(81)(80)(82)(83)>
101.78	1.56	<(82)(83)>
101.78	1.55	<(83)(82)>
101.79	1.57	<(82)(83)>

Frequent sequences were generated from two types of dataset namely hotspot - precipitation and hotspot – temperature. Each dataset is divided into several groups based on the year from 2001 to 2010. Minimum supports used are 1%, 2%, 3%, 4%, 5%, 10%, 15%, and 20%. The number of sequential patterns of hotspots based on precipitation data is provided in Table IV. The number of generated sequential patterns in 2005 can be seen in Table V. The sequence dataset that was formed from precipitation data in 2005 contains as many 2287 occurrences of hotspots.

TABLE IV
NUMBER OF HOTSPOTS SEQUENTIAL PATTERNS BASED ON PRECIPITATION

Dataset (year)	Minimum support (%)							
	1	2	3	4	5	10	15	20
2001	38	14	12	9	9	4	4	1
2002	13	7	7	7	6	4	2	2
2003	17	12	7	6	5	4	1	1
2004	21	12	9	7	7	3	1	1
2005	30	19	14	12	7	1	1	1
2006	24	18	16	11	9	3	0	0
2007	24	12	9	9	7	2	1	1
2008	19	13	10	9	6	2	1	1
2009	22	12	10	7	7	3	1	1
2010	23	17	15	9	8	2	2	0
2001-2010	43	21	10	9	5	0	0	0

TABLE V
HOTSPOT SEQUENTIAL PATTERNS BASED ON PRECIPITATION IN 2005

Min_sup	1-sequence	2-sequence
1%	175 -1 #SUP: 504; 46 -1 #SUP: 227; 237 -1 #SUP: 218; 288 -1 #SUP: 166; 179 -1 #SUP: 122	175 -1 237 -1 #SUP: 71 260 -1 175 -1 #SUP: 28 229 -1 175 -1 #SUP: 22
2%	175 -1 #SUP: 504; 46 -1 #SUP: 227; 237 -1 #SUP: 218; 288 -1 #SUP: 166; 179 -1 #SUP: 122	175 -1 237 -1 #SUP: 71
3%	175 -1 #SUP: 504; 46 -1 #SUP: 227; 237 -1 #SUP: 218; 288 -1 #SUP: 166; 179 -1 #SUP: 122	175 -1 237 -1 #SUP: 71
4%	175 -1 #SUP: 504; 46 -1 #SUP: 227; 237 -1 #SUP: 218; 288 -1 #SUP: 166; 179 -1 #SUP: 122	
5%	175 -1 #SUP: 504; 46 -1 #SUP: 227; 237 -1 #SUP: 218; 288 -1 #SUP: 166; 179 -1 #SUP: 122	
10%	175 -1 #SUP: 504	
15%	175 -1 #SUP: 504	
20%	175 -1 #SUP: 504	

According to Table V, the resulting 2-sequences with the minimum support of 1% are as follows:

```
175 -1 237 -1 #SUP: 71
260 -1 175 -1 #SUP: 28
229 -1 175 -1 #SUP: 22
```

The first pattern<175 237> states that as many 71 of 2287 hotspot occurrences are appear in the location with the precipitation code of 175 (0.03 inch of precipitation derived from the sum of the three reports precipitation per 6 hours). These occurrences are followed by other occurrences at different times in the same locations with the precipitation code of 237 (0.20 inches of precipitation derived from the sum of the four reports of precipitation per 6 hours).

Sequential patterns of hotspots are also found based on the temperature data. The sequence dataset that was formed from temperature data in 2005 contains as many 9279 occurrences of hotspots. The number of generated sequential patterns can be seen in Table VI. Table VII provides sequential patterns based on temperature in 2005.

TABLE VI
NUMBER OF HOTSPOT SEQUENTIAL PATTERNSBASED ON TEMPERATURE

Dataset (year)	Minimum support (%)							
	1	2	3	4	5	10	15	20
2001	33	17	12	11	7	5	4	3
2002	35	18	14	10	8	5	4	3
2003	38	20	14	9	8	5	4	4
2004	36	24	10	9	6	6	4	4
2005	83	42	31	22	15	6	6	4
2006	28	19	13	9	5	4	4	3
2007	21	9	8	7	6	5	3	2
2008	19	10	9	9	9	5	5	2
2009	40	19	12	8	8	5	4	3
2010	22	13	11	8	7	4	3	1
2001-2010	111	43	38	28	20	6	6	5

TABLE VII
HOTSPOT SEQUENTIAL PATTERNS BASED ON TEMPERATURE IN 2005

Min_sup	1-sequence	2-sequence	3-sequence
1%	85 -1 #SUP: 3595 83 -1 #SUP: 3521 84 -1 #SUP: 2694 86 -1 #SUP: 2019 82 -1 #SUP: 1853	83 -1 85 -1 #SUP: 672 85 -1 83 -1 #SUP: 655 84 -1 83 -1 #SUP: 532 83 -1 84 -1 #SUP: 517 84 -1 85 -1 #SUP: 512	83 -1 84 -1 85 -1 #SUP: 172 85 -1 84 -1 83 -1 #SUP: 159 83 -1 82 -1 85 -1 #SUP: 158 81 -1 82 -1 83 -1 #SUP: 153 83 -1 81 -1 85 -1 #SUP: 149
2%	85 -1 #SUP: 3595 83 -1 #SUP: 3521 84 -1 #SUP: 2694 86 -1 #SUP: 2019 82 -1 #SUP: 1853	83 -1 85 -1 #SUP: 672 85 -1 83 -1 #SUP: 655 84 -1 83 -1 #SUP: 532 83 -1 84 -1 #SUP: 517 84 -1 85 -1 #SUP: 512	
3%	85 -1 #SUP: 3595 83 -1 #SUP: 3521 84 -1 #SUP: 2694 86 -1 #SUP: 2019 82 -1 #SUP: 1853	83 -1 85 -1 #SUP: 672 85 -1 83 -1 #SUP: 655 84 -1 83 -1 #SUP: 532 83 -1 84 -1 #SUP: 517 84 -1 85 -1 #SUP: 512	
4%	85 -1 #SUP: 3595 83 -1 #SUP: 3521 84 -1 #SUP: 2694 86 -1 #SUP: 2019 82 -1 #SUP: 1853	83 -1 85 -1 #SUP: 672 85 -1 83 -1 #SUP: 655 84 -1 83 -1 #SUP: 532 83 -1 84 -1 #SUP: 517 84 -1 85 -1 #SUP: 512	
5%	85 -1 #SUP: 3595 83 -1 #SUP: 3521 84 -1 #SUP: 2694	83 -1 85 -1 #SUP: 672 85 -1 83 -1 #SUP: 655 84 -1 83 -1 #SUP: 532 83 -1 84 -1 #SUP: 517 84 -1 85 -1 #SUP: 512	

Table VII shows there are four 1-sequences generated on the minimum support of 20%:

The first pattern states that as many 3595 of 9279 hotspot events are found in the area with the temperature of 85°F (29.44 °C). In addition, most hotspots are occurred in the area with the temperature of 83 °F (28.33 °C).

According to Table VII, 2-sequence patterns are obtained with the minimum support of 5%, which means there are at least 463 of 9279 hotspots occurred in two different times in the same location. The patternsare as follows:

The first pattern denotes as many 672 hotspots are found in the area with the temperatureof 83 °F (28.33 °C) and these occurrences are followed by other hotspots in the same area but with temperatureof 85 °F (29.44 °C) in the next time period.

The longest sequences discovered from the dataset of hotspots based on temperature are the following 3-sequences:

The first pattern shows as many 172 hotspots appear in locations with the temperatureof 83 °F (28.33 °C) followed by the temperature of 84 °F (28.89 °C), and then followed by the temperature of 85 °F (29.44 °C) in the next time period.

IV. SUMMARY

Frequent sequences for hotspot occurrences were discovered in this work based on precipitation and temperature data. Frequent 2-sequential patterns of hotspots based on precipitation are found in the locations with the precipitation of 0.03 inch (derived from the sum of the three reports precipitation per 6 hours), followed by the occurrences of hotspot in the location with the precipitation of 0.20 inches (derived from the sum of the four reports of precipitation per 6 hours). In addition, frequent 3-sequential patterns of hotspots based on temperature are occurred in locations with the temperature of 28.33 °C. These occurrences are followed by other hotspots in the same location with the temperature of 28.89 °C and the temperature 29.44 °C in the next time period.

ISBN : 978-1-4673-7404-0

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 ISBN : 978-1-4673-7404-0

How to Deal with Diversity in Cultivation Practices Using Scenario Generation Techniques: Lessons from the Asian Rice LCI Initiative

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***Abstract*—We established a research initiative to construct life cycle inventory (LCI) database of agricultural production systems in Asian countries. Our activities started from the preparation of LCI data on rice production systems in each country, because rice is an important common crop in Asian countries. In order to deal with diversity of cultivation practices, we used the methodology of scenario generation techniques, in which an agricultural production system is defined as combinations of many elements, i.e., agricultural management practices. This paper provides an outline of our activities so far and future perspectives on the development of LCI databases for agriculture and foods in Asian countries.**

Manuscript received May 10, 2015. This work was in part supported by the Japan Society for the Promotion of Science, Grant-in-Aid for Scientific Research (B), 26310316.

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I. Introduction

One of the important objectives of applying life cycle assessment (LCA) to agricultural production systems is to support decisions made by farmers and policy makers whether to introduce alternative agricultural practices. A typical example is the decision problem to select conventional or organic agricultural production. In this case, it is important to assess the changes in environmental impacts and profitability caused by the conversion to organic systems [1]. Another example is the decision whether to use functional materials such as fertilizers made from by-products of food products. Although they tend to increase crop yields, the assessment of environmental impacts cause by the application of the materials is not straightforward [2].

However, in earlier studies of LCA of agricultural production systems, the definition of agricultural production processes is conventionally conducted during the phase of "goal and scope definitions" and no explicit effort has been devoted to the problem of how to generate alternative agricultural production systems. If we use the terminology of decision analysis [3]–[5], the issue is how to invent innovative alternatives through the use of alternatives generation techniques in problem structuring. This is especially applicable to LCA of agriculture and food in Asia, because there are a

 ISBN : 978-1-4673-7404-0

wide variety of agricultural systems under a wide variety of climatic conditions.

Therefore, we established an research initiative to develop life cycle inventory (LCI) databases of agricultural products in Asian countries. As a first step, we tried to make LCI data for rice production systems under site-specific conditions using scenario generation techniques. This paper outlines our recent activities on the development of LCI data of rice production systems in each countries.

II. Methods

A. Scenario generation techniques

One of the most important ideas in our initiative is how to understand site-specific agricultural practices from more general and methodological perspectives. Although general procedures to construct LCIs have already been developed (e.g., [6], [7]), there is room to develop procedures to deal with diversity of cultivation practices in the real world. Therefore, we employed a scenario generation techniques derived from "the strategy generation table" [8], which has been used for inventing creative alternatives in decision analysis, in order to systematically define agricultural production systems as combinations of management practices under site-specific conditions [9].

TABLE I
Items for Rice Cultivation Scenarios

No.	Item
1.01	Crop name
1.02	Variety (cultivar)
2.01	Location
2.02	Soil type
2.03	Average yield
2.04	Transplanting or direct seeding
2.05	Maximum depth of water
2.06	Proceeding crop (if rotated)
2.07	Following crop (if rotated)
3.01	Plowing and land preparation
3.02	Border coating
3.03	Raising of seedling
3.04	Basal fertilize application
3.05	Application of other organic materials
3.06	Start of flooding
3.07	Soil puddling
3.08	Transplanting
3.09	Weeding
3.10	Midseason drainage
3.11	Water management after midseason drainage (intermittent irrigation)
3.12	Additional fertilizer application
3.13	Fungicide application
3.14	Insecticide application
3.15	Herbicide application
3.16	Herbicide application (ridges between rice fields)
3.17	Weeding in ridges between rice fields
3.18	Harvesting
3.19	Drying
3.20	Management of rice straw

B. Scenario generation of rice cultivation in Asian countries

As a method to generate rice cultivation scenarios in each country, we prepared items of management practices, which are equivalent to strategy elements in strategy generation tables. The list of items are shown in Table I.

C. From scenario generation to inventories

On the basis of the rice cultivation scenarios, we made LCI data for foreground processes of rice production systems.

III. Results

A. Rice cultivation scenarios

This section summarizes the current progress of scenario generation in our initiative.

Indonesia: Rice production systems in West Java are tentatively defined.

Japan: Since paddy rice is cultivated all over Japan, we made cultivation scenarios for conventional, environmentally friendly, and organic rice production systems in several prefectures. Organic production systems are, in many cases, based on the use of weeding machinery [10]– [12].

Korea: Conventional, no-pesticide, and organic rice production systems in the southern part of Korea were defined. No-pesticide and organic production systems are based on the use of river snails [12].

Malaysia: Rice production systems in in Peninsular Malaysia were tentatively defined.

Philippines: Two rice production systems, including NSIC (National Seed Industry Council) Rc varieties and NSIC hybrid rice varieties, in Nueva Ecija and one rice production system in Cagayan Valley, which uses NSIC Rc varieties, were defines [13].

Vietnam: Two rice production systems were defined. One is located in the Mekong River Delta and the other in the Red River Delta [14].

B. Construction of Foreground processes

We prepared the foreground process data on the basis of the scenarios. As a first step to the construction of LCI data for rice production systems in each country, we gathered data on yield, fossil-fuel consumption, electricity consumption, cultivation condition, agricultural machinery, greenhouses, fertilizers, pesticides, seedling, and other materials.

IV. Discussion

A. Representativeness

We tried to construct our data empirically so far. The reason is that our primary purpose is the development of a common framework to assess rice production systems under the site-specific conditions, rather than preparing

 ISBN : 978-1-4673-7404-0

a comprehensive database for environmental labelling policy making. Although the term “representativeness” is sometimes used for expressing the appropriateness of background data used for the assessment of a foreground process, we have now clarified that suitability and compatibility of scenarios are more appropriate terminologies in understanding the relationship between foreground and background process data. For example, in modeling processed foods made from rice, the issue is what kind of rice is used as the raw material for the processing and not whether the rice cultivation is representative in the country.

B. Inheritance of data structure

Although it seems to be a reasonable way to derive regionalized data (children) from global data (parents) as explained in ecoinvent 3 [7], our experience on tentative data development illustrates that further considerations on data structure and their inheritance are necessary for constructing LCI databases.

C. Background processes

Our project on the development of LCI data for rice production systems is still in progress in the sense that LCI data for agricultural inputs (such as fertilizers, pesticides, and agricultural machinery) have not yet been established. The situation we face makes a striking contrast to the case for AGRIBALYSE [15], which uses ecoinvent data for agricultural inputs in European regions. Although ecoinvent, for example, uses such European data in constructing LCIs for agricultural production systems in Asia (e.g., oil palm production in Malaysia) and South America (e.g., soybean production in Brazil), we have to reconsider the appropriateness of such LCI practices.

V. Concluding Remarks

This paper is an outline of our initiative on the development of Asian LCI databases of agricultural production systems. We started our activities on rice production systems, because rice is an important common crop in Asian countries. Our next step would be the extension of our activities into food supply chains including rice processing, distribution, and consumption. Paying attention to the other commodities such as palm oil and coffee is also important from the perspective of regional development. Recent diet shifts in Asian countries necessitate the assessment of animal products.

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ISBN : 978-1-4673-7404-0

Development of Life Cycle Inventories for Palm Oil in North Sumatra: Modeling Site-Specific Activities and Conditions

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***Abstract*—Life Cycle Assessment (LCA) has been applied to palm oil to assess the environmental impacts due to production activties at palm oil industries including up- and and downstreams. However, earlier studies on LCA on palm oil were based, in many cases, on averaged data and regiobnal conditions were not sufficiently considered. In this study we established Life Cycle Inventories (LCI) data for palm oil to on the basis of plantation management at the site-specific conditions. Two areas of oil palm plantation and two units of palm oil mill which selected for collecting inventory data were located in North Sumatra province. To compile the inventory data of relevant inputs, processes and outputs production from palm oil, the study was carried out to inventory all inputs includes the process starting from seedling-farm, plantation and pal oil mill. The inventory also includes the process with consumption of raw material and energy as well as the emission. Results of this study comprise set of data inventories from plantation and mill for construction life cycle inventory on palm oil biodiesel concerning to utilisation of palm oil as new sorces of energy to substitute for the petroleum products.**

Keywords :inventory data, palm oil plantation, palm oil mill, palm oil biodiesel

Manuscript received April 30, 2015. This work was in part supported by the Japan Society for the Promotion of Science, Grant-in-Aid for Scientific Research (B) 26310316 and (C) 26340110.

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I. Introduction

THE Indonesian palm oil industry has grown rapidly over the years to become the world's largest producer of palm oil. In 2012, more than 9 million hectares of land were oil palm cultivation with crude palm oil (CPO) production about 23.5 million ton [1]. A lots of CPO produced were exports and about 4 million ton used in domestic consumption. The increase in palm oil demand has been largely in line with the growth in food and industrial uses. It is expected that the demand will continue to grow even faster due to the development of the first and second generations of biofuel or bio-energy which is supported by the advancement of processing technology [2].

Being involved in 3 sectors, namely plantation, transport and mill, the production of palm oil faces a triple environmental challenge which must be monitored and dealt with. With a vast use of fertilizer in the plantations, poorly maintained transportation trucks and air emissions and wastewater from the mill, the industry has both environmental responsibilities to live up to and money to save by making the right technological investments and incorporating environmental management [3].

The environmental impact in a chain of the production process regarding to greenhouse gas emissions (GHG) and a decrease of natural resources quality is a concern to any industry today. In palm oil industry, the largest GHG emissions resulting from the production process of CPO in palm oil mill. However, the assessment of emissions caused by palm oil industry is an accumulation from nursery, plantation and palm oil mill.

LCA is a systematic tool for assessing the environmental impacts associated with any products, processes and activities, which is standardized in ISO 14000 series [4,7, 9, 10]. LCA has been applied to assess the environmental impacts [5] due to production activities at palm oil industries. LCA used to identify, emission calculation, evaluation and interpretation of environmental impact, so the opportunities and strategies for mitigation of emissions can be arranged for the

ISBN : 978-1-4673-7404-0

improvement of production processes in order to improve the performance of plantation and palm oil mill, evaluated the environmental impacts include climate change, eutrophication, acidification and energy consumption.

One of the steps in applied LCA is Life cycle inventory (LCI), which plays a very important role in conducting the assessment. LCI is a method to collect real data which occur in existing time. Due to this function, LCI is time consuming. The accuracy of LCA depends on the data input collection which is presented by data reliability and sufficiency and also reflects real field condition [4]. The result of LCA is highly influenced by the reliability and sufficiency of data inventory of the assessed object [6]. In the case of Indonesia, the availability of the data that will be used for LCA is still very limited. To compile the inventory data of relevant inputs, processes and outputs production from palm oil, the study was carried out to inventory all inputs and outputs includes the process starting from seedling-farm, plantation and palm oil mill. The data were inventoried including the amount of raw materials, production, seeds, fertilizers, pesticides and herbicides, fuel and energy consumption, water usage and others.

II. System Boundary

Concerning to construct data for life cycle inventory on oil palm, therefore data inventory in oil palm plantation refer to 1 kg oil palm fresh fruit bunch (FFB) and in palm oil mill refer to 1 ton CPO (crude palm oil). The system includes the process starting from seedling-farm (both pre- and main-nursery), plantation and palm oil mill. All unit processes is differentiated and identified as ‘input’, ‘process’, and ‘output’ as well as ‘emission’ (Figure 1). Where, during the process of each unit is releasing the emission to air, water and soil depend on the product or material used. The inventory includes the process with consumption of raw material and as well as the emission.

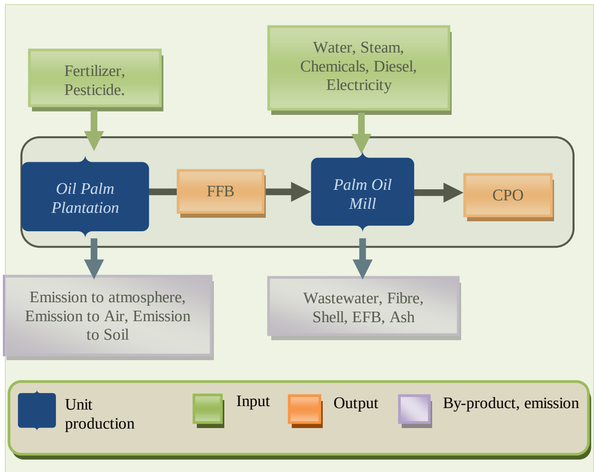

Figure 1. Life cycle inventory of oil palm industry (plantation and mill)

In this study LCI for palm oil were conducted on the basis of plantation management at the site-specific conditions. Two areas of oil palm plantation and two units of palm oil mill which selected for collecting inventory data were located in North Sumatra province. Plantation A is located about 60 km from Medan while Plantation B is located about 180 km from Medan. The plantation also has palm oil mill with production capacity each mill is 30 tons FFB per hour.

The unit processes that are related to the oil palm plantation from the life cycle perspective include:

- Fertilizer application
- FFB production
- Pesticides application
- Water consumption at nursery

Whereas the unit processes that are related to the oil palm mill from the life cycle perspective include:

- Material input
- Energy input
- Palm oil product as output
- By product output

III. LCI of Oil Palm Plantation

Fertilizer is one of the important factors in fruit production in oil palm plantation, particularly for mature palms. Fertilizer demand and FFB yield depend on a number of site-specific factors and can vary considerably [11]. Therefore, the application of fertilizer should be guided by standard practices which are usually in line with fertilizer recommendation. The recommendation is issued as the results of evaluation on crop condition, particularly nutrient status as identified through visual observation, soil and leaf analysis. The fertilizers must be applied in the proper dosage, right types of fertilizer, right time (especially during wet session) and right target (at weeding-circle of the palm).

The type of soil of plantation in this study was mineral soil. The realization of fertilizer application and FFB production were dully recorded by the planters. For the purpose of the present study, the data were obtained from the plantation management and presented in Table 1.

Table I

The Average Uses of Fertilizer in Oil Palm in This Study

Type of Fertilizer	Nutrient	kg kg^{-1} FFB *
Urea	ammonium sulphate as N	1.21E-02
Rock Phosphate	diammonium phosphate as P_2O_5	8.73E-03
Muriate of Potash	potashium chloride as K_2O	6.49E-03
Dolomite	dolomite as MgO	8.49E-03

Note: *) average value of the two plantations

Pesticide used in oil palm plantation to protect plant from pest which consists of herbicide and insecticide. There are various brand name of pesticide used in plantation but some of them have similar active ingredient. The average value of pesticide used in the

ISBN : 978-1-4673-7404-0

two plantations is presented in Table 2. It is shown that paraquat dichloride was the highest amount active ingredient used as herbicide, while methyl metsulfuron was the least amount.

TABLE II
PESTICED USED OF OIL PALM PLANTATION IN THIS STUDY

Brand name of Pesticide	Active Ingredient	kg kg^{-1} FFB
Basmilang *	isopropilamina glyphosate	4.60E-05
Sun Up *	isopropilamina glyphosate	
Gramoxon *	Paraquat dichloride	8.15E-05
Paratop *	Paraquat dichloride	
Ally 20 WDG *	metil metsulfuron	3.22E-06
Marshall **	carbosulfan	2.79E-05
Amcothene **	asefat	5.83E-05
Decis **	deltametrin	9.70E-06
Matador **	lamda sihalotrin	9.70E-06
Manufer **	Dimehipo	6.61E-05
Total Pesticides		3.02E-04

Note:
*) herbicide
**) insecticide

Irrigation is only applied in oil palm nursery and not in mature palms [8], therefore data of water consumption ware collected from oil palm nursery. The water consumption is presented in Table 3. The oil palm seedlings at main-nursery stage consumed water almost two times of the amount (0.73 m^3/polybag/yr) compared to that in seedlings at pre-nursery (0.37 m^3/polybag/yr).

TABLE III
WATER CONSUMPTION IN OIL PALM NURSERY

Nursery Stage	Seedling Quantity/ha	Water Consumption in m^3/polybag/yr	Water Consumption in m^3/ha/yr
Pre nursery	144,000	0.365	52,560
Main nursery	16,000	0.730	11,680
Total Water Consumption			64,240

Emission to atmosphere, water and soil were calculated from fertilizer application. The emission from oil palm cultivation presented in Table 4.

TABLE IV
EMISSION FROM OIL PALM CULTIVATION

Emission	Value	Unit
NH_3-N	4.438E-04	kg/kg FFB
N_2O	1.803E-04	kg/kg FFB
NO_x	3.786E-05	kg/kg FFB
CO_2	8.710E-03	kg/kg FFB
Phosphorus, to surface water	1.75E-01	kg/kg FFB
Phosphorus, to ground water	7.00E-02	kg/kg FFB
Nitrate, to ground water	4.44E-03	kg/kg FFB
Cd	1.00E-09	kg/kg FFB
Cr	3.71E-08	kg/kg FFB
Cu	1.05E-07	kg/kg FFB
Ni	3.78E-08	kg/kg FFB
Pb	4.90E-08	kg/kg FFB
Zn	8.29E-07	kg/kg FFB

IV. LCI OF PALM OIL MILL

The data inventory of palm oil mill was based on calculation and analysis of the two palm oil mills. The capacity of the palm oil mill was 30 tons of FFB per hour and the mills operated for approx. 20 hours per day with one line process. Based on the collected data from the mills operating, it can be estimated that the effective capacity of the mills was about 27.35 ton FFB per hour. The extraction rates of oil and kernel in this study were 23.30% and 4.88%, respectively. Unit process of CPO production for 1 ton CPO presented in Figure 2.

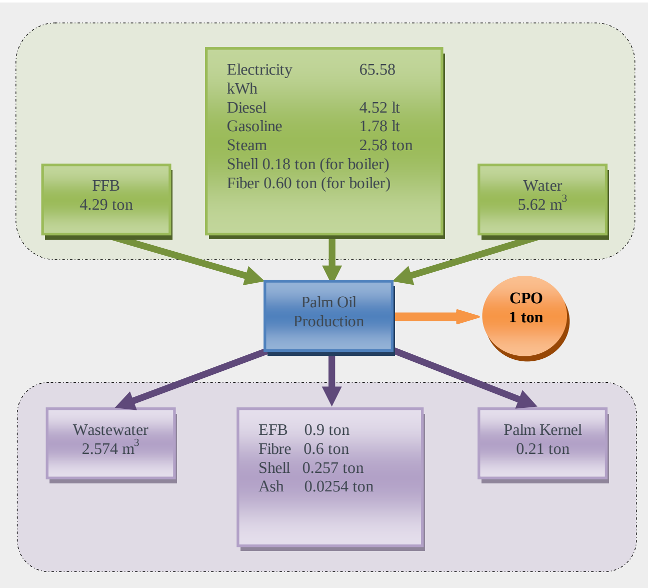

Figure 2. Unit process of CPO production (the calculation referred to produce 1 ton

Input materials for CPO production in palm oil mill consist of FFB, water and some chemicals. The water used in the process was taken from the nearest river and treatment in water treatment plant to obtain the proper quality of water for oil palm processing. The chemicals used for water treatment were Al_2O_3, H_2SO_4, and NaOH. The material consumption to produce CPO presented in Table 5.

TABLE V
MATERIAL CONSUMPTION AS INPUTS TO PRODUCE 1 TON CPO

Material Consumption (Input)	Quantity	Unit

FFB	4.29	ton/ton CPO
Water	5.62	m^3/ton CPO
Al_2O_3	3.2175	kg/ton CPO
H_2SO_4	2.1450	kg/ton CPO
NaOH	4.29	kg/ton CPO
Hexane (for oil losses analysis)	2.36	ml/ton CPO
Hexane (for FFA Analysis)	0.9438	ml/ton CPO
NaOH (for FFA Analysis)	0.001	g/ton CPO
Indicator Phenolphthalein (for FFA Analysis)	0.00005	g/ton CPO

Energy consumption as input to produce CPO in palm oil mill presented in Table 6. Gasoline and diesel used to generated power from engine, after that to mantain energy supply in the mill used fibre and shell as fuel for boiler. Electricity in this input was used for all processes in the mill and also to supply the demand for the office and emplacement.

TABLE VI
ENERGY USAGE TO PRODUCE 1 TON CPO

Energy Consumption (Input)	Quantity	Unit
Electricity	65.58	kWh/ton CPO
Fibre (100%) as fuel for boiler	0.60	ton/ton CPO
Shell (70%) as fuel for boiler	0.18	ton/ton CPO
Steam	2.58	ton/ton CPO
Gasoline	1.78	l/ton CPO
Diesel	4.52	l/ton CPO

The outputs from processing FFB in palm oil mill as palm oil product were crude palm oil and palm kernel, which presented in Table 7. CPO yield was about 23.30% of FFB and Palm Kernel yield was about 4.88% of FFB (or 0.21 ton/ton CPO production).

TABLE VII
PALM OIL PRODUCTS PRODUCED FROM PROCESSING OF 1 TON FFB

Palm Oil Product (Output)	Quantity	Unit
Crude Palm Oil	233	kg/ton FFB
Palm Kernel	48.8	kg/ton FFB

Another output from processing FFB in palm oil mill as waste (by-products) were empty fruit bunch (EFB), fruit fibre, shell, boiler ash and palm oil mill effluent (POME) as waste water presented in Table 8. EFB yield was about 22% of FFB. Boiler ash was generated from fiber and shell burnt, where 100% of fiber and 70% of shell were used as fuel for boiler.

TABLE VIII
THE AMOUNT OF WASTES (BY-PRODUCTS) GENERATED FROM PRODUCING OF 1 TON CPO

Waste (by product)	Quantity	Unit
Empty fruit bunch (EFB)	0.9009	ton/ton CPO
Fruit fibre	0.6006	ton/ton CPO
Shell	0.2574	ton/ton CPO
Boiler ash	0.0254	ton/ton CPO
Waste water	2.574	m^3/ton CPO

V. CONCLUSION

The input and output data to construct LCI on palm oil has differences among each plantation and mill. It depends on agriculture application in each plantation and system in the mill.

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 ISBN : 978-1-4673-7404-0

Sequential Pattern Mining on Hotspot Data in Riau Province using The PrefixSpan Algorithm

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***Abstract*— One effort to prevent forest fires is to determine the appearance of hotspots as indicators of forest fires in a region. Sequential patterns of hotspot occurrences can be extracted from a hotspot dataset. Based on sequential patterns, we can know some regions where forest fires may potentially occur. In addition, we can know the time interval of hotspot occurrences in the region. Such information can be used to make decisions to prevent the forest fires. This work applies the sequential pattern mining algorithm namely PrefixSpan to find frequent sequences in the hotspot dataset in Riau from 2000 to 2014. We utilized the Sequential Pattern Mining Framework (SPMF) tool to generate sequences on hotspots data. Using the dataset of the year 2005 and the minimum support of 1% to 11%, we obtain 67 one-frequent sequences, 46 two-frequent sequences, and 1 three-frequent sequence. The sequential pattern with 2 items and minimum support of 2% shows that there were 178 hotspots sequentially occurred on Feb 10, 2005 then on Feb 12, 2005. The time interval of hotspot occurrences is of 3 days.**

Keywords: hotspot, PrefixSpan, sequential pattern mining, SPMF

I. Introduction

Forest fires become a problem and a threat to the preservation of forests. Facts show that burning peat land in Bengkalis, Riau in March 2014 led to the destruction of forests of Riau around 21 900 hectares [1]. This triggers the efforts of various parties in the prevention of forest fires.

The occurrence of forest fires can be detected through the number and distribution of hotspots in a region. Hotspot data contain the location and time of hotspots occurrences that are collected every day so that result large data. However, these data are often only stored and are not processed to result useful information. Yet when the data has become a useful information, it becomes a reference for making decisions.

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One technique to manage hotspot data is data mining. Data mining has many methods in managing and analyzing data, among which is a sequential pattern mining which discovers sequential patterns on a sequence dataset. This method can be performed on the hotspot data to obtain information about the patterns of sequential appearance of hotspots that indicate the occurrences of forest fires in the region. Such information can be useful for prevention of forest fires for related parties in making decisions. There are several algorithms that are applied in a sequential pattern mining, including the Generalized Sequential Pattern (GSP), Sequential Pattern Discovery using Equivalent classes (SPADE), Frequent-Pattern Projected Sequential Pattern Mining (FreeSpan), Prefix Projected Sequential Pattern Mining (PrefixSpan), and Mining Frequent Closed Sequential Pattern Mining (CloSpan) [2].

The previous researches have applied data mining techniques including classification and clustering on hotspot data. In 2015, Nurpratami and Sitanggang have created a classification model for hotspot occurences in Bengkalis district, Riau province using the spatial entropy-based decision tree algorithm [3]. The result shows that as many 255 rules were obtained to classify hotspot occurrences [3]. Another work applied the Density-Based Spatial Clustering Algorithm with Noise (DBSCAN) on hotspot data in Sumatra in the years of 2002 and 2013 [4]. The result of the research shows that in 2002 hotspots were mostly found in moderate depth peat land, whereas in 2013, hotspots were frequently found in very deep peat land area [4].

This work applies the PrefixSpan algorithm because according to Han et al. [2] this algorithm has a better performance compared to the GSP, SPADE, and FreeSpan algorithm. PrefixSpan projects a sequence database into the smaller projected database. Therefore, in term of memory usage, PrefixSpan is more efficient and requires less memory space [2]. PrefixSpan is able to work well in a large database and does not require candidates generation. The algorithm creates a projection database recursively through the prefix in order to minimize execution time [5].

II. DATA AND METHODS

A. *Dataset and Data Preprocessing*

The data used in this study are hotspot data in Riau Province on 1st November 2000 to 30 August 2014. The data were obtained from the National Aeronautics and Space Administration (NASA) Fire Information for Resource Management (FIRMS) at http://earthdata.nasa.gov/ in shape file format (shp). Hotspot data consists of 12 attributes and 141 049 records.

Data preprocessing is divided into four stages, namely data selection, data cleaning, data transformation, and sequential data generation. Data selection was done to select the attributes that will be used in research. The selected attributes are longitude, latitude, and acq_date. Data cleaning was done by removing the attributes or data that have many missing values or noises. The data set has a lot of noises. There are several hotspots located outside Riau Province. These hotspots are removed so the number of records in the dataset is 140 930. Data transformation was done to convert the type of attributes. This study adds an attribute, namely acq_date2 that has type of integer. The value of acq_date2 is conversion result of acq_date that its type is the date. The values of longitude and latitude are rounded to two decimal places to get some appearances of hotspots in the area with a diameter of approximately 1 km. Sequential data generation was performed by sorting the data based on attributes longitude, latitude, and date. Longitude and latitude are used as id in the database. While acq_date2 denotes events or items that is sorted by date.

B. *Sequential Pattern Mining and PrefixSpan Algorithm*

Sequential pattern mining is a process to extract sequential patterns that its support exceeds the minimum support. The value of minimum support is usually defined by the user. Based on the value of minimum support, the patterns that are less attractive can be ignored so that the mining process becomes more efficient [5].

Sequential pattern mining can be applied when given a set of sequences and support threshold, then this method finds a complete set of frequent subsequences. Sequential pattern mining aims to find the relationship between the events that occur in a sequence dataset and find a pattern if there is a specific sequence of an incident or event. Results of sequential pattern mining process can describe a data or predict the next data [5].

