BACHELOR THESIS & COLLOQUIUM – ME184841

ECONOMIC ANALYSIS OF BIO-DIESEL FOR AGRICULTURE PURPOSE OF INDONESIAN FARM

MUHAMMAD BISMADVER BUDIMAN
04211541000026

SUPERVISOR:
PROF. DR. ING. KARSTEN WEHNER
NIP. 421707283
M.SC. STEFFEN LOEST
NIP. 421708022

DOUBLE DEGREE PROGRAM
DEPARTEMENT OF MARINE ENGINEERING
FACULTY OF MARINE TECHNOLOGY
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
2019

This Page is Intentionally Left Blank

TUGAS AKHIR – ME184841

ECONOMIC ANALYSIS OF BIODIESEL FOR AGRICULTURE PURPOSE OF INDONESIAN FARM

MUHAMMAD BISMADVER BUDIMAN
NRP. 04211541000026

PEMBIMBING:
PROF. DR. ING. KARSTEN WEHNER
NIP. 421707283
M.SC. STEFFEN LOEST
NIP. 421708022

(Sathiyagnanam & Saravan, 2011)

PROGRAM DOUBLE DEGREE
JURUSAN TEKNIK SISTEM PERKAPALAN
FAKULTAS TEKNOLOGI KELAUTAN
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA
2019

This Page is Intentionally Left Blank

APPROVAL FORM

ECONOMIC ANALYSIS OF BIO-DIESEL FOR AGRICULTURE PURPOSE OF INDONESIAN FARM

BACHELOR THESIS

Submitted as one of Requirements to obtain Bachelor Degree in Engineering
on
Bachelor Program in Marine Engineering Department
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopember

Prepared by:

MUHAMMAD BISMADVER BUDIMAN

NRP. 04211541000026

Approved By Supervisor

Prof. Dr. Ing. Karsten Wehner ( )
NIP. 421707283

M.Sc. Steffen Loest ( )
NIP. 421708022

This Page is Intentionally Left Blank

APPROVAL FORM

ECONOMIC ANALYSIS OF BIO-DIESEL FOR AGRICULTURE PURPOSE OF INDONESIAN FARM

BACHELOR THESIS

Submitted to Comply One of the Requirements to Obtain Bachelor Engineering Degree

on

Bachelor Program Department of Marine Engineering
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopermber

Prepared by:
MUHAMMAD BISMADVER BUDIMAN
NRP. 04211541000026

Approved by
Representative of Hochschule Wismar in Indonesia

Dr. –Ing. Wolfgang Busse

This Page is Intentionally Left Blank

APPROVAL FORM

ECONOMIC ANALYSIS OF BIO-DIESEL FOR AGRICULTURE PURPOSE OF INDONESIAN FARM

BACHELOR THESIS

Submitted to Comply One of the Requirements to Obtain Bachelor Engineering Degree

on

Bachelor Program Department of Marine Engineering
Faculty of Marine Technology
Institut Teknologi Sepuluh Nopermber

Prepared by:
MUHAMMAD BISMADVER BUDIMAN
NRP. 04211541000026

Approved by
Head of Department of Marine Engineering

Dr. Eng. Muhammad Badrus Zaman, S.T., M.T.
NIP. 197708022008011007

This Page is Intentionally Left Blank

DECLARATION OF HONOR

I hereby who signed below declare that:

This final project has written and developed independently without any plagiarism act. All contents and ideas drawn directly from internal and external sources are indicated such as cited sources, literatures, and other professional sources.

Name	:	Muhammad Bismadver Budiman
NRP	:	04211541000026
Bachelor Thesis Title	:	Economic Analysis of Bio-Diesel for Agriculture purpose of Indonesian Farm
Department	:	Marine Engineering

If there is plagiarism act in the future, I will fully responsible and receive the penalty given by ITS according to the regulation applied.

Surabaya, July 2019

Muhammd Bismadver Budiman

This Page is Intentionally Left Blank

ECONOMIC ANALYSIS OF BIO-DIESEL FOR AGRICULTURE PURPOSE OF INDONESIAN FARM

Student Name	**: Muhammad Bismadver Budiman**
NRP.	**: 04211541000026**
Department	**: Teknik Sistem Perkapalan**
Supervisor I	**: Prof. Dr. Ing. Karsten Wehner**
Supervisor II	**: M.Sc. Steffen Loest**

Abstract

Based on the 2015 annual energy forecast from Indonesia's Agency for the Assessment and Application of Technology (BPPT), if present trends in energy usage continue unaltered, transport fuel consumption in Indonesia will increase on average almost 5% per year through 2050. Currently, liquid fossil fuel accounts for around 35% of Indonesia's energy demand across all sectors. From various renewable energy and possible alternative fuels to replace the consumption of fossil fuels, biodiesel is projected to have potential to be developed regarding to the simple production process and affordable feed stocks. Biodiesel, as diesel engine fuel alternative, receives more attention among many feasible options. Biodiesel as one of the renewable energies, biodegradable and nontoxic fuel is expected to be one of the solutions. With the affordable feed stocks that can be obtained from various organic source like vegetable oils or animal fats and also the simple production, From the discussion of this Bachelor Thesis, the economic feasibility, necessary equipment and the time of storage of the biodiesel will be analyzed for biodiesel production plant including investment cost of making the biodiesel production plant by calculating the capital cost and the operational cost of a 5000-ton annual capacity of biodiesel. The purpose of this study is to analyze the investment of the biodiesel production facility by using a feasibility study method by using four parameters of economic feasibility study namely Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PP), and the Profitability Index (PI) for assessing the Investment. Th result obtained is that the biodiesel production facility with the annual production of 5000 ton of biodiesel is feasible.

Keywords-Biodiesel, Agriculture, Renewable Energies, Investment.