PrefixSpan algorithm was first introduced by Agrawal and Srikant [6]. PrefixSpan applies a divide and conquers approach. With this approach, the database is projected recursively into a bunch of smaller databases, then the projection is extracted to obtain the patterns. PrefixSpan projects the prefix so that the size of projected database will shrink and evaluation on each possible position of a potential candidate will be reduced [6]. PrefixSpan algorithm is provided in Fig. 1 [6].

```
Algorithm 1 (PrefixSpan)
Input: A sequence database S, and the
minimum support
Output: The complete set of sequential
patterns
Method: Call PrefixSpan (<> ,0,S)
Subroutine PrefixSpan (α, l, S|α )
Parameter: 1) α is a sequential pattern;
2) l is the length of α; 3) S|α is the α
projected database if α ≠ <>, otherwise,
it is the sequence database S.
Method:
1. Scan S|α once, find each frequent item,
   b, such that:
    a) b can be assembled to the last
       element of α to form a sequential
       pattern; or
    b) <b> can be appended to α to form a
       sequential pattern.
2. For each frequent item b, append it to
   α to form a sequential pattern α', and
   output α'.
3. For each α', construct α'-projected
   database S|α', and call PrefixSpan (α',
   l+1, S|α').
```

Fig. 1. PrefixSpan algorithm

III. RESULT AND DISCUSSION

Sequential data generation on data preprocessing was done using programming language PHP. Size of sequence dataset each year is provided in Table I. The largest of the total of hotspot occurrences is those in 2005, 2013, and 2014. The dataset of the year 2005 has 23 040 hotspot occurrences that result 7 350 sequences in the sequential dataset.

TABLE I
SIZE OF SEQUENTIAL DATASET

Year	Size of hotspot data	Size of sequential data
2000	124	105
2001	1 677	1 025
2002	5 954	3 000
2003	6 874	3 433
2004	8 388	3 927
2005	23 040	7 350
2006	11 124	5 330
2007	4 094	2 477
2008	5 650	3 321
2009	10 895	5 096
2010	4 100	2 486
2011	6 840	3 849
2012	7 853	4 204
2013	25 461	6 215
2014	18 856	5 640
2000-2014	140 930	27 418

The examples of sequential data of hotspots occurrences in 2005 are shown in Table II. Sequential patterns were discovered using the SPMF tool. SPMF cannot read the input of the sign ‘(’, ‘)’, ‘<’ and ‘>’

 ISBN : 978-1-4673-7404-0

[7]. SPMF only read the input that its type is the integer so that adjustment of SPMF format is required as shown in Table III [7]. The '-1' indicates the order between items while the end of the sequence is marked as '-1 -2' [7].

TABLE II
EXAMPLES OF SEQUENTIAL DATA OF HOTSPOTS IN 2005

Longitude	Latitude	Sequential data
101.51	1.76	<(1587)>
101.51	1.77	<(1587)(1589)(1601)>
101.51	1.78	<(1585)(1587)>

TABLE III
EXAMPLES OF SEQUENTIAL DATA IN SPMF FORMAT

Longitude	Latitude	Sequential data
101.51	1.76	1587 -1 -2
101.51	1.77	1587 -1 1589 -1 1601 -1 -2
101.51	1.78	1585 -1 1587 -1 -2

Sequence data in Table II and III indicate that in the area with the longitude of 101.51 and the latitude of 1.76, there is the emergence of hotspots on the 1587th day (March 7, 2005). As for the longitude of 101.51 and the latitude of 1.77, hotspots occurrences are found on the 1587th day (March 7, 2005) then on the 1589th day (March 9, 2005) and they are followed by the hotspots occurrences on the 1601st day (March 21, 2005).

The value of minimum support is determined by the method of trial and error, which is started by selecting the minimum support of 1% to the value of the minimum support that does not generate a sequential patterns. Number of sequential patterns in 2005, 2013, 2014, and 2000 to 2014 can be seen in Table IV. Experiments using the dataset of the year 2005 and minimum support 1% to 11% result 67 one-frequent sequences, 46 two-frequent sequences, and 1 three-frequent sequence. The results of the hotspot sequential patterns in 2005 are provided in Table V. Table V shows only five sequential patterns of hotspot occurrences with the highest support value.

TABLE IV
NUMBER OF SEQUENTIAL PATTERNS

Min. support (%)	Data set			
	2005	2013	2014	2000-2014
1	114	71	137	79
2	43	35	56	13
3	24	20	30	3
4	18	18	21	2
5	11	12	15	1
6	7	8	11	0
7	3	7	10	0
8	2	5	7	0
9	2	5	4	0
10	2	4	4	0
11	0	4	3	0
12	0	3	2	0
13	0	2	2	0
14	0	2	1	0
15 to 21	0	1	1	0
22 to 26	0	1	0	0
27	0	0	0	0

TABLE V
HOTSPOT SEQUENTIAL PATTERNS IN 2005

Min. support (%)	1-item	2-item	3-item
1	1573 -1 #SUP: 770 1740 -1 #SUP: 743 1559 -1 #SUP: 538 1589 -1 #SUP: 489 1562 -1 #SUP: 481	1562 -1 1564 -1 #SUP: 178 1587 -1 1589 -1 #SUP: 160 1696 -1 1697 -1 #SUP: 155 1545 -1 1546 -1 #SUP: 149 1561 -1 1562 -1 #SUP: 147	1561 -1 1562 -1 1564 -1 #SUP: 75
2	1573 -1 #SUP: 770 1740 -1 #SUP: 743 1559 -1 #SUP: 538 1589 -1 #SUP: 489 1562 -1 #SUP: 481	1562 -1 1564 -1 #SUP: 178 1587 -1 1589 -1 #SUP: 160 1696 -1 1697 -1 #SUP: 155 1545 -1 1546 -1 #SUP: 149 1561 -1 1562 -1 #SUP: 147	
3 - 6	1573 -1 #SUP: 770 1740 -1 #SUP: 743 1559 -1 #SUP: 538 1589 -1 #SUP: 489 1562 -1 #SUP: 481		
7	1573 -1 #SUP: 770 1740 -1 #SUP: 743 1559 -1 #SUP: 538		
8 - 10	1573 -1 #SUP: 770 1740 -1 #SUP: 743		

According to Table V, the sequential patterns of hotspots in 2005 have length up to 3 events. Sequential patterns with length 1 item are obtained on the minimum support of 1% to 10%. The minimum support of 10% means that the total of frequent sequential patterns at least is 735. The frequent sequential patterns when the minimum support of 10% are as follows:

1573 -1 #SUP: 770
1740 -1 #SUP: 743

There are two frequent sequential patterns on the minimum support of 10%. The sequential pattern <(1573)> states that as many 770 hotspots are occurred in the 1573rd day (February 21, 2005). The locations of the sequential pattern <1573> are in 64 districts including Bantan, Pelangiran, and Tapung Hilir.

Sequential patterns with the length of 2 events were obtained on the minimum support of 1% to 2%. The minimum support of 2% states that any frequent sequential pattern has the value of support at least 147. The frequent sequential patterns on the minimum support of 2% are as follows:

1562 -1 1564 -1 #SUP: 178
1587 -1 1589 -1 #SUP: 160
1696 -1 1697 -1 #SUP: 155
1545 -1 1546 -1 #SUP: 149
1561 -1 1562 -1 #SUP: 147

TABLE VI
NUMBER OF 2-SEQUENCES IN 2005

Sequential Pattern (2 *items, min. support* 1%)	Total of *supports*	Total of hotspots	Percentage (%)
1572 -1 1573 -1 #SUP: 74	2 448	23 040	10.625
1573 -1 1574 -1 #SUP: 89			
1594 -1 1596 -1 #SUP: 80			
1587 -1 1589 -1 #SUP: 160			
1585 -1 1587 -1 #SUP: 123			
1584 -1 1585 -1 #SUP: 101			
1544 -1 1546 -1 #SUP: 102			
1545 -1 1546 -1 #SUP: 149			
1546 -1 1547 -1 #SUP: 76			
1541 -1 1543 -1 #SUP: 105			
1543 -1 1545 -1 #SUP: 95			
1543 -1 1544 -1 #SUP: 106			
1564 -1 1566 -1 #SUP: 114			
1566 -1 1568 -1 #SUP: 104			
1561 -1 1562 -1 #SUP: 147			
1560 -1 1562 -1 #SUP: 76			
1562 -1 1564 -1 #SUP: 178			
1557 -1 1559 -1 #SUP: 80			
1559 -1 1561 -1 #SUP: 137			
1559 -1 1560 -1 #SUP: 96			
1740 -1 1742 -1 #SUP: 101			
1696 -1 1697 -1 #SUP: 155			

There are 5 frequent sequential patterns with the minimum support of 2%. The sequential pattern that has highest support value is <(1562)(1564)>. The sequence pattern shows that there are 178 hotspots occurrences started on the 1562nd day (10 February 2005) followed by occurrences on the 1564th day (12 February 2005). The time interval of hotspots occurrences on the sequential patterns is 3 days. The locations of the sequential pattern are in 20 districts including Bengkalis, Mandah, and Kerumutan.

The sequential pattern of hotspots occurrences with the length of 3 events was obtained with the minimum support of 1%. As many 73 frequent sequential patterns contain three events sequentially. The 3-frequent sequential pattern with the minimum support of 1% is as follows:

1561 -1 1562 -1 1564 -1 #SUP: 75

The sequence pattern shows that there are 75 appearance of hotspots that start on the 1561st day (9 February 2005) then on the 1562nd day (10 February 2005) then it is followed by other hotspots on the 1564th day (12 February 2005). The time interval of the hotspots occurrences on the sequential pattern is 2 days starting from 9 February 2005 until 10 February 2005. Furthermore, the time interval from 10 February 2005 to 12 February 2005 is 3 days. The locations of the sequential pattern are in 11 districts including Rupat, Sungai Sembilan, and Kuala Kampar.

IV. SUMMARY

This work discovered as many 7 350 sequential patterns of hotspots occurrences in 2005 from the hotspots dataset consisting of 23 040 events with the minimum support of 1% to 11%. The sequential patterns of hotspots occurrences in 2005 have length up to 3 events. As many 770 hotspots were occurred on 21 February 2005. The sequential patterns with length of 2 events shows that there are 178 hotspot appearances on the 10 February 2005 followed by other occurrences on 12 February 2005. Sequential pattern with length of 3 events shows that there are 75 hotspot appearances on 9 February 2005 then on 10 February 2005 and then these occurrences are followed by other occurrences on 12 February 2005. The time interval of hotspots occurrences in sequential patterns is 2 to 3 days.

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 ISBN : 978-1-4673-7404-0

An Intelligent Optimization Model Analysis and Design of Bio-filtration in Raw Water Quality Improvement

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Abstract – Currently clean water treatment technology is in-need to optimize available environmental–friendly bio-filtration technology as means for pre-treatment of raw water quality improvement with the intelligent computational model. The objectives of this research is to identify the component and process in systems analysis, to develop the design for an intelligent optimization model of bio-filtration in raw water quality improvement. In this paper, optimization model of bio-filtration was simulated by using Process Hierarchy Diagram (PHD) and Business Process Modeling and Notation (BPMN) model with numerical integration to assist researchers in clean water technology by using artificial neuron network (ANN). The intelligent system was designed in two processing variables as the model inputs, namely pollutant concentration and hydraulic retention time (HRT). By modifying and controlling value of these variables, researchers determined the influences on the three bio-filtration crucial biochemical properties, such as pollutant index (PI), mass balance (MB), and microbial growth (MG). Model verification result showed that the model succeeded conducting an optimization for all properties. Thus this proposed system is potentially to optimize model of bio-filtration in raw water improvement in a simpler and fully controllable model.

I. INTRODUCTION

Applied industrial bioprocesses in water treatment present a difficult challenge to control engineers. Several computational intelligence approaches have contributed to enhance bioprocess observability. Optimization in bioprocesses is one of the few research approaches that directly translate results into value. Many optimization techniques have been investigated and successfully deployed in industry. The higher the complexity of a problem, the stronger the limitations of classical optimization methods. In the case of complex high dimensional with noisy data, these methods have difficulties in finding global optimum. Fortunately, computational intelligence offers several approaches that can deliver solutions beyond the limitations of classical optimization. In bioprocess optimization, artificial neuron network can deliver unique capabilities for finding steady state and dynamic optimum [1].

As a result by investigated water treatment regional enterprise[2, 3], clean water treatment process still lack in concentration loading of raw water that pass minimum raw water quality which quality and control water pollutant. For example: organic material ($KMnO_4$) 10-19 mg/L, Ammonium (NH_4-N) 0.06-1.09 mg/L, detergent 0.9 mg/L. Effort for clean water still continue is by using chlorine to reduce microorganism and active carbon filter in advanced treatment. This way still causes many problem such as: using coagulant increasing along with raw water quality decrease, it showed the side effect by using chloric disinfection affects trihalometan (THM) to form halogen chloric-phenol as carcinogen, if THM reaction phenol as raw water component [2].

In order to improve and optimize the above process, it is required to construct a business process modeling in a system simulation. This modeling potentially embraces all perspectives which are necessary in content model such as information, functions and behaviors as much as possible. This modeling currently uses Business Process Modeling and Notation (BPMN) to construct a simple and fully – controllable system presenting a real bio filtration process [1, 4].

The following sub-sections describe more in detail about each step and diagrams built in the modeling. First the proposed system was defined and then its requirement and variables were identified and analyzed. Then the diagram's construction was initiated sequentially with PHD, BPD up to BPMN in order to optimize formula for MB and MG requirement. Their optimization with ANN deployment as a decision tools to find the solution of models. These solution were then used extensively to predict water quality as well as to provide reliable tools for investigation of the steady state occurrence by considering the removal of pollution [6]. All of above description is assumed to comply with **System Development Life Cycle** (SDLC) from planning, analysis, designing, implementation and maintenance [3].

In order to raise more appropriate solution in term of pilot plant we proposed the use of a bio filtration in pilot plant scale with the objectives of this research as follows:

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1. To analyze the influence of hydraulic retention time and pollutant concentration by mapping process Hierarchy Diagram (PHD) and Business Process Diagram of bio filtration process (BPMN).
2. To formulate mathematical models for scale up bio filtration process.
3. To verify and validate model.

The rest of this paper is organized as follows. In section II, we introduced related works in bio-filtration process. In section III utilizes methodology by the mapping of PHD and BPMN of bio-filtration process as well as the controller the problem concerning the water quality and mathematical models for scale up bio-filtration by simultaneously economic technique. In Section IV utilizes experimental results, and finally some concluding remarks are provided in section V.

II. RELATED WORKS

Bio-filtration is a pollution control technique that uses living microorganisms to capture and degrade pollutants from air as air pollution control and water as water pollution control. Basically, this process that combines mechanisms of adsorption, desorption, and biodegradation of gas or water phase pollutants [7, 8].

Modeling stage role in identifying and decomposing business process so that system can be identified by detail and focused on control flow (sequence execution) or data flow (data exchange). In BPM, there are diagrams that relate each other in analyzing the model. PHD represents processes held in system into a hierarchy, where each process was analyzed one by one afterwards in BPD. As addition, BPM also uses various languages representing its process, which one of them is analysis language that uses graphical notations standardized to illustrate control flow in critical business process in BPMN which has optimized formulation model for MB and MG using ANN.

To develop bio-filtration as pre-treatment technology in water treatment process, we need to observability the structural system properties that relates to the possibility of estimating bio filtration system, state on the basis of the available measurement information. BPMN modeling of bio-filtration properties characterization, consisting of mass balance and microbial growth, aimed to evaluate the compatibility of bio-filtration which its process in packed bed reactor related to influences of variables pollutant concentration and **hydraulic retention time** (HRT). For formulation this system, a neural based **computational intelligence** (CI) and bioprocess were considered as vast application area with complexity and challenging task to deal with bioprocess area [2, 5, 8, 9, 10]. The formula in CI technique is used to solve the problem for scaling up bio filtration process which can described as three bio filtration properties such as : (1) pollutant index [6] ; (2) mass balance and (3) microbial growth [7, 8, 9, 10] . Therefore optimum value could be identified to reach the best bio filtration characteristics.

III. METHODOLOGY

A. Process Requirement for Analysis and Mathematical Formulation

Process requirement analysis defined as first stage assessment in system approach and require to develop a system properness [9]. The aim's in this stage is to define factors in analysis system in overall stakeholder. To certain information in process requirements properly and to design appropriate information systems, it is of primary importance to understand the stakeholder as a whole because all system are composed a sub-system [11]. In this topic, a system or sub-system as it exists within the cooperate stakeholder may be graphically model which show the boundary system and the information used in the system by using ***United Model Language*** (UML).

The gap in this study, is to find the harmony between stakeholder (in forms of actor, equipment and supporting system agents) and bio-filtration technology in real condition. The main process in bio-filtration is growth and product formation in continuous microbial culture is a process that maintained for prolonged periods. Furthermore, a steady state can be maintained such that the cell concentration, growth rate, and culture environment (e.g. nutrient and product concentration) do not change with time. As a consequence, continuous culture provides a unique tool for investigating the response of continued production of cell mass or other products under optimal environmental conditions. Because of this gap, we need identify input in bio-filtration process for measure met and predict in of raw water dynamic. Afterwards we considered the status of raw water (river) quality using **Pollutant Index** (PI) refers to The Ministry of Environment No 115 (2003) concern in water quality standard. Then PI can be determined [6]:

a. If the water quality parameter low (dissolve oxygen, BOD, COD, and others), then water quality good.
b. Arrange value of Pollutant Index (PI) using formula :

$$\mathrm{PI} = \sqrt{\frac{(\frac{\mathrm{Ci}}{\mathrm{Lij}})^2 M + (\frac{\mathrm{Ci}}{\mathrm{Lij}})^2 \mathrm{R}}{2}} \quad \text{......................} \quad (1)$$

Where,

PI	=	Pollutant Index
Ci	=	Water Quality (i)
Lij	=	Water Quality Standard (j)

 ISBN : 978-1-4673-7404-0

$(\frac{Ci}{Lij})_M$ = Maximum value for $\frac{Ci}{Lij}$
$(\frac{Ci}{Lij})_R$ = Average value for $\frac{Ci}{Lij}$

Where evaluation PI value for evaluate:

$$PI(x) = \begin{cases} \text{Good} & : 0 \leq PI \leq 1.0 \\ \text{Slightly} & : 1.0 < PI \leq 5.0 \\ \text{Moderately} & : 5.0 < PI \leq 10 \\ \text{Highly} & : PI > 10 \end{cases}$$

Hydraulic retention time in this paper decide in HRT optimum is 2 hours for this bio filtration system [2, 5, 7] . The system was formulated mathematically based on previous study. In former researches about optimize bio-filtration process, focus on bio-filter properties such as Mass Balance (MB) and Microbial Growth (MG).

A1. Mass Balance (MB)

Continuous culture in bioprocess system must provide the steady state microbial growth condition. In order to describe the bio filtration's steady state behavior, it is necessary to devise a set of equations relating cell and limiting nutrient concentration. Component-wise mass balances give the following differential equations [9, 10] :

$$\frac{dX}{dt} = (r1 + r2)X - DX \text{ .... } (2)$$
$$\frac{dS}{dt} = (k1r1 + k2r2)X - D\ (S - S\text{ feed}) \text{ .... } (3)$$
$$D = \frac{Fin\ (t)}{V\ (t)} = S\text{ feed} \text{ .... } (4)$$

Where, **D** is dilution rate, **V** is the medium volume and $\mathbf{F_{in}}$ is the inlet flow rate. In order to satisfy the second objective, it is necessary to control cell physiology so as to maximize the nutrient flow through the cell (biofilm) to the product and thus minimize nutrient use for cell mass synthesis and cell maintenance (**mX**). The importance of this may be seen from the following material balance on substrate which define as polluted water (raw water) at steady state [9, 10]:

$$D(S_0 - S) = \frac{DX}{Yx/s} + mX + \frac{qp\ X}{Yp/s} \text{ ... } (5)$$

Where $\mathbf{Y_{x/s}}$ and $\mathbf{Y_{p/s}}$ are the conversion yields of substrate to cell mass and product respectively.

A2. Microbial Growth (MG)

This formula presents a catabolism that can be macroscopically described by the following two main reactions:

Respiratory capacity	$ro = \mu o \frac{O}{O+Ko} \times \frac{KiO}{KiO+O}$ ... (6)
[S] consumption	$rs = \mu s \frac{S}{S+Ks}$ .... (7)
F1 ([S] oxidation)	min (rs, ro/ks) .... (8)
F2 ([S] degradation)	max $(0, rs - \frac{ro}{ks})$ .... (9)

These expressions take the classical form of Monod laws where **μo** and **μs** are the maximal values of specific growth rates and **Ks** and **Ko** are the saturation constants of corresponding element which performance function (ANN) is MSE for a quantitative examination of the fit of predictive models was made using error measurement indices which can evaluate forecasting models [9, 11] .

B. Computational Intelligence for Optimization

An important factor in efficient operation of bio-filter reactor is the definition of the mass balance composition and microbial growth which compose a biofilm pattern in matrix surface. This is a complicated problem since they should take into consideration a large number of substrate (pollution concentration) as well as input for microbial growth and metabolic complexity of microbial involved.

There have been a few attempts using CI techniques, as an alternative to bioprocess monitoring modeling technique in relation to mass balance (MB) and microbial growth (MG). The problem of determining a MB and MG can be approached as an optimization and problem implemented during steady state condition. Hence, it is of significant interest to develop bioprocess monitoring which make available information sources used, e.g. mathematical process model with ANN technique to find a optimal key value. Using CI offers several approaches that can deliver solutions beyond the limitations of classical optimization [9].

It means this approach can establish a simple mathematical relation model in bioprocess specially bacteria activity in bio-filtration phenomenon. The advantage using ANN technique are capable of defining unknown patterns and dependencies from available data; can approximate any continuous nonlinear mathematical function; and it is very fast relative to most of known approaches as based modelling process [11] .

C. Process Hierarchy Diagram (PHD)

The process requirement for certain hierarchy structure implemented as a PHD. PHD is high level diagram that used to analyze business function as a hierarchy of process so it is also known as functional decomposition diagram. PHD illustrates graphically functions of the system and spreads them into many sub-processes.

D. Business Process Diagram (BPD)

In order to support business process clarity, BPD analyzes how many sub-processes of the system built by PHD being allocated to people, organizations or groups. This diagram determines the control flow of process and helps user to figure how data goes through them. BPD also defines the

ISBN : 978-1-4673-7404-0

data flow influences on sub-processes implementation.

E. Business Process Model and Notation (BPMN)

The composition and combination of PHD and BPD eventually lead to a construct of BPMN. BPMN consists of diagrams such as: choreography diagram defines details of conversation held between two/more stakeholders that explains sequence flow of each process own by stakeholders. In this modeling, choreography diagram is generally applied to illustrate the processing system by analyzing how each stakeholder switch or trade information and messages.

IV. EXPERIMENTAL RESULTS

Input of the system were derived from previous studies data [2] while some were hypothetical such as in variable analysis. Data were assumed by adjusting the range given in former researches result with the system needs. Subsequently, output were confronted with reference data which had been best so far, so that existence of improvement could be analyzed.

A. System Development

Definition and development of the system will be described below. SDLC described that idea (Fig 1), as the first element which began bio filtration process as means for pre-treatment of raw water quality improvement, water quality declination can be prevented with optimize bio filter properties. Afterwards, model could be designed by using success indicators that can be generate by Computational Intelligence.

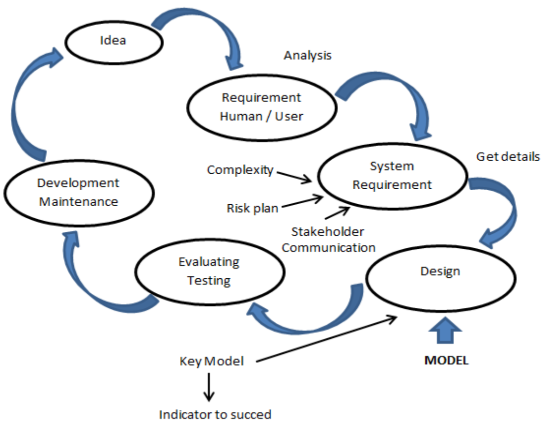


Figure 1. *System development life cycle* [1, 3]

To get system requirements in bio-filtration we can find a whole system abstraction as well as the detail in bio filtration system as follows. First in Table 1 describe the water quality state which proceed to measure PI for decision making (Table 2) when we need to design the bio filter reactor in pilot plan.

TABLE 1.
EXISTING RIVER CONDITION [6]

Location and Level of Pollutant	Parameter					
	DO (mg/L)		COD (mg/L)		BOD (mg/L)	
River flow (m^3/s)	14.5	94.5	14.6	94.5	14.6	94.5
Upstream	5.34	5.76	13.9	18.9	3.9	1.1
Downstream	2.47	3.75	219.2	71.9	89.4	5.2
Level I	6		10		2	
Level II	4		25		3	
Level III	3		50		6	
Level IV	0		100		12	

TABLE 2.
POLLUTANT INDEX [6]

Location of River Water	Pij (Level I)		Pij (Level II)	
	Non-Load	With Load	Non-Load	With Load
Upstream	1.79*	1.88*	3.28*	1.84*
Downstream	6.75**	11.22***	6.11**	6.16**
Location of River Water	**Pij (Level III)**		**Pij (Level IV)**	
	Non-Load	**With Load**	**Non-Load**	**With Load**
Upstream	0.76#	1.82*	0.71#	1.80*
Downstream	5.03**	5.05**	3.46*	4.09*

Note: (#) is good, (*) is slightly, (**) is moderately and (***) is highly polluted.

After we get the pollutant index that can make this result as a reference to predict the dynamic river quality caused river polluted and erratic climate change, thus design bio filter reactor performance confront uncertain river condition as well as for traceability if there are decrease performance in bio-filtration process.

B. Model Analysis Result

The main challenge for the application of any database modeling technique is that process kinetic rate are measured variables. The ANN supervised learning paradigm is based on error correction principle and in order to update the network weights, an error signal between the network output and the corresponding target (reference output) is required. However for the kinetic rates, targets (measurements) are not available. Hence, the bio-filtration control system must be connection with rules in bio filtration process (especially microbial aspect such as: growth, kinetic). To describe the

 ISBN : 978-1-4673-7404-0

kinetic of microbial growth (Table 3) which form biofilm and mass balance law (Table 4).

BPMN diagram designed in this production system consists of 2 divisions and each one is divided into 1 to 2 sub-divisions of Process Engineer which branches into sub division Pre-Operation Design and Information Processing and Bio-filtration Process which branch into sub division Acclimation and Shocked Load Process. As a result in Table 3 and Table 4, indicates that microbial kinetics in steady state condition which find optimum MB value 27.67 mg/L NH_4 production; Yx/O_2 as oxygen consumption measure 13.00 mg/L; specific growth rate for Yp/x; Yp/s and Yx/s as slope in the curve. It means that 0.01 mg/L NH_4 per biomass; 0.02 mg/L NH_4 per substrate consumption; and 0.49 g/L biomass growth rate per substrate consumption.

TABLE 3
MICROBIAL KINETIC GROWTH IN BIOFILTRATION

Time (day)	r_S	r_X	r_P	r_O
0	0.00	0.00	0.00	0.00
4	0.25	0.00	0.50	0.04
7	1.33	0.00	0.00	0.04
11	1.00	1.00	0.00	0.03
17	0.83	0.50	0.17	0.14
25	1.75	2.13	0.38	0.12
28	19.00	4.33	8.33	0.03

Time (day)	$Y_{x/s}$	$Y_{x/O2}$	$Y_{p/x}$	mX
0	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
11	1.00	3.33	0.00	6.00
17	0.60	3.57	0.33	5.40
25	1.21	17.35	0.18	31.57
28	0.23	13.00	1.92	2.96

For control analysis and design system in intelligence optimization bio filtration. There were critical tasks in swim lane which define how determining variables influence the process output which can implemented PI, MG, and MB equation. In Fig 2, there is a division namely bio-filtration unit. Message flow in this diagram continued to deliver river existing data from preparation as process design requirements as an input for control the optimum of MG and MB [9].

TABLE 4.
BIO FILTER MASS BALANCE

Time (day)	Substrate In	Matrix Volume	D	MB
0	12	60	0.20	1.00
4	11	60	0.18	3.00
7	7	60	0.12	3.00
11	11	60	0.18	4.00
17	6	60	0.10	4.50
25	20	60	0.33	9.13
28	77	60	1.28	27.67

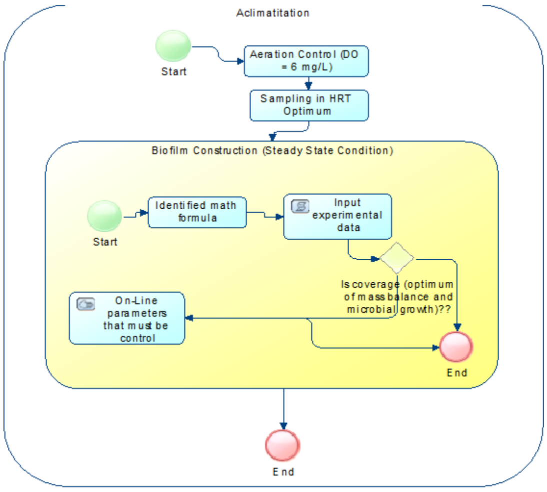
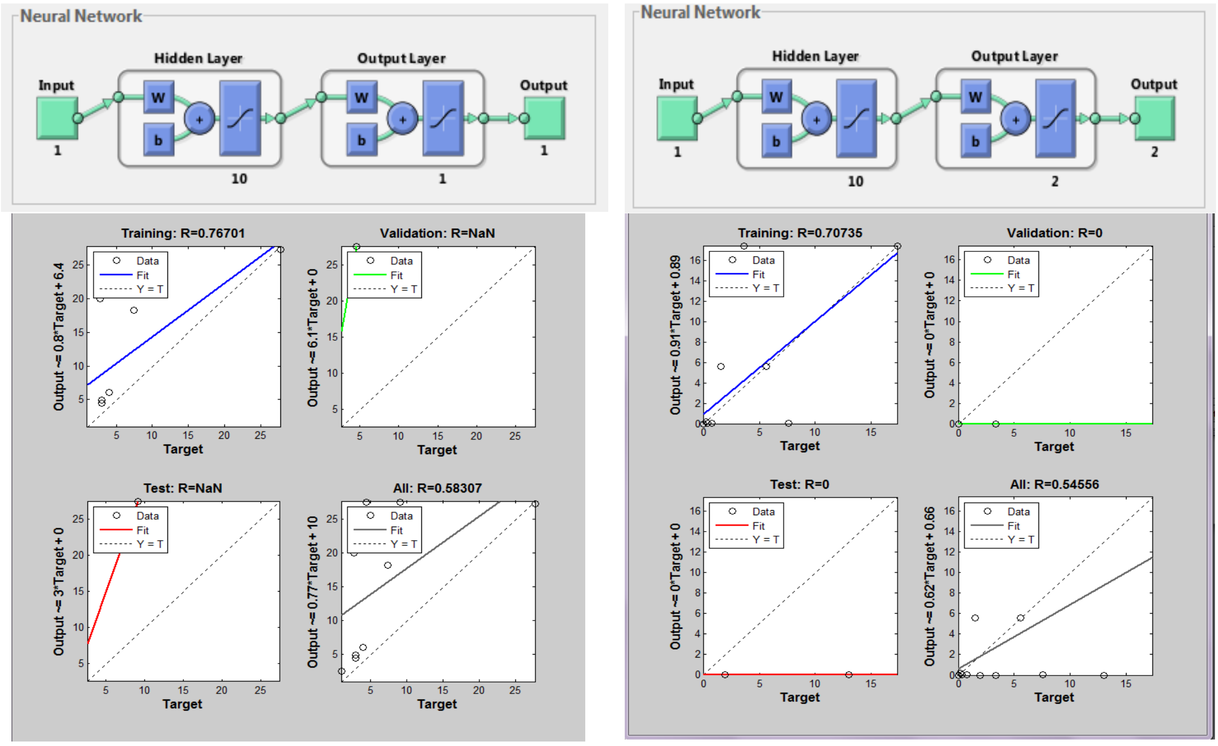


Figure 2. BPMN swim lane: acclimatization in stakeholder bio-filtration unit.

C. Model Verification and Validation

Based on formula and reference data gathered from previous studies [7, 9, 10, 11], the designed production system model was compared then its optimization was analyzed. ANN result was presented in graphs (Fig 3). Fig 3 showed that MB have 76.70% valid and MG have 70.74 % valid. It indicated higher mass balance and microbial growth in bio-filtration unit which is good to biofilm stability. It verified that model is able to deploy an improvement, in case of MB and MG value. Those output were verified as optimum and improvement model in case of the bio-filtration in raw water quality improvement.

ISBN : 978-1-4673-7404-0



(a) (b)

Figure 3. Verification and validation intelligent model of biofiltrasion by using ANN : (a) MB neural network and (b) MG neural network

V. CONCLUSION

1. Complexity in bio filtration to optimize bio filtration in pilot scale has a massive inter-dependencies among each processing steps were required in system analysis and design. On analysis showed that PHD and BPD clearly presented process which describe the influence of HRT and pollutant concentration that affects dynamic bio-filtration performance.
2. Our formulation succeeded to optimize solution for MB and MG using ANN approach. The model validation result showed null error and warning in each modeling steps.
3. In BPMN verification, sample that indicated optimal model is applicable for researchers to assist them in developing various clean water technology using bio filter. In this study, ANN was successfully employed as a part of the numerical solution of MB and MG which enabled intelligent modeling in bio-filter reactor.

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ISBN : 978-1-4673-7404-0

DEVELOPMENT OF PEOPLE FOOD CONSUMPTION PATTERNSINFORMATION SYSTEM BASED ON WEBMOBILE APPLICATION (Case Study District of Jatinangor, Sumedang)

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***Abstract* - Food Consumption Patterns will be very important to regulate human nutrition.With good and organized food consumption patterns all the nutritional needs can be fullfilled.An unorganized food consumption patterns can lead to lack of nutritional needs..Besides, it will cause disease.The problems that occurred in Indonesia are still many people who lack awareness about good food consumption patterns, knowledge of the nutritional needs and nutritional content of food.The purpose of this research is to design and create a system of food consumption patterns of web-based mobile application to provide recommendations based on the pattern of food consumption by the body's nutritional needs and based on the nominal money.The method used in this study are engineering methods.The results of the research are, the system can display the information about nutritional needs of the user.system is can display the information nutrient content of foods.system can provide food recommendations option based on the nutritional needs of userssystem can provide food recommendations option based on nominal money that be input andthesystem database can be regulated or controlled by admin.**

I. INTRODUCTION

Food is one of the primary needs for humans. According to WHO, food has three functions. First, food as a energy source as heat can be generated from food as well as energy.Second, food as a building essence because food is useful for build a new body tissue, maintain and repair old body tissues.Third, food as a regulator because food regulate natural processes, chemical, and physiological processes in the body [1]. Food consumption patterns very important to regulate human nutrition. By good and organized food consumption patterns, all the nutritional needs can be fullfilled. In Indonesia, the standard of good food consumption patterns known as a nutritionally balanced food menu [2].

An unorganized food consumption patterns besides lead to lack of nutritional needs, it will cause disease too.According to Thabrani in merdeka.com "In Indonesia, according to Local Health Research (Risetda) in 2007, about 31 percent of Indonesia's population who aged 15 years and over, suffer from hypertension that, this disease is actually caused by food consumption patterns that are unorganized [3].

In Indonesia, there are currently have two problems about nutrition, malnutrition and overnutrition.The problem of malnutrition is generally caused by poverty, lack of food supplies, bad environment, lack of knowledge about nutrition, a balanced food menu and health, and there are malnutrition areas (iodine). Otherwise, overnutrition problems caused by economic progress in specific segments of society and lack of knowledge about nutrition, a balanced food menu and health [4].The problem of malnutrition in Indonesia and other developing countries generally is still dominated by the lack of protein, iron, iodine, and vitamin A [5].

According to Bardarsono, "cause of nutritional problems are multifactorial, which primarily involves the factor of education, economy, security, population growth control, improved sanitation, social justice for women and children, right practices on the environment and agricultural productivity. Hence, to solve the nutritional problems needed an integrated program that is associated with all of these factors" [6]. While according to Balitbangkes, "The results of the survey in 2010 by Balitbangkes says 30 percent of Indonesia is still lack of knowledge about good nutrition. So it is necessary that efforts should be increased in a balanced nutritional counseling " [7].

People believe that nutritios food is the expensive food. Therefore, many people who have deficiency economy forced to consume cheap and less nutritios food. Whereas, it is not all nutritious food is expensive. By knowing the nutrient content in foods, people can choose substitutional foods when nutritios foods which is needed by our body is more expensive by the cheaper foods but with the same nutritional content.

The problem of lack of sufficient knowledge about nutrition and good food consumption patterns should be a problem that can be solved by reading or learning about it. But there is still a lack of programs or counseling to the community in an effort to study good food consumption patterns and food nutrition.In the era of modern technology, to learn something difficult problems can be solved by using IT approach. Internet became a daily consumption of Indonesian people even globally, become one of the media for studying something easilyand quickly. Including to study about nutrition problem and good food consumption patterns.

According to the Ministry of Communications and Information Technology (Kemkominfo) stated that the Indonesian Internet users by the year 2014 reached 82 million people, ranked eight in the world [8]. By the number of Indonesian people using the internet could be one alternative media to improve programs or

 ISBN : 978-1-4673-7404-0

counseling good food consumption patterns and balanced nutrition food menu. In addition, the internet is now more accessible can be used anytime and anywhere using smartphone. Smartphone users in Indonesia has reached 47 million, or approximately 14% of the total mobile users, ranks fifth in the world [9].

Hence the need for research on peeople food consumption patterns information system that can be useful to the people in an effort to raise awareness to do good food consumption patterns and provide knowledge about nutrition. In addition, the information system is also web mobile application based in the efforts can be acceptable around of the people.

II. METHODOLOGY

A. Time and Place Research

This researchis conducted in September 2014 to Mei 2015. The research in the Laboratory Agricultural Information System and Management and Computer Laboratory, Department of Industrial Engineering and Management of Agricultural, Industrial Technology Faculty of Agriculture. And several restaurants in Jatinangor, West Java.

B. Research Methods

The research method used in this study is waterfall development method. This method has the sequence: initiation, analysis, construction and implementation.

- *System Initiation*

The following is an overwiew of the planning People food consumption patterns information system based on web mobile application.

1. The system can display information on the nutritional content of food.Nutrients are displayed including: Energy, Carbohydrate, Protein, Fat, Iron, Vitamin A and Water.
2. The system can displayfood price information.
3. The system can display information about nutritional needs of the user.
4. The system can provide an option of nutritious food recommendations based on the nutritional needs of the user.
5. The system can provide an option of nutritious food recommendations based on the nominal that user had input.
6. The system has an admin that serves to regulate or control thesystem database.

- *System Analysis*

Toobtain nutritious foods recommendations for the user first thing to know is the nutrion need of users.Then the nutrion need of user compared to the nutritional content of food. The suitable nutritional content of food with the the nutrion need of user will be used as an option for food recommendations.

In this research, the required data is asresearch material which will be a reference that is stored in a database of Information System, that is in the process will be taken by the program when the programrunning or use. The data collection is done as completely as possible. Data collection was came from sources that can be justified.

The data that collected are:

1. Primary Data, namely: name and the price of food derived from a survey of restaurants in the area Jatinangor.
2. Secondary Data, namely: Food Nutrition Content Data obtained from the *Tabel Komposisi Pangan Indonesia* (Widyakarya Nasional Pangan dan Gizi, 2004) and Human Nutritional Needs obtained from *Tabel Angka Kecukupan Giz i*(Widyakarya Nasional Pangan dan Gizi, 2004).

In Information Systems of Food Consumption Pattern, there are two types of output, the first isnutritious food recommendation based on nutrition need of user and the second is nutritious food recommendation based on food price. In this second type, user must input the nominal money before.

- *System Design*

System design outline described by *Data* Context diagram(DCD) and Data Flow Diagram (DFD). Data Context Diagramis an outline of a system that describes all the inputs, processes and outputs that occur in the system.DCD in the system represented in the following picture.

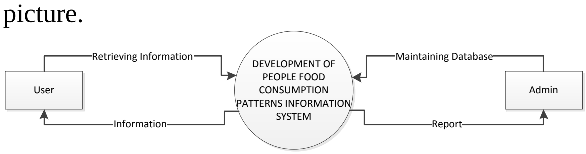

Fig. 1. DCD of the system

The picture above shows that users are able to use the system is a general user and admin. General users take or request information into the system and the system will automatically respond to the request. After that the system provides feedback of information sourced in the system database.

While administrators can use the system as a regulator or controller database.All types of arrangements that admin databasedo will automatically respond by system. After that, the system provide the feedback in the form of a report where arrangements or changes to the admin do whether successful or unsuccessful.

Data Flow Diagrams (DFD) is a diagram illustrating the entire input, process and output of the

ISBN : 978-1-4673-7404-0

system in more detail when compared with DCD. DFD is one medium that is used to describe the data flow or processes running on the system information. DFD level 1 represented in the following picture.

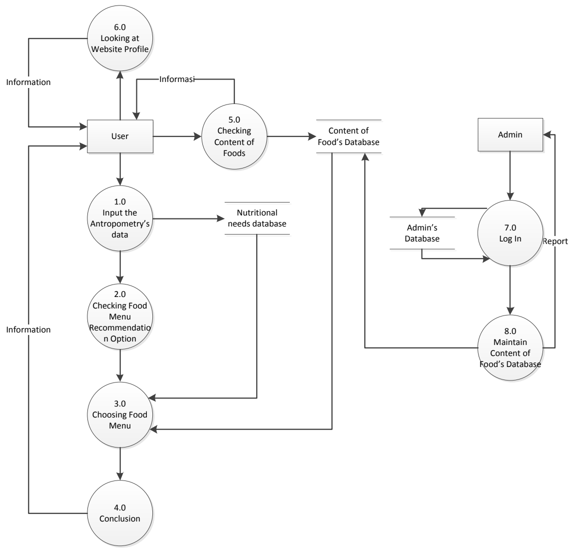

Fig. 2. DFD of the system

Diagram above shows the system process flow works. There are two users that can use the system. General users in the system can do three things in the system. First, users can instantly check on nutritious foods. Previously users had to go through a process of self anthropometric data entry.In the diagram shown there is an arrow in the 1.0 to the database of nutritional needs. That means that the input is entered in the 1.0 will go well in the database. After that the process flow continues to the number 2.0 is choose the option food recommendations. After that the process flow continues to the number 3.0 is choosing food. Food that will appear in the system is the nutritional content of food that the value according to the nutritional needs of the user. Therefore, in this process there are two data provided by the two databases are nutritional needs and food contents databases. After selecting the food, that will be the conclusion of selected food and adequate nutrition of food choices. The conclusion is feedback.

Secondly, in this system the user can also directly check the nutritional content of the food without having to adjust the nutritional needs. In the picture there is only one process flow that is processes 5.0. Thirdly, users can also see the system's profile.

While admins use this system as a regulator or controller database. Therefore, when the first enter the process flow, admin system must login first. This is done in order to prevent someone who is not admin misuse the database. Login process can bedone by admin who has ID and Password to enter the system.

- *System Implementation*

People food consumption patterns information system based on web mobile application created by using Notepad++ and XAMPP software. The software function as a coding media. Programming language that used here is HTML, PHP, MySQL and CSS. And XAMPP function is to running website and connect website with database in computer personally. The system created on two version, desktop and mobile version.

The system that created before is tested by published the website in local using Unpad server. User can access the website by computer or smartphone with condition that is connect with local network (LAN) or Unpad wifi. And then access domain with IP address of the server.

III. RESULTS

The homepage of the system or webis showing some main menu, that are Home, Nutrition Calculator, Food Database and About Uswhich is located at the top of the food web after the banner image. At the homepage, system is on the Home menu. In addition to Home, in the menu bar there are also others which Calculator Nutrition menu that serves to check the nutritional needs of the user followed by the provision of food choice recommendations based on the nutritional needs of nominal money or by the user had.

On this menu, user must input the antropometry data that are age, gender, weight and activity. After that, system will retrieve the nutritional needed data on database where on that table contain the information of human nutritional needs. Data retrieval of nutritional needs information based on parameter age, gender, weight and activity that user have input before. And then system will show the information of user nutritional needs where the needs are energy in kkal, carbohydrate in gram, protein in gra, fat in gram, iron mineral in miligram, vitamin A in mcg and water in gram. That nutritional needs is the information reference to fullfill by user on a day.

After nutritional needs information per day showed, the next are Check Food Recommendation and Check Food Recommendation Based on Nominal. Check Food Recommendation function is to show recommended option of nutritional foods for user based on parameter user nutrition needs that counted from Nurition Calculator menu. Meanwhile, Check Food Recommendation Based on Nominal function is same as the first option, and also based on parameter nominal that user will input then.

In sub-menu Check Food Recommendation it will showed food recommendation for user. It refer to user's nutritional needs. The result of nutrition calculator that contain result of user's nutritional needs on a day for Check Food Recommendation will refer to user's nutritional needs per eating time. There are 5 eating time options: breakfast, noon snacks, lunch, afternoon snacks and dinner. These eating time based on eating time of Indonesian people habits. Nutritional needs per day will divide into 5 portion where are every time has

ISBN : 978-1-4673-7404-0

different portion. Nutritional needs on breakfast is fewer than lunch, meanwhile, nutritional needs on snacks time have same portion but with fewer option than nutrtional foods for breakfast, lunch and dinner.

After choose the eating time, user can choose food recommendation menu. Recommended food menu that showed by system is the menu that fitted with user's nutritional needs. Meanwhile, on Check Food Recommendation, recommended food menu that showed by system is the menu that fitted by user input nominal.

In the final stage of this menu will appear to see the conclusion of the food that the user choose whether the food menu that user select in accordance with the concept of a balanced food menu.If it does not fit with a balanced food menu will display the message " menu makan belum memenuhi konsep pola makan seimbang", then appear the information whether the selected food menu deficiency or over nutrients.

Then the other menu options available are food database, in this menu the user can check the nutritional information contained in the food.User can search the food that have a nutrition by type on search column. Or user also can choose from food category index. In food category index, system will show foods that fit with category based on user's choice. List of food contained in this system are the foods that are the results of the survey in the area Jatinangor. The last, there is a menu About Us, on this menu contains a description and information about web.The homepage full system presented in figure 3.

Fig. 3. Homepage of the system

In the body of the web there is one-sentence summary of information about the function of this web applications, namely "Sisten Informasi Pola Konsumsi Pangan Masyarakat Berbasis Online memberikan informasi kebutuhan gizi beserta rekomendasi pola makan sehat, bergizi dan seimbang bagi tubuh anda". In addition there are boxes that the function same as the menu Calculator Nutrition and Food Database, but in this boxalso given a sentence description to affirm of the menu functions. It is given to anticipate if the userconfuse when first get into the web and do not know the function of menus that available.

Figure 3 is the homepage of the system when the user opens the website through the use of either a desktop PC or laptop. If the user opens the web through mobile using a smartphone or mobile phone that can open the internet, it will look different. It is made to prevent if the desktopand mobileview, there are incompatibility screen size.Initially in the desktop has a larger screen size than mobile. So if the size of the desktop and mobile together then the mobile display will be oversized and uncomfortable seen or call it is not user friendly.

In principle, the contents of the desktop view and mobile is the same. At the beginning of the user opens a web by typing the domain in the address bar before the internet asking for the display of the requested domain, the initial coding domain will first check what device is being requested domain or device is being used that user. If the device used is a desktop it will show the desktop versions of the web interface, if the device used is a mobile it will show the mobile version of the web interface.

There is no content changes on the start screen system mobile version. The difference in appearance with the desktop version is located on the menu bar. Because ofthe limited size so not all of the menu can be displayed. So given the option menu button if the user wants to select a menu. The homepage view of mobile version of the system is presented in Figure 4.

Fig. 4. Homepage of the system in mobile version

Other differences home page system is the position of the mobile version of one-sentence summary of information about the function of this web applicationsand the box of Calculator Nutrition Menu and Food Database Menu function.If in the view of the desktop version, the box of Calculator Nutrition Menu and Food Database Menu functions is locatedon the next sentence of web information. But in the view of

ISBN : 978-1-4673-7404-0

the mobile version, the box is located under sentence of web information.

IV. CONCLUSIONS AND SUGGESTIONS

A. Conclusion

The conclusion of the system that have been made include:

1. the system can display the information about nutritional needs of the user.
2. system is can display the information nutrient content of foods.
3. system can provide food recommendations option based on the nutritional needs of users
4. system can provide food recommendations option based on nominal money that be input
5. thesystem database can be regulated or controlled by admin.

B. Suggestion

As for suggestions for further research are as follows:

1. Nutritional information on food added more complete.
2. Must be other research to determine the nutrient content of cooked food that has not been available in the Table of Food Composition Indonesia.
3. Food database on the system can be added to other foods that are in other areas besides Jatinangor.

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FIGURES

Fig. 1. DCD of the system

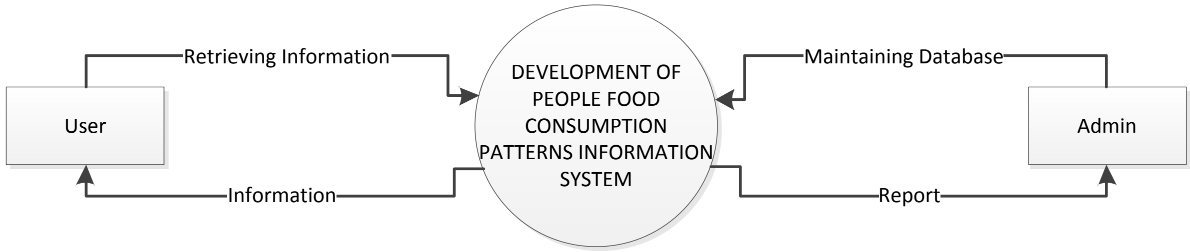
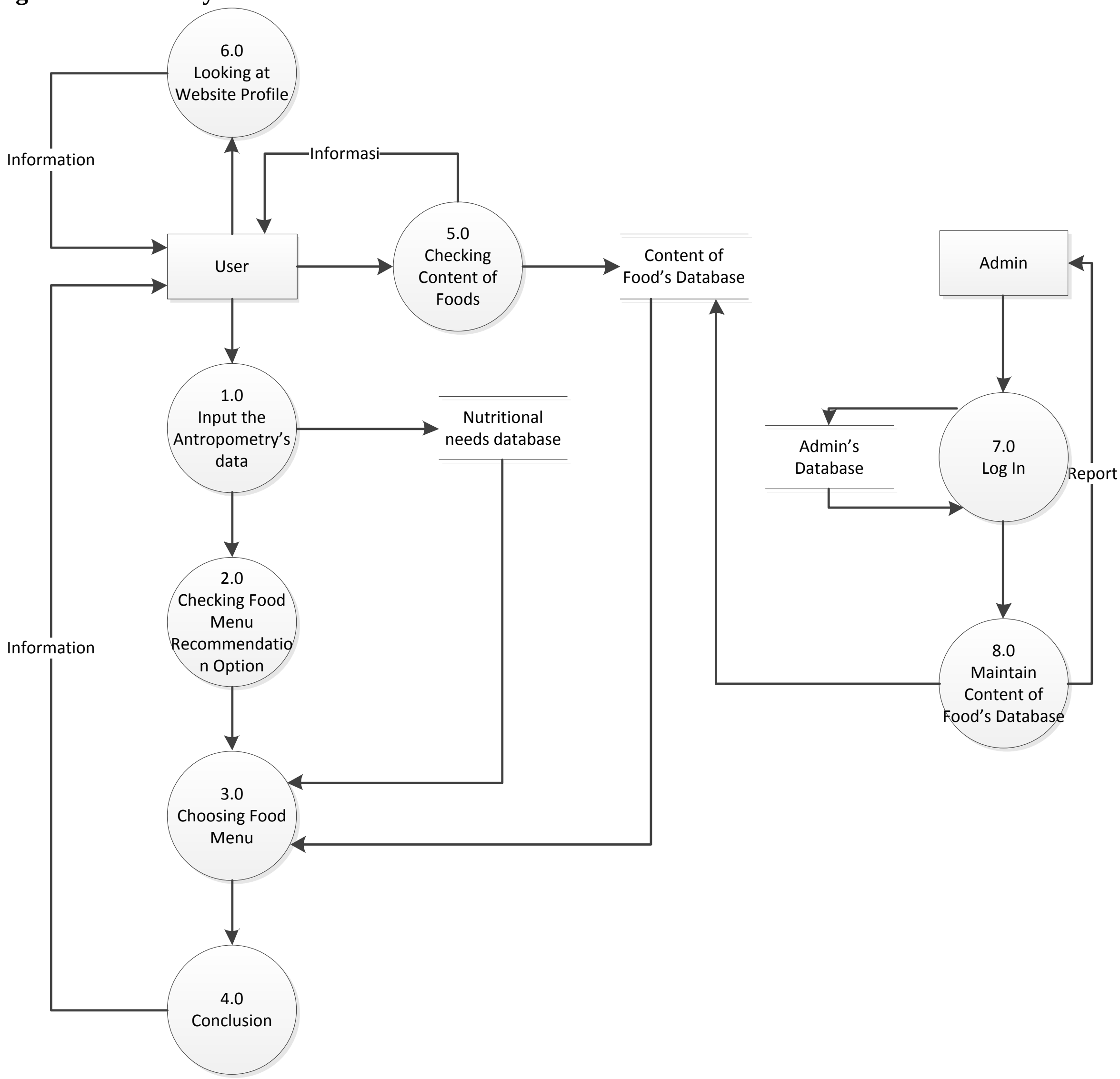


Fig. 2. DFD of the system



ISBN : 978-1-4673-7404-0

Fig. 3. Homepage of the system

Fig. 4. Homepage of the system in mobile version

ISBN : 978-1-4673-7404-0

Association Rules Mining on Forest Fires Data using FP-Growth and ECLAT Algorithm

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***Abstract*—Forest fires and land are a serious problem that must be solved by the Indonesian government including Riau Province. One of forest fires prevention effort is discovering relationship patterns of hotspot occurrences as fire indicators with characteristics of geographic objects where the hotspots occur. The objective of this research is to apply the multidimensional association rule mining method with Frequent Pattern Growth algorithm (FP-Growth) and Equivalence Class Transformation algorithm (ECLAT) to determine association patterns between hotspot occurrences and its supporting factors. The factors that influence hotspot occurrences were discovered on minimum support of 30% and minimum confidence of 80% with hotspot occurrence as the target attribute. The result of this research shows that strong relationships between hotspot occurrences and its influence factor were found with the the highest support of 44.49%, confidence of 100%, and lift of 1.02, where hotspot are mostly occurred in areas which has precipitation greater than or equal to 3 mm/day.**
Keywords: ECLAT, FP-Growth, hotspot, multidimensional association rule

I. Introduction

Forest and land fires are a serious problem that must be solved by the Indonesian government including Riau Province because it causes high economic losses. In addition to damage to the ecosystem, impacts of forest fires influence people not only nationally but also globally. This is due to smoke from forest fires that spread to neighboring countries. To overcome this problem, fire prevention should be based on research results and no longer relies on the translation of the textbook or the experience of other countries without having adjustment to the situation of land in Indonesia [1].

In order to minimize the negative effects due to forest fires, prevention activities are required. One of forest fires prevention efforts is discovering relationship patterns of hotspot occurrences as fire indicators with characteristics of geographic objects where the hotspots occur. Therefore we can predict where the hotspots will occur in the future. This information is important as an early warning for the fire fighters and related parties. The concept of data mining is appropriate to be applied to search such patterns. Data mining is the process of finding an interesting relationship or important patterns in large datasets [2]. Data mining techniques used in this research is a multidimensional association rule mining. Association rule mining discovers interesting relations between variables in a dataset. In this study the dataset contains hotspot data and influencing factors of hotspot occurrences.

A study on discovering relations between the hotspot occurrences and the characteristics of neighboring objects of hotspots has been done by [3]. This study applies the multidimensional association rules mining technique based on the Apriori algorithm. Apriori algorithm was first introduced by [4]. Apriori algorithm is based on the principle is that if any not frequent pattern of length k appears in a dataset, then the pattern of length (k + 1) which contains a sub pattern k is also not frequent. However, Apriori algorithm has a bottleneck because it must perform a scan on dataset in each iteration. This situation increases the execution time of the algorithm. The previous study revealed 324 multidimensional association rules indicating the relationship between hotspot occurrences with other factors [3]. The relationships are obtained at minimum support of 10% and minimum confidence of 80%.

In this study, the algorithms used are the Frequent Pattern Growth (FP-Growth) and Equivalence Class Transformation (ECLAT) to determine associations between hotspots occurrences and supporting factors for forest fires. The FP-Growth algorithm searches frequent items based on the structural Frequent Pattern Tree (FP-Tree) [2]. FP-Growth applies the divide and conquer technique that divides a big problem into smaller problems. In the ECLAT algorithm, itemsets are represented vertically from transaction-based datasets and id-list (tid-list) of the itemset is a list of IDs that are sorted from all transactions that contain itemsets [5]. With the advantages of FP-Growth and

 ISBN : 978-1-4673-7404-0

ECLAT algorithms, association patterns are expected be more interesting based on the value of support, confidence and lift. In addition, the number of association rules generated is fewer than the results of previous studies because the FP-Growth [2] and Eclat algorithm [6] search frequent itemsets faster than Apriori algorithm.

II. MATERIAL AND METHODS

A. Data

All data have been through a preprocessing stage in the previous study [3]. Data used in this study are as follows:

1. Hotspots in 2008. Data were obtained from the Fire Information for Resource Management System (FIRMS), University of Maryland, NASA, Conservation International.
2. Digital maps for land cover, major roads, rivers, and the city center.
3. Socio-economic data including sources of income, number of inhabitants per km², and number of schools per km². Data were obtained from the Central Statistics Agency (BPS), Indonesia.
4. Weather Data (in netCDF format) in 2008 include rainfall, wind speed, and temperature.
5. Digital maps for depth of peat and peatland types. Data were collected from Wetland International.

B. Research steps

The study was conducted through the following steps: determining association rules using FP-Growth and ECLAT algorithm, comparison of association rules generated from FP-Growth and ECLAT, visualization of association rules, and the determination of the factors supporting hotspots occurrences.

1) Determining frequent itemsets and association rules using FP-Growth and ECLAT Algorithm

At this stage, the FP-Growth algorithm was used to discover frequent itemsets through two processes i.e. creating the FP-Tree and applying the FP-Growth algorithm to find frequent itemsets. In addition to the FP-Growth algorithm, ECLAT algorithm was applied to obtained frequent itemsets. The ECLAT algorithm represents a dataset vertically [5]. Association rules are generated from frequent itemset that meet the minimum support and minimum confidence.

2) Plotting association rules

Visualization is used for the depiction of association rules that have been produced. There are several kinds of visualization of association rules such as scatter plots, balloon plot, graph, and parallel coordinates plot. This work visualizes association rules using scatter plots.

3) Determining supporting factors for hotspot occurrences

At this stage, association rules are analyzed to identify factors that influence hotspots occurrences.

III. RESULT AND DISCUSSION

Data used in this study are obtained from the previous research [3]. Preprocessing steps have been applied to the data in the previous research. Some numeric data are converted into intervals. The dataset contains 490 transactions and 12 variables with one target variable. The data are grouped as follows:

- Physical environment: distance to the nearest city center (dist_city), distance to the nearest river (dist_river), and distance to the nearest road (dist_road), land cover types (land_cover), peatland types (peatland_type), and peatland depth (peatland_depth)
- Socio-economic data: number of inhabitants per km² (population), sources of income (income_source), and number of schools per km² (school).
- Weather data: precipitation, temperature (screen_temp), and wind speed of 10 m (wind_speed).
- Target variable: hotspots occurrences (hotspot_occurrence).

Frequent itemsets are generated to find itemsets that often occur in the dataset. FP-Growth algorithm is obtained from http://www.borgelt.net/fpgrowth. html. It is implemented using C programming language. ECLAT algorithm to generate frequent itemsets is available in the package arules in the R statistical application. Minimum supports used to generate frequent itemsets are 10%, 20%, 30%, 40%, and 50%. Table I represents number of frequent itemsets generated for each minimum support using FP-Growth and ECLAT algorithm.

TABLE I
NUMBER OF FREQUENT ITEMSETS GENERATED USING FP-GROWTH AND ECLAT ALGORITHM

No	Minimum Support (%)	Number of Large Itemset	k-itemset	Number of Itemset	
				FP-Growth	ECLAT
1	10	2568	1	34	34
			2	251	251
			3	670	670
2	20	476	1	27	27
			2	103	103
			3	176	176
3	30	156	1	16	16
			2	55	55
			3	61	61

ISBN : 978-1-4673-7404-0

No	Minimum Support (%)	Number of Large Itemset	k-itemset	Number of Itemset	
				FP-Growth	ECLAT
4	40	55	1	13	13
			2	24	24
			3	15	15
5	50	23	1	7	7
			2	10	10
			3	5	5

Table I shows that both FP-Growth and ECLAT algorithm result the same number of frequent itemsets and the smaller the minimum support, the more frequent itemsets generated.

In the previous study [3], as many 2981 association rules were generated by using Apriori algorithm. The association rules that include the predicate of hotspot occurrences (hotspot_occurrence = Yes) are analyzed to find factors that may influence hotspot occurrences. There are 324 rules or approximately 10.87% containing the hotspot occurrences generated from the dataset with the minimum support of 10% and the minimum confidence of 80%.

Table II represents the number of association rules generated using Apriori, FP-Growth and ECLAT algorithm with the minimum support (minsup) of 10%, 20%, 30%, 40%, and the minimum confidence (mincof) of 80%. In Table II Left Hand Side (LHS) denotes the antecedent of rule and the Right Hand Side (RHS) denotes the consequent of rule.

TABLE II
NUMBER OF ASSOCIATION RULES GENERATED USING APRIORI, FP-GROWTH AND ECLAT ALGORITHM

Algorithm	Minsup (%)	Mincof (%)	Number of rules	*Hotspot_ occurrence= Yes*	
				LHS	RHS
Apriori	10	80	3737	324	0
	20	80	597	47	0
	30	80	183	17	0
	40	80	61	1	0
FP-Growth	10	80	3737	324	0
	20	80	597	47	0
	30	80	183	17	0
	40	80	61	1	0
ECLAT	10	80	3737	324	0
	20	80	597	47	0
	30	80	183	17	0
	40	80	61	1	0

According to Table II there are 17 association rules that contain hotspot occurrences resulted from the three algorithms with the high minimum support of 30% and high minimum confidence of 80%. Some of these rules are provided in Table III.

TABLE III
ASSOCIATION RULES THAT CONTAIN HOTSPOT OCCURRENCES

No	LHS	RHS	Support (%), Confidence (%), Lift
1	hotspot_occurrence=Yes	precipitation= >=3mm/day	44.49,100,1.02
2	school=<=0.1, hotspot_occurrence=Yes	precipitation= >=3mm/day	36.94,100,1.02
3	hotspot_occurrence=Yes, precipitation=>=3mm/day	school=<=0.1	36.94,83.03,1.00
4	hotspot_occurrence=Yes	school=<=0.1	36.94,83.03,1.00
5	screen_temp=[297K;298K), hotspot_occurrence=Yes	precipitation= >=3mm/day	35.31,100,1.02
6	hotspot_occurrence=Yes, school=<=0.1, precipitation=>=3mm/day	population= <=50	31.63,85.64,1.26
7	hotspot_occurrence=Yes ,school=<=0.1	population= <=50	31.63,85.64,1.26
8	precipitation=>=3mm/day, population=<=50, hotspot_occurrence=Yes	school=<=0.1	31.63,100, 1.20
9	population=<=50, hotspot_occurrence=Yes	school=<=0.1	31.63, 100, 1.20
10	population=<=50, hotspot_occurrence=Yes, school=<=0.1	precipitation= >=3mm/day	31.63, 100, 1.02
11	population=<=50 ,hotspot_occurrence=Yes	precipitation= >=3mm/day	31.63, 100, 1.02
12	wind_speed=[1m/s;2m/s), hotspot_occurrence=Yes	precipitation= >=3mm/day	30.61, 100, 1.02

The minimum support of 30% means there are 147 of 490 transactions supporting the association rules. According to Table III, the predicate related to socio-economic and weather data appear with the predicate of hotspot_occurrence = Yes. Socio-economic data that appears in the rules are number of schools per km² (school)<=0.1 and number of inhabitants per km² (population)<=50. In addition, several rules that contain the predicate of hotspot_occurrence = Yes also include the predicate of precipitation >= 3 mm / day, screen_temp = [297 K, 298 K), and wind_speed = [1 m/s, 2 m/s).

The first rule in Table III is the most interesting rule with the support of 44.49%, confidence of 100% and lift of 1.02. This rule states that there are approximately 44.49% of the transactions in the dataset that contains hotspot_occurrence = Yes also contain precipitation greater than or equal to 3 mm/day meaning that hotspots are most likely occurred in the area with precipitation greater than or equal to 3 mm/day. Lift value of the rule is greater than 1 meaning that hotspot occurrences and precipitation greater than or equal to 3 mm/day are positively correlated.

The previous work results that a strong relationship between hotspot occurrences and the factors that influence hotspot occurrences was found at support of

12.42%, confidence of 100%, and lift of 2.26 [3]. These factors include precipitation greater than or equal to 3 mm/day, wind speed of 10 m in the interval [1 m/s, 2 m/s), non-peatland areas, temperatures in the interval [297 K, 298 K), number of schools in the 1 km² is less than or equal to 0.1, and distance to the nearest road is less than or equal to 2.5 km.

Fig. 1 visualizes the 17 association rules that are generated using the FP-Growth algorithm with minimum support of 30% and minimum confidence of 80%. Each point on the plot represents a rule. The x and y axis denote support and lift respectively. The color of the point indicates confidence value of the rule.

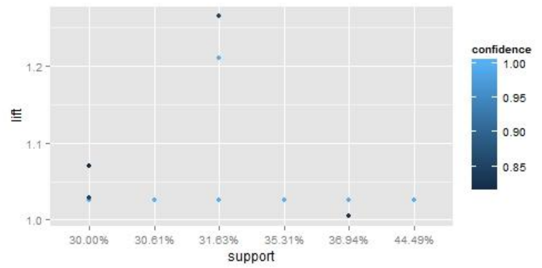

Fig 1. Scatter plot of 17 association rules containing hotspot_occurrence = Yes

According to [7] precipitation is one of the factors which determines occurrences of forest fires. In addition to weather factors, socio-economic factors may influence occurrence of forest fires. This study discovers the rules representing hotspots occurrences in the area that have number of schools in 1 km² less than or equal to 0.1 and population of less than or equal to 50. A study by [8] shows that in the study area of Kampar forest and Bengkalis Riau Province, number of schools is a few. Therefore communities are difficult to obtain formal education due to the location where people living is far from the city. This led to 70% of population in the study area has the education level of Elementary School. Low levels of formal education causes communities have lack of knowledge regarding benefits of forests as a conservation area and danger of forest fires. For that communities remain do activities that damage forests such as forest fires. This study results the characteristics of area where hotspots are probably occurred that are discovered from the interesting association rules. This information is important for preventing the area from fires.

IV. SUMMARY

This work applied association rule mining algorithms namely FP-Growth and ECLAT to discover frequent itemsets on forest fires data with the minimum support of 30% and minimum confidence of 80%. Experimental results show that there is a strong relationship between hotspots occurrences with characteristics of the area where hotspots are probably occurred. Hotspots are probably occurred in areas with precipitation greater than or equal to 3 mm/day. This pattern is considered as a strong rule with the support of 12.42%, confidence of 100%, and lift of 2.26. In addition, other factors that are considered to affect hotspots occurrences are number of schools in 1 km² least equal to 0.1, number of inhabitants in 1 km² least equal to 50, temperature in the interval [297 K, 298 K), and wind speed 10 m in the interval [1 m / s, 2 m / s).

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ISBN : 978-1-4673-7404-0

DEVELOPMENT OF EXPERT SYSTEM FOR SELECTING TOMATO (*Solanum lycopersicum* L.) VARIETIES

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***Abstract*— The increasing number of tomato varieties with their unique features, has introduced greater subjectivity and complexity for selection of tomato varieties. This study developed Expert System Selection of Tomato Varieties (SIPMAT) to assist dissemination of knowledge related to the selection of tomato varieties. This system was also developed to help farmers to determine varieties that match with some parameters or user preferences. This expert system used 135 tomato varieties. Inference engine developed on the expert system using Tahani fuzzy logic rules combined with Simple Additive Weighting (SAW) as weighting rules. There are 9 parameters used for selection in the system including planting goals, altitude, resistance to diseases, fruit size, fruit shape, hardness, yield potential, maturity and fruit color with weight of each parameter according to experts and farmer preferences. The prototype was developed on web using PHP programming language and MySql for data base management system. The system was tested and it showed the accuracy of 86.2%.**

I. INTRODUCTION

A. Overview of tomato and tomato seed varieties production in Indonesia

Tomato is a popular vegetable in Indonesia because tomato are relatively easy to grow and the yields can be very high. Tomato production has the contribution of 8.03% to the total production of vegetables in Indonesia and its total production increased from 839 504 tons in 2012 to 992 780 tons in 2013 [1]. The uses of tomato in Indonesia are for cooking, vegetable, table fruit and processed materials. Therefore, tomato production will increase each year to meet necessity of community and market expansion. Improved quantity and quality of tomato fruit needs to be achieved to meet the higher needs of tomato by planting superior tomato varieties which are appropriate with the land condition. So, one of the keys for succesful tomato cultivation is selection of tomato varieties.

In Indonesia, there are about 138 tomato varieties that have been released nowadays and these varieties have advantages in production, resistance to pests and diseases, and adaptability to environment. The advantages above are unique features that become an important consideration for consumer and important characteristic relative to culture. So, selection of tomato varieties has become more complex and usually farmers need consideration from expert to determine tomato varieties will be planted.