This Page is Intentionally Left Blank

ECONOMIC ANALYSIS OF BIO-DIESEL FOR AGRICULTURE PURPOSE OF INDONESIAN FARM

Nama : Muhammad Bismadver Budiman
NRP. : 04211541000026
Jurusan : Teknik Sistem Perkapalan
Pembimbing I : Prof. Dr. Ing. Karsten Wehner
Pembimbing II : M.Sc. Steffen Loest

Abstrak

Berdasarkan proyeksi energi tahunan tahun 2015 dari lembaga Indonesia untuk Penilaian dan Penerapan Teknologi (BPPT), jika tren penggunaan energi saat ini terus tidak berubah, konsumsi bahan bakar transportasi di Indonesia akan meningkat rata-rata hampir 5% per tahun hingga tahun 2050. Terkini, akun bahan bakar fosil cair sekitar 35% dari permintaan energi indoensia di semua sektor. Dari berbagai energi terbarukan dan kemungkinan bahan bakar alternatif untuk menggantikan konsumsi bahan bakar fosil, biodiesel diperkirakan memiliki potensi untuk dikembangkan sehubungan dengan proses produksi yang sederhana dan stok pakan yang terjangkau. Biodiesel, sebagai alternatif bahan bakar mesin diesel, menerima lebih banyak perhatian di antara banyak opsi yang layak. Biodiesel sebagai salah satu energi terbarukan, biodiegradable dan bahan bakar tidak beracun diharapkan menjadi salah satu solusi. Dengan *feedstock* yang terjangkau yang dapat diperoleh dari berbagai sumber organik seperti minyak nabati atau lemak hewani dan juga produksi sederhana. Dari pembahasan tugas akhir ini, kelayakan ekonomi, peralatan yang diperlukan dan waktu penyimpanan biodiesel akan dianalisis untuk pabrik produksi biodiesel termasuk biaya investasi dari pembuatan pabrik produksi biodiesel dengan menghitung biaya modal dan biaya operasional dari 5000- ton kapasitas biodiesel tahunan. Tujuan dari penelitian ini adalah untuk menganalisis investasi fasilitas produksi biodiesel dengan menggunakan metode studi kelayakan dengan menggunakan empat parameter studi kelayakan ekonomi yaitu *Net Present Value* (NPV), *Internal Rate of Return* (IRR), *Payback Periode* (PP), dan Indeks Profitabilitas (PI) untuk menilai Investasi. Hasil yang diperoleh adalah bahwa fasilitas produksi biodiesel dengan produksi tahunan 5.000 ton biodiesel layak.

Keywords- Biodiesel, Agriculture, Renewable Energies, Investment.

This Page is Intentionally Left Blank

PREFACE

Praise to Allah SWT for his grace and mercy this Bachelor Thesis entitled "Economic Analysis of Biodiesel for Agriculture Purpose of Indonesian Farm" can be completed. This thesis is made to attain Double Degree Bachelor of Marine Engineering from Faculty of Marine Technology of Hochschule Wismar and Institut Teknologi Sepuluh Nopember Surabaya.

During the Process of completing this thesis, the author has also received numerous supports, prayers, and assistance from many parties. The author would like to dedicate the gratefulness to these names below:

1. Prof Dr. -Ing. Karsten Wehner, Mr. M.Sc. Steffen Loest, and Mr.Ilja Fiebak B.Sc. as the supervisor who had guide the author through all the process of completing this Bachelor Thesis.
2. Both my Parents who had provided me with the resources so that the author has the opportunity to write the Bachelor Thesis in Rostock Germany. And for my beloved mother and sister for their generous, prayers, patience, encouragement, and moral assistance to the author at all time that has been precious and priceless.Mr Indra Ranu Kusuma ST. M.Sc as supervisor of this bachelor thesis
3. Mr Taufik Fajar Nugroho ST. M.Sc as academic supervisor that gives author academical knowledge and non-academical knowledge either in class or outside the class
4. Mr. Dr. Eng. M. Badrus Zaman, S.T., M.T. and Mr. Semin, S.T., M.T., Ph.D. as Head and Secretary of the Department Marine Engineering FTK - ITS.
5. Every technician on Department Marine Engineering especialy at Marine Electrical and Automation Laboratory who helped author to finish this experiment
6. The author friends who also writing their Bachelor Thesis in Rostock, Germany. Akbar, Rifram, Rachel, Andari, and Gea who has support each other during the times of completing this Bachelor Thesis.
7. And SALVAGE family, as a batch who accompany author in college life

Hopefully, this Bachelor Thesis can provide information's and benefits for any parties. The author realizes that this Bachelor Thesis is very far from perfect. Therefore, every constructive suggestion and idea from all parties is highly expected by author for this Bachelor Thesis correction and Improvement in the future.

Rostock, July 8, 2019

This Page is Intentionally Left Blank

TABLE OF CONTENT

LIST OF FIGURE AND TABLE

This Page is Intentionally Left Blank

CHAPTER I
INTRODUCTION

1.1. Background

The consumption of energy such as fossil fuels and petroleum products will always be increasing alongside with the population growth and increasing use of transportation and also other Sector which are using fuels as their main source of power. Also, the preservations of this non-renewable energy are depleting and projected to be running out in the upcoming years. It is required to find the replacement of this fossil fuel or known as alternative fuel to be used in generating power.

Based on the 2015 annual energy forecast from Indonesia's Agency for the Assessment and Application of Technology (BPPT), if present trends in energy usage continue unaltered, transport fuel consumption in Indonesia will increase on average almost 5% per year through 2050. Currently, liquid fossil fuel accounts for around 35% of Indonesia's energy demand across all sectors (ESDM, 2015).

From various renewable energy and possible alternative fuels to replace the consumption of fossil fuels, biodiesel is projected to have potential to be developed regarding to the simple production process and affordable feed stocks. Biodiesel, as diesel engine fuel alternative, receives more attention among many feasible options. Biodiesel as one of the renewable energies, biodegradable and nontoxic fuel is expected to be one of the solutions. With the affordable feed stocks that can be obtained from various organic source like vegetable oils or animal fats and also the simple production,

As the Second Largest Biodiesel Producing Countries, Indonesia has a great potential in case of the development of the Biodiesel, Especially in Agriculture sector. Indonesia is very rich in natural resources which can be utilized as a biodiesel raw material. The development of biodiesel requires vegetable oil raw materials as the feedstock that can produced from plants containing fatty acids such as oil palm (Crude Palm Oil / CPO), Jatropha (Jatropha Curcas), soybean, coconut, soursop and kapok.

Agriculture Sector is a very important sector which they are not only playing the role of the producer of production of the Biodiesel, but also forms as a potential user in which it uses the Biodiesel Product from the feedstock that are produced by the farmer itself to replace the needs to use diesel fuel. This way the it may be possible to reduce the cost for diesel fuel consumption by totally replacing the diesel fuel with the produced biodiesel.

This bachelor thesis will be talking about the economic feasibility for biodiesel production plant in specific area including investment cost of making the biodiesel production plant by calculating the capital cost and the operational cost so that it can be determined whether the biodiesel it is feasible or not. The yearly consumption of the biodiesel for a specific area will be calculated, also the economical calculation to allow the most cost-effective implementation as possible.