B. Overview of tomato varieties selection in Liwa, Sumatra Island

The selection of tomato varieties that have been done by farmers in field study location on highland areas of Liwa, Sumatra Island is determined from several considerations. Firstly, belief of farmers on tomato seed companies through a track record of famous seed companies. There are several tomato seed companies that are trusted by farmers because high intensity of tomato varieties socialization. Secondly, farmers choose varieties based on one parameter only, for example parameter of resistance to diseases include example diseases caused by Gemini virus. As a result, farmers ignored the important parameters of altitude as an important condition of growing tomato plants.

C. Knowledge of tomato varieties selection

Knowledge base of expert systems contain both tacit and explicit knowledge. Tacit knowledge exists in mind and is difficult to articulate [2]. Explicit knowledge is context specific and easily captured and codified [3]. Knowledge of tomato cultivation especially in selection of tomato varieties are still stored on a variety of published sources and it also gained from experts knowledge. These knowledges are still implicit because there are difficulties in accessing information.

ISBN : 978-1-4673-7404-0

D. Previous research

The previous study that was integrated with this research is Intelligent System Selection Superior Seed Vegetable Based on Fuzzy Query [4]. The system has been built for selecting tomato varieties with fuzzy logic and based on web. The scope of previous study are only three selection parameters including size, maturation and yield potential. The number of tomato varieties that exist in the system as much as 36 varieties.

II. OBJECTIVE

The objective of this research is to develop a web base expert system for selecting tomato varieties that can be widely accessible by users.

III. METHOD

A. Time and Place

The research was conducted in the Laboratory of Bioinformatics, Department of Mechanical and Bio-systems Engineering, Faculty of Agricultural Technology. Extraction of expert knowledge was conducted in Plant Breeding Laboratory, Department of Agronomy and Horticulture, Faculty of Agriculture. In this research was also conducted a field study to explore farmers preferences for selecting tomato varieties in highlands areas of Liwa, Sumatra Island.

B. Tools and Materials

The tools were used in this research a set of personal computer, DBMS software (Data Base Management System) is MySQL, software for fuzzy data analysis is Matlab, software for building web-based applications are Adobe Dreamweaver CS6 , Notepad ++, and a web browser, the web server software is XAMPP and PHP programming language.

The materials were used in this research are secondary data sourced from books, journals, literature, knowledge from expert and results of farmer preferences in field study location for selecting tomato varieties.

C. Method

The method that is used in this research is development of expert system stage is shown in Fig 1.

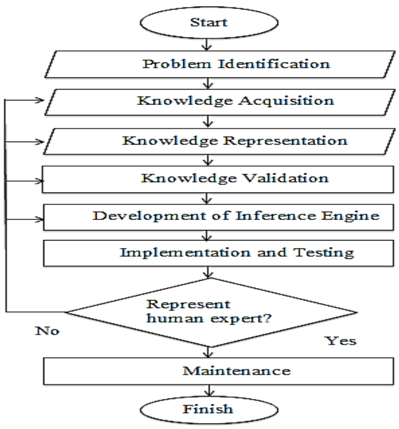

Fig. 1. Development of expert system stage [5]

D. Fuzzy Expert System

Fuzzy expert system are developed using the method of fuzzy logic, which deals with uncertainty. This technique, which uses the mathematical theory of fuzzy sets, simulates the process of normal human reasoning by allowing the computer to behave less precisely and logically than conventional computers. This approach is used because decision-making is not always a matter of black and white, true or false; it often involves gray areas and the term may be. Accordingly, creative decision-making processes can be characterized unstructured, playful, contentious, and rambling [6].

E. Development of Inference Engine

Generally, development of inference engine in this system consisting set of theories including crisp set theory, fuzzy set theory and decision making method. Fuzzy logic is used because fuzzy logic worked like human intelligence [7]. So this research used fuzzy logic to develop the system that integrated with human inteligence and also human preferences. In fuzzy logic, there are several membership functions that can be used for determination of membership degree in fuzzy set. References [8] shows that membership function is a function to distinguish characteristic function of the fuzzy rules and the characteristic function of non-fuzzy rules. This study used a trapezoidal curve because process of calculating membership degree easily with computational method and it is shown in Fig 2.

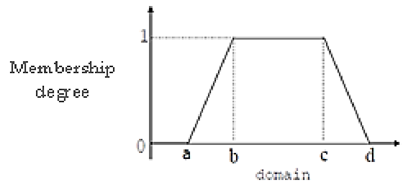

Fig. 2. Trapezoidal curve [7]

Membership functions for trapezoidal curve is defined as follows:

$$\mu(x) \begin{cases} 0; & x \le a \text{ atau } x \ge d \\ (x-a)/(b-a); & a \le x \le b \\ 1; & b \le x \le c \\ (d-x)/(d-c); & c \le x \le d \end{cases}$$

Value of a is left point from crisp value range, b and c is top point, while d is right point from crisp value range. X variable is the elemen that will be sought its membership function.

In determining results of recommended varieties used Multi Criteria Decision Making (MCDM). Decision-making method is intended to establish the best alternative from a number of alternatives based on certain criteria. There are several methods of MCDM, one of those method is Simple Additive Weighting Method. Simple Additive Weighting (SAW) which is also known as weighted linear combination or scoring methods is a simple and most often used multi attribute decision technique. Evaluation score is calculated for each alternatives by multiplying membership degree of

ISBN : 978-1-4673-7404-0

each parameter to weighting factor [9]. The process of normalization is done by calculating the value of a normalized performance rating criteria is given in equation 1 as:

$$x_{ij} = \frac{r_{ij}}{Max\ r_j} \ldots\ldots\ldots\ldots..(1)$$

where Xij is normalized performance rating values, rij is the value of the attributes possessed by each criterion and Max rj is the maximum value of each criterion. Preference value or score for each alternative (Ai) is given in equation 2 as:

$$A_i = \Sigma\ w_j\ x_{ij} \ldots\ldots\ldots\ldots..(2)$$

where Ai is the ranking for each alternative, wj is the weighting factor of each criterion.

F. Field Survey

This field study was locating in Liwa, West Lampung. The rural areas that produce tomato were considered for investigation. The survey focused to figure out farmer preferences in choosing tomato varieties order by parameters that important for farmers. Method of field survey is interview and discussion method with some farmers and farmers group leader.

IV. RESULT AND DISCUSSION

A. Analysis

The three main processes of expert systems are knowledge acquisition, inference engine and interface in implementation stage [10]. There are three primary activities for develop an inference engine including design of user interface, design of database and design of process is shown in Fig 3.

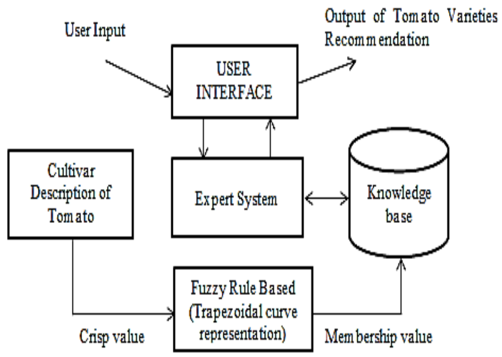

Fig. 3. Design of expert system

From cultivar description, there are about 30 description attributes of tomato cultivar as a crisp value. Then crisp values from attributes are transformed to be membership values based on fuzzy set theory and those values are stored in the knowledge base. Users connected to the system through a user interface. User input is used as input in system then the system processed to generate the output of recommendation of tomato varieties.

B. Knowledge Acquisition

The acquisition of knowledge is conducted by interviews and discussions with experts. Based on the obtained results of the knowledge acquisition, there are 9 parameters: 1 main parameter, 4 fuzzy parameters and 4 non-fuzzy parameters. Main parameter is altitude. Fuzzy parameters are fruit size, maturation, yield potential and planting goals. Non-fuzzy parameters are resistance to diseases, hardness, fruit color and fruit shape. The explanation for main parameter is as follow:

Altitude

Generally, tomato is grown at 0-1500 meters above sea level. Altitude from sea level determines air temperature and solar radiation received by the plant. Higher place the temperature increased as well as intensity of sun increase. Altitude locations are grouped in 3 sets including lowland, medium land and highland. For tomato cultivation, lowland is about 0-400 meters above sea level, medium land is about 400-700 meters above sea level and highland is above 700 meters above sea level.

C. Knowledge Representation

Knowledge representation in fuzzy parameters formulated into fuzzy set theory with trapezoidal curve to determine membership degree. While non-fuzzy parameters represented by crisp set theory. The explanation of 4 non-fuzzy parameters followed by 4 fuzzy parameters are sequentially as follows:

Resistance of diseases

Various types of pests and diseases of tomato that are often found are caterpillar pests and vermin, while diseases caused by bacteria, viruses and fungi [11]. Resistance to pests and diseases are classified as non-fuzzy parameters and has 5 categories namely fusarium wilt, late blight, bacterial wilt, Gemini virus, and mosaic virus.

Hardness

Hardness of fruit is essential in post-harvest handling process. Hardness of fruit grouped into 3 categories namely hard, medium and soft.

Fruit shape

Fruit shape is a consideration of fruit consumer selection. Shape of fruit that is often found is round, oval and roses. Shape of round is fruit that has the same length and diameter. Oval shape has greater length than its diameter. Rose shape has greater diameter than its length.

Fruit color

Categories of fruit color consist of bright red, red and red orange. It is based on information contained in the description of cultivars.

Fruit size

Consumers have a certain acceptance (acceptability) consider certain physical characteristics. Categories of fruit size consist of big, medium and small. The small size of tomato that have weighs under 30 grams, medium size is sized to the tomato that weighs between 30 grams to 60 grams and a big size for a tomato that weighs over 80 grams. Membership function for fruit

ISBN : 978-1-4673-7404-0

size parameter are for small (a=0, b=0, c=30, d=40), medium (a=30, b=40, c=60, d=80) and big (a=60, b=80, c=200, d=200) and are represented in Fig 4.

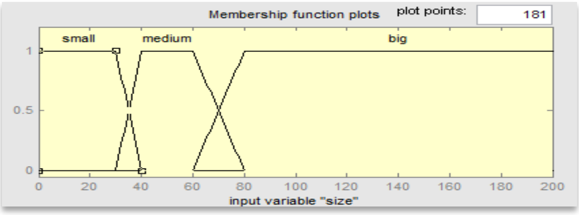

Fig. 4. Membership function for fruit size parameter

Membership functions for trapezoidal curve is defined as follows:

$$\mu_{small}(x)\begin{cases}0; & x > 30\\ (40-x)/(40-30); & 30< x < 40\\ 1; & 0 \le x \le 30\end{cases}$$

$$\mu_{medium}(x)\begin{cases}0; & x < 30 \text{ and } x > 80\\ (x-30)/(40-30); & 30 < x < 40\\ 1; & 40 \le x \le 60\\ (80-x)/(80-60); & 60 < x < 80\end{cases}$$

$$\mu_{big}(x)\begin{cases}0; & x < 60\\ (x-60)/(80-60); & 60 < x < 80\\ 1; & x \ge 80\end{cases}$$

Yield potential

Yield potential is using units of weight per plant, for the low yield potential is below 1.5 kg per plant. Medium yield potential is between 1.5 kg to 2.5 kg per plant per plant. High yield potential that is above 2.5 kg per plant. Membership function for fruit size parameter are for low (a=0, b=0, c=1.5, d=2.2), medium (a=1.5, b=2.2, c=2.5, d=2.8) dan high (a=2.5, b=2.8, c=9, d=9) and are represented in Fig 5.

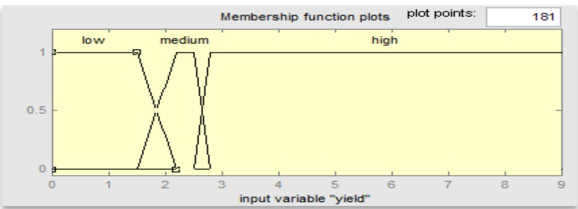

Fig. 5. Membership function for yield potential parameter

Membership functions for trapezoidal curve is defined as follows:

$$\mu_{low}(x)\begin{cases}0; & x > 2.2\\ (2.2-x)/(2.2-1.5); & 1.5< x < 2.2\\ 1; & 0 \le x \le 1.5\end{cases}$$

$$\mu_{medium}(x)\begin{cases}0; & x < 1.5 \text{ and } x > 2.8\\ (x-1.5)/(2.2-1.5); & 1.5 < x < 2.2\\ 1; & 2.2 \le x \le 2.5\\ (2.8-x)/(2.8-2.5); & 2.5 < x < 2.8\end{cases}$$

$$\mu_{high}(x)\begin{cases}0; & x < 2.5\\ (x-2.5)/(2.8-2.5); & 2.5 < x < 2.8\\ 1; & x \ge 2.8\end{cases}$$

Maturation

Maturation are divided into three categories namely early maturation, medium maturation and late maturation. References [12] shows that the early maturation of plants is harvested when about 60 days. Medium maturation is harvested between 60 to 70 days. Late maturation is harvested from 70 to 100 days. Membership function for maturation parameter are for early maturing (a=50, b=50, c=60, d=65), medium maturing (a=60, b=70, c=75, d=80), late maturing (a=75, b=85, c=110, d=110) are represented in Fig 6.

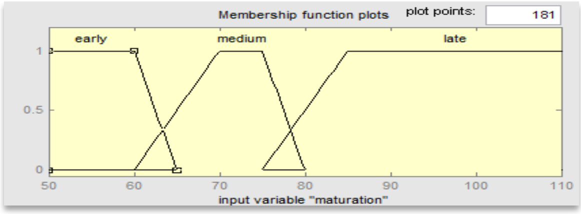

Fig. 6. Membership function for maturation parameter

Membership functions for trapezoidal curve is defined as follows:

$$\mu_{early}(x)\begin{cases}0; & x > 65\\ (65-x)/(65-60); & 60< x < 65\\ 1; & 50 \le x \le 60\end{cases}$$

$$\mu_{medium}(x)\begin{cases}0; & x < 60 \text{ and } x > 80\\ (x-60)/(70-60); & 60 < x <70\\ 1; & 70 \le x \le 75\\ (80-x)/(80-75); & 75 < x < 80\end{cases}$$

$$\mu_{late}(x)\begin{cases}0; & x < 75\\ (x-75)/(85-75); & 75 < x < 85\\ 1; & x \ge 85\end{cases}$$

Planting goals

Fresh tomato can be used for multiple purposes as a direct consumption (table fruit), cook ingredients (vegetable fruit) and fresh beverage ingredients (processing fruit). Tomato for table fruit is selected from tomato that have weighs more than 100 grams. Tomato for vegetable fruit weighs less than 50 grams. While for processing fruit have weighs between 50 grams to 100 grams [13]. Membership function for maturation parameter are for vegetable fruit (a=0, b=0, c=40, d=50), for processing fruit (a=40, b=50, c=90, d=100) and for table fruit (a=90, b=100, c=200, d=200) and are represented Fig 7.

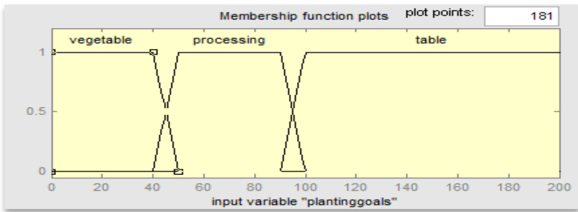

Fig. 7. Membership function for planting goals parameter

Membership functions for trapezoidal curve is defined as follows:

$$\mu_{veg}(x)\begin{cases}0; & x > 50\\ (50-x)/(50-40); & 40< x <50\\ 1; & 0 \le x \le 40\end{cases}$$

$$\mu_{process}(x)\begin{cases}0; & x < 40 \text{ and } x > 90\\ (x-40)/(50-40); & 40 < x < 50\\ 1; & 50 \le x \le 90\\ (100-x)/(100-90); & 90 < x < 100\end{cases}$$

$$\mu_{table}(x)\begin{cases}0; & x < 90\\ (x-90)/(100-90); & 90 < x < 100\\ 1; & x \ge 100\end{cases}$$

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D. Development of Inference Engine

Development of an inference engine includes design of database, design of process and design of user interface.

Design of database

Design of database defines relationship of data conceptually be implemented into the system. Because system used fuzzy rules Tahani, so structure of the database used is structure of a relational database.

Design of process

Based on knowledge representation, non-fuzzy parameters are a nominal variable that consist membership value 0 or 1 in accordance with a set of crisp. While fuzzy parameters consist of membership degree set has continuous values from 0 to 1. Development of inference engine continued with the process of fuzzy query to achieve a flexibility of a Database Management System (DBMS). The design of fuzzy query is presented in Fig 8.

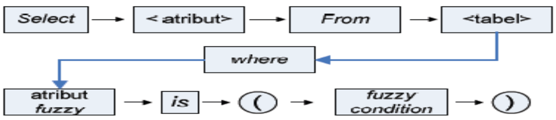

Fig. 8. The design of fuzzy query [14]

Fuzzy query terdiri dari fuzzy predicates dan fuzzy quantifiers. The system that developed using fuzzy predicates are represented by membership functions [14]. The example of fuzzy condition are “big” or “small”.

Then in determining the outcome of tomato varieties recommendations used Multi Criteria Decision Making (MCDM) method, Simple Additive Weighting (SAW). Selection parameters is sorted by the weight of parameters and based on the farmers preferences under the provisions of experts presented in Table 1. The higher weighing factor the more important parameter.

Table 1 Weighting factor of each parameter

Parameters	Weighting factor
Yield potential	0.3
Resistance to diseases	0.2
Fruit size	0.1
Planting goals	0.1
Maturation	0.08
Hardness	0.08
Fruit shape	0.07
Fruit color	0.07

Design of User Interface

In the user interface design, there are 3 criteria for selecting namely characteristics of location, characteristic of tomato fruit and characteristic of tomato plant. Each selection criteria have one or more than one parameter can be filled by user. The sequence of these characteristics was designed by looking at parameters which most independent among other parameters of user interface were developed.

In the design of the user interface display search results there is a component to display records of parameter that have been selected by user. Furthermore, there is a table to display the results of recommended variety that contains the name of the variety, score of results, download menu to download selected varieties of tomato cultivar description and links of the company of tomato seed varieties to connect users with web seed companies.

E. Implementation

The main view of the system shown in Fig 9. Users have to choose one of criteria in parameters as input of the system.

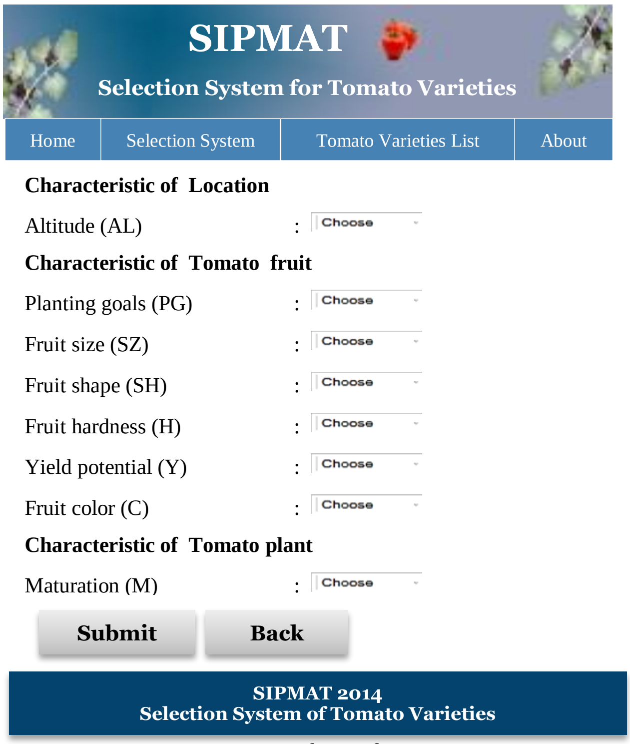

Fig. 9. Main interface of SIPMAT

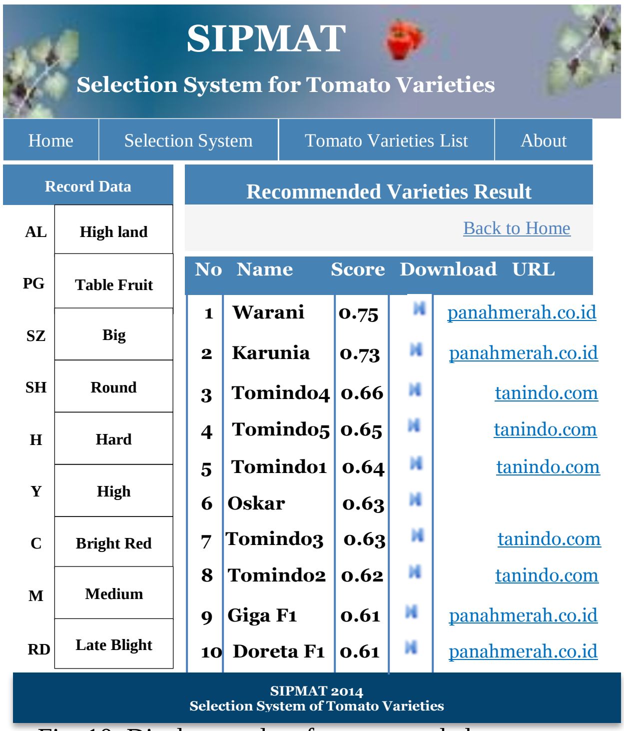

Fig. 10. Display results of recommended tomato varieties

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Display of recommendation varieties result will show 10 recommended tomato varieties sort from highest to lowest score. Variety with the highest score is a variety that match with user preferences. Display of search results are presented in Fig 10.

In the search results display of tomato varieties recommendation contained an explanation facility component to illustrate the reasoning system to users. This explanation facility is shown in Fig 11.

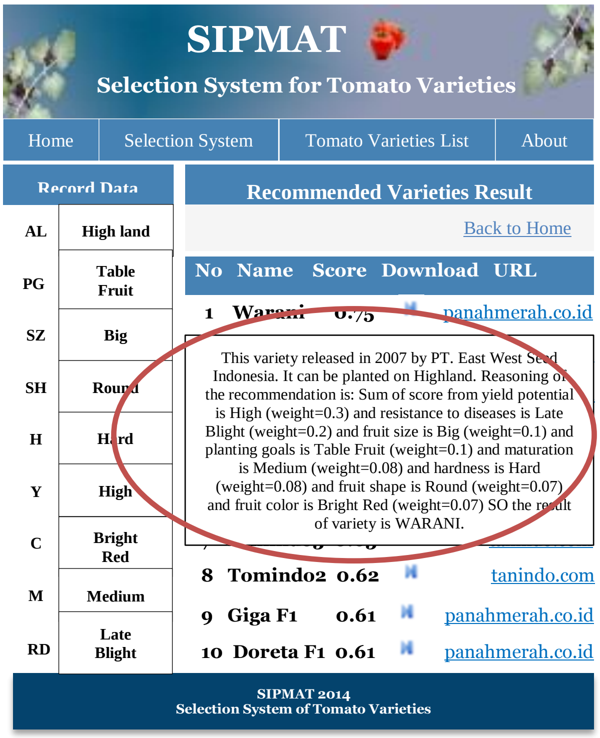

Fig. 11. Display of explanation facilities on the search results of tomato varieties

F. Testing

In stage of testing used 51 testing data from the result of system that have been compared with a variety of search methods based on expert. There are 44 data that appropriate and 7 data that did not fit data results based on expert varieties, so the accuracy of the system is 86.2%. This is because there are some incomplete data that cannot be processed in the knowledge base, in addition to the limited amount of testing data also affects the accuracy of the system results.

The advantage of the system is to can help farmers determine which varieties will be planted according with the expertise more objectively, quickly and accurately. The weaknesses of this system is lack of data of seed availability on the market so there is no explanation for the varieties that no longer exists and have not been produced.

V. Conclusion

Expert system for selecting tomato varieties has been built on web base. In accordance with its functional requirements, this system has been able to determine recommendation of varieties which appropriate user preferences. The output of this system is also equipped with an explanation facility. This system has an accuracy of 86.2 %. From the test results it can be concluded that the selection of tomato varieties expert system has represented an expert in determining tomato varieties for the user.

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ISBN : 978-1-4673-7404-0

Developing life cycle inventories for rice production systems in Philippines: how to establish site-specific data within the general framework

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Abstract— Numerous number of studies have been conducted on rice production in Philippines, including cultivation practices, plant breeding, and social-economic research. Especially, there are many studies on the green revolution.

However, studies on life cycle assessment (LCA) of rice production are limited in Philippines. Since LCA will play an important role in assessing agricultural technology and in establishing sustainable society, further studies on LCA have to be conducted.

Therefore, we established a research project to study LCA of rice in Philippines. After clarifying cultivation scenarios based on site-specific conditions, we discussed the possibility of the development of life cycle inventory (LCI) data for rice production at main production areas in Philippines using the general LCI framework such as ILCD and EcoSpold.

I. Introduction

AGRICULTURE, especially rice cultivation, is very important to the Philippine economy. Rice cultivation occupies 34% of its total agricultural area of 12.64 million hectares which is the largest area of any crop [1].

Since IRRI main office is located in the Philippines, numerous studies about rice have been conducted including rice cultivation practices [2] [3], pedagogical characterization of lowland areas in the Philippines [4], growth and development of rice plant [5]; fertilization [6], land preparation [7] [8], field water management [9] [10], plant breeding, chemistry, machinery [11]–[15], and social-economic researches.

Due to the effect of global warming, several studies related to methane emissions of rice cultivation were conducted. Methane emissions from major rice ecosystems in Asia [16] [17]. Methane emissions from anaerobic decomposition of organic matter [17]; from irrigated [18] [19]; from increased CO2 and temperature [20]; from rice fields using the DNDC model [21]; and from wetland rice fields with different N applications [22]; were studied.

Rice byproducts utilization were also widely studied. Rice straw was studied for possible energy production [23]. It is a renewable energy source in India, Thailand and the Philippines [24].

However, studies on life cycle assessment (LCA) of rice production are limited in Philippines. Since LCA will play an important role in assessing agricultural technology and in establishing sustainable society, studies on LCA have to be conducted. Life cycle assessment (LCA) is used for quantitative analysis of environmental aspects of a product or services over all its life cycle stages. An LCA is a systematic tool that enables the analysis of environmental loads of a product throughout its entire life cycle and the potential impacts of these loads on the environment [25]. He found out that LCA can be used for integrating environmental and food safety issues; that the characteristics of the agricultural LCA that clearly defines alternative production systems (decision alternatives) are that they analyze environmental impacts of environmental measures.

Therefore, we established a research project to study LCA of rice in the Philippines. After clarifying cultivation scenarios based on site-specific conditions, we discussed the possibility of the development of life cycle inventory (LCI) data for rice production at main production areas in Philippines using the general LCI framework such as ILCD and EcoSpold.

II. Methods

Data used were taken from the results of nationwide surveys and experiments in the Philippines from

Manuscript received May 10, 2015. This work was in part supported by the Japan Society for the Promotion of Science, Grant-in-Aid for Scientific Research (B), 26310316.

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ISBN : 978-1-4673-7404-0

2006-2008. The actual surveys were latest conducted in several provinces in the Philippines. Traditional rice cultivation methods could be identified from specific locations given the diversified climatic conditions.

Data revealed the actual rice production activities in the Philippines because the national survey represents the traditional rice farming in the country.

Central Luzon and Cagayan Valley having different climatic conditions are the main rice growing areas which have around 30% of total rice in the Philippines. NSIC (National Seed Industry Council) varieties are the most popular to farmers with different response to different locality. Hybrid variety is becoming popular because of higher yield per unit area especially during the dry season cropping.

III. Results

A. Rice cultivation scenarios in Philippines

We empirically constructed three scenarios of rice cultivation in Philippines.

Scenario 1 used NSIC variety in Nueva Ecija Philippines with average yield of 5 tons per hectare paddy. It was transplanted rice with maximum water depth of 10 cm. Handtractor was used for land preparation and seedling was raised on a seedbed and planted at 25 days old. Fertilizer was manually applied using inorganic fertilizers while spraying was done using knapsack sprayers. Organic fertilizer was not used. Harvesting is done manually using sickle and threshed by axial flow thresher. Drying of paddy was done on concrete pavement

Scenario 2 used Hybrid rice because of its higher yield potential compared to inbred varieties. It is very popular to farmer especially during the dry season cropping. Handtractor is used for land preparation but carabao is used for levee-side plowing. Seedling was raised on the field and transplanted at 22 days old. Inorganic fertilizer was manually applied and spraying is by knapsack sprayer. Herbicide is used to eradicate weeds. Harvesting and drying were also manually done.

Scenario 3 used NSIC variety also but located in Cagayan Valley. Transplanted rice had yield of 5 ton per hectare. Rice field was first rotovated by four wheel tractor and leveled by handtractor. Seedling were raised in seed trays in 15 days during planting. Inorganic fertilizer was manually applied while knapsack sprayer is used for pesticides. Combine rice harvester is popular and flatbed dryer for paddy drying is used.

B. Foreground processes for rice cultivation scenarios in Philippines

Selection of area for this study was based on intensity of rice. Nueva ecija and Cagayan regions are the most rice growing in the Philippines representing about 1/3 of total area. Varieties are the most popularly known and planted in all areas.

We tentatively constructed unit processes for each rice cultivation scenario using working sheets prepared for rice production systems.

IV. Discussions

A. Representativeness

Site specific data are very important because it actually quantify certain parameters of the area. Specifics are dictated by climate, topography, water availability, temperature, variety used, and status of mechanization.

Therefore, we tentatively recognized that rather than trying to construct, for example, national representative production systems, it is important to concentrate our efforts to the modeling of rice production systems in the real-world. In other words, the discussion of representativeness should be linked with the discussion of scenario generation.

B. Preparation of background process data (agricultural inputs)

The establishment of LCI data for agricultural inputs in Philippines are necessary in conducting LCI analysis of agricultural production systems. Although there are no national projects about LCI databases in Philippines, we have to invent a methodology to cope with the situation.

V. Concluding Remarks

Rice production has many important roles in Philippines. The first step to understand the multiple functions is the assessment of environmental sustainability. After constructing detailed LCIs for rice production systems, we plan to analyze several environmental impacts of rice production.

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ISBN : 978-1-4673-7404-0

Construction of site-specific life cycle inventories for rice production systems in Vietnam

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***Abstract*—Establishment of sustainable rice production is important in Vietnam for the development of rural and national economy. However, studies on life cycle assessment (LCA) of rice production are limited in Vietnam. Therefore, we initiated a research project on the development of life cycle inventory (LCI) data for rice production at two main production areas. After constructing representative rice cultivation scenarios using scenario generation techniques, we discussed the possibility of developing representative rice LCI data on the basis of general LCI frameworks.**

I. INTRODUCTION

RICE production is important in Vietnam for the development of rural and national economy [1, 2]. It is still 70% of the population involving to the agriculture sector in a total area of about 14.8 million ha. Of which, paddy rice occupies almost half of the area with total about 7.9 million ha (data released by National General Statistic Office). More than half of the rice area and yield is come from Mekong river delta, which is the biggest rice production area in Vietnam. In 2013, of the total 26 million tons of rice yield in Vietnam, Mekong river delta contributed 14.8 million tons (or about 56.7%); while the population occupied only about 20%. Thus, many studies on cultivation practices and plant breeding have been conducted, especially in the delta. Because of the importance of rice production in the delta, intensive cultivation are now spreading in this region and the amount of fertilizers application rate significantly increase by time. This new situation led to the need of measuring the negative effects of chemical fertilizers application, like GHGs emission, in the delta where the climate change effects are predicted as a one of the most affected regions in the world.

However, studies on life cycle assessment (LCA) of rice production are limited so far in Vietnam, in spite of the important role of LCA in establishing sustainable agricultural systems. Very little studies were implemented with the support from overseas. For example, a project of "LCA for intensive striped catfish farming in MRD for screening hotspots as input to environmental policy and research agenda" was implemented by a group of Van Lang University in HCM city and a Netherland scientists' group.

This paper presents the results on the development of life cycle inventory (LCI) data for rice, which is based on a recently-established research project to study LCA of rice in Vietnam. Since there are wide varieties of cultivations practices in the Mekong and Red River deltas, we try to clarify cultivation scenarios based on site-specific conditions. Then, we discussed the possibility of the development of life cycle inventory (LCI) data for rice production at main production areas in Vietnam using the general LCI framework such as ILCD and EcoSpold.

II. METHODS

As a method to generate rice cultivation scenarios in the Mekong River Delta and the Red River Delta, we applied a scenario generation techniques derived from "the strategy generation table" [3]. We prepared items of management practices, which are equivalent to strategy elements in strategy generation tables [4].

Then, we discussed the possibility of constructing LCI data for rice production systems in the both delta.

Manuscript received June 13, 2015. This work was supported in part by the Japan Society for the Promotion of Science, Grant-in-Aid for Scientific Research (B), 26310316.

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ISBN : 978-1-4673-7404-0

TABLE I
PADDY RICE CULTIVATION SCENARIO GENERATION TABLE

1.01	Crop name	Rice	Rice
1.02	Variety (cultivar)	IR50404; OM1490; OM576; OMCS2000; VND 95-20; IR 64; AS 996; MTL 250; OM 2031	Khang dân 18; IR 8423; Nhi ưu 838; Bao thai; San ưu 63; Q 5; Nhị ưu 63; Ải hoabinh; Boitap St; Iri 352, BC 15, BTR 225.
2.01	Location	Mekong river delta	Red river delta
2.02	Soil type	Thionic Fluvisols, Salic Fluvisols, Fluvisols, Vetic Acrisols; follow FAO - UNESCO - WRB system	Fluvisols, Salic Fluvisols, Thionic Fluvisols, Plinthosols, Vetic Acrisols (by FAO - UNESCO - WRB system)
2.03	Average yield	58.3 quintals/ha in average, 68.2 quintals/ ha in Winter - Spring season; 53.1 quintals/ha in Summer - Autumn season; and 50 quintals/ha in Autumn - Winter season (milled rice)	66 quintal/ha in Spring season and 58.3 quintal/ha in Summer season (milled rice)
2.04	Transplanting or direct seeding	Direct seeding	Transplanting
2.05	Maximum depth of water	10 cm	15 cm
2.06	Proceeding crop (if rotated)	usually no	
2.07	Following crop (if rotated)	usually no	Winter crops (maize, vegetables)
3.01	Plowing and land preparation	Use a small tractor to shallow plough in field surface before seeding	Farmers plow fields before each season (two times a year, normally): in spring and in summer. In summer season, they burn the straw left from the spring season as an amendment.
3.02	Border coating	The fields here are very large, hence, the border coating is not a real care	Farmers use hand to create levees among fields.
3.03	Raising of seedling		Rice are planted when the seedling is 10 - 15 days old with 3 to 4 leaves and 8 - 10 cm of height
3.04	Basal fertilize application	Mostly applied NPK fertilizers and by machines	Farmers use NPK fertilizers for paddy rice and apply by hand.
3.05	Application of other organic materials	Many straw were burnt directly in fields and used as amendment	Rice straw are collected and burnt on field to apply for next season
3.06	Start of flooding	From late June	Flood start in mid - summer, usually in July and August
3.07	Soil puddling	Using a tractor with the implement	Farmers usually use small tractors for puddling soil
3.08	Transplanting	Direct seeding with density of 100 - 120 kg seeds/ ha (row separated with distance of 20 cm)	Seedling was transplanted by hand. Density is 2 - 3 slips/ cluster and 45 - 50 clusters/m^2 in Spring season or 40 - 45 clusters/m^2 in Summer season.
3.09	Weeding	Accompany with soil preparation, using cage - wheel tractor.	Weeding 2 - 3 times per season by hand, herbicides or claw
3.10	Midseason drainage	In vegetative growth stage, drainage is practiced 2 - 3 times; each time is 2 - 3 days long. 7 - 10 days before harvesting, drainage is practice again	If rice well grows, drainage was applied at the end of tilling time for 1 -2 days.
3.11	Water management after midseason drainage (intermittent irrigation)	In reproductive growth stage, keep the water level at 3 - 5 cm above the field surface	In ripening period, drainage also was applied accompanying with irrigation.
3.12	Additional fertilizer application	Not too much	Usually it is not too much application, except few manure where castle breeding is developed, manure was used before transplanting
3.13	Fungicide application	Not too much	Not too popular
3.14	Insecticide application	In folio type when insects were detected	used in folio type when insects were found
3.15	Herbicide application	In folio type when detected	Sometime were used before transplanting or when weeds were found
3.16	Herbicide application (ridges between rice fields)	Not a significant care	Not too popular
3.17	Weeding in ridges between rice fields	Not a real care	No application
3.18	Harvesting	use machine like row strip ripper or combine harvester	By a sickle
3.19	Drying	Dry under sunlight in 2 - 3 days in Winter - Spring season and use dryer in Summer - Autumn season	Dry by sunlight (in 3 days)
3.20	Management of rice straw	Straw was burnt directly in fields and plowing in.	Part of straw was taken to produce mushroom; used to feed buffalos or as bed for them; other was burnt in field and used as amendment for next season

ISBN : 978-1-4673-7404-0

III. Results

A. Rice cultivation scenarios in Vietnam

Table I describes rice cultivation scenarios in a specific site in the Mekong River Delta and the Red River Delta.

In the Mekong River Delta, the observation was implemented at an area of 1 ha rice field grown in alluvial soil in Tan Thanh commune, Thoi Lai district, Can Tho city, center of Mekong river delta. This area is an intensive cultivation field with 3 seasons in a year, the spring season start from November of the previous year and end at February of the next year. The data belong to spring season activity in 2013 - 2014. The variety used is OM5451, one variety which was invented by Mekong river delta rice research Institute with high potential of salty and sulphate resistance and high yield.

In the Red River Delta, the observation was carried out at Dong Lam commune, Tien Hai district, Thai Binh province in a scattered area of about 1 ha in total. This is also an intensive cultivation field with 3 seasons in a year; include a vegetable crop in winter. The spring season start in February and end in June. The data describes the scenario of 2014 spring season. The variety is BC15; a new high quality rice variety which now is widely spreading through the region.

B. Foreground processes for rice cultivation scenarios in Vietnam

We tentatively constructed unit processes (rice production systems) for each rice cultivation scenario using worksheets (an Excel file) prepared for gathering inventory data.

IV. Discussions

A. How to defining site-specific data and how to establish the representativeness

We tentatively constructed inventories for rice production systems using simplified worksheets. Although the development of the detailed and structured version of LCIs for rice production systems is still on progress, we tentatively understand that the development of LCIs with paying explicit attention to cultivations scenarios is an effective approach for constructing LCI data.

B. Applicability of the parent-children relationship (inheritance) in ecoinvent

Although the consideration of the parent-children relationship is our next step of the research program, we tentatively think that further scrutiny is necessary in applying the concept of global data used in ecoinvent 3.

C. How to establish background process data (agricultural inputs)

Because of the lack of national LCI database for Vietnamese industries, we think that preparation of LCI data for agricultural inputs in Vietnam needs much time. We have to invent a methodology to cope with the situation

V. Concluding Remarks

Because of the importance of rice production in Vietnamese societies, as is often the case in Asian societies, we established the rice LCI initiative. Although it has just established, we think that life cycle approaches to agricultural production systems will become important tools in evaluating and designing sustainable agriculture in Vietnam from a transdisciplinary perspective.

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 ISBN : 978-1-4673-7404-0

Study on Life Cycle Benefit Assessment as a solution aiding tool for the environmental problems

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Abstract— **It goes without saying that it is difficult to introduce effective social problem solution technologies such as the ones for environmental problem. Because stakeholders have different varieties of interests, it is difficult to come up with everybody agreeable new technologies to be introduced, no matter how good they are.**
For example, in the corporate organization, sales department and product management in marketing department have the priority in increasing sales and profits rather than in the environmentally friendly issues. Meanwhile consumers in general tend to look for quick tangible benefits such as good taste, quality and low price in case of food products.

Taking the incentive as consumers' intrinsic motivation factor into consideration, we must come up with some thoughtful approach to better connect consumers' immediate wants with consumer appealing environmental loading concept.
Having said that, here I would like to share the case results of Japanese carbon footprint and carbon offset project called "Acorn Point System" implemented by agribusiness.
In this case, the very mutual benefit shared by both agri-food producers and their customers showed the important element of successfully tackling on environmental loading.

Using this actual evidence, I would like to stress Life Cycle Benefit Assessment (LCBA) as the effective approach for the performance improvement of the addressed issue.

I. Introduction

As a matter of fact, even if a company developed an environmentally friendly product, it does not necessarily lead to a successful sales performance. Figure 1 shows the reason for choosing food products among Japanese consumers based on the results of internet research conducted in 2014. As you can see price is the most important factor for the product chosen, which was supported by 61.3 percentages of respondents. The next important reason is taste, followed by freshness, safety, nutrition, company reliability, environment-considering product, company's social contribution and color and design of package. A little disappointingly, the environment appears in the seventh.

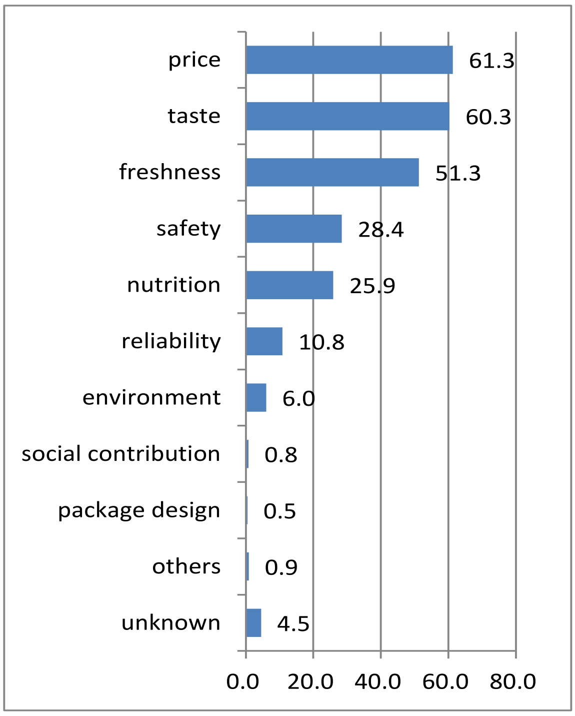

Fig1 Percentage of Response

Fig1 is Trend of the reason to choose food among Japanese This is the result of an internet research on 1200 persons in all Japan performed on March 2014

According to the results it is quite obvious that companies are expected by consumers to satisfy both environmentally friendliness as well as product itself. And based on this learning, we undertook the acorn mark carbon footprint and offset project of Japan in 2013, i.e., Acorn point system.

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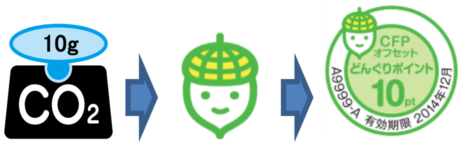
ISBN : 978-1-4673-7404-0

Here in my discussion, I would like to talk about the need of non-environmental benefit being considered when promoting sales of environmental products, based on the implication acquired through the Acorn point system project experience.

II. Overview of Acorn point mark project

A. *Framework of Acorn point system*

First of all, the goal of Acorn point system is to promote the reduction of carbon dioxide. This is a three stage system comprising of CFP mark, Acorn mark and Acorn point mark stage as shown in Figure 2. Let me each of the stages one by one.



CFP mark Acorn mark Acorn point mark

Fig2 Type of marks in Acorn point system

(1)Stage of CFP mark
First, the company which wants to attach Acorn point mark on a product they make and participate in this project scheme, is required to measure the volume of all carbon dioxide emissions exhausted in all processes from upper to lower stream, and then to calculate the volume of the emission of each product. This calculation is named by carbon footprint (abbreviated to CFP). The product which CFP was performed can be permitted to put CFP mark on the product. CFP mark is expressed in the numerical value of exhausted CO_2 volume per each product. 10g of CFP mark in Figure 2 indicates that this product exhausts 10g -CO_2 per each product.

(2)Stage of Acorn mark
Secondly, in order to attach Acorn point on a product, the company must offset the same CO_2 volume as the one exhausted by means of the carbon offset program such as tree planting or installing energy-saving facilities. In this way the offset product is permitted to attach Acorn mark.
By the way, there are two reasons why this particular acorn character was adopted as the mark. First, the acorn is very familiar tree with Japanese partly because of acorn frequently appearing in the relics of most popular children's song. Secondly, the acorn has been used for a traditional Japanese toy "Yajirobei", which keeps a balance between left and right hand by having a weight in their arms. It seems to be the same analogy that carbon offset keeps balance between amount of CO_2 emission and amount of CO_2 reduction. Carbon offset is a sort of Yajirobei balancing in environment context.

(3)Stage of Acorn point mark
Thirdly the company can attach Acorn point mark by paying two types of charges to CFP offset point committee which is managing Acorn point system. First is point charge in which one point is one yen. If a company wants to attach ten points each on one hundred products, it must pay one thousand yen to the committee. And second is the commission fee for office work at the committee. This commission fee is the same amount of money as the point fee. In total, the company which attaches 10 points to their product must pay 20 yen to the committee. By the way, in addition to the company commission, the committee is also subsidized by Ministry of economy, trade and industry.

B. *Stakeholders of Acorn point system*

To cause to realize this scheme, various stakeholders were needed. In order to build up this project scheme, various stake holders have to be involved.
That is to say, Acorn point supplier, Acorn point community, Acorn point supporter, Acorn point exchanging commodity supplier, Acorn point environmental contribution group and CFP offset point committee are inevitable. Figure 3 shows the relation of these stakeholders.

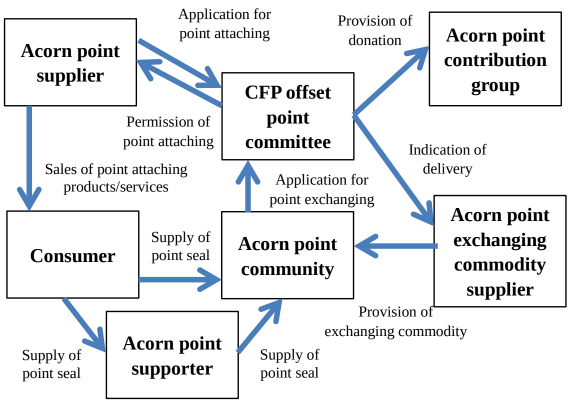


Fig3 Relation of Stakeholders

(1) Acorn point supplier
Acorn point suppliers can attach Acorn point mark to their products and services.
They can select either attaching the point seal or giving the point card in their products and services. Actually the company conducting the environmental bus tour gives Acorn point card to the tour participants.

(2) Acorn point community and Acorn point supporter
Acorn point communities, some school PTA as an example collect Acorn point mark at the purchase of acorn point products or services. They exchange Acorn point mark to environmentally friendly products or

services which Acorn point exchanging commodity suppliers offer, or they donate the equivalent value of money to Acorn point environmental contribution group. Acorn point supporters help Acorn point communities collect Acorn point mark. For example, a retailer placing Acorn point mark collection box in his shop sends the point marks to Acorn point community. This retailer is an Acorn point supporter.

(3) Acorn point exchanging commodity supplier and Acorn point contribution group
Acorn point exchanging commodity supplier provides the products/services to the Acorn point communities. They must provide environmentally friendly products or services to the acorn point communities. Acorn point contribution groups make use of the acorn point for the environmental activity fund.

(4) CFP offset point committee
CFP offset point committee takes charge of all administration and management about the acorn mark system. It judges all stakeholders like Acorn point supplier, Acorn point community and so on. It permits that Acorn point suppliers issue acorn point mark to their products. And also it delivers the products/services to Acorn point communities when the products/services are requested for the points exchange and it gives money to Acorn point contribution group when Acorn point communities want to donate for environmental activities conducted by Acorn point contribution groups.

III. Outcome of Acorn point project

Thirteen companies participated as Acorn point supplier. And two of them, Aigamo Farm Onogoe and Pasona Nouentai were agricultural producers.
Aigamo Farm Onogoe is a rice producer which uses Aigamo-ducks in the rice field to weed instead of using herbicide, thus implements environmentally friendly natural agriculture. And Pasona Nouentai produces vegetables and sauce for Bagna cauda sauce for Italian cuisine. They attach the acorn point to their products. Their points are collected by Acorn point community and used in favor of the environmental activities by the acorn point contribution group.
In the event at Tokyo Sky Tree Tower's Soramachi square, the Aigamo Farm Onogoe sold their rice with Acorn points. The points were used for the activities of Minami Soma Agri-Park's students learning facility for the natural energy. The facility was constructed in the land devastated by Tsunami at the Tohoku Pacific-Ocean Earthquake in 2011. The Aigamo Farm Onogoe has been well appreciated by the people of Minami Soma district and the market of their products is expanding.
Acorn points of Pasona Nouentai were collected by NPO. Their points have been used for the protection of Simafukurou, a kind of owl which is an endangered species. Now Pasona Nouentai is highly appreciated by their customers, too.

IV. Importance of benefit as the incentive for the action

Their successes are owing very much to good matching between the benefit of producers and the benefit of local people and consumers. Namely, the benefit of producers is increasing sales volume and profit and company reputation from consumers. The benefit of local people is improvement of local environment and local facilities, and the benefit of consumers is the availability of high quality products and low price. These benefits were beautifully linked together in Acorn point system case.
The benefit stimulates the motivation. Until today, Life Cycle Assessment (LCA) have been devised for the reduction of environmental loading.
LCA is an environmental assessment tool for evaluating impacts of a product (or service) on the environment throughout its life stage – from raw materials extraction stage all the way through manufacturing, packaging, marketing, consumer use, re-use, product maintenance, and eventually recycling or disposal as waste at the end of its life stage.
LCA helps us get at the heart of the issue. LCA has been also used by policy makers. LCA has been used to prepare the green purchasing plan for the purchase of goods and services that minimize environmental impacts.
However, LCA does not include the assessment of motivation of people or companies.
I think an incentive is essential to stimulate those who currently do not have so much interests in environmental activity to taking action. The benefit can move people who have not much interest in environmental problems to get engaged in the environmental activities like Acorn point system.
Therefore I would like to suggest that LCA should include the benefit as the incentive for motivation.
I would like to call the LCA which include the benefit assessment over the entire period of product life cycle as LCBA.
Namely LCBA is the assessment of benefits which each stakeholder in all processes including producers of raw materials, managers and workers of factory, distributors and salespersons, consumers, dealers of the waste and so on.
Here my suggestion is, to combine both outcomes of LCA and LCBA, and to plan the reduction of environmental impacts by upgrading the benefits into the incentives.
And I also named LCA in which LCBA is included as Advanced LCA (ALCA). Figure 4 indicates the relation of LCA, LCBA and ALCA.

ISBN : 978-1-4673-7404-0

Life Cycle Assessment (LCA)	+	Life Cycle Benefit Assessment (LCBA)	=	Advanced Life Cycle Assessment (ALCA)

Fig4 Relation of LCA, LCBA and ALCA

V. ROLE OF LCBA IN SUSTAINABLE SOCIETY

Therefore I think we should include the benefit as important element for improving social, environmental, financial conditions in TLCA.
I named TLCA which is included benefit "Advanced Total Life Cycle Assessment (ATLCA)".Fair trade mark is such a popular case.
I think we need to utilize ATLCA to solve the various social problems.
LCA has been evolving to Total Life Cycle Assessment (TLCA) and Life Cycle Sustainability Assessment (LCSA).
That is to say TLCA is a tool for evaluating various social elements like cost, safety and others.
LCSA is an objectively and quantifiably accountable framework for objective and quantifiable measurement consisting of three parts, i.e., social, environmental and financial. LCSA is in line with the concept of Triple bottom lines. As you know the Triple bottom lines is to aim at raising the standard of three aspects: social, environmental and financial in all countries. Thus the change from LCA to TLCA or LCSA is definitely required for realizing the sustainable society.
However both TLCA and LCSA have never included the incentive for promoting the participation of various stakeholders.
I think we should include the benefit as a critically important element for improving social, environmental, financial conditions in TLCA.
By the way, I named TLCA with included benefit as "Advanced Total Life Cycle Assessment (ATLCA)". And I think Fair trade mark is a popular applied case of the ATLCA. Figure 5 represents the relation of TLCA, TLCBA and ATLCA.

Total Life Cycle Assessment (TLCA)	+	Total Life Cycle Benefit Assessment (TLCBA)	=	Advanced Total Life Cycle Assessment (ATLCA)

Fig5 Relation of TLCA, TLCBA and ATLCA

Finally and most importantly, we should aggressively utilize ATLCA to better solve the various social problems.

VI. CONCLUSION

I expressed the importance and possibility of benefit as the motivation for the environmental activities as before.
Namely first, the benefit separate from the environmental improvement gives the incentive for the environmental activities to people who don't have interests in the environmental problems. In other words, the benefit helps the environmental activities to spread over many people.
Secondly, the benefit contributes to solve many different problems like energy, health, sales and profits and so on at the same time.
In order to utilize the benefit, we need to grasp the benefit as the incentive, i.e., cost saving, psychological satisfaction and so forth. And also we must analyze the character of these benefits, i.e., the short term ones or the long term ones, personal ones or shared ones and the like. Moreover we need to construct the scheme like Acorn point system in order to make the best use of benefit.
Finally I think that the idea of the benefit as the incentive can be very useful to solve the agricultural problems, too.

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ISBN : 978-1-4673-7404-0

Real Time Monitoring GlycerolEsterificationProcess with Mid IR Sensors using Support Vector Machine Classification

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***Abstract*—The commercial synthesis of fatty acid esters of glycerol is important as it plays role in other derivative production varieties. This research aims to construct the monitoring system for faster esterification statusidentification and increaseefficiency ofenergy used forproduction. The monitoring systems are based on the measurement parameters from two sources LED mid IR 3,4μm and 5,5 μm and two detectors that connected using the data acquisition system with computer database via USB 2.0 and classifying the esterification status using the SupportVectorMachine (SVM) classifier. The purpose of SVM method is to classify the variations of parameter inputs from the LED mid IR sensors in real time monitoring connected with microcontroler. In this research,three esterification status divided for monitoring process in bioreactor.The construction of classification based on SVM deployed in orange system software. In the application of esterification monitoring, the influence of various parameters such as temperature set in the reactor has relation to the process time needed. By monitoringthis classifying system, we obtained one of the experiment in optimum process in temperature 210°C is 2 hours.**

Keywords:*Glycerol ester, monitoring, esterification, LED IR sensor, SVM.*

Manuscript received May 14, 2015. This work was supported in part by the Lembaga Dana Pengelola Pendidikan PRJ1600/LPDP/2014

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I. INTRODUCTION

The commercial synthesis of fatty acid esters of glycerol is carried out by two different ways: direct esterification of fatty acid with the glycerol and catalysis by a homogenous acid [1]. In Indonesia, synthesis by direct esterification is widely used in the esterification of glycerol because this process is simple and feasible in batch production system [2]. The major factors affecting the conversion efficiency of esterification process are molar ratio of oil, amount of catalyst, reaction temperature, catalyst type and stirring speed according to the reaction duration [3]. However, in this research we focus on monitoring the process by relating it to the temperature and process time needed. Determination of the esterification reaction is highly desirable for glycerol ester product in order to increase the efficiency energy and the cost of production. A current method for determination of esterification is sampling, which needs high cost and time. In this paper, to determine the true esterification status in real time, direct and close online monitoring of the product and critical components is highly desirable. Optical measurement techniques are promising candidates in spectral region i.e. multi-channel NDIR (non-diffractive infrared) absorption or IR spectroscopy. The later method is also used in laboratories, thus allowing better correlation of online data and laboratory results with data acquisition interfacedby database to the computer. SVM method used to find the correlation is used for calibration parameter in online measurement sensors, especially to identify the esterification status. The position of sensors from Sinelli et al. demonstrated a set up with detector array combined with the gradient filter to avoid the need for movable parts [4] was inspirating and applied. Wiesent et al. presented a system with an infrared source, a fluid cell consisting of two sapphire windows and a quadruple infrared detector equipped with different filter windows for analysis of phosphate ester [5]. The objective of this paper is to develop a system for the identification of esterification status

ISBN : 978-1-4673-7404-0

using LED mid IR sources, thermopile detectors and data acquisition system, as well as to find the variable condition related to temperature in the reactor and the duration of the esterification process. In Section 2 of this paper, we briefly explain the materials and methods. In Section 3, we briefly describe the calibration. In Section 4, thereview of concept of classifying esterification status with SVM. Finally, in Section 5 discussed about the conclusion.

II. MATERIALS AND METHODS

A. Materials

In this research, we used pure glycerol with purity level of 85-90% and synthesized it with Oleic acids pro analysis grade specification in 1:1 ratio mixed in reactor with heater and stirring blade. For the catalyst, we used Methyl Ester Sulfonic Acid (MESA) of 0.5%.

B. Equipment

Esterification reactions were carried out in a laboratory-built apparatus. Apparatus consists of 250 ml laboratory conical flask with 30 ml working volume. The esterification reaction was under atmospheric pressure (opened system), and the temperature of the reactor was controlled using hot plate (controlled by internal thermostat) as in Figure 1. All the reactants (oleic acids, pure glycerol and catalyst) were weighted and charged into the reactor. Then, the temperature was increased by adjusting the thermostat. The magnetic stirrer was allowed to operate after 2-3 min (to heat up the mixture). After passing the desired reaction time, the reactor was removed from the hot plate. Samples were withdrawn from the reaction mixture for analysis. The reaction mixture was cooled down to the ambient temperature by immersing it into water bath. The esterification process in closed system was also investigated, where all the reactors were isolated.

C. Variation Condition

Several reaction and variation conditionwere tested in Surfactan Bioenergy Research Center (SBRC) IPB Baranangsiang Bogor laboratorium, in order to get various conditions of the temperature and reaction time. The temperature was varied between 150 ^{o}C, 160 ^{o}C and 165^{o}C. On the other hand, the process time was varied between 180, 240 and 260 minutes.

Fig 1. Apparatus experiment in laboratory

D. Sensor System

A commercial infrared LED source as original growth of narrow gap semiconductor alloys onto n+-InAs substrate, optical coupling through the use of chalcogenide glasses and Si lenses with antireflection coating (Boston Electronic,2014). Three types Mid IR sensors of 3,4 micron LED-34SR full thread body , 5,5 micron LED-55SR full thread body and 7micron OPLED 70 full thread body, with the specification in Table 1-3,also the thermopile detectors from Heimann HTIA Dx-Tx used as in Figure 2. For detecting the sample as reach steady state and to record signal amplitude with a good signal to-noise ratioand positionlayout of the sensor and detector as in Figure 3.

Fig 2. LED MID IR Source and Detector

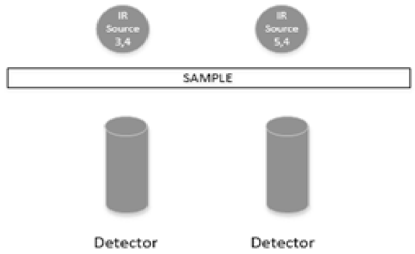


Fig 3.Position LED IR Source and Detector

TABLE 1.
SPECIFICATION OF LED34SR

Peak wavelength	µm	3,4±0.05
Pulse Power	mW	0.25÷0.35
CW Voltage	V	Drive Current 0.2A 0.26÷0.29

TABLE 2.
SPECIFICATION OF LED55SR

Peak wavelength	µm	5,4÷5.5
Pulse Power	µW	5÷7
CW Voltage	V	Drive Current 0.2A 1.5÷2.5

TABLE 3.
SPECIFICATION OF OPLED70

Peak wavelength	µm	6,5÷7.0
Pulse Power	µW	5÷7
CW Voltage	V	Drive Current 0.2A 1.5÷2.5

E. System Data Acquisition

To ensure the data parameters get collected from the sensors, the system was interfaced with database such as MySQL. In this research, we built the data acquisition system by using microcontroller

ATMEGA 8535 with Universal Serial Bus (USB) 2.0 connector to connect the data streaming in real time to the computer(Figure 4). After that, the output was processed using SVM method with personal computer[6].

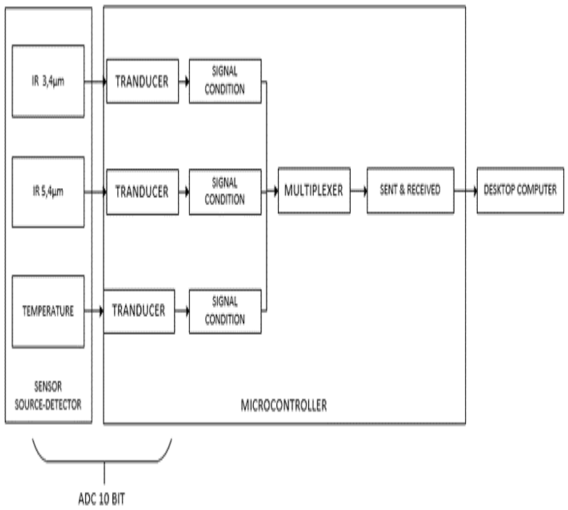


Fig 4. System block diagram for sensors and microcontroller

F. Relief

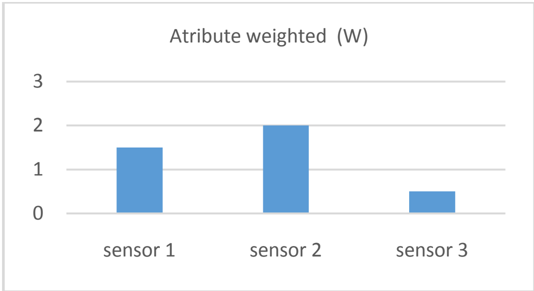
In this work, to analyze the sensors closely related to esterification forming parameter, we used Recursive Elimination of Features (Relief) algorithm, which is generalizable to polynomial classification by decomposing it into a number of binary problems proposed by Kira and Randall [7].The equation of Relief is represented as in (1). To perform Relief in this research, first, defines i^{th} output sensor as f_i where $\mathbf{F} = \{f_1, f_2,..., f_m\}$, the weight of the i^{th}output sensor asw_{fi} where $\mathbf{W} = \{w_{f1}, w_{f2},\ldots,w_{fm}\}$, and the result of esterification condition for m dimensional features ($i= 1, 2,...,m$) and n sample size ($t = 1, 2,..., n$) which denotes as x_{ti} where $\mathbf{X} = \{x_{t1}, x_{t2},\ldots, x_{tm}\}$.

$$w_{f_i} = \frac{\sum_{t=1}^{(n-1)} \sum_{j=(t+1)}^{n} diff(x_t, y_j)^2}{(n-1)} \quad ....(1)$$

Traditionally, Relief equation above runs using pairwise between data record (x_t and y_j) where x_t indicates an instance of output and y_j indicates an instance neighbor of x_t. In equation above, function $diff\ (x_t, y_j)^2$ is calculated as in (3), where r_{fi} is a range unit of i^{th}esterification status to normalize the values of the functioninto the interval [0, 1].

$$diff(x_t, y_j)^2 = \left(\frac{x_t - y_j}{r_{f_i}} \right)^2 \quad ....(2)$$

As in (3), if pairwise between x_t and y_j are in the same class, then the value of function *diff* is negative. Otherwise, function *diff* will have a positive value when x_t and y_j are in a different class. Kononenko [8]said that the relevant features means the features which has weight above 0. The result of weights of design elements of Relief which generated using R language which threshold was set on zero (τ=0) is represented in Figure 5. As the result of attribute weighted in Relief, the sensors that closely related with esterification identification was 3,4µm and 5,5µm



Note: Sensor 1: 5,5µm, Sensor 2: 3,4 µm and Sensor 3: 7µm

Fig5. Relief Attribute weighted from 3 sensors for esterification identification

G. Support Vector Machine (SVM)

Support Vector Machine (SVM) was first heard in 1992, introduced by Boser, Guyon, andVapnik in COLT-92. Support vector machines (SVMs) are a set of related supervised learningmethods used for classification and regression [9].SVM is a useful technique for data classification.

For this type of SVM, training involves the minimization of the error function:

$$\frac{1}{2}\omega^T\omega + C\sum_{i=1}^{N}\zeta_i \quad ....(3)$$

subject to the constraints:

$$y_i(\omega^T\phi(x_i)+b) \geq 1-\zeta_i \quad ....(4)$$

$$\text{and } \zeta_i \geq 0, i = 1,....., N \quad ....(5)$$

where C is the capacity constant, ω is the vector of coefficients, b is a constant, and $\xi_i$represents parameters for handling non-separable data (inputs). The index i labels the N training cases. Note that $y \in \pm 1$represents the class labels and xi represents the independent variables. The kernel $\phi$is used to transform data from the input (independent) to the feature space. It should be noted that the larger the C, the more the error is penalized. Thus, C should be chosen with care to avoid over fitting. A classification task like esterification status process usually involves with training and testing data, whichconsist of some data instances.Each instance in the training set contains one-targetvalues and several attributes, which tested in laboratory using sample process in each,

ISBN : 978-1-4673-7404-0

attribute. The goal of SVM is to produce a model, which predictstarget value of data instances in the testing set whichare given only the attributes [10]. In this research the target value is esterification status.

III. CALIBRATION

A. Calibration

To ensure the precision esterification measurement, this system calibrated by 3 step method: testing with blank sample, full closed sample(using a sheet of paper) and tested glycerol ester FTIR spectrum with parameter 180°C and 150 minutes process as in Fig 6.

TABLE 4.
BLANK SAMPLE

Blank Sample	Digital Output		Transmittance Calibration	
Time (Second)	5,5µm	3,4µm	5,5µm	3,4µm
1	205	258	100	100
2	209	260	100	100
3	208	258	100	100
4	210	257	100	100
5	207	258	100	100
6	208	256	100	100
7	209	255	100	100
8	207	259	100	100
9	208	257	100	100
10	206	258	100	100
Average	207.7	257.6	100	100

TABLE 5.
FULL CLOSED SAMPLE

Blank Sample	Digital Output		Transmittance Calibration	
Time (Second)	5,5µm	3,4µm	5,5µm	3,4µm
1	178	203	0	0
2	178	203	0	0
3	182	201	0	0
4	181	202	0	0
5	182	203	0	0
6	182	201	0	0
7	182	201	0	0
8	181	202	0	0
9	178	201	0	0
10	179	201	0	0
Average	180.3	201.8	0	0

After we get the average value for the two condition (blank sample and closed sample) to described transmittance upper and lowerlimit valuefor the detector, we can find the calibration factor for this identification system. The calibration used formula as in Equation 3.

$$\textit{Transmitance (\%)} = \frac{x_n - \frac{\sum x_{iclose}}{n_{iclose}}}{\frac{\sum x_{iblanko}}{n_{iblanko}} - \frac{\sum x_{iclose}}{n_{iclose}}} \quad .... \ (6)$$

Where:

Xn= bit number digital output;

$$\frac{\Sigma X_{i\ Close}}{n_{i\ close}} = average\ bit\ number(closed);$$

$$\frac{\Sigma x_{i\ blanko}}{n_{i\ blanko}} = average\ bit\ number\ (blanko)$$

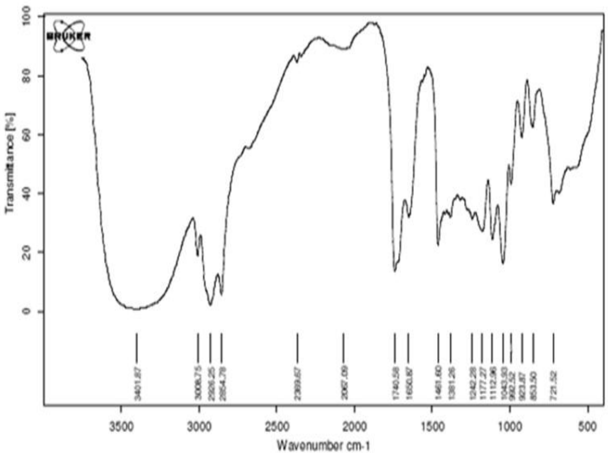


Fig 6. FTIR spectrum of Glycerol Ester 180°C-150 minutes

IV. RESULT AND DISCUSSION

A. Online Measurement

In the laboratory, we doing experimental process using this sensor and data acquisition with temperature from 160°Cuntil210°C with various process time. The graphical data was describe in Fig 7.With data acquisition system, we can get the real time data plotted in interval of 3 seconds and average it in each hours to compare with SVM method

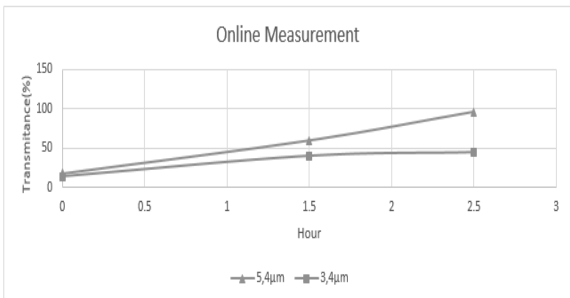


Fig 7. Online real time data acquisition transmitance

In our research, we used SVM method to classify the input parameter identified by sensor as a transmittance parameter. The performance of SVM was tested by using ROC analysis.

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B. *Esterification Status with SVM*

For the data acquisition in this research, we used online data measurement interfaced with SQL database and identified the parameter inputs by using optical sensors MID IR that attached in bioreactor . The input database was collected and clustered into esterification status by using SVM method. Using computer software application Orange ver 2.6.1, the SVM method was trained and tested by processing the data file of 250 examples, 2 attributes and Classification Discrete Class with 3 values as in Figure 8 and the knowledge flow Orange software schema as in Figure 9 with C-SVM using C=1,00 and Kernel type:Sigmoid.

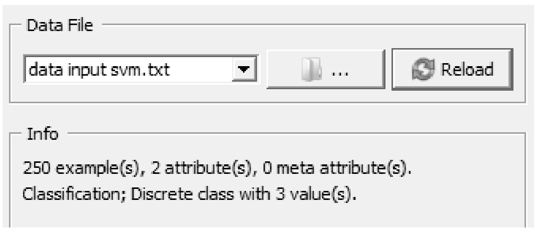

Fig 8. Data input from database (Orange Software)

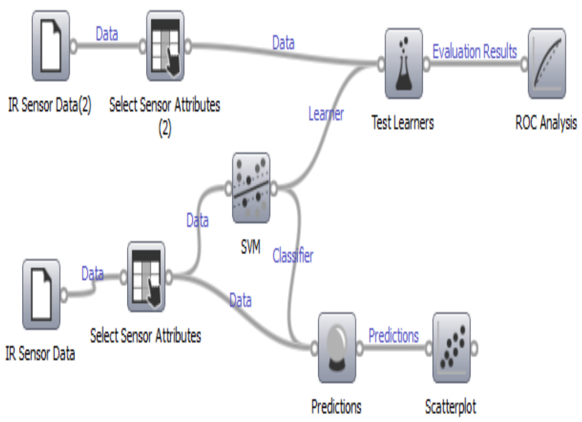

Fig 9. Knowledge flow schema in Orange software for data mining

C. *ROC Analysis*

To measure the performance of SVM classifier, we used test learners with sampling Cross validation 5 number folds. The evaluation result was as in Table 6 with Classification Accuracy 95,58%, sensitivity 97.81% and specifity 95.54%. And another test method this classification was tested byROC curve is a graphical plot that illustrates the performance of a classifier system as its discrimination threshold is varied. The curve generated by Orange Software data mining was shown by plotting the true positive rate against the false positive rate at various threshold settings. From the three predicted classes in Figure10, we found that the classifying performance of SVM was excellent. The interpretation of ROC curve is similar to a single point in the ROC space, the closer the point on

the ROC curve to the ideal coordinate, the more accurate the test is. The closer the points on the ROC curve to the diagonal, the less accurate the test is.