1.2. Problem of Statement

Based on the Background of this Bachelor Thesis, the Author can state some problem as below:

1. How big the capacity of the Biodiesel Production facility?
2. What kind of Equipment that are necessary to produce and Store Produced Biodiesel?
3. How long the storage time for the Biodiesel?
4. How to determine the investment costs, development cost and the operational cost of the biodiesel production facility?
5. How to predict the economic feasibility of the biodiesel production facility?
6. How to determine the return on investment and the result obtained after the investment?

1.3. Objective of Study

The Objectives of this Thesis are:

1. To Determine the capacity of the Biodiesel production facility.
2. To Determine the Equipment that are needed to produce and Store the Biodiesel.
3. To know the maximum storage time of the biodiesel.
4. To Determine the investment cost, construction cost for the biodiesel production facility.
5. To predict the economic feasibility of the Biodiesel production facility.
6. To Determine the return on investment ant the result obtained after the investment.

1.4. Research Limitation

To define the clear limit of the research, the author has set the limitations of the research to be:

1. The Feedstock of the Biodiesel will be focused on soybean for the main source.
2. Analysis of the Economical calculation will be conducted using MS EXCEL.
3. Data for the analysis is only coming from Literature.

1.5. Research Benefit

The Benefit of this research is:

1. To give an explanation about the Biodiesel Production process and Equipment necessary.
2. To know the feasibility of investing in biodiesel production facility.
3. Provide information about the benefits of investing in biodiesel production facility.
4. To be used as a reference for Building a Biodiesel Plant/ Facility in Indonesia

CHAPTER II
LITERATURE REVIEW

2.1. Biodiesel

Biodiesel fuel is an alternative renewable fuel for diesel fuel that are produced from different kinds of vegetable oils. As a renewable fuel, biodiesel can be used in diesel engines without significant modification. However, the performance, emission and combustion characteristic will be different for the same biodiesel used in different types of engine. (Sathiyagnanam & Saravan, 2011).

Biodiesel can be produced from several variety of feedstock. Commonly the production of the biodiesel is using grease, vegetable-oils, or animal fats for its raw material. These raw materials have the chemical structure is of fatty acid alkyl esters that are the main source for producing biodiesel. Biodiesel is produced by the transesterification process of oils with short chain alcohols or by the esterification of fatty acids. (Vasudevan & Briggs, 2008).

The advantages of bio-diesels as diesel fuel are the minimal sulfur and aromatic content and higher flash point, lubricity, cetane number, biodegradability and non-toxicity. On the other hand, their disadvantages include the higher viscosity and pour point and the lower calorific value and volatility. Furthermore, their oxidation stability is lower, they are hygroscopic, and as solvents may cause corrosion in various engine components. Moreover, it is generally accepted that blends of diesel fuel, with up to 20% bio-diesels can be used in existing diesel engines without modifications (Sathiyagnanam & Saravan, 2011). Biodiesel has been used in many countries such as United States of America, Malaysia, Indonesia, Brazil, Germany, France, Italy and other European countries. Moreover, the potential for its production and application of the Biodiesel. Table 2.1 shows the list of the top 10 countries that has the biggest potential for the biodiesel development.

Table 2. 1 Top 10 Countries in term of biodiesel potential
(Source: A.E. Atabani et.al, 2012)

Rank	Country	Biodiesel potential (ML)	Production ($/L)
1	Malaysia	14,540	0.53
2	Indonesia	7595	0.49
3	Argentina	5255	0.62
4	USA	3212	0.70
5	Brazil	2567	0.62
6	Netherlands	2496	0.75
7	Germany	2024	0.79
8	Philippines	1234	0.53
9	Belgium	1213	0.78
10	Spain	1073	1.71

The wide range of available variety of the feedstocks for the production of biodiesel represents one of the most significant factors of producing biodiesel. For that the available feedstock should fulfill two main requirements, low production costs and large production scale. The availability and the quality of feedstock for producing biodiesel depends on several factors, the geographical locations, soil condition, climate and agricultural practices.

Table 2. 2 Primary Biodiesel Feedstock according to country
(Source: A.E. Atabani et.al, 2012)

Country	Feedstock
USA	Soybeans/waste oil/peanut
Canada	Rapeseed/animal fat/soybeans/yellow grease and tallow/mustard/flax
Mexico	Animal fat/waste oil
Germany	Rapeseed
Italy	Rapeseed/sunflower
France	Rapeseed/sunflower
Spain	Linseed oil/sunflower
Greece	Cottonseed
UK	Rapeseed/waste cooking oil
Sweden	Rapeseed
Ireland	Frying oil/animal fats
India	Jatropha/*Pongamia pinnata* (karanja)/soybean/rapeseed/sunflower/peanut
Malaysia	Palm oil
Indonesia	Palm oil/jatropha/coconut
Singapore	Palm oil
Philippines	Coconut/jatropha
Thailand	Palm/jatropha/coconut
China	Jatropha/waste cooking oil/rapeseed
Brazil	Soybeans/palm oil/castor/cotton oil
Argentina	Soybeans
Japan	Waste cooking oil
New Zealand	Waste cooking oil/tallow

Over than 350-oil bearing crops have been identified as potential sources for producing biodiesel. However, there are only several plant that are considered to be viable feedstock for the commercial production of biodiesel such as, Palm, Jathropha, rapeseed, sunflower, soybean, safflower and peanut oils. In general, biodiesel feedstock can be categorized into four main categories which are Edible Oil, Non-edible oil, Animal Fats, and Other Sources (Ahmad, Khan, Zafar, & Sultana, 2011).

Edible oils are considered as the first-generation feedstock for biodiesel production it is due to reason of that these crops are the first crops to be used for biodiesel production. Resources such as soybeans, palm oil, sunflower, safflower, rapeseed, coconut and peanut are considered as the first generation of biodiesel feedstock. The plantations of the first generation of biodiesel feedstock have been established in many countries around the world with great biodiesel potential. This includes Malaysia, USA and Germany. More than 95% of the world biodiesel is produced from edible oils such as rapeseed (84%), sunflower oil (13%), palm oil (1%), soybean oil and others (2%). But the use of these crops raises many concerns such as food versus fuel crisis and major environmental problems such as serious destruction of vital soil resources, deforestation and usage of much of the available land. Moreover, in the last 10 years the prices of vegetable oil plants have increased dramatically which will affect the economic viability of biodiesel industry (Balat & Balat, 2010).

For overcoming these problems, one of the possible solutions is to reduce the utilization of the edible oil for biodiesel production is by exploiting non-edible oils. Non-edible oil resources are gaining worldwide attention because their availability. These Non-Edible feedstocks can be found in many parts of the world especially wastelands that are not suitable for food crops that will eliminate competition for food, reducing deforestation rate, more environmentally friendly, produce useful by-products and they are very economical comparable to edible oils. The main sources for biodiesel production from non-edible oils are jatropha or ratanjyote or seemaikattamankku (Jatropha curcas), karanja or honge (Pongamia pinnata), Aleurites moluccana, Pachira glabra nagchampa (Calophyllum inophyllum), rubber seed tree (Hevca brasiliensis), Desert date (Balanites aegyptiaca), Croton megalocarpus, Rice bran, Seamango (Cerbera odollam), Terminalia belerica,neem(Azadirachta indica), Koroch seed oil (Pongamia glabra vent.), mahua (Madhuca indica and Madhuca longifolia), Tobacco seed (Nicotiana tabacum L.), Chinese tallow, silk cotton tree (Ceiba pentandra), jojoba (Simmondsia chinensis), babassu tree and Euphorbia tirucalli. Non-edible oil is considered as the second generation of biodiesel feedstocks. Another feedstock that are also considered as the second-generation feedstock are animal fat waste oil and grease. Usually these feedstocks are disposed. The use of these types of feedstock eliminates the need to dispose them. However, it has been reported that second generation feedstocks may not be plentiful enough to satisfy the global energy demand. Furthermore, for many types of animal fats the transesterification process is difficult because they contain high amount of saturated fatty acids. In case of waste cooking oil, collection infrastructure and logistics could be hurdle as the sources are generally scattered.

Table 2. 3 Main Feedstock of Biodiesel
(Source: A.E. Atabani et.al, 2012)

Edible oils	Non-edible oils	Animal fats	Other sources
Soybeans (*Glycine max*)	*Jatropha curcas*	Pork lard	Bacteria
Rapeseed (*Brassica napus L.*)	Mahua (*Madhuca indica*)	Beef tallow	Algae (Cyanobacteria)
Safflower	Pongamia (*Pongamia pinnata*)	Poultry fat	Microalgae (Chlorellavulgaris)
Rice bran oil (*Oryza sativum*)	Camelina (*Camelina Sativa*)	Fish oil	Tarpenes
Barley	Cotton seed (*Gossypium hirsutum*)	Chicken fat	Poplar
Sesame (*Sesamum indicum L.*)	Karanja or honge (*Pongamia pinnata*)		Switchgrass
Groundnut	Cumaru		Miscanthus
Sorghum	*Cynara cardunculus*		Latexes
Wheat	*Abutilon muticum*		Fungi
Corn	Neem (*Azadirachta indica*)		
Coconut	Jojoba (*Simmondsia chinensis*)		
Canola	Passion seed (*Passiflora edulis*)		
Peanut	Moringa (*Moringa oleifera*)		
Palm and palm kernel (*Elaeis guineensis*)	Tobacco seed		
Sunflower (*Helianthus annuus*)	Rubber seed tree (*Hevca brasiliensis*)		
	Salmon oil		
	Tall (*Carnegiea gigantean*)		
	Coffee ground (*Coffea arabica*)		
	Nagchampa (*Calophyllum inophyllum*)		
	Croton megalocarpus		
	Pachira glabra		
	Aleurites moluccana		
	Terminalia belerica		

Stated by Balat M., in 2011 selecting the cheapest feedstock is vital to ensure low production cost of biodiesel. For comparing between different feedstock to be for producing biodiesel several factors are needed to be considered. The feedstock should be evaluated based on a full life-cycle analysis. This analysis includes: Availability of land, Cultivation Practices, Energy Supply and Balance, Emission of Greenhouse Gasses, Soil Erosion and Fertility, Logistic cost, Economic value of the feedstock taking into account the co-products, Water requirement and water availability, and the effects of feedstock on air quality. To consider any feedstock as a biodiesel source, the oil percentage and the yield per hectare are important parameters. Table 2.4 shows the estimated oil content and yields of different biodiesel feedstocks.

Table 2. 4 Estimated Oil Content and yields of biodiesel feedstock (Source: A.E. Atabani et.al, 2012)

Feedstocks	Oil content (%)	Oil yield (L/ha/year)
Castor	53	1413
Jatropha	Seed: 35–40, kernel: 50–60	1892
Linseed	40–44	–
Neem	20–30	–
Pongamia pinnata (karanja)	27–39	225–2250[a]
Soybean	15–20	446
Sunflower	25–35	952
Calophyllum inophyllum L.	65	4680
Moringa oleifera	40	–
Euphorbia lathyris L.	48	1500–2500[a]
Sapium sebiferum L.	Kernel 12–29	–
Rapeseed	38–46	1190
Tung	16–18	940
Pachira glabra	40–50	–
Palm oil	30–60	5950
Peanut oil	45–55	1059
Olive oil	45–70	1212
Corn (Germ)	48	172
Coconut	63–65	2689
Cottonseed	18–25	325
Rice bran	15–23	828
Sesame	–	696
Jojoba	45–50	1818
Rubber seed	40–50	80–120[a]
Sea mango	54	–
Microalgae (low oil content)	30	58,700
Microalgae (medium oil content)	50	97,800
Microalgae (high oil content)	70	136,900

[a] (kg oil/ha).

2.2. Biodiesel Production

In producing biodiesel, it is important to know the characteristic and properties of the feedstock oil that will be used to determine the process and the right treatment to produce the Biodiesel. There are some steps to be taken before transforming the raw oil to biodiesel which includes the raw oil production, pre-treatment process, transesterification process and purification process.