TABLE 6.
TEST LEARNER EVALUATION RESULT

CA	Sens	Spec
0.9558	0.9781	0.9554

D. *Effect of temperature and time*

Both temperature and time of the process had major effects on the conversion of the esterification process. Accordingly, they were studied together. The obtained results showed that by increasing the reaction temperature, the reaction conversionalso increased rapidly. Table 5. Shows that after 2 hours, the esterification reached a well-formed esterification status.

Therefore, another esterification reaction was carried outwithin a temperature range of 120°C-210°C (maximum heater temperature) as shown in Table 7. The results revealed that by increasing the esterification time, the esterification yields also increased up to a maximum conversion. To determine the time needed of esterification process, besides considering the maximum yields of esterification, it was also necessary to take the time required to reach the reaction temperature into account (Table 8).The length for heating time to reach the reaction temperature was certainly longer and the energy consumption was surely greater for higher reaction temperature. Consequently, a faster reaction at a set temperature was desirable.

TABLE 7.
EXAMPLE IDENTIFICATION ESTERIFICATION WITH SVM

Time (minutes)	Temperature(°C)	Esterification Status With SVM
40	120	Initialize
78	180	On Process
120	210	Finish

TABLE 8.
EXAMPLE DATA TESTING WITH SVM

TEMPERATURE (CELCIUS)	TIME (MINUTES)	ESTERIFICATION STATUS
170	180	Finish
190	140	Finish
210	120	Finish
210	135	On Process

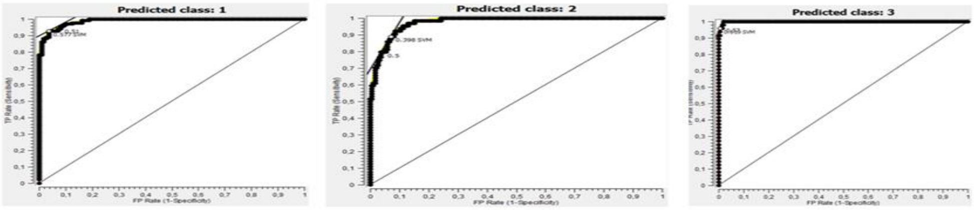

Fig 10. ROC analysis curve

V. CONCLUSION

The system of real time monitoring glycerol esterification process with mid IR sensors classyfying with SVM, was contributed to support the identification esterification status and to get information for the time consume of the esterification process. This esterification status achieved a good performance when classify into 3status: Initialize, on process and finish. This classification was trained and tested in Orange Software for data mining using SVM method whereas the performance of the classifier was tested usingROC analysis. In applying for esterification optimization, the influence of various parameters, such as the temperature set in the reactor, had a relation to the process time needed. By using this monitoring system based on the measurement and classification of esterification forming using SVM from two inputs of LED mid IR 3,4 and 5,5 µm sensors, we obtained the optimumprocess condition was 210^{o}C and the time needed for the process was 120 minutes.

ACKNOWLEDGMENT

The authors would like to acknowledge the financial support of Lembaga Pengelola Dana Pendidikan (LPDP) Kementerian Keuangan RI number: PRJ-1600/LPDP/2014

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ISBN : 978-1-4673-7404-0

Extraction of Multi-Dimensional Research Knowledge Model from Scientific Articles for Technology Monitoring

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***Abstract*—the usage of patent and journal articles for technology evaluation are highly recognized. Unfortunately, there is a lack of identifying knowledge within. In this paper we propose an approach to extract knowledge inside the document to develop a research map for monitoring and evaluating technology development.**

I. INTRODUCTION

THE usage of patents and journal articles for technology evaluation are highly recognized. For this purpose, several methods were proposed to solve a long lasting obstacle in monitoring the development of technology from research activity [1], [2], [3], [4], [5], [6], [7]. Those methods provided important information for decision making process in management of innovation and technology.

Those methods used written resources as input which have knowledge within it. This knowledge can be seen from several point of views. For example, if we have a long text which its content is about fermentation of *Saccharomyces cerevisiae,* thus the knowledge in the text can be seen in context of fermentation process or yeast characteristics. If we see the knowledge in the context of fermentation process, then we will put the text on the group of fermentation technology and so on. For simplicity, we can see the knowledge from several dimensions.

Completing methods which have been developed, in this paper we propose a simple approach to model knowledge within the document to be used for research monitoring and evaluation. This paper will also describe briefly the foundation of our approach based on the knowledge inside the documents, the algorithm and several options for further development of the approach, then closed by a brief conclusion statement of the overall work.

II. THE FOUNDATION

A. *Knowledge in Text*

In this section we will explain briefly how a knowledge in the text document. As described by Nonaka [8], who has proposed a model of knowledge dynamics, the knowledge can be transformed from one state to another state. For an example, a knowledge can be transformed from implicit form into explicit form such as in a writing process. In writing process, a writer selects some vocabulary to represent some object he thinking about and put it on a certain vocabulary order to develop sentences. Thus, the sentences represent linkage between objects. By reading the sentences, the reader understands the writer’s thinking. In the process, the writer represents his knowledge into text modelled knowledge. This text can be reverse engineered to get back the knowledge and can be used for several needs, such as for decision making process [9].

In the research article writing process, the above mechanism occurs as well. This article such as primary output of the research activity beside patent document and have positive correlation to the development of technology [10]. Thus, its content has full of knowledge about development of technology to be extracted. This knowledge can be used for several purposes such as for basic information in research monitoring and evaluation.

B. *Extracting Knowledge from Research Articles*

Using the above basic process, we can get the knowledge of certain research from research articles and use it to monitor research development in particular research area. Using the result from the extraction process we can develop a map which is representing research development. The extraction process was inspired by Sahlgren [11]. He developed a geometrical model of words meaning based on text collection which is called word space. His work was

 ISBN : 978-1-4673-7404-0

TABLE 1
TWO FOUNDATION USED BY SAHLGREN [11] TO MODEL WORDS

Foundation	Description
The geometric metaphor of meaning	This foundation stated that a word can be modelled into geometrical space with its meaning.
The distributional hypothesis	This foundation stated that similarity of words can be approximate by its distribution in a text collection.

built on two foundations as shown in Table 1. In the word space model we can observe the meaning of a word relative to other words. This concept was adapted to model researches linkage into a visual representation.

The researches can be visualized into a map after we know the relative position of a research to other researches. For this reason, we adopt the foundations to metaphor the researches and to enable analyzing its relative position. Thus, it can be decided how far a research to other researches. Nearer researches mean that content of the researches are more similar, while farer researches mean that content of the researches are more different. This approach is known as similarity-is-proximity which observes distance between objects to measure its similarity.

In this research we define two foundations adapted from the [11] as follow:

--First: "*a research topic is a location in research area which is modelled as geometrical space, while its similarity can be determined by the distance between locations*".

--Second: "*researches which have similar properties in its dimension have similar content*".

A research in this context is represented by its journal articles, while a research area is an n-dimensional space where the research is located in those dimension based on its content. The content of a journal article is assumed represents about the research itself as it was wrote by researcher through writing process as mentioned before.

The content of the text will affect the dimension properties of a research within the research area, this properties is considered as topic for simple. The topic is indicated implicitly by the vocabularies of the text. Thus, every similar research has similarity in its topic, *vice versa*.

The properties of dimension in this context are shown by the vocabularies itself. By these properties, a research is located in the n-dimensional research area.

For a simple example, say there is an event which is such as abstract object which was represented by a writer as a sentence:

"*Ekstrak vanili diolah menjadi bubuk vanili dengan cara mikroenkapsulasi*." [12]

The sentence above mentions about how the process of vanillin extraction by microencapsulation resulting in powdered vanillin. Technically, the sentence shows several linked objects as shown in Table 2. By the example, we know that a sentence represent linkage between one object to other objects.

In a larger scale, that is a paragraph, this phenomenon can be used as a basis to determine the topic of a paragraph. As in the example of the following paragraph:

"*Kestabilan komponen flavor terenkapsulasi selama penyimpanan dan distribusi dipengaruhi beberapa faktor, diantaranya adalah AW, suhu, jenis komponen flavor dan jenis penyalut. Waktu paruh bubuk vanili yang disimpan pada suhu rendah adalah sekitar tiga bulan. Bubuk vanili disimpan pada botol kaca bertutup, untuk mengurangi kehilangan komponen volatil, produk enkapsulasi sebaiknya disimpan dalam kondisi dingin dalam wadah kedap udara. Pemberian kemasan sekunder atau tersier dapat memperpanjang umur simpan produk.*" [12]

TABLE 2
OBJECTS DESCRIPTION OF THE EXAMPLE

Word	Object
ekstrak	a preparation containing the active ingredient of a substance in concentrated form.
vanili	a tropical climbing orchid that has fragrant flowers and long pod like fruit
diolah	perform a series of mechanical or chemical operations on (something) in order to change or preserve it
menjadi	begin to be
bubuk	fine dry particles produced by the grinding, crushing, or disintegration of a solid substance
vanili	a tropical climbing orchid that has fragrant flowers and long pod like fruit
dengan	indicating the means of achieving something
cara	a method, style, or manner of doing something
mikroenkapsulasi	process in which tiny particles or droplets are surrounded by a coating to give small capsules of many useful properties

The paragraph above can be analyzed based on its words frequency, as listed in Table 3. Knowledge of the current paragraph is about the condition of encapsulated vanillin components as flavor during

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TABLE 3
FREQUENCY OF WORD OCCURRENCE IN THE EXAMPLE PARAGRAPH

Word	Frequency	Word	Frequency	Word	Frequency
disimpan	3	*dapat*	1	*penyimpanan*	1
komponen	3	*diantaranya*	1	*rendah*	1
adalah	2	*dingin*	1	*sebaiknya*	1
bubuk	2	*dipengaruhi*	1	*sekitar*	1
dalam	2	*distribusi*	1	*sekunder*	1
dan	2	*enkapsulasi*	1	*selama*	1
flavor	2	*faktor*	1	*simpan*	1
jenis	2	*kaca*	1	*terenkapsulasi*	1
pada	2	*kedap*	1	*tersier*	1
produk	2	*kehilangan*	1	*tiga*	1
suhu	2	*kemasan*	1	*udara*	1
vanili	2	*kestabilan*	1	*umur*	1
atau	1	*kondisi*	1	*untuk*	1
aw	1	*memperpanjang*	1	*volatil*	1
beberapa	1	*mengurangi*	1	*wadah*	1
bertutup	1	*paruh*	1	*waktu*	1
botol	1	*pemberian*	1	*yang*	1
bulan	1	*penyalut*	1		

storage. Therefore, it can be expected high number of word occurrence such as "*vanila*", "*enkapsulasi*", "*komponen*", "*simpan*", and "*flavor*" as shown in Table 3. By only selecting these significant words to represent the knowledge we can determine the topic of a paragraph.

Selected words then act as properties of a text in geometrical space with the words as its axis and frequency as position of a text in the dimension. For an example assume that there is a dimension in geometrical space of research area, that is "*vanili*". Thus, the paragraph before can be positioned in the dimension of "*vanili*" in position 2 as the frequency of word "*vanili*" is 2. This example can be drawn in Cartesian diagram as in Figure 1 a. Let say, we extend the geometrical space by adding another dimension, say "*enkapsulasi*", then the position of the paragraph as shown in Figure 1 b, and so on.

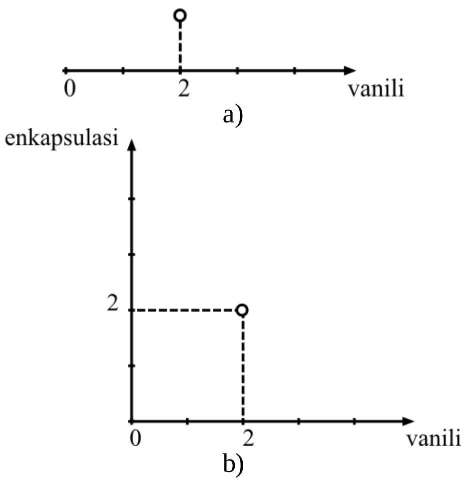

Fig. 1. Cartesian chart of topic a) one dimensional, and b) two dimensional

Using the mentioned approach, we can locate a research in geometrical research area as implementation of first foundation.

C. Generating Research Linkage

After all of the researches were determined its position in the research area, we can perform a mathematical calculation to measure distance between researches. For example, there are four sentences:

--Sentence 1: "*Vanili tersebut telah melalui proses curing*."

--Sentence 2: "*Vanili tersebut telah melalui proses curing*."

--Sentence 3: "*Proses enkapsulasi dilakukan dengan penyalut*."

--Sentence 4: "*Transesterifikasi menghasilkan metil ester*."

It is assumed that the sentences are content of four documents. Although Sentence 1 and Sentence 2 are similar, they are considered as different object since it is from different document.

Relative position the documents can be determined using approach as described in section above. The result of the analysis is shown in Table 4. The words in Table 4 only represent the significant words.

From the result we can create word-document matrix as in Table 5. The dimensions in the matrix are aggregation of all significant words we have collected. And again, the frequency of the word acts as position of the document in a dimension. If a document have no topic in a dimension, it position will be 0.

ISBN : 978-1-4673-7404-0

TABLE 4
SIGNIFICANT WORDS FROM THE EXAMPLE

Doc. 1	Doc. 2	Doc. 3	Doc. 4
vanili (1)	*vanili* (1)	*proses* (1)	*transesterifikasi* (1)
lalu (1)	*lalu* (1)	*enkapsulasi* (1)	*hasil* (1)
proses (1)	*proses* (1)	*laku* (1)	*metil* (1)
curing (1)	*curing* (1)	*salut* (1)	*ester* (1)

The matrix can be written as a single vector for every document as follow:

--Document 1 = {1,1,1,1,0,0,0,0,0,0,0};

--Document 2 = {1,1,1,1,0,0,0,0,0,0,0};

--Document 3 = {0,0,1,0,1,1,1,0,0,0,0};

--Document 4 = {0,0,0,0,0,0,0,1,1,1,1}.

As the documents can be represented by vector, it is enables measurement of documents relative distance. From the example we know that Document 1 and Document 2 are similar. Thus, we expect that the documents considered as similar from the calculation. If we use Association Value measurement from [3], then we expect that the Association Value of Document 1 and Document 2 is 1. While Document 1 and Document 4 have no similarity in its topic and will have value 0. The rest of the calculation for the example is shown in Table 6.

TABLE 5
WORD-DOCUMENT MATRIX OF THE EXAMPLE

Dimension	Doc. 1	Doc. 2	Doc. 3	Doc. 4
vanili	1	1	0	0
lalu	1	1	0	0
proses	1	1	1	0
curing	1	1	0	0
enkapsulasi	0	0	1	0
laku	0	0	1	0
penyalut	0	0	1	0
transesterifikasi	0	0	0	1
hasil	0	0	0	1
metil	0	0	0	1
ester	0	0	0	1

By using Association Value, we can decide whether two documents have association or not after we decide the boundary value. This documents linkage can be modelled as a simple graph to enable advanced processing and measurements.

D. Visualizing the Researches

As the researches modelled into graph, we can easily visualize it. For example, we can use NodeXL to get several visualization features [13]. In this paper we cluster the researches graph before visualize it using Clauset-Newman-Moore method [14]. This clustering method was embedded in NodeXL. For research monitoring purpose we used document metadata that is published year to know the researches order. The result of the visualization is a map as shown in Figure 2. In this work, we used journal articles issued in “Jurnal Teknologi Industri Pertanian” from 2004 to 2013.

Vertices in the map represent one individual research. The vertices which have same color indicate that the vertices belong to one particular research group. The edges in the map represent the association between two researches, while the line thickness indicates how strong the relation is. The map can be used to monitor research development in particular research group by zooming out the particular area and filtering it year by year.

TABLE 6
ASSOCIATION VALUE OF THE EXAMPLE

	Doc. 1	Doc. 2	Doc. 3	Doc. 4
Doc. 1	-	1,0000	0,1429	0,0000
Doc. 2	1,0000	-	0,1429	0,0000
Doc. 3	0,1429	0,1429	-	0,0000
Doc. 4	0,0000	0,0000	0,0000	-

III. DISCUSSION

We have described the foundations of how to model knowledge from journal articles to enable advanced processing and measurement. For simplicity, we propose overall algorithm as follow:

--Convert pdf articles into plain text file;

--Tokenize the words in the files;

--Cleaning the set of words from non-words and stop words;

--Stem the words to normalize the words, in this case we used Nazief & Andriani methods [15];

--Get the significant words as research topic, in this case we used TF-IDF methods [16];

--Calculate the association between researches using its words frequency [3] to generate researches graph;

--Cluster the researches into particular area of researches [14];

--Visualize the research map.

Converting pdf file into plain text file will enables easier effort to processing the file in PHP which is used in this work. This process will simply the process but ignore several content of the article such as figure and table. In our case, we only focused on

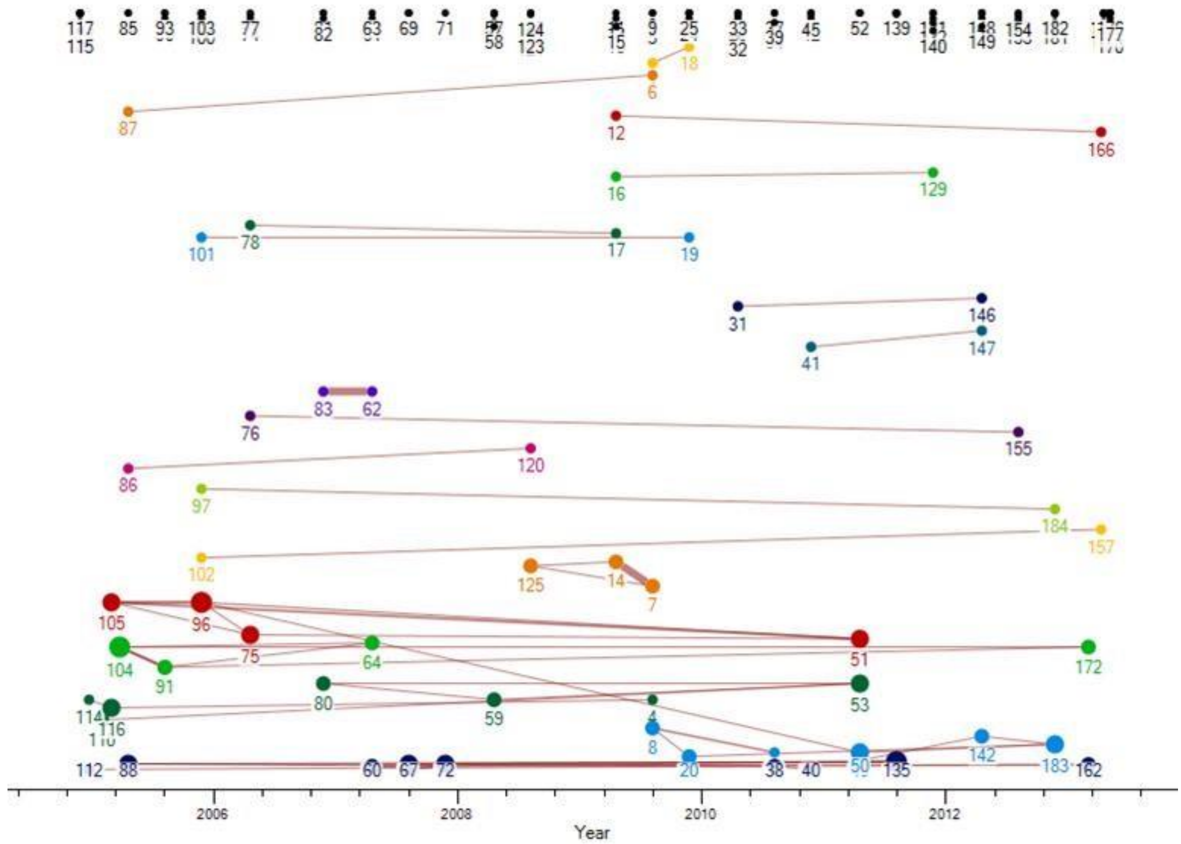

Fig. 2. Visualization of researches from journal articles

text content and ignoring figures and tables in the article.

Stemming in the process is very important to extract the topic from the natural language data. It converts the word into its root word to get it basic meaning of the word. This process is available in several methods depends on the language of the text. Another important process of the topic determination is getting the significant words which represent the topic of the text. This process can be conducted in several methods, such as cosine similarity, Euclidean distance, or key element extraction.

In this work we cluster the researches after model the researches into graph using Clauset-Newman-Moore method. This method is efficient in clustering a large graph [14]. Others way to cluster the research are available such as support vector machine (SVM), hierarchical clustering, K-means, etc. The one difference of those methods from Clauset-Newman-Moore method are those methods use the document vector directly before it is modelled into graph.

The important part of this all work is it enables advanced measurement of the researches as we mentioned above. As the researches modelled as graph, we can calculate several graph measurement such as degree [14], betweeness centrality [17], closeness centrality [18], etc.

Those measurements represent some aspect for evaluating of the researches. For example, degree of the research represents popularity of a research among other researches. Betweeness centrality represents importance of a research among the development path of the researches which are linked to it, while closeness centrality represents strength of a research belongs to a research group.

IV. Conclusion

We have described and proposed an approach to model the implicit knowledge in the journal articles to develop technology map. This approach consists of several step to be followed and can be used as basis for further development of research modelling based on text processing and graph theory. By model the researches into a map which is developed from simple graph, it enables further processing and measuring the researches for monitoring the research development and evaluate individual research in the collection.

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ISBN : 978-1-4673-7404-0

PERFORMANCE OF ARTIFICIAL LIGHTING USING GENETICS ALGORITHMS

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***Abstract*—The needs of lighting in a room can be achieved from a natural illumination such as sun-shines and also from a artificial lighting or the combination of both natural and artificial lighting. For artificial lighting, people use mostly electric lamp, which needs an innovation to maintain the usage of electric lamp. Good lighting system will enable users to optimized artificial lighting usage in a room and also good to save energy.**

In this research we analyze the performance of artificial lighting using genetics algorithms to search the best candidate. The simulation is done in a room using 4 different types of lamp which is tube lamp (TL), fluorescent lamp, neon lamp, and halogen lamp. The simulation results show that maximum power efficiency is 3,1289 watt/m2 from 16 TL lamp with 250,231 of illumination intensity.

I. INTRODUCTION

The needs of ligting in a room can be achieved from a natural lighting system e.g sun-shines, and artificial lighting system e.g electric lamp, candle,etc.

The natural lighting in a room depends on the position of the room or building to the earth rotation. For the earth rotation is moving from west to the east, it gives a best lighting for a room or building facades to west or east.

For the artificial lighting, people mostly uses electric lamp. Electric lamp needs more effort to achieve a good and efficient way of lighting to optimized its performance where the effective artificial light will also help us to save the energy.

This research simulates the intensity of artificial light using genetics algorithm using *Matlab*. This research analyze the lighting intensity *(lux) and* also calculates the electric power usage efficiency in a room to optimized the lighting in a room.

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II. LITERATURE REVIEW

A. Lighting

Lighting is one form of electromagnetic wave with certain wave length and certain frequency. The quality of lighting can be differ from light energy in electromagnetic spectrum. Each waveform illuminates different light with different color approaching human eyes as shown in Fig1.

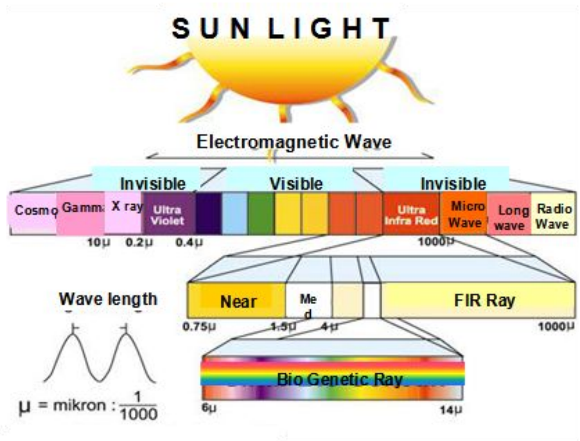

Fig 1. Electromagnetic wave spectrum

The source of light consist of natural and artificial lighting. The natural lighting comes from sunshine (daylight) and also from a reflected sunlight by moon (moonlight). Artificial lighting comes from electric lamp as we use daily.

Beside natural lighting, a room lighting is also achieve from an artificial lighting using lamps. An inappropriate lighting in a room will ruin the room comfort, wasting energy, and also affect the human eyes.

Every color has different wave length which indicates that every lamp with different lighting intensity and different color produces different intensity. Every room has standard for lighting intensity as shown in S*tandard Nasional Indonesia (SNI)* BSN-2000 as shown in Table 1.

ISBN : 978-1-4673-7404-0

TABLE I
STANDARD OF ROOM LIGHTING

Room Type	Lighting Intensity
Classroom	120 – 250
Bedroom	150
Office	120 – 250
Living Room	120 – 250
Sketch room	750
Laboratory	250
Toilet	100
Hall	100
Kitchen	200
Garage	60
Ballroom	200
Praying room	200
Library	300
Archive Room	150
Factory	1000
Store	500
Display Room	500
Supermarket	750

The room lighting intensity (E) and power efficiency(η) is express in equation below :

$$E = \frac{n\phi d\mu}{A} \quad \text{.......... .... 1)}$$

$$\text{Power Efficiency } (\eta) = \frac{E(lux)}{Efficacy} \quad \text{......... .... .2)}$$

Where,,

E = lighting intensity (lux)

η = number of lighting source

ϕ = intensity of lighting source (lumen)

μ = constants of room efficient

d = factor of reflector usage

A = room width (m2)

Efficacy = comparison of output of countable lumen and power usage

B. Genetic Algorithm

Genetic Algorithm is a optimization method to search for certain value of parameters with basic principle that only best solution survives and create qualified off-springs. Optimization is defined as a process to gain a certain function.

The process in Genetics Algorithms is quite simple that only involve copy and exchange string. Genetics Algorithms process mainly include selection, crossover and mutation as explained below.

1)Evaluation Function

A better evaluation function must able to provide a fitness value match with chromosome performance. At early stage of optimization, fitness value of each individual has a wide range. As the generation develop some chromosome dominates the population and shrink the range value. This will cause an early convergent.

2)Selection

The increment of selection stress affects the population variety to be minimum. Other wise, a selection decrements stress affects the selection to be inefficient because the population becomes widely vary. Selection creates next generation, where next generation chromosome might comes from all parents and all off-springs or probably from part or parents and off-springs.

3)Crossover

Crossover is a main genetics operator. This operator takes 2 individual and cut the chromosome strings at the random position to produce two segment of head and two segment of tail as shown in Fig 2. .

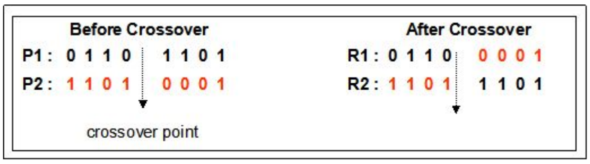

Fig. 2. Illustration of Crossover in Genetics Algorithms

4)Mutation

Mutation is an operator in genetics Algorithms to modified one or more gene value in the same individual.Mutation confirm that probability to search in certain area in a problem will not be zero and prevent total loss or genetics material after selection and deletion.

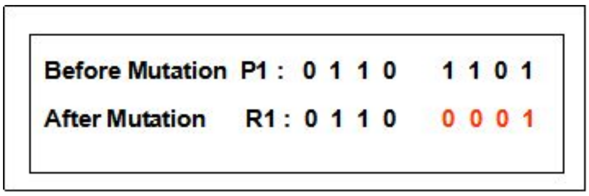

Fig 3. Illustration of Mutation in Genetics Algorithms

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III. SYSTEM MODEL

The objectives of this research is to maintain the lighting necessity in a building or room to achieve a better usage energy based on type of lamp, room width, reflector and quantity of lamp power. The system model of the research can be seen in Fig 4.

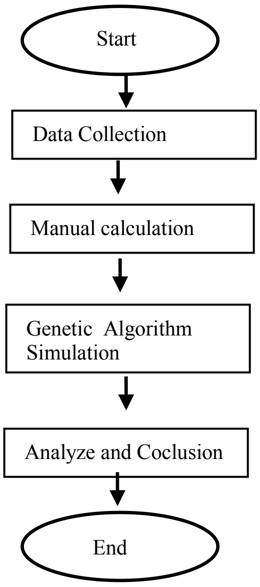

Fig 5. Research Flowchart

The simulation was done in a room with 12 TL lamp where each lamp needs power 40 watt to operate, aluminum reflector, white wall with room size 10 meters in length, 5 meters in width and 4 meters heights.

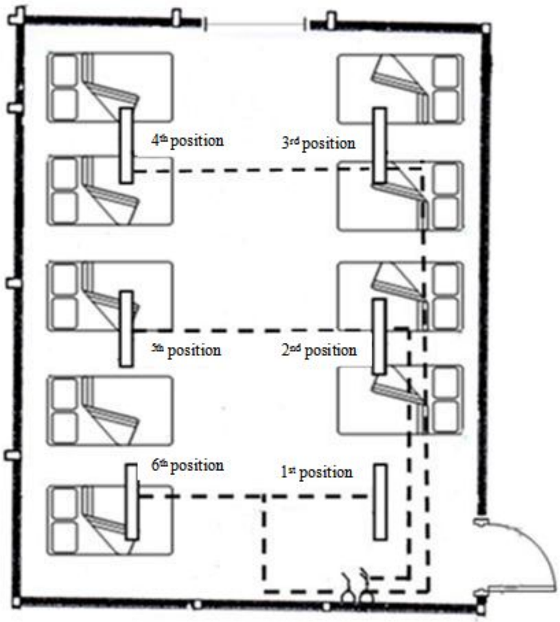

Fig 5. Sketch of Simulation room

IV. RESULT

A. Room lighting measurement

Table 2 to table 5 below show the measurement result of lighting using lux meter. The measurement done in 4 days from June 1 to June 4, 2014.

TABLE 2
MEASUREMENT RESULTS ON JUNE 1 2014

Measurement Position	Lighting Intensity (Lux)
Position 1	208
Position 2	215
Position 3	250
Position 4	260
Position 5	226
Position 6	222
Mean (lux)	230,16

TABLE 3
MEASUREMENT RESULTS ON JUNE 2, 2014

Measurement Position	Lighting Intensity (Lux)
Position 1	190
Position 2	203
Position 3	240
Position 4	235
Position 5	215
Position 6	220
Mean (lux)	271,16

TABLE 4
MEASUREMENT RESULTS ON JUNE 3, 2014

Measurement Position	Lighting Intensity (Lux)
Position 1	190
Position 2	225
Position 3	245
Position 4	235
Position 5	220
Position 6	220
Mean (lux)	219,16

TABLE 5
MEASUREMENT RESULTS ON JUNE 4, 2014

Measurement Position	Lighting Intensity (Lux)
Position 1	195
Position 2	215
Position 3	240
Position 4	237
Position 5	218
Position 6	225
Mean (lux)	221,67

ISBN : 978-1-4673-7404-0

B. Calculation of Room Specification

Calculation uses the equation in equation 1 and equation 2 as shown below : TL lamp (efficacy : 80lumen/watt), 40 watt of lamp power.

Φ = efficacy x lamp power
= 80 x 40 = 3200 lumen

By using equation 1, the lighting intensity E will be :

$$E = \frac{12x3200x0,7x0,405}{10x5}$$

$$E = 217,72 lux$$

Using equation 2, the power efficiency η become :

$$\eta = \frac{217,72}{80}$$

$$\eta = 2,72 watt / m^2$$

C. Calculation of room lighting measurement

The calculation of room lighting intensity (E) uses mean of everyday illumination from June 1 to June 4 2014 as listed below

$$E = \frac{\textit{mean} \text{ of everyday illumination (lux)}}{\text{number of days}}$$

$$E = \frac{230,16 + 217,16 + 219,16 + 221,67}{4}$$

$$E = 222,03 \text{ lux}$$

Using the equation 2, the power efficiency (η) will be :

$$\eta = \frac{222,03}{80}$$

$$\eta = 2,75 \text{ watt/m}^2$$

Based on this calculation it is found that the lighting intensity in a room and the result of lighting measurement is a little bit different. This might be affected by the daylight of the sun entering the simulation room

D. Optimization Result

For optimization, simulation needs data as follows :
Type of lamps : TL or fluorescent,
Lamp power : 40 watt
Type of room : laboratory
Room length : 10 meters
Room width : 5 meters
Room heights : 4 meter
Also parameters for genetics algorithms:
Number of generations : 150
Crossover probability : 0.8
Mutation probability : 0.1

Based on above parameter, we gain the result as shown in Fig. 6

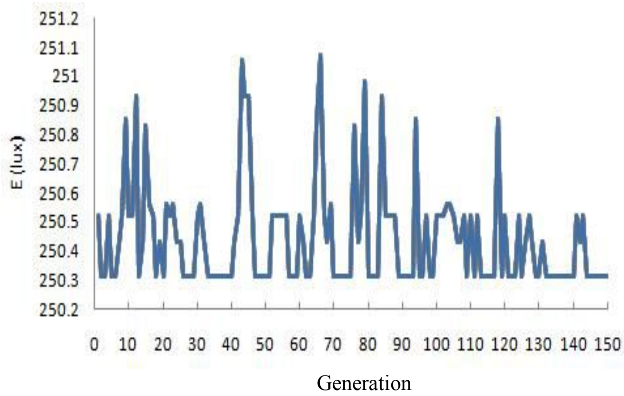

Fig 6. Optimization result

Optimization simulation using parameters of genetics algorithm is obtained from the comparison of fitness among experiment taken at 50th generation as shown in table 6.

TABLE 6
FITNESS COMPARISON AMONG EXPERIMENT

experiment	Generation	Crossover probability	Mutation probability	Fitness sample. 1	Fitness sample 2
1	50	0,8	0,1	250,312533	250,312533
2	50	0,8	0,02	250,56	250,312533
3	50	0,8	0,001	250,5216	250,5216
4	50	0,5	0,1	250,312533	250,5216
5	50	0,5	0,001	250,432	250,312533
6	50	1	0	250,8288	250,432
7	50	1	0,02	250,312533	250,5216
8	50	0,8	0,02	250,312533	250,312533
9	50	0,8	0,02	250,312533	250,56
10	50	0,8	0,02	250,5216	250,312533

Table 6 shows that in two times experiment with the same genetics algorithm parameter is not granted that the experiment provide the same results. The fitness value obtained at 9th and 10th experiment is different even the crossover and mutation probability are the same. This is because genetics algorithms apply random system in each process of optimization.