2.2.1. Transesterification Process

Biodiesel is formed by the process of chemical known as transesterification and also esterification. The most general alcohol to be utilized for this reaction are methanol and ethanol. This is one of the reasons of the other name of biodiesel is known as Fatty Acid Methyl Esters (FAME). 100% of FAME is often designated as B100, and with slight concentration such as B20 is suitably known to be biodiesel blends.Transesterification reaction is the most common method in the process of producing biodiesel. Some researchers indicated that the physical properties of biodiesel from fish waste oils, including viscosity and acidity are much higher than the regular diesel. (Kara, et al., 2017)

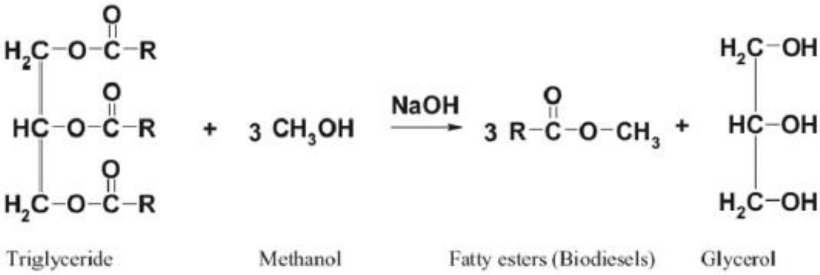

Figure 2. 1 Transesterification Process
(Source : Saifuddin, M. and Boyce, A. N., 21017)

The transesterification process is the process of reacting a triglyceride of a crude fish oil with an excess of alcohol in the presence of sodium hydroxide as a catalyst to produce the fatty acid esters and glycerol. The fatty acid esters are obtained from the transformation of triglyceride which is reduced to diglycerides to monoglycerides and become fatty acid esters. Viscosity gets reduced considerably. Transesterification was prepared from the reaction between the methanol and the catalyst (Sodium Hydroxide) when the raw oil will be heated at 60oC for two hours. The samples were taken to ensure the settlement of the reaction by product of glycerol and ready for purification process. (Pavan , Venkanna, Mudhol, & Pavan, 2015).

2.2.2. Purification Process

There are three major steps on the purification stage of biodiesel production which includes of the separation step, washing step and lastly, drying step. Separation step is done by pouring the solution into separating funnel and let it to settle down. After two distinct layers are formed, the lower layer that contains glycerol and fatty acid methyl esters. The lower layer that contains glycerol will be released out and left the FAME. Methyl esters obtained are then washed with distilled water for at least four times to remove impurities such as pigments, excess alcohol, excess catalysts, glycerol and soaps. Washing step is complete when the distilled water is clear after washing the methyl esters. Distilled water is then removed. The last step will be the drying step. Drying step is carried out by drying up the biodiesels in the oven at 48oC and by using sodium sulphate anhydrous as well. Small amount of water can be eliminated when biodiesel is dried up to the oven meanwhile large amount of water is removed by using sodium sulphate anhydrous. As sodium anhydrous meets with water, hard crystals will be formed. Hence, the crystals can be filtered off by pouring the solution into filter paper. Pure and dry biodiesels are prepared for the analysis. (Saifuddin & Boyce, 2017).

2.3. Stability of Biodiesel

The stability of biodiesel is a very important aspect for biodiesel which has the connection with how long the biodiesel can be storage. The stability of biodiesel may be affected by interaction between the biodiesel with contaminants, light, temperature, and factors that causing the biodiesel into forming sediments, changes in color that reduce the cleanliness of the biodiesel (Robert O.Dunn, 2008). Biodiesel mainly produced from the transesterification process of vegetable oils or other viable feedstock that have been found to be more susceptible to oxidation from the exposure to oxygen of the air and because the high temperature. The storage ability of the biodiesel fuel to change in its physical and chemical characteristic happens because the interaction with the surrounding environment. The stability of biodiesel during storage is more severe than that of normal diesel fuel. The resistance of biodiesel to oxidative degradation during storage is important for the viability and sustainability of the biodiesel.

2.3.1. Biodiesel Storage Stability

In General, biodiesel is an organic compound that derives from vegetable oil, whereas organic compound can be categorized to be easily degraded. Silviana and Luqman Buchori (2015) have done the research about the storage stability and the parameters to know the time of storage of the biodiesel. Based on the research the parameter that were analyzed was the Acid value, Base value, Iodine value, total glycerol content, and the ester content.

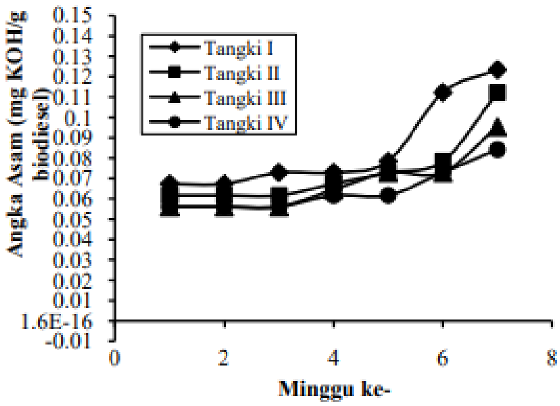

Figure 2. 2. The relationship between acid number and storage time (Source : Silviana and Luqman Buchori, 2015)

In Figure2.2 shows that the longer the storage time the acidity value is increasing. This increase is due to chemical composition of biodiesel reacting. Beside the chemical reaction of the biodiesel it can also be occurred because of the presence of oxygen in the storage system. Oxygen can cause biodiesel to be easily reacting that will produce the compounds of acids, aldehydes, ketones, and non-soluble compounds (Jakeria, Fazal, & Haseeb, 2014).

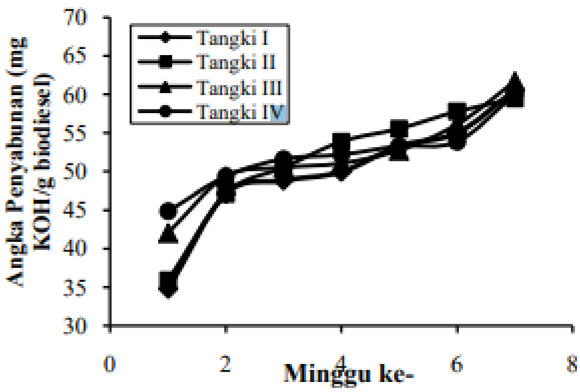

Figure 2. 3. The relationship between base number and storage time (Source : Silviana and Luqman Buchori, 2015)

From figure 2.3 it can be seen that the base value increases with time storage. The increase of the base value is caused by auto oxidation and the contaminant inside the storage.

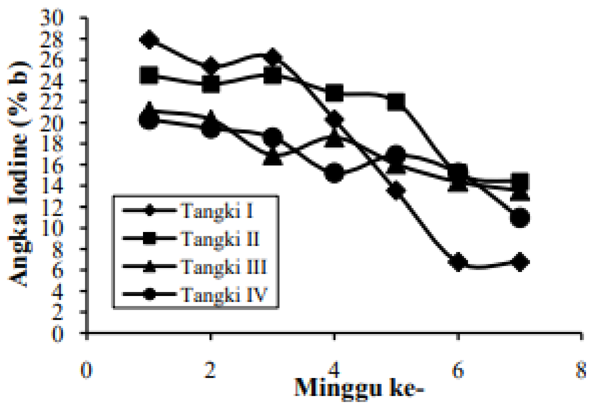

Figure 2. 4. The relationship between iodine number and storage time (Source : Silviana and Luqman Buchori, 2015)

From figure 2.4 the longer the storage time the lower the iodine number of the stored biodiesel. The iodine number indicate the number of double bonds in biodiesel. From figure 2.5 it can be seen that the iodine number is decreasing, that means that the double bonds is becoming a single bond that at the end will be saturated. This proves that in this time the degradation of the biodiesel quality is already occurring.

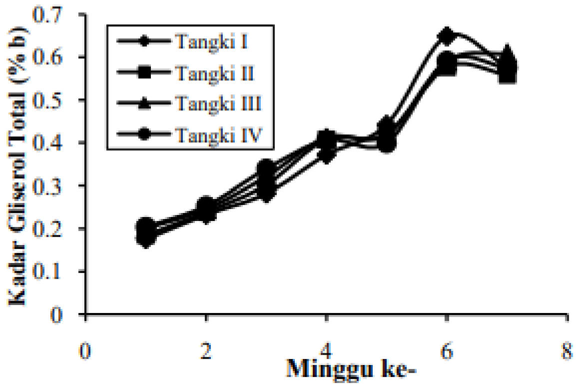

Figure 2. 5. The relationship between glycerol content and storage time (Source : Silviana and Luqman Buchori, 2015)

From the figure 2.6 it can be seen that the glycerol content is increasing due to the time of the storage. This is because the biodiesel itself is produced by the transesterification process that produce not only biodiesel but also its co product that is glycerol. Because of that the longer the storage time of the biodiesel will cause with the increasing of the glycerol content due to the residual alcohol that still contained in the stored biodiesel.

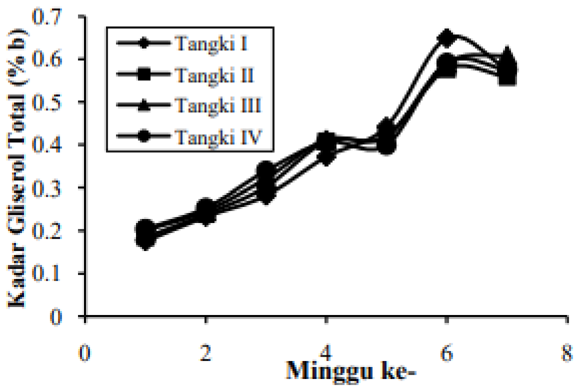

Figure 2. 6. The relationship between glycerol content and storage time (Source : Silviana and Luqman Buchori, 2015)

The ester content will be decreasing together with the time for the storage. This decrease in ester content is caused by the oxidation process which result in the degradation of the biodiesel. This is why the changes of ester into acid and glycerol and the longer time of the storage will cause the acid number to increase and also the glycerol level. With the increasing of the acid numbers that means the higher the acid numbers consequences in the low ester content in the biodiesel

2.4. Cash Flow

Cash Flow is the flow of cash in a company inside certain period that shows the amount of money that goes into the company and the types of income and the amount of money that comes out and the types of costs incurred. The cash flow report is compiled to show changes in cash for one certain period and provide reasons for changes in the whole flow of the cash by showing the source of cash and the usage of the cash. When analyzing for future estimated cash flow, uncertainty is there. As a result, the estimated calculation can deviate far from reality. This uncertainty can cause a reduction in the ability for the development of the project to operate for generate profits for the company.

2.5. Parameters of the economic Feasibility Analysis

To determine the feasibility of an investment or project terms of financial aspects, it can be measured by assessing the value of several factors. Every assessment has standard value for similar business by comparing with the average industry or predetermined target. The criteria commonly used for determining the feasibility of a business of investment :

2.5.1. Net Present Value (NPV)

NPV is a net financial assessment that is in the company after reduced by the other cost so that the value of the increase or shortage of the financial in the company can be used as a reference for judging the worthiness of the company's finance. In other words , The assessment of NPV is the net flow of the company's financial so that it can be interpreted as financial analysis which is used to determine the worthiness of the business or investment by seeing through the present value of the net cashflow that are received by the company compared to the value from the investment capital done by the company. The NPV can be determined using the following formula (BI, 2014).

$$NPV = \sum_{t=1}^{n} \frac{Bt - Ct}{(1+i)^t} \quad (1)$$

Whereas,

Bt = Benefit obtained at year-t
Ct = Expenditures incurred t year-t
i = Interest rate
n = Total number of Periods

The assessment of NPV value can be seen with the following conditions:

•If NPV> 0, then the project is feasible to be implemented financially as the investment of the project are beneficial.
•If NPV= 0, then the projects or investment returns the exact funds as the investment capital exactly the same amount with interest rates.
•If NPV< 0, then the project is not feasible to proceed because the project cannot cover the interest rate used resulting in losses for the company.

2.5.2. Internal Rate of Return (IRR)

IRR (Internal Rate of Return) is an investment calculation method that is done by calculating the interest rates which equates the present value of investment with the future present value of net cash receipt. The IRR can also be used as the value of the discount rate which makes the NPV of the projects equal to zero. It can also be considered as the rate of return on net investment from a project, as long as every net benefit is obtained automatically reinvested by the following year with the same level of profit and the given interest.. The IRR itself can be determined by the following formula

$$IRR = i_1 + \left[\frac{NPV_1}{NPV_1 - NPV_2}\right](i_2 - i_1) \quad (2)$$

Whereas,

IRR = Internal Rate of Return
NPV_1 = Positive value of NPV
NPV_2 = Negative value of NPV
i_1 = Interest rate at Positive value of NPV
i_2 = Interest rate at Negative value of NPV

The feasibility of a project can be approached by considering the value of IRR as follows::

•If the IRR (Internal Rate of Return) value is equal to or greater than the value of the interest rate, then the investment or project is feasible to be done.

•If the IRR (Internal Rate of Return) value is smaller or less than the interest rate, then the project is declared unfit.