E. Power Efficiency of Artificial Lighting(Lamp) Performance

Evaluation of power efficiency in a room based on parameter as follows :
Lamp Power : 40 watt
Room length : 10 meters
Room width : 5 meters
Room heights : 4 meter
Also parameters for genetics algorithms:
Number of individual : 50
Number of generations : 150
Crossover probability : 0.8
Mutation probability : 0.02

Fig.6 shows the results that by using 4 type of lamp which is tube lamp (TL), fluorescent lamp, neon lamp, and halogen lamp for individual result in each generations up to the 150^{th} generations.

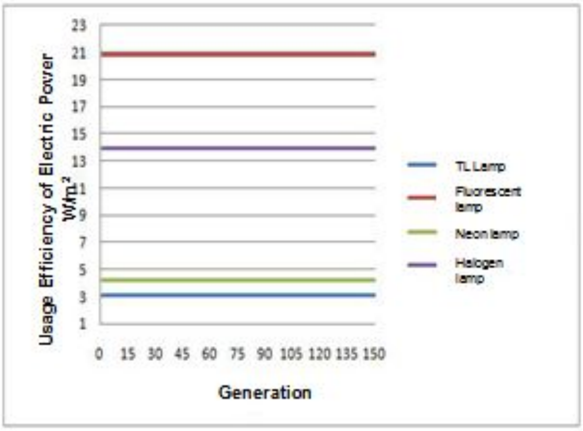

FIG 7. RELATION OF GENERATION AND LAMP POWER EFFICIENCY

Table 7 shows that the most efficient power of artificial lighting in a laboratory room can be obtained from a TL lamp or fluorescence lamp with 40 watt of power. Using fluorescent lamp, neon lamp, and halogen lamp with the same power of 40 watt needs more lamp and the power efficiency is lower that TL lamp which is assume not efficient compare to TL lamp.

TABLE 7
POWER EFFICIENCY OF EACH LAMP

Lamp Type	Room Type	Number of Lamp	Power efficiency (watt/m²)
TL (Flourense)	Lab	16	3,1289
Fluorescent	Lab	158	20,8344
Neon Kompak	Lab	37	4,1681
Halogen	Lab	131	13,8894

For a room with 12 TL lamps consist of 222,03 lux lighting intensity and 2,75watt/m2 of power efficiency While for power efficiency simulation as shown in Table 7 using 16 TL lamp, it is obtained 250,3 lux of lighting intensity and 3,1289 watt/m2 of power efficiency. The simulation result shows that to match the standard for a room lighting according to SNI BSN-2000, the laboratory in this simulation must add 4 TL lamp.

V. CONCLUSION

1)The calculation of room with technical data obtained results of 217,72 lux of lighting intensity while calculation from the measurement show that lighting intensity (E) is about 222,03 lux. The mismatch result of two calculation consider to be the effect of the sunshine entering the room when the measurements were done.
2)The optimization evaluation using genetics algorithms shows that the bigger number of generations affects the possibility to obtained a better solution more quick.
3). The crossover probability between 0.7-0.9 raise the possibility to obtained better solution from generations.
4) Probability value which is too small or too big decrease the variety solutions which blocks process to find the best solution.

ACKNOWLEDGMENT

Author would like to thank LPPM Atma Jaya University Makassar for supporting this research.

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 ISBN : 978-1-4673-7404-0

The Application of Fuzzy-Neuro Approach for ERP System Selection: Case Study on an Agro-industrial Enterprise

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***Abstract*— Enterprise Resource Planning (ERP) adoption emphasizes business transformation that leads to change business processes in an effort to maximize profits and competitive advantage of the enterprise. Many companies were unsuccessful in implementing ERP system. Selection failure affected implementation failure. ERP system selection that misfit and ineffectively caused a major failure of ERP system adoption which is a critical investment, risky and expensive. ERP selection is a complex decision-making process and must be conducted carefully because of the important impacts. Many researchers have studied related to the approach used, but still little was associated with complex and standardized criteria. Most studies were to simplify the complex criteria, which often will eliminate the meaning of the standardized criteria. This study discusses the hybrid approach of Fuzzy - Neural Network (Fuzzy-Neuro) for the ERP selection with numerous and complex criteria. The criterions used were the characteristics and sub-characteristics that compatible with ISO25010, vendors and consultants, fit strategy, change management and cost. A case study was simulated in the agro industrial company that has some special characteristics. The results confirm the Fuzzy-Neuro approach can be used optimally even for ERP selection with many, complex and tiered standardized criteria.**

Key words : Agro-industry, ERP Selection, Fuzzy-Neuro, ISO25010

Manuscript received May 8, 2015.

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I. Introduction

A. Background

ERP is an information system (IS) and integrated business applications or computer packages of application system that serves to integrate the enterprises business processes, starting from budget planning, marketing, sales, production planning, purchasing, production execution and monitoring of production, raw material and product that store in warehouses, scheduling and delivery, payment processing to the vendor, customer billing, accounting and controlling functions, human resources functions, as well as other functions within a company. ERP is a software package of best practice, centralization of data, real time transactions [41] and E-business enabled [9].

Adoption of ERP systems within the enterprise can provide both business and technical benefits. Strategic business, best practice and unique business process built in ERP system will become the foundation of the company competitiveness and operation excellence, as evidenced by the many previous studies.

Rayner and Woods [42] defines ERP systems as a strategy of enterprise: "*Technology strategy that integrates a set of business functions, such as finance, HR and purchasing, with operational aspects, such as manufacturing or distribution, through tight linkages from operational business transactions to financial records".* Aberdeen [1] considers ERP as part of the most important aset on enterprise: *"ERP software could be considered the brain of on organization, it tracks necessary information used to make decisions and should be the epicenter that guides and enables business processes, it is a vital component of a successful organization and needs to be treated as such"*.

ERP has life cycle consists of several stages: pre-implementation, implementation and post-implementation. ERP selection is the initial step on ERP adoption life cycle and as the one of the critical processes in the pre-implementation stage.

ISBN : 978-1-4673-7404-0

Based on the KPMG survey in 1997, ERP project failure reached 61%, and in 2008 decreased to 51% [28], [19]. Panorama [39] in 2013 reported that 40% of ERP projects still unsuccessful. One of the causes of failure was improper package selection [19], the failure of the selection affected the implementation failure [20], [40]. Initial scope of the project implementation and budget accounted for 32.4% was over delay and 16.7% was over budget [38].

ERP selection is a complex decision-making process [31] about the ERP system itself, vendors and consultants, adoption of best practices, customization of company's unique practices, fitting with corporate strategy and should involve employees from the beginning [2]. Selection systems that did not fit [49] and ineffective [27] could be the main cause of failure of ERP system that is a critical investment, risky, expensive [7], [15] and affect enterprise performance and profit [32] and a competitive advantage in the future [6]. ERP selection is the activity associated with the processes, methods and tools that are used to decide the ERP implementation vendors and consultants, that chosen from a wide range of available solutions. ERP selection should be carried with carefully because the significant impact on the medium and long term and related in helping companies to build competitive advantage [48]. ERP selection is the first and an important step [4], [6], [33], towards the successful implementation [37] to understand the critical factors [13]. However, many companies take this important decision did not based on the proven selection method, whereas the selected ERP system contributed significantly to the success or failure of the ERP implementation [8], [52], the selection criteria are also very important in the success of ERP adoption [23], [47].

B. *Previous Research*

Quantitative approaches are widely used in the ERP selection methods, including traditional investment analysis approach such as NPV, ROI, payback, and other [18], real options [46], as well as approaches that use basic programming theory and MCDM. Approach and the use of modern tools in computing-based intelligent system increases its use along with the development tools themselves as well the development of computational science, statistics and science system in conjunction with the development of computer and information technology. Processes with complex iteration can now be executed by a computer in a short time. The study of literature shows that AHP and Fuzzy most popular and widely used, including the hybrid of both results. Fisher *et al*. [17] used DEA approach to determine the scoring of factors or selection criteria. Wei *et al*. [51] applied AHP to determine the influence of criteria and the final score of the ERP vendor selection. Shyur [44] and Ayag [5] used the ANP to cover the weaknesses of AHP, making structures of criteria more flexible and getting feedback. Wei and Wang [50] applied fuzzy logic, Asgari *et al*. [3] used the triangular fuzzy. Lien and Chan [29], Onut and Efendigil [34] applied the hybrid of fuzzy-AHP, Ayağ and Özdemir [5] used fuzzy-ANP, Cebeci [10] applied the BSC-DSS criteria, Karsak and Ozogul [24] and Yazgan *et al*. [53] used a combination of ANP and ANN, where the ANP was used to determine the weight of each criterion and ANN was used to optimally process by following the principles of neural networks to transform inputs into the final score. Ozalp *et al*. [36] used three approaches at the same time to select ERP consultants i.e. AHP, FAHP and ANP, which confirmed the same result rankings. Fuzzy-Goal Programming was also used in the selection for the process optimization [14]. PCA was applied to simplify the criteria [35] and DEMATEL was used to search for causal relationships between criteria [16], [22]. While Tazyen [45], used system dinamics in ERP selection. Approach to decision analysis can be used for complex problems, multiple criteria and full of uncertainty [30].

This study used a hybrid approach between triangular fuzzy and neural network that is Fuzzy-Neuro for the many and complex ERP selection criteria. Simplification of the criteria is not suggested to preserve the characteristics and sub-characteristics of ISO25010 international quality software standards [21] and other criteria that have been developed based on the literature review, experience and competence in the world of ERP and the criteria have been validated by experts in the ERP system [41]. This approach is proposed as an alternative solution based on computing and intelligent systems without simplifying the existing standard criteria to avoid loss of meaning of the selection criteria, as if we use PCA, and to overcome many and tiered criteria, that will be very complicated if using pairwise comparation method on AHP/ANN group technique.

II. FUZZY-NEURO APPROACH

A. *Fuzzy Theory*

The usefulness of fuzzy set theory is to quantify the vagueness concept in human thought. The formation process of fuzzy membership function there are a number of ways such as through intuition, inference, ratings, neural networks, genetic algorithms and induction [43].

One form of fuzzy functions most widely used is triangular fuzzy. Triangular fuzzy widely used because it is easy in the calculation and can assist

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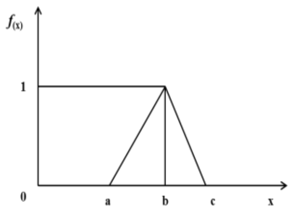
decision-making [3]. Triangular fuzzy membership function follows the function in Figure 1.



$$f(x) = \begin{cases} \dfrac{x-a}{b-a} & a \le x \le b \\ \dfrac{c-x}{c-b} & b \le x \le c \\ 0 & lainnya \end{cases}$$

Figure 1. Membership function of triangular fuzzy.

Cochran and Chen [12] have used the generic membership functions that are useful for weighting and values. Asgari *et al.* [3] utilized the membership function with different weights and values, that has been widely used in various fields of research and are very popular among users [25]. Linguistic terms were used in this study include the weight and value (score) with symbols and membership function as shown in Figure 2. [3], [12], [25].

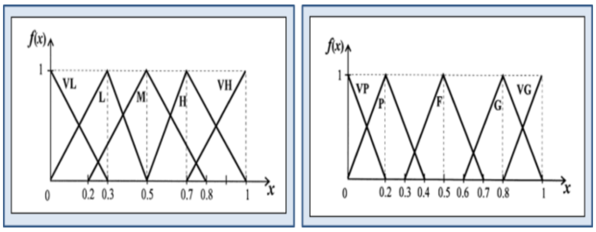


Figure 2. Fuzzy number for weight and score

B. *Fuzzy - Neuro*

The basic idea of fuzzy-neuro hybrid is to use the results of fuzzy as weights to optimize the neural network output (Figure 3).

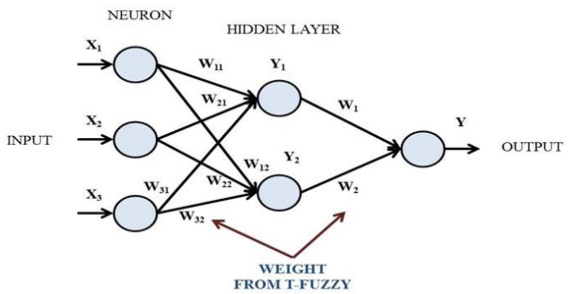


Figure 3. Analytical framework of Fuzzy-Neuro, modified from AHP-NN framework [26].

Output of fuzzy will be calculated to be defuzzy number using Center of Gravity (CoG) technique, due to the popularity and easy to use [12]. Then the weights and scores can be calculated, and used in the neural network to generate vendor-consultants final value. The detail flow can be seen in Figure 4.

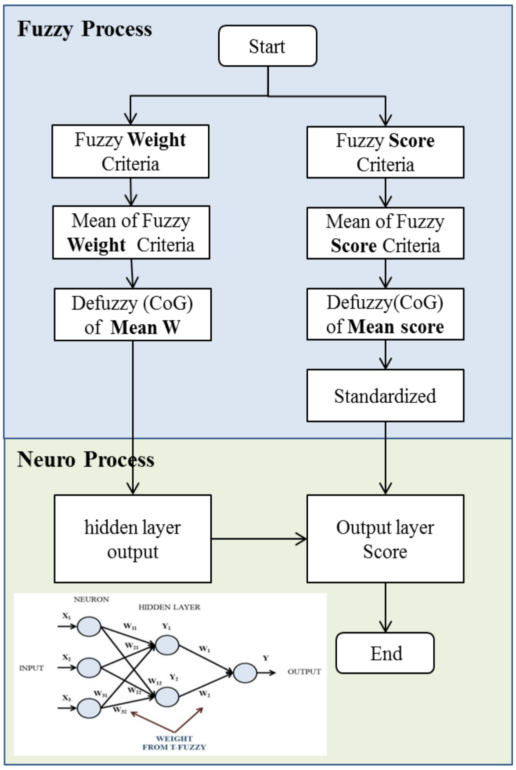


Figure 4. Fuzzy-Neuro process

III. Simulation of Fuzzy-Neuro Approach

The simulation was performed on one of the national agro-industry in the food bakery. The company has approximately 9 factories spread both in Java and outside Java. The business process of the company has a high complexity both in the manufacturing and distribution and has very unique product characteristics which have a life cycle product of 4 days only. The need for an ERP system is very urgent to be enabling the company to grow rapidly, competing with other world-class companies. Vendor-consultant who entered the contest in the ERP selection, there is 8 vendor-consultants who has been known the competency and experience in the ERP field and food industries.

IV. Scoring Process Calculation with Fuzzy-Neuro

Fuzzy-Neuro architecture in this simulation is shown in Figure 5. A total of 8 Vendor-consultants in this contest will be selected by the 5-tiered selection with 3 level criteria used.

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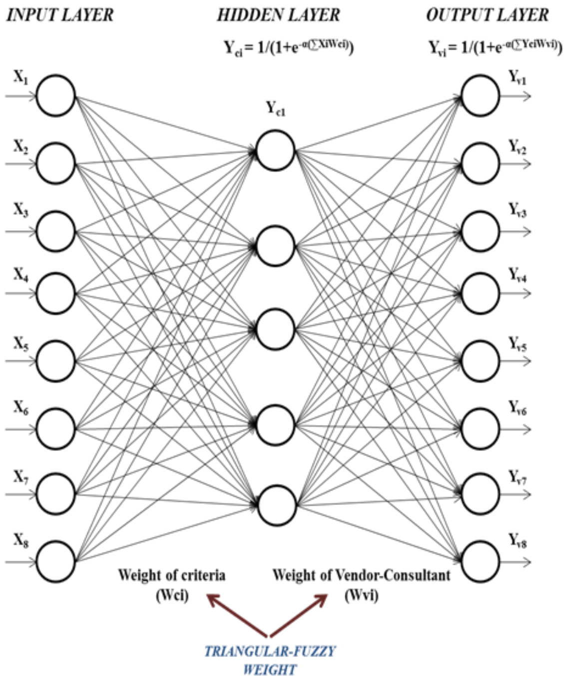

Figure 5. Fuzzy-Neuro architecture in simulation

Notation notes:
X_i : Input value for vendor-consultant i
Y_{ci} : Output of hidden layer for i group criteria
Y_{vi} : Final score (output layer) for vendor-consultant i.

V. Discussion and Results

Top management is the key factor of ERP adoption and available as a resource to provide an assessment to simulate the ERP vendor-consultant selection. The composition of the vendor-consultant is three consulting companies with SAP vendor, one each consulting company Oracle vendor and Microsoft Axapta vendor and the other three consulting companies with other ERP vendor. All vendor-consultants were given the opportunity to conduct scoping together to deepen understanding on existing and to be business processes in the food bakery company, understanding the goals, vision and mission in future and exercising the potential solution for improvement and development related to the ERP adoption. The expected result of this process was vendor-consultant could understand the needs of the future, the scope of the function/department and branches/location, as well as the problems facing companies today and are going to look for solutions. On the other side vendor-consultants also should sell theirself with competency and experienced consultants and solutions, as well as they have proven methodology and accelerated implementation tools that they already developed to facilitate the ERP implementation and how the vendor-consultants also have the concept of change management in ERP adoption. Vendor-consultants were also required to explore the need for the necessary supporting infrastructure such as servers and network specifications required related transaction data volume, distribution and location, approximate data growth in future by using the new ERP system. Vendor-consulting firms were also expected to have an industrial solution / special programs in the food industry, manufacturing and distribution area that were developed on the vendor platform and become the basis of the bakery food development. Results of scoping would be the basis of vendor-consultant provided solutions and presented in outline to the ERP adoption team and top management. Related team then could provide assessments according to the given guidance. Results can be seen in Table 1. Percentage of weight was resulted from preliminary research.

Table 1. Data of assesment result for Fuzzy-Neuro

ERP Vendor and Consultant Selection Criteria	Weight	VK1	VK2	VK3	VK4	VK5	VK6	VK7	VK8
Product Quality Software (ISO25010)									
Functional suitability	13,18%								
Appropriateness	33,54%	G	F	P	P	F	F	P	P
Completeness	32,28%	VG	G	F	F	F	P	P	P
Correctness	34,18%	G	G	G	F	G	P	F	P
Performance Efficiency	12,38%	VG	G	G	F	G	F	F	F
Compatibility	11,38%	VG	G	F	G	G	P	F	P
Usability	12,61%	G	G	F	F	G	F	F	P
Reliability	13,09%	G	F	G	F	G	P	P	P
Security	13,42%	G	G	G	F	G	P	P	P
Portability	11,90%	G	G	F	G	F	F	F	P
Maintainability	12,04%	VG	G	G	G	F	P	P	F
Vendor & Consultant									
Competency	20,65%	VG	G	F	F	F	F	P	P
Methodology	21,41%	VG	F	F	F	G	F	F	P
Profile	18,60%	G	G	F	F	G	F	F	F
Accelarated tools	19,21%	VG	G	F	G	G	P	P	P
Project Management	20,12%	G	G	G	G	G	F	P	F
Fit Strategy									
Best Product	35,25%								
Low Cost	49,66%	VG	VG	F	G	G	F	F	F
Differentiation	50,34%	VG	G	G	G	VG	F	F	F
Total Customer Solution	33,94%								
Customer Integration	34,19%	VG	G	G	F	G	G	F	F
Redefine customer relationship	33,43%	VG	F	F	F	G	F	P	F
Horizontal breadth	32,38%	G	G	F	G	F	F	F	F
System Lock in	30,81%								
Restricted Access	36,42%	G	G	F	F	G	P	F	P
Dominant Exchange	31,38%	G	G	F	F	F	F	P	F
Proprietary standard	32,20%	G	G	F	F	G	P	P	P
Change Management									
Communication strategy & planning	19,66%	VG	F	F	F	G	G	F	F
Impact mapping & transition plan	20,46%	G	F	F	G	G	F	P	P
Perform transition plan	20,22%	G	F	F	F	F	F	F	P
User Acceptance	20,62%	G	G	G	F	G	P	F	F
User Training & Budget	19,02%	G	G	G	G	F	F	F	F
Cost or Economic Value	15,38%								
Total Cost	55,22%	G	F	P	G	VP	F	G	G
Financing	44,78%	G	G	P	G	P	G	G	VG

Notes: *VK1-VK8*:Vendor-consultant 1-8, *VG*:Very Good, *G*:Good, *F*:Fair, *P*:Poor, *VP*:Very Poor.

This assessment technique looks better and simpler when compared to pairwise comparison method in a tiered structure criteria. Results of the assessment were then processed into triangular fuzzy numbers. In this context it would seem more complicated calculations, due to incorporate fuzzyness, but it can be simplified by providing templates and formulas in Microsoft Excel. Most detailed calculation can be seen in Table 2 for calculation of the vendor-consultants 1 to 3, and Table 3 for vendor-consultants 4 to 6 and Table 4 for vendor-consultants 7-8. The data processing is starting from level 3 hierarchies. Each value multiplied by the weights, then summed into level 2. For example, the values of criteria:

ISBN : 978-1-4673-7404-0

appropriateness, completeness, correctness (level 3) multiplied by their respective weights and summed so that become a value of functional suitability criteria (level 2). Furthermore, the criteria in level 2, each criterion multiplied by each weight and summed to level 1 criterion for the fifth group of criteria i.e. criteria for product quality ERP software (*KSPE*), vendors-consultants (*VEKO*), fit-strategy (*FITS*), change management (*MAPE*) and Cost (*COST*). This value is then calculated into a krispy value, as a result of defuzzy number process based on center of gravity (CoG) method.

Table 2. Data calculation for *VK1-VK3*

ERP Vendor & Consultant Selection Criteria	Weight	VK1	Fuzzy a	b	c	VK2	Fuzzy a	b	c	VK3	Fuzzy a	b	c
Quality Software (ISO25010)-KPSE	17,80%	0,8534	0,6801	0,8801	1,0000	0,7475	0,5475	0,7475	0,9475	0,6530	0,4530	0,6530	0,8530
Functional suitability	13,18%		0,6646	0,8646	1,0000		0,4994	0,6994	0,8994		0,3019	0,5019	0,7019
Appropriateness	33,54%	G	0,6	0,8	1	F	0,3	0,5	0,7	P	0	0,2	0,4
Completeness	32,28%	VG	0,8	1	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Correctness	34,18%	G	0,6	0,8	1	G	0,6	0,8	1	G	0,6	0,8	1
Performance Efficiency	12,38%	VG	0,8	1	1	G	0,6	0,8	1	G	0,6	0,8	1
Compatibility	11,38%	VG	0,8	1	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Usability	12,61%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Reliability	13,09%	G	0,6	0,8	1	F	0,3	0,5	0,7	G	0,6	0,8	1
Security	13,42%	G	0,6	0,8	1	G	0,6	0,8	1	G	0,6	0,8	1
Portability	11,90%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Maintainability	12,04%	VG	0,8	1	1	G	0,6	0,8	1	G	0,6	0,8	1
Vendor & Consultant-VEKO	17,18%	0,8816	0,7225	0,9225	0,9999	0,7357	0,5357	0,7357	0,9357	0,5603	0,3603	0,5603	0,7603
Competency	20,65%	VG	0,8	1	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Methodology	21,41%	VG	0,8	1	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Profile	18,60%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Accelarated tools	19,21%	VG	0,8	1	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Project Management	20,12%	G	0,6	0,8	1	G	0,6	0,8	1	G	0,6	0,8	1
Fit Strategy-FITS	17,06%	0,8776	0,7164	0,9164	1,0000	0,7893	0,6010	0,8010	0,9660	0,5880	0,3880	0,5880	0,7880
Best Product	35,25%		0,8000	1,0000	1,0000		0,6993	0,8993	1,0000		0,4510	0,6510	0,8510
Low Cost	49,66%	VG	0,8	1	1	VG	0,8	1	1	F	0,3	0,5	0,7
Differentiation	50,34%	VG	0,8	1	1	G	0,6	0,8	1	G	0,6	0,8	1
Total Customer Solution	33,94%		0,7352	0,9352	1		0,4997	0,6997	0,8997		0,4026	0,6026	0,8026
Customer Integration	34,19%	VG	0,8	1	1	G	0,6	0,8	1	G	0,6	0,8	1
Redefine customer relationship	33,43%	VG	0,8	1	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Horizontal breadth	32,38%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
System Lock in	30,81%		0,6	0,8	1		0,6	0,8	1		0,3	0,5	0,7
Restricted Access	36,42%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Dominant Exchange	31,38%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Proprietary standard	32,20%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Change Management-MAPE	16,75%	0,8261	0,6392	0,8392	0,9998	0,6188	0,4189	0,6188	0,8188	0,6188	0,4189	0,6188	0,8188
Communication strategy & planning	19,66%	VG	0,8	1	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Impact mapping & transition plan	20,46%	G	0,6	0,8	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Perform transition plan	20,22%	G	0,6	0,8	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
User Acceptance	20,62%	G	0,6	0,8	1	G	0,6	0,8	1	G	0,6	0,8	1
User Training & Budget	19,02%	G	0,6	0,8	1	G	0,6	0,8	1	G	0,6	0,8	1
Cost	15,38%	0,8000	0,6	0,8	1	0,6343	0,4343	0,6343	0,8343	0,2000	0	0,2	0,4
Total Cost	55,22%	G	0,6	0,8	1	F	0,3	0,5	0,7	P	0	0,2	0,4
Financing	44,78%	G	0,6	0,8	1	G	0,6	0,8	1	P	0	0,2	0,4

Table 3. Data calculation for *VK4-VK6*

ERP Vendor & Consultant Selection Criteria	Weight	VK4	Fuzzy a	b	c	VK5	Fuzzy a	b	c	VK6	Fuzzy a	b	c
Quality Software (ISO25010)-KPSE	17,80%	0,5927	0,3927	0,5927	0,7927	0,7022	0,5022	0,7022	0,9022	0,3239	0,1239	0,3239	0,5239
Functional suitability	13,18%		0,1994	0,3994	0,5994		0,4025	0,6025	0,8025		0,1006	0,3006	0,5006
Appropriateness	33,54%	P	0	0,2	0,4	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Completeness	32,28%	F	0,3	0,5	0,7	F	0,3	0,5	0,7	P	0	0,2	0,4
Correctness	34,18%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
Performance Efficiency	12,38%	F	0,3	0,5	0,7	G	0,6	0,8	1	F	0,3	0,5	0,7
Compatibility	11,38%	G	0,6	0,8	1	G	0,6	0,8	1	P	0	0,2	0,4
Usability	12,61%	F	0,3	0,5	0,7	G	0,6	0,8	1	F	0,3	0,5	0,7
Reliability	13,09%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
Security	13,42%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
Portability	11,90%	G	0,6	0,8	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Maintainability	12,04%	G	0,6	0,8	1	F	0,3	0,5	0,7	P	0	0,2	0,4
Vendor & Consultant-VEKO	17,18%	0,6179	0,4180	0,6179	0,8179	0,7380	0,5380	0,7380	0,9380	0,4423	0,2423	0,4423	0,6423
Competency	20,65%	F	0,3	0,5	0,7	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Methodology	21,41%	F	0,3	0,5	0,7	G	0,6	0,8	1	F	0,3	0,5	0,7
Profile	18,60%	F	0,3	0,5	0,7	G	0,6	0,8	1	F	0,3	0,5	0,7
Accelarated tools	19,21%	G	0,6	0,8	1	G	0,6	0,8	1	P	0	0,2	0,4
Project Management	20,12%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Fit Strategy-FITS	17,06%	0,6387	0,4387	0,6387	0,8387	0,7617	0,5735	0,7735	0,9380	0,4714	0,2714	0,4714	0,6714
Best Product	35,25%		0,6000	0,8000	1,0000		0,7007	0,9007	1,0000		0,3000	0,5000	0,7000
Low Cost	49,66%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Differentiation	50,34%	G	0,6	0,8	1	VG	0,8	1	1	F	0,3	0,5	0,7
Total Customer Solution	33,94%		0,3971	0,5971	0,7971		0,5029	0,7029	0,9029		0,4026	0,6026	0,8026
Customer Integration	34,19%	F	0,3	0,5	0,7	G	0,6	0,8	1	G	0,6	0,8	1
Redefine customer relationship	33,43%	F	0,3	0,5	0,7	G	0,6	0,8	1	F	0,3	0,5	0,7
Horizontal breadth	32,38%	G	0,6	0,8	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
System Lock in	30,81%		0,3	0,5	0,7		0,5059	0,7059	0,9059		0,0941	0,2941	0,4941
Restricted Access	36,42%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
Dominant Exchange	31,38%	F	0,3	0,5	0,7	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Proprietary standard	32,20%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
Change Management-MAPE	16,75%	0,6183	0,4184	0,6183	0,8183	0,6821	0,4822	0,6821	0,8821	0,4970	0,2971	0,4970	0,6970
Communication strategy & planning	19,66%	F	0,3	0,5	0,7	G	0,6	0,8	1	G	0,6	0,8	1
Impact mapping & transition plan	20,46%	G	0,6	0,8	1	G	0,6	0,8	1	F	0,3	0,5	0,7
Perform transition plan	20,22%	F	0,3	0,5	0,7	F	0,3	0,5	0,7	F	0,3	0,5	0,7
User Acceptance	20,62%	F	0,3	0,5	0,7	G	0,6	0,8	1	P	0	0,2	0,4
User Training & Budget	19,02%	G	0,6	0,8	1	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Cost	15,38%	0,8000	0,6	0,8	1	0,1264	0	0,0896	0,2896	0,6343	0,4343	0,6343	0,8343
Total Cost	55,22%	G	0,6	0,8	1	VP	0	0	0,2	F	0,3	0,5	0,7
Financing	44,78%	G	0,6	0,8	1	P	0	0,2	0,4	G	0,6	0,8	1

Table 4. Data Calculation for *VK7-VK8*

ERP Vendor & Consultant Selection Criteria	Weight	VK7	Fuzzy a	b	c	VK8	Fuzzy a	b	c
Quality Software (ISO25010)-KPSE	17,80%	0,3583	0,1583	0,3583	0,5583	0,2733	0,0733	0,2733	0,4733
Functional suitability	13,18%		0,1025	0,3025	0,5025		0,0000	0,2000	0,4000
Appropriateness	33,54%	P	0	0,2	0,4	P	0	0,2	0,4
Completeness	32,28%	P	0	0,2	0,4	P	0	0,2	0,4
Correctness	34,18%	F	0,3	0,5	0,7	P	0	0,2	0,4
Performance Efficiency	12,38%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Compatibility	11,38%	F	0,3	0,5	0,7	P	0	0,2	0,4
Usability	12,61%	F	0,3	0,5	0,7	P	0	0,2	0,4
Reliability	13,09%	P	0	0,2	0,4	P	0	0,2	0,4
Security	13,42%	P	0	0,2	0,4	P	0	0,2	0,4
Portability	11,90%	F	0,3	0,5	0,7	P	0	0,2	0,4
Maintainability	12,04%	P	0	0,2	0,4	F	0,3	0,5	0,7
Vendor & Consultant-VEKO	17,18%	0,3200	0,1200	0,3200	0,5200	0,3161	0,1162	0,3161	0,5161
Competency	20,65%	P	0	0,2	0,4	P	0	0,2	0,4
Methodology	21,41%	F	0,3	0,5	0,7	P	0	0,2	0,4
Profile	18,60%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Accelarated tools	19,21%	P	0	0,2	0,4	P	0	0,2	0,4
Project Management	20,12%	P	0	0,2	0,4	F	0,3	0,5	0,7
Fit Strategy-FITS	17,06%	0,4072	0,2072	0,4072	0,6072	0,4366	0,2366	0,4366	0,6366
Best Product	35,25%		0,3000	0,5000	0,7000		0,3000	0,5000	0,7000
Low Cost	49,66%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Differentiation	50,34%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Total Customer Solution	33,94%		0,1997	0,3997	0,5997		0,3	0,5	0,7
Customer Integration	34,19%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Redefine customer relationship	33,43%	P	0	0,2	0,4	F	0,3	0,5	0,7
Horizontal breadth	32,38%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
System Lock in	30,81%		0,1093	0,3093	0,5093		0,0941	0,2941	0,4941
Restricted Access	36,42%	F	0,3	0,5	0,7	P	0	0,2	0,4
Dominant Exchange	31,38%	P	0	0,2	0,4	F	0,3	0,5	0,7
Proprietary standard	32,20%	P	0	0,2	0,4	P	0	0,2	0,4
Change Management-MAPE	16,75%	0,4385	0,2386	0,4385	0,6385	0,3779	0,1779	0,3779	0,5778
Communication strategy & planning	19,66%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Impact mapping & transition plan	20,46%	P	0	0,2	0,4	P	0	0,2	0,4
Perform transition plan	20,22%	F	0,3	0,5	0,7	P	0	0,2	0,4
User Acceptance	20,62%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
User Training & Budget	19,02%	F	0,3	0,5	0,7	F	0,3	0,5	0,7
Cost	15,38%	0,8000	0,6	0,8	1	0,8597	0,6896	0,8896	1
Total Cost	55,22%	G	0,6	0,8	1	G	0,6	0,8	1
Financing	44,78%	G	0,6	0,8	1	VG	0,8	1	1

The weight of the hidden layer using standard industry experts for consumer product goods (CPG) from previous preliminary study. *KPSE* = 17.8%; *VEKO* = 17.18% then *FITS* = 17.06%, *MAPE* = 16.75% and *COST* = 15.38 %. The input *Xi* is calculated by 1 / *n* = 1/8 = 0.125, n is the number of vendor-consultants, can be seen in Table 5. It will use two weights; they are weight of selection criteria and weight of score for each vendor-consultant that will determine the value of the final outcome of the process in both the neural network for input layer and the output layer. The process of neural network is actually a transformation process value by weighting the results of the fuzzy process using a sigmoid function. The techniques used in this neural network is a type of unsupervised learning. This method is easier when compared to the ranking techniques developed by Chen [11], as a further step the rating results from fuzzy calculation.

Furthermore, by taking the input value to bias neuron = 1 and a weight of bias neuron = 0.2 then $\Sigma XiWci$ can be calculated. The results are presented in Table 5. By taking the value of α = 1, the output value of the hidden layer $Yci = 1 / (1 + e^{-\alpha(\sum XiWci)})$ can be calculated. *Yci* will be inputted in the process along with the output layer and the weights of *Wv*.

ISBN : 978-1-4673-7404-0

Table 5. Weight for input dan the hidden layer output

Criteria	Persentage	Weight	Input (Xi)	∑XiWci	Yci
KPSE	17,80%	0,2115	0,125	0,4115	0,6014
VEKO	17,18%	0,2041	0,125	0,4041	0,5997
FITS	17,06%	0,2027	0,125	0,4027	0,5993
MAPE	16,75%	0,1990	0,125	0,3990	0,5984
COST	15,38%	0,1827	0,125	0,3827	0,5945

Results of calculation for the eight vendors and consultants in each of the criteria can be seen in Table 6. These values will be the weight (*Wv*) as the input to the output layer. It needs to be normalized so that the amount of weight to eight vendors and consultants alike with one. *Wv* value is used to calculate the weight of the output layer which is actually the score of every vendor-consultant on selection criteria.