2.5.3. Payback Period (PP)

Payback period is a period of time to indicate how long the return of an investment or project will be., by paying attention to assessment techniques for a certain period of time. Whereas according to Darmansyah (2009) that Payback Period is the time needed in units of year to return the investment that are invested based on the cash inflow generated by the investment or project. Payback Period (PP) shows a comparison between the initial investment and the annual cash flow. Payback Period (PP) can be determined using the following formula:

$$Payback\ Period = i/\pi \ \times 1\ year \tag{3}$$

Whereas,

i = Investment

π = Profit per year

2.5.4. Profitability Index (PI)

Profitability index (PI) or benefit cost ratio is a comparison between the present value of future cash inflows with the value of the investment. For the Profitability Index is equal to or greater than one PI≥1 , then the project is to be accepted. Generally, the NPV and PI methods are used to assess an investment proposal, the results will always be consistent. In other words, if the NPV is acceptable than the Profitability index is acceptable too and vice versa (Darmansyah, 2009). So, for calculating the Profitability Index (PI), the NPV has to be determined first and in several other cases, which after determining the Profitability index (PI) decision could not be made before being returned to the NPV method. This can be concluded that Profitability Index (PI) is a method of predicting the feasibility of a project by comparing the value of net profitability with the investment, with eligibility criteria if the Profitability Index is greater than one PI≥1, then the investment is acceptable, whereas if the Profitability index is smaller than one PI≤1, the investment is not acceptable.

2.5.5. Net Benefit Cost (Net B/C)

Net Benefit Cost is a comparison of benefits and net cost of a project. It is the comparison between the total value of benefits in the year which the benefits are positive and the total present value of the benefits net in years where they are negative (losses) (BI, 2014). The method for calculating Net Benefit cost use the formula below:

$$Net\ B/C = \frac{NPV_{B-C\ positive}}{NPV_{B-C\ negative}} \tag{4}$$

Whereas,

Net B/C = Net Benefit cost

$NPV_{B-C\ positive}$ = Positive value of NPV

$NPV_{B-C\ negative}$ = Negative value of NPV

The results of the Net Benefit cost can be considered as follows:

•If the value of Net B/C> 1, then the project is considered as feasible.
•If the value of Net B/C< 1, then the project is considered to be not feasible tobe implemented.

2.5.6. Break Even Point (BEP)

Break event point is a situation where the level of production or the amount of income are equals to the amount of expenditure on a project, sot that in these circumstances the project does not gain benefit or not losses (BI, 2014). Breakeven point can found using the following formula:

$$BEP\ (Rupiah) = \left[\frac{Fixed\ cost}{1 - \frac{Total\ Variable\ Cost}{Sales\ Revenue}}\right] \tag{5}$$

$$BEP\ (Unit) = \left[\frac{BEP(Rupiah)}{Selling\ Price\ of\ Unit}\right] \tag{6}$$

This Page is Intentionally Left Blan

CHAPTER III
RESEARCH METHODOLOGY

The following is a flow diagram of a research methodology that describes the overall research

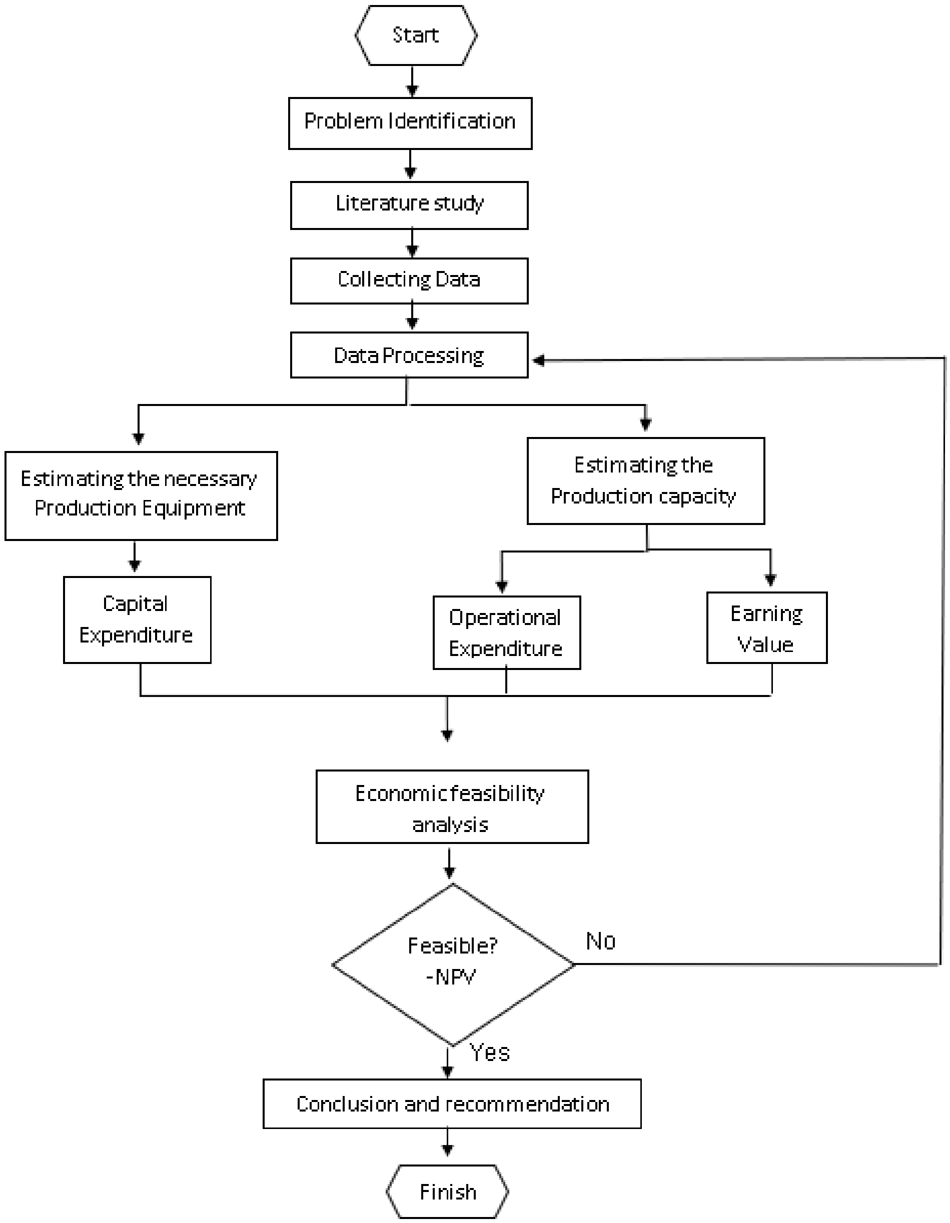

Figure 3. 1 Methodology Flowchart Diagram

3.1. Problem Formulation

The research will begin with problem statement and identification to the related topics. At this stage it will be determined why existing problems must be solved so that they are worthy of research and become material for the bachelor work which will be discussed regarding the production of biodiesel in specific area based on their diesel consumption, then it will be compared between the profitability of using biodiesel and diesel. This includes investment for the biodiesel production facility that will be identify for the economic feasibility.