Table 6. Score (*DfzCoG*) and Weight (*Wv*) for vendor-consultants

DFzCoG	KPSE	VEKO	FITS	MAPE	COST	Wv	KPSE	VEKO	FITS	MAPE	COST
VK1	0,8534	0,8816	0,8776	0,8261	0,6000	VK1	0,1895	0,1912	0,1766	0,1766	0,1510
VK2	0,7475	0,7357	0,7893	0,6188	0,4343	VK2	0,1659	0,1595	0,1588	0,1323	0,1093
VK3	0,6530	0,5603	0,5880	0,6188	0,2000	VK3	0,1450	0,1215	0,1183	0,1323	0,0503
VK4	0,5927	0,6179	0,6387	0,6183	0,8000	VK4	0,1316	0,1340	0,1285	0,1322	0,2014
VK5	0,7022	0,7380	0,7617	0,6821	0,1264	VK5	0,1559	0,1600	0,1532	0,1458	0,0318
VK6	0,3239	0,4423	0,4714	0,4970	0,6343	VK6	0,0719	0,0959	0,0948	0,1063	0,1597
VK7	0,3583	0,3200	0,4072	0,4385	0,8000	VK7	0,0796	0,0694	0,0819	0,0937	0,2014
VK8	0,2733	0,3161	0,4366	0,3779	0,3779	VK8	0,0607	0,0685	0,0878	0,0808	0,0951

Yvi is a final score of vendor-consultants calculated as $Yvi = 1 / (1 + e^{-\alpha(\sum YciWv)})$. The final results (*Yvi*) of the output layer are presented in Table 7.

Table 7. Final score of vendor-konsultan from output layer and rank

VK	KPSE Yc1 = 0,6014	VEKO Yc2 = 0,5997	FITS Yc3 = 0,5993	MAPE Yc4 = 0,5984	COST Yc5 = 0,5945	∑YciWv	Yvi	Rank
VK1	0,1895	0,1912	0,1766	0,1766	0,1510	0,7299	**0,6748**	**1**
VK2	0,1659	0,1595	0,1588	0,1323	0,1093	0,6348	**0,6536**	**3**
VK3	0,1450	0,1215	0,1183	0,1323	0,0503	0,5401	**0,6318**	**5**
VK4	0,1316	0,1340	0,1285	0,1322	0,2014	0,6353	**0,6537**	**2**
VK5	0,1559	0,1600	0,1532	0,1458	0,0318	0,5877	**0,6428**	**4**
VK6	0,0719	0,0959	0,0948	0,1063	0,1597	0,5161	0,6262	**6**
VK7	0,0796	0,0694	0,0819	0,0937	0,2014	0,5144	0,6258	**7**
VK8	0,0607	0,0685	0,0878	0,0808	0,0951	0,4351	0,6071	**8**

Table 7, it can be seen that the final score vendor-consultant consecutive top five of highest to lowest *VK1* = 0.6748; *VK4* = 0.6537; *VK2* = 0.6536; *VK5* = 0.6428; and *VK3* = 0.6318. The final results of the assessment process and calculation by using the tools of fuzzy-neuro show that *VK1* gets the highest score. The assessment process of fuzzy-neuro approach by related expert person in team is very easy to do although the criteria used are many and tiered. The complexity of the case in the calculation process can be assisted by a program or formula with computer applications such as microsoft excel to produce score of vendor-consultants easily. Finally, fuzzy-neuro approach can be used to choose the right implementor.

VI. CONCLUSION

Fuzzy-neuro approach can be used optimally and easily in the ERP selection as one approach to address the complexity and the large number of standard selection criteria used. Standard and valid criteria have been only referenced to avoid the simplification of the criteria in advance which would eliminate the significance meaning of original standard criteria.

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Potential Applications Modified Nagara Bean Flour through Fermentation for Innovation Analog Rice High Protein

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Abstract

Rice is the staple food for most people of Indonesia and the rate of rice consumption is increasing every year, while the partial fulfillment by import. On the other hand not only a source of carbohydrates from rice, but there are many other materials such as cereals, tubers that have not been utilized optimally. Similarly, the occurrence of a shortage of protein in some communities in Indonesia are still being found. Therefore, the strategy used one of them with food diversification to substitute or replace the rice needs from other carbohydrate sources with the use of rice analog based nagara beans (*Vigna unguiculata* ssp *Cylindrica*). Nagara beans have a high carbohydrate content of about 50-60% and 20-25% protein. Nagara beans contain amino acid dominant aspartic acid 0.913%, glutamic acid 2.182% and histidine 0.826%. Grits size produce flour yield, protein content, water absorption capacity, and the swelling volume greater than others. Fermentation time up to 120 hours tend to lower flour yield and protein content while the water absorption capacity and volume expansion tends to be stable up to 96 hours fermentation periods.

Keywords : nagara bean flour, spontaneous fermentation, protein, water absorption capacity

I. INTRODUCTION

One alternative in achieving national food security is the food diversification. But the culture of Indonesian people who are very strong presumption not eat if not consume rice makes the process of diversification has not run smoothly. Therefore, we need an alternative food that resembles the staple food of Indonesia, namely rice. The food resembling rice is called analog rice.

Analog rice generally processed from cereals or tubers with a dominant carbohydrate content, but on the other hand there are actually several types of legumes that contain carbohydrates dominant one of which is a type of bean which is the country of residence of agricultural products sub-optimal land swampy areas.

Nagara bean (*Vigna unguiculata* ssp. Cylindrica) is one of the local bean which grow in South Kalimantan, especially in Hulu Sungai Selatan area. The largest component in the in the nagara bean is a carbohydrate and implies almost the same as cowpea and green beans which ranges from 62%. On the other hand, nagara bean is also one source of vegetable protein. Protein content ranged from 22.7 to 27% (Noor 1993), the protein is higher than green bean and cowpea.

According Niba (2003) limitations legume characteristics can be improved by fermentation and bioprocessing techniques. The fermentation process was known as one method can be to modify starch structure and physicochemical properties of a material (Chinsamran *et al*. 2005), where the fermentation can affect the solubility, the development of granule, and viscosity of starch (Abia *et al*., 1993; Nche *et al*., 1994; Yadav and Khetarpaul,

1994) the specific characteristics very instrumental on subsequent product processing. Prinyawiwatkul *et al*. (1997) assess the functional properties of bean flour were influenced by soaking, boiling and fermenting fungi, and Yadav and Khetarpaul (1994) on *Phaseoulus* mungo fermentation process at a temperature of 25-30 ºC for 12 and 18 hours was able to increase the digestibility of starch from 57% to more than 88%.

The process of fermentation with submersion is a technique that is easy to modify starch, and on the other hand were able to improve in vitro starch digestibility 17-23% after 12 hours of immersion. With longer soaking treatment is expected to increase digestibility of starch and contribute to the decline antinutrition such as phytic acid and polyphenols which can inhibit the activity of α-amylase (Desphande and Cheryan 1984).

Material that has been fermented legumes are digested significantly faster than the legume is not fermented. This is possible because of the loss of structural integrity of the starch granules, changing the interaction between starch and fiber because inactivation of some antinutrien (such as phytic acid).

Natural fermentation process is simple and is one inexpensive method to reduce and eliminate oligosaccharides. Zamora and Fields (1979) states that fermented cowpea will reduce stachiosa and raffinose, this is caused by the ability of lactic acid bacteria for use oligosaccharides for metabolism. Lactic acid is the dominant role in the process of fermentation include *Lactobacillus casei, Lactobacillus leichmanni*, *Lactobacillus plantarum*, *Pediococcus pentosaceus and Pediococcus acidilactici.*

This study was aimed to assess the modification process nagara bean flour through spontaneous fermentation process to produce flour with optimal characteristics as a raw material rice analog formulations

II. MATERIAL AND METHODS

Materials

Nagara bean take from Hulu Sungai Selatan districts exactly Nagara area, South Kalimantan Indonesia

Methods of Spontaneous Fermentation

Nagara beans soaked with water at a ratio of 1: 4 (w / v). Spontaneous fermentation with some variation wet fermentation periods (24 hours, 48 hours, 72 hours, 96 hours and 120 hours) and form a fermented material that are whole bean (with skin), and grits. The fermented beans are cleaned from the peel, dried at a temperature of 60 ° C for 48 hours, then powdered and sieved to 80 mesh size. Nagara beans tested amino acid composition using HPLC. Flour obtained by testing the moisture content (oven method) protein content (method Kjeldhal) Kamba density, water absorption capacity, swelling volume and solubility.

Bulk Density

Bulk density was measured using a measuring cup. Samples to be measured, weighed as much as 10 g. Then put in a 50 ml measuring cup and readable volume. Kamba density is calculated as the ratio of the sample weight by volume of the sample read on the measuring cup.

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{weight sample (g)}}{\text{volume(cm}^3\text{)}}$$

Water absorption capacity

Centrifuge tube filled with 2 g of flour samples were weighed and the weight of the sample tube (a), then added 9 mL of distilled water and vortex. Furthermore allowed to stand for 30 minutes and then centrifuged at 3000 rpm for 15 minutes, decanted and weighed (b).

Water absorption capacity (% db)

$$\text{Water absorption capacity (\% db)} = \frac{b\text{-}a}{ms} \times \frac{100\%}{(1\text{- }mc)}$$

a = weight of sample + weight sentrifuge tube (g)
b = weight of wet sample + weight sentrifuge tube (g)
ms = weight sample
mc = moisture content

Swelling volume (g/g db)
Swelling volume is determined by weighing as much as 0.35 g of flour are then added water to 12.5 mL centrifuge tube. Furthermore divorteks solution and then heated in a water bath with a temperature of 92.5 ° C and divorteks once every 5 minutes for 10 minutes. Furthermore, the solution was cooled in ice water for 1 minute and at 25 ° C for 15 minutes. Then the solution was centrifuged at a speed of 3600 rpm for 15 minutes. Gel that is formed is measured in volume and is expressed as a swelling volume in unit g / g (db)

$$\text{Water swelling volume (g/g db)} = \frac{w2}{ms\ (1-mc)}$$

w2 = weight of formed gel (g)
ms = weight sample
mc = moisture content

Statistical Analysis
Data analysis of variance (ANOVA) and if the real effect then continued with Duncan test (DMRT) at a rate of error of 5%.

III RESULT AND DISCUSSION

Composition amino acid in nagara bean

Nagara bean is one type of bean with carbohydrate and protein high content. Quality protein in a material can be seen from the composition of amino acids contained therein. The results showed that nagara bean dominant contain amino acids glutamate (2,183%), amino acid composition are presented in Table 1.

Table 1 Amino acid composition in nagara bean

Amino acid	Total (%)
Aspartic acid	0.913
Glutamic acid	2.182
Serin	0.578
Glisin	0.258
Histidin	0.826
Arginin	0.584
Threonin	0.282
Alanin	0.116
Prolin	0.196
Tyrosin	0.218
Valin	0.734
Methionin	0.791
Sistin	0.321
Isoleusin	0.393
Leusin	0.775
Phenilalanin	0.417
Lysin	0.438
Tryptofan	-

Characteristics of nagara bean flour get better can be obtained either by way of a natural modification through a process of spontaneous fermentation. Spontaneous fermentation is fermentation which does not add inoculum or starter from the outside, and the process is very influenced by the length of fermentation is done. During fermentation expected to occur degradation of starch granules that will affect the characteristics of the resulting flour. During fermentation, lactic acid bacteria to grow and produce organic acids especially lactic acid. Subagio (2006) stated that during the fermentation of starch changes in characteristics such as solubility, rehydration value, aroma and color. In this study, the fermentation is done spontaneously by soaking nagara bean in the form of whole beans and grits with a long fermentation time of 24 hours to 120 hours. The test results are presented in Table 2.

Table 2 The characteristics of spontaneous fermented nagara bean flour

Treatments		Parameter						
Size	Fermentation periods (hours)	Yields (%)	Moisture content (%)	Protein (%)	Bulk density (g/cm^3)	Water absorption capasity (% bk)	Swelling volume (% g/g bk)	Solubility (% bk)
Whole grain	24	57.00±7.07	7.59±0.21	22.56±0.97^{ab}	0.46±0.01	142.22±8.16^{a}	461.95±129.61	6.23±0.51^{d}
	48	58.00±14.14	6.77±0.94	22.71±1.86^{ab}	0.50±0.03	177.40±14.84^{b}	474.56±137.08	4.37±1.97^{c}
	72	57.50±3.53	6.83±1.71	24.20±0.63^{b}	0.49±0.02	200.46±11.62^{cd}	518.10±5.82	2.71±0.35^{b}
	96	45.50±7.77	5.94±0.65	23.12±0.99^{ab}	0.50±0.00	204.61±6.19^{cd}	530.76±72.28	1.83±0.01^{ab}
	120	40.00±2.82	5.17±1.05	22.55±0.16^{ab}	0.51±0.01	193.41±5.05^{bcd}	711.06±33.75	1.52±0.16^{ab}
Grits	24	60.50±4.95	6.34±0.22	24.29±2.50^{b}	0.50±0.03	186.54±5.97^{bc}	556.23±80.49	2.95±0.83^{b}
	48	59.50±12.02	6.29±0.27	23.92±0.67^{b}	0.52±0.05	201.12±3.09^{cd}	554.66±115.99	2.14±0.24^{ab}
	72	53.50±2.12	5.97±1.93	21.03±0.87^{a}	0.50±0.01	202.07±3.30^{cd}	541.86±38.33	1.68±0.24^{ab}
	96	51.50±0.70	5.82±0.53	22.20±0.75^{ab}	0.49±0.01	208.76±2.66^{d}	554.06±16.63	1.67±0.06^{ab}
	120	51.50±0.70	5.29±0.007	21.54±0.17^{a}	0.50±0.03	190.29±8.66^{bcd}	693.50±49.74	1.15±0.25^{a}

*numbers followed by the same letter are not significantly different (α 5%)

Yields

In a process, determining the yields are very important as a measure of the performance of processes. In the process of spontaneous fermentation nagara bean, the average yield of 53.45% which produced flour yield of grits size is relatively higher than the size of the whole, and the longer the fermentation yield of flour will decrease. This was caused by the longer the contact time, the process of absorption of water into the matrix of nagara bean increased, so did the performance degradation of lactic acid from lactic acid bacteria in degrading cellulose structure intensified. So this causes the texture of nagara bean increasingly softened, and the washing process will lead to losses. The process of softening the nagara beans larger after fermentation time 72 hours. In whole bean sizes, after the fermentation process, the skin was stripped, after 72 hours of fermentation the beans are tender texture, very soft so that when the washing will be destroyed and a lot of starch dissolved in water. While the grits size, skin already partially separated from the beans so that the emphasis on beans to remove the skin is relatively small, lower structural damage so that loses the resulting smaller.

Moisture Content

Determination of moisture content was aimed to determine the water content in the fermented nagara bean flour. Nagara bean flour moisture content ranging from 4.42 to 8.04% with an average value of 6.20%. Results of analysis of variance showed that the size of bean and periods of fermentation had no significant effect on water content produced nagara bean flour.

On the whole size beans, flour moisture content ranges from 5-7.5% while the grits size ranges from 5-6% water content. The size of bean which are still intact beans are enveloped by the skin so that the rate of diffusion of water into the bean will be slower than bean in the form of grits. Size grits expand the surface area so contact between the beans with water and organic acids degrade performance granular structure will be easier, so that when the water content in the drying process easily evaporated. The longer the fermentation process, the process of degradation of larger granules so that during the drying process, the water content of flour will decrease.

Crude Protein Content

The crude protein content of fermented nagara bean flour is high enough range 21.02 to 24.20%. Bean in general are a source of protein, with the fermentation process through soaking, it will be possible of protein hydrolysis into simpler components namely peptides so that its availability will be higher. The lactic acid produced from lactic bacteria that grow spontaneously will accelerate the process of hydrolysis of proteins.

Results of analysis of variance showed interaction size bean and periods of fermentation significantly affected protein content nagara of modified nagara bean flour. The highest protein content generated on the grits were fermented for 24 hours (24. 29%) and did not differ with whole nuts with a fermentation time of 72 hours (24.20%). On the size of grits is suspected hydrolysis or breakdown of protein by proteolytic enzymes and acids occurs faster than the size of the whole. At grits size decrease faster fermentation medium pH at which the fermentation 24 hours to measure grits able to achieve pH 5, while on the size of the whole 24-hour fermentation was the normal range at pH 6-7. Grits size allows lactic bacteria are able to grow rapidly due to the availability of nutrients from beans country of residence is more easily obtained than in the intact natural nut crusted.

Bulk Density

Bulk density is needed to determine the weight of material per unit volume. In modified nagara bean flour had a softer texture than without spontaneous modification. Bulk density of modified nagara bean flour ranges from 0.46 to 0.52 g /cm^3. Results of analysis of variance showed nagara bean size, fermentation periods and interaction of both not significant effect on the density of the nagara bean flour. With the smaller the bulk density of a material will facilitate the packaging process and transport.

Water Absorption Capasity

Starch granules which are the main components that can be inflated by soaking in cold water. In cold water and the water absorption capacity is limited because of the development of hydrogen bonds between amylose and amylopectin, but when starch is heated, the thermal energy will break the hydrogen bonds so that the surface area for absorption of water become larger and starch granules will absorb more water.

Results of analysis of variance showed that the interaction size nagara bean and fermentation periods significantly affect the water absorption capacity of the nagara bean flour produced. Greater water absorption supposedly due to the fragmentation of the starch and protein during spontaneous fermentation process so that the binding of water becomes greater. Differences in the absorption of water is caused due to differences in surface area, that broken grains and protein content (Sabularse *et al.* 1991). Water absorption capacity tends to increase in fermentation time up to 96 hours, while at fermentation periods of 120 hours tend to lower water absorption. Grits size at 24-hour fermentation had water absorption capacity is greater than the size of the whole, it is presumably because the larger surface area, fragmentation of starches and proteins occur more quickly so that the absorption of water more quickly.

Swelling Volume

Results of analysis of variance (α 5%) showed that the single factor significantly affect of swelling volume of the fermented bean flour. Swelling volume is likely to increase up to 96 hours fermentation periods and fermentation periods of 120 hours, the swelling volume declined slightly. It is positively correlated with water absorption capacity nagara bean flour also decreased in fermentation periods of 120 hours. It is suspected after 96 hours, the degradation of starch granules is large enough, so the structure of the starch that binds water is becoming weaker.

Solubility

The solubility of the modified nagara bean flour ranges from 0.97 - 6.59 % db. Results of analysis of variance showed that the interaction of nagara bean and fermentation periods significant effect on the solubility of flour. On the size of grits solubility in water flour is relatively lower than full size and the longer the fermentation showed the smaller the solubility flour. Swelling of the starch granules above the gelatinization temperature is accompanied by washing polisaccharides soluble. Amount of dissolved amylose is a function of the organization's internal granular starch (Walter *et al*. 2000)

IV CONCLUSION

Treatment of grits size produce flour yield, protein content, water absorption capacity, and the swelling volume greater than others. Fermentation time up to 120 hours tend to lower flour yield and protein content while the water absorption capacity and volume expansion tends to be stable up to 96 hours fermentation periods.

ACKNOWLEDGMENT

We wish to thank Directorate General of Higher Education, Ministry of National Education Indonesia for the research funding through Hibah Pekerti.

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ICAIA 2015 submission 73 update

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Authors : Susi, Lya Agustina and Chondro Wibowo

Based on IEEE review most papers submitted before can not be published at IEEE Xplore due to : (1) Inadequate English Quality, (2) Weak relevance to Engineering and Information Technology disciplines. So, the ICAIA committee is asked to re-evaluate and re-select the papers. The papers passed second selection need to be re-submitted to IEEE. These processes will be very time consuming. So, if you want to withdraw your paper for some reasons, please let me know. Otherwise, your paper will be re-evaluated and re-selected by ICAIA reviewers and if passed IEEE

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Authors : Susi, Lya Agustina and Chondro Wibowo

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Potential Applications Modified Nagara Bean Flour through Fermentation for Innovation Analog Rice High Protein

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Abstract

Rice is the staple food for most people of Indonesia and the rate of rice consumption is increasing every year, while the partial fulfillment by import. On the other hand not only a source of carbohydrates from rice, but there are many other materials such as cereals, tubers that have not been utilized optimally. Similarly, the occurrence of a shortage of protein in some communities in Indonesia are still being found. Therefore, the strategy used one of them with food diversification to substitute or replace the rice needs from other carbohydrate sources with the use of rice analog based nagara beans (*Vigna unguiculata* ssp *Cylindrica*). Nagara beans have a high carbohydrate content of about 50-60% and 20-25% protein. Nagara beans contain amino acid dominant aspartic acid 0.913%, glutamic acid 2.182% and histidine 0.826%. Grits size produce flour yield, protein content, water absorption capacity, and the swelling volume greater than others. Fermentation time up to 120 hours tend to lower flour yield and protein content while the water absorption capacity and volume expansion tends to be stable up to 96 hours fermentation periods.

Keywords : nagara bean flour, spontaneous fermentation, protein, water absorption capacity

I. INTRODUCTION

One alternative in achieving national food security is the food diversification. But the culture of Indonesian people who are very strong presumption not eat if not consume rice makes the process of diversification has not run smoothly. Therefore, we need an alternative food that resembles the staple food of Indonesia, namely rice. The food resembling rice is called analog rice.

Analog rice generally processed from cereals or tubers with a dominant carbohydrate content, but on the other hand there are actually several types of legumes that contain carbohydrates dominant one of which is a type of bean which is the country of residence of agricultural products sub-optimal land swampy areas.

Nagara bean (*Vigna unguiculata* ssp. Cylindrica) is one of the local bean which grow in South Kalimantan, especially in Hulu Sungai Selatan area. The largest component in the in the nagara bean is a carbohydrate and implies almost the same as cowpea and green beans which ranges from 62%. On the other hand, nagara bean is also one source of vegetable protein. Protein content ranged from 22.7 to 27% (Noor 1993), the protein is higher than green bean and cowpea.

According Niba (2003) limitations legume characteristics can be improved by fermentation and bioprocessing techniques. The fermentation process was known as one method can be to modify starch structure and physicochemical properties of a material (Chinsamran *et al*. 2005), where the fermentation can affect the solubility, the development of granule, and viscosity of starch (Abia *et al*., 1993; Nche *et al*., 1994; Yadav and Khetarpaul,

1994) the specific characteristics very instrumental on subsequent product processing. Prinyawiwatkul *et al*. (1997) assess the functional properties of bean flour were influenced by soaking, boiling and fermenting fungi, and Yadav and Khetarpaul (1994) on *Phaseoulus* mungo fermentation process at a temperature of 25-30 ºC for 12 and 18 hours was able to increase the digestibility of starch from 57% to more than 88%.

The process of fermentation with submersion is a technique that is easy to modify starch, and on the other hand were able to improve in vitro starch digestibility 17-23% after 12 hours of immersion. With longer soaking treatment is expected to increase digestibility of starch and contribute to the decline antinutrition such as phytic acid and polyphenols which can inhibit the activity of α-amylase (Desphande and Cheryan 1984).

Material that has been fermented legumes are digested significantly faster than the legume is not fermented. This is possible because of the loss of structural integrity of the starch granules, changing the interaction between starch and fiber because inactivation of some antinutrien (such as phytic acid).

Natural fermentation process is simple and is one inexpensive method to reduce and eliminate oligosaccharides. Zamora and Fields (1979) states that fermented cowpea will reduce stachiosa and raffinose, this is caused by the ability of lactic acid bacteria for use oligosaccharides for metabolism. Lactic acid is the dominant role in the process of fermentation include *Lactobacillus casei, Lactobacillus leichmanni*, *Lactobacillus plantarum*, *Pediococcus pentosaceus and Pediococcus acidilactici.*

This study was aimed to assess the modification process nagara bean flour through spontaneous fermentation process to produce flour with optimal characteristics as a raw material rice analog formulations

II. MATERIAL AND METHODS

Materials

Nagara bean take from Hulu Sungai Selatan districts exactly Nagara area, South Kalimantan Indonesia

Methods of Spontaneous Fermentation

Nagara beans soaked with water at a ratio of 1: 4 (w / v). Spontaneous fermentation with some variation wet fermentation periods (24 hours, 48 hours, 72 hours, 96 hours and 120 hours) and form a fermented material that are whole bean (with skin), and grits. The fermented beans are cleaned from the peel, dried at a temperature of 60 ° C for 48 hours, then powdered and sieved to 80 mesh size. Nagara beans tested amino acid composition using HPLC. Flour obtained by testing the moisture content (oven method) protein content (method Kjeldhal) Kamba density, water absorption capacity, swelling volume and solubility.

Bulk Density

Bulk density was measured using a measuring cup. Samples to be measured, weighed as much as 10 g. Then put in a 50 ml measuring cup and readable volume. Kamba density is calculated as the ratio of the sample weight by volume of the sample read on the measuring cup.

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{weight sample (g)}}{\text{volume(cm}^3\text{)}}$$

Water absorption capacity

Centrifuge tube filled with 2 g of flour samples were weighed and the weight of the sample tube (a), then added 9 mL of distilled water and vortex. Furthermore allowed to stand for 30 minutes and then centrifuged at 3000 rpm for 15 minutes, decanted and weighed (b).

Water absorption capacity (% db)

$$\text{Water absorption capacity (\% db)} = \frac{b-a}{ms} \times \frac{100\%}{(1-mc)}$$

a = weight of sample + weight sentrifuge tube (g)
b = weight of wet sample + weight sentrifuge tube (g)
ms = weight sample
mc = moisture content

Swelling volume (g/g db)
Swelling volume is determined by weighing as much as 0.35 g of flour are then added water to 12.5 mL centrifuge tube. Furthermore divorteks solution and then heated in a water bath with a temperature of 92.5 ° C and divorteks once every 5 minutes for 10 minutes. Furthermore, the solution was cooled in ice water for 1 minute and at 25 ° C for 15 minutes. Then the solution was centrifuged at a speed of 3600 rpm for 15 minutes. Gel that is formed is measured in volume and is expressed as a swelling volume in unit g / g (db)

$$\text{Water swelling volume (g/g db)} = \frac{w2}{ms\ (1\text{-}mc)}$$

w2 = weight of formed gel (g)
ms = weight sample
mc = moisture content

Statistical Analysis
Data analysis of variance (ANOVA) and if the real effect then continued with Duncan test (DMRT) at a rate of error of 5%.

III RESULT AND DISCUSSION

Composition amino acid in nagara bean
Nagara bean is one type of bean with carbohydrate and protein high content. Quality protein in a material can be seen from the composition of amino acids contained therein. The results showed that nagara bean dominant contain amino acids glutamate (2,183%), amino acid composition are presented in Table 1.

Table 1 Amino acid composition in nagara bean

Amino acid	Total (%)
Aspartic acid	0.913
Glutamic acid	2.182
Serin	0.578
Glisin	0.258
Histidin	0.826
Arginin	0.584
Threonin	0.282
Alanin	0.116
Prolin	0.196
Tyrosin	0.218
Valin	0.734
Methionin	0.791
Sistin	0.321
Isoleusin	0.393
Leusin	0.775
Phenilalanin	0.417
Lysin	0.438
Tryptofan	-

Characteristics of nagara bean flour get better can be obtained either by way of a natural modification through a process of spontaneous fermentation. Spontaneous fermentation is fermentation which does not add inoculum or starter from the outside, and the process is very influenced by the length of fermentation is done. During fermentation expected to occur degradation of starch granules that will affect the characteristics of the resulting flour. During fermentation, lactic acid bacteria to grow and produce organic acids especially lactic acid. Subagio (2006) stated that during the fermentation of starch changes in characteristics such as solubility, rehydration value, aroma and color. In this study, the fermentation is done spontaneously by soaking nagara bean in the form of whole beans and grits with a long fermentation time of 24 hours to 120 hours. The test results are presented in Table 2.

Table 2 The characteristics of spontaneous fermented nagara bean flour

Treatments		Parameter						
Size	Fermentation periods (hours)	Yields (%)	Moisture content (%)	Protein (%)	Bulk density (g/cm^3)	Water absorption capasity (% bk)	Swelling volume (% g/g bk)	Solubility (% bk)
Whole grain	24	57.00±7.07	7.59±0.21	22.56±0.97^{ab}	0.46±0.01	142.22±8.16^{a}	461.95±129.61	6.23±0.51^{d}
	48	58.00±14.14	6.77±0.94	22.71±1.86^{ab}	0.50±0.03	177.40±14.84^{b}	474.56±137.08	4.37±1.97^{c}
	72	57.50±3.53	6.83±1.71	24.20±0.63^{b}	0.49±0.02	200.46±11.62^{cd}	518.10±5.82	2.71±0.35^{b}
	96	45.50±7.77	5.94±0.65	23.12±0.99^{ab}	0.50±0.00	204.61±6.19^{cd}	530.76±72.28	1.83±0.01^{ab}
	120	40.00±2.82	5.17±1.05	22.55±0.16^{ab}	0.51±0.01	193.41±5.05^{bcd}	711.06±33.75	1.52±0.16^{ab}
Grits	24	60.50±4.95	6.34±0.22	24.29±2.50^{b}	0.50±0.03	186.54±5.97^{bc}	556.23±80.49	2.95±0.83^{b}
	48	59.50±12.02	6.29±0.27	23.92±0.67^{b}	0.52±0.05	201.12±3.09^{cd}	554.66±115.99	2.14±0.24^{ab}
	72	53.50±2.12	5.97±1.93	21.03±0.87^{a}	0.50±0.01	202.07±3.30^{cd}	541.86±38.33	1.68±0.24^{ab}
	96	51.50±0.70	5.82±0.53	22.20±0.75^{ab}	0.49±0.01	208.76±2.66^{d}	554.06±16.63	1.67±0.06^{ab}
	120	51.50±0.70	5.29±0.007	21.54±0.17^{a}	0.50±0.03	190.29±8.66^{bcd}	693.50±49.74	1.15±0.25^{a}

*numbers followed by the same letter are not significantly different (α 5%)

Yields

In a process, determining the yields are very important as a measure of the performance of processes. In the process of spontaneous fermentation nagara bean, the average yield of 53.45% which produced flour yield of grits size is relatively higher than the size of the whole, and the longer the fermentation yield of flour will decrease. This was caused by the longer the contact time, the process of absorption of water into the matrix of nagara bean increased, so did the performance degradation of lactic acid from lactic acid bacteria in degrading cellulose structure intensified. So this causes the texture of nagara bean increasingly softened, and the washing process will lead to losses. The process of softening the nagara beans larger after fermentation time 72 hours. In whole bean sizes, after the fermentation process, the skin was stripped, after 72 hours of fermentation the beans are tender texture, very soft so that when the washing will be destroyed and a lot of starch dissolved in water. While the grits size, skin already partially separated from the beans so that the emphasis on beans to remove the skin is relatively small, lower structural damage so that loses the resulting smaller.

Moisture Content

Determination of moisture content was aimed to determine the water content in the fermented nagara bean flour. Nagara bean flour moisture content ranging from 4.42 to 8.04% with an average value of 6.20%. Results of analysis of variance showed that the size of bean and periods of fermentation had no significant effect on water content produced nagara bean flour.

On the whole size beans, flour moisture content ranges from 5-7.5% while the grits size ranges from 5-6% water content. The size of bean which are still intact beans are enveloped by the skin so that the rate of diffusion of water into the bean will be slower than bean in the form of grits. Size grits expand the surface area so contact between the beans with water and organic acids degrade performance granular structure will be easier, so that when the water content in the drying process easily evaporated. The longer the fermentation process, the process of degradation of larger granules so that during the drying process, the water content of flour will decrease.

Crude Protein Content

The crude protein content of fermented nagara bean flour is high enough range 21.02 to 24.20%. Bean in general are a source of protein, with the fermentation process through soaking, it will be possible of protein hydrolysis into simpler components namely peptides so that its availability will be higher. The lactic acid produced from lactic bacteria that grow spontaneously will accelerate the process of hydrolysis of proteins.

Results of analysis of variance showed interaction size bean and periods of fermentation significantly affected protein content nagara of modified nagara bean flour. The highest protein content generated on the grits were fermented for 24 hours (24. 29%) and did not differ with whole nuts with a fermentation time of 72 hours (24.20%). On the size of grits is suspected hydrolysis or breakdown of protein by proteolytic enzymes and acids occurs faster than the size of the whole. At grits size decrease faster fermentation medium pH at which the fermentation 24 hours to measure grits able to achieve pH 5, while on the size of the whole 24-hour fermentation was the normal range at pH 6-7. Grits size allows lactic bacteria are able to grow rapidly due to the availability of nutrients from beans country of residence is more easily obtained than in the intact natural nut crusted.

Bulk Density

Bulk density is needed to determine the weight of material per unit volume. In modified nagara bean flour had a softer texture than without spontaneous modification. Bulk density of modified nagara bean flour ranges from 0.46 to 0.52 g /cm^3. Results of analysis of variance showed nagara bean size, fermentation periods and interaction of both not significant effect on the density of the nagara bean flour. With the smaller the bulk density of a material will facilitate the packaging process and transport.

Water Absorption Capasity

Starch granules which are the main components that can be inflated by soaking in cold water. In cold water and the water absorption capacity is limited because of the development of hydrogen bonds between amylose and amylopectin, but when starch is heated, the thermal energy will break the hydrogen bonds so that the surface area for absorption of water become larger and starch granules will absorb more water.

Results of analysis of variance showed that the interaction size nagara bean and fermentation periods significantly affect the water absorption capacity of the nagara bean flour produced. Greater water absorption supposedly due to the fragmentation of the starch and protein during spontaneous fermentation process so that the binding of water becomes greater. Differences in the absorption of water is caused due to differences in surface area, that broken grains and protein content (Sabularse *et al.* 1991). Water absorption capacity tends to increase in fermentation time up to 96 hours, while at fermentation periods of 120 hours tend to lower water absorption. Grits size at 24-hour fermentation had water absorption capacity is greater than the size of the whole, it is presumably because the larger surface area, fragmentation of starches and proteins occur more quickly so that the absorption of water more quickly.

Swelling Volume

Results of analysis of variance (α 5%) showed that the single factor significantly affect of swelling volume of the fermented bean flour. Swelling volume is likely to increase up to 96 hours fermentation periods and fermentation periods of 120 hours, the swelling volume declined slightly. It is positively correlated with water absorption capacity nagara bean flour also decreased in fermentation periods of 120 hours. It is suspected after 96 hours, the degradation of starch granules is large enough, so the structure of the starch that binds water is becoming weaker.

Solubility

The solubility of the modified nagara bean flour ranges from 0.97 - 6.59 % db. Results of analysis of variance showed that the interaction of nagara bean and fermentation periods significant effect on the solubility of flour. On the size of grits solubility in water flour is relatively lower than full size and the longer the fermentation showed the smaller the solubility flour. Swelling of the starch granules above the gelatinization temperature is accompanied by washing polisaccharides soluble. Amount of dissolved amylose is a function of the organization's internal granular starch (Walter *et al*. 2000)

IV CONCLUSION

Treatment of grits size produce flour yield, protein content, water absorption capacity, and the swelling volume greater than others. Fermentation time up to 120 hours tend to lower flour yield and protein content while the water absorption capacity and volume expansion tends to be stable up to 96 hours fermentation periods.

ACKNOWLEDGMENT

We wish to thank Directorate General of Higher Education, Ministry of National Education Indonesia for the research funding through Hibah Pekerti.

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