3.2. Literature Study

For literature study, it was conducted to find information and references related to the themes that support for the bachelor work. The literature reviewed is sourced from:

- Books / Module / e-books / handbook
- Publication of scientific articles (journals, papers)
- Final Project
- Internet

Supporting Literature in the execution of this bachelor work concerning study feasibility, economics, and other materials that support the bachelor work.

3.3. Data Collecting

This stage some data collection is needed for later feasibility analysis that is carried out. The data to be collected such as:

1. Yearly Consumption of Diesel in Specified Area
2. Production cost of biodiesel
3. Selling price of the feedstock

3.4. Data Processing

At this stage data processing is carried out from all the data that has been done obtained to solve a predetermined problem, namely:

- Estimated project cost for biodiesel production
- Estimated Operational
- Revenue generated
- Cash flow and projections within the specified time period

3.5. Economic Feasibility

After processing the data, the next step is to conduct a feasibility analysis, which is an analysis whether or not the project is being carried out using criteria investment valuation. So that it can be seen how worthy the research.

3.6. Conclusion & Suggestion

After collecting, processing data and analyzing, then the conclusion of the bachelor work will be obtained. The conclusion will answer the purpose of the Bachelor work.

CHAPTER IV
DATA ANALYSIS AND DISCUSSION

4.1. Diesel Consumption

For the first decision for making the biodiesel production facility is the capacity of the production which will provides and cover the consumption of the area. For that reason, it is necessary to look for the consumption for that specific area or province. Fuel consumption in the province of Nusa Tenggara Barat have increased each year. The consumption of the premium type and the diese4l fuel increased when compared to the previous year, with the consumption of the premium and the diesel fuel for Nusa Tenggara Province in 2016 is 203,998.37 Kiloliter.

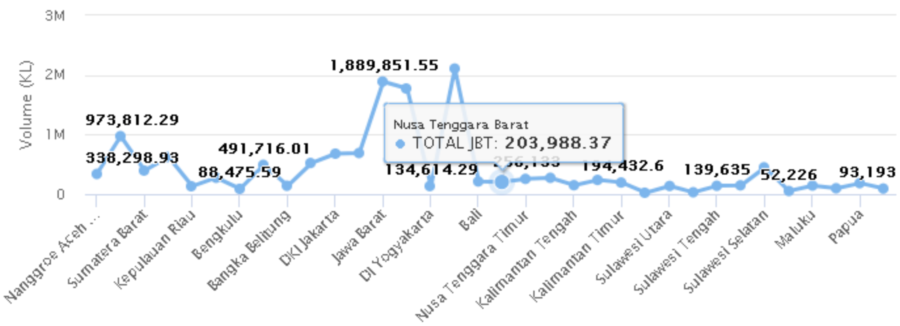

Figure 4. 1. Consumption of Diesel Oil in 2016 for each province in Indonesia. (Source : http://www.bphmigas.go.id/chart/konsumsi-bbm-nasional-per-provinsi)

According to current available data of the diesel consumption for Nusa Tenggara Barat region, with the total of 203,988.37 Kiloliters. Another parameter that must be taken into consideration are the availability of the raw material or feedstock that will be produced into biodiesel. Nusa Tenggara Barat is well known as one of the most Soybean Producer province in Indonesia with the productivity of 97.200 ton of soybean in 2014 and in the next year the production has increase into 115.000 ton in 2015.

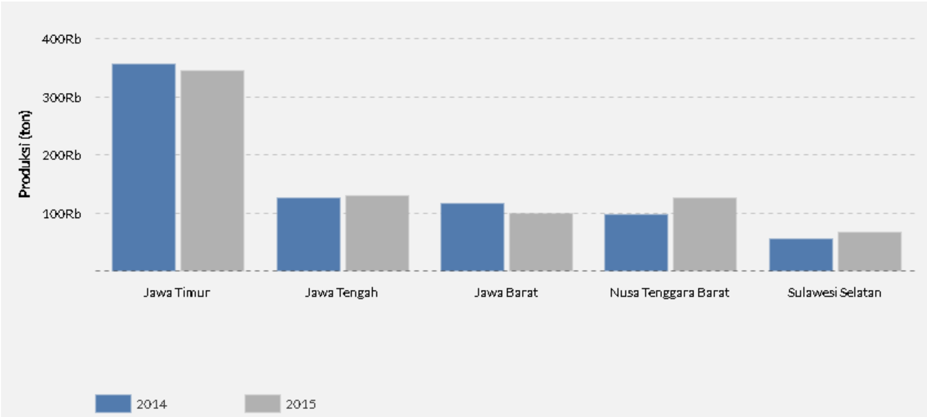

Figure 4. 2. The 5 biggest soybean producers in Indonesia.
(Source : Badan Pusat Statistik 2015)

Summarizing from the parameters above, the construction of a 5000-ton annual capacity of the biodiesel plant may be reasonable and feasible to be invested since it results in a moderate investment for the farmer to be investing in. Furthermore, the selection of the capacity for the current bachelor thesis is convenient in case of the capital investment and a reasonable and feasible operational cost. In this case of bachelor thesis, the design and cost analysis that of a biodiesel production with an annual capacity of 5000-tons.

4.2. Biodiesel Production Equipment

The Objective of this chapter is to discuss the necessary equipment and the principles behind the primary equipment for the biodiesel plant facility. The plant design is modelled based on two sequential transesterification reactions. Biodiesel is the product obtained from the chemical reaction of vegetable oil or animal fat with an alcohol to produce fatty acid alkyl esters. In the reaction, a catalyst is required. In a biodiesel production process, glycerol can be produced as a co-product. The approximate proportions for the reaction from making the biodiesel product are:

1000 Kg of Oil + 110 Kg of Methanol → 1000 Kg of Biodiesel + 110 Kg of Glycerol

For the purpose of the reaction catalyst use usually requires a quantity of 1.5% of the oil quantity that will be processed. Based on several researches the production for a ton of biodiesel required approximately 60 kWh of input electricity. For a biodiesel plant operation Natural gas is often used to generate steam for the evaporation and distillation process. For a ton of biodiesel produced an average of 440kWh of Natural gas supply is required. For water requirements, biodiesel plant used approximately 1.28 tons of water for each ton of biodiesel.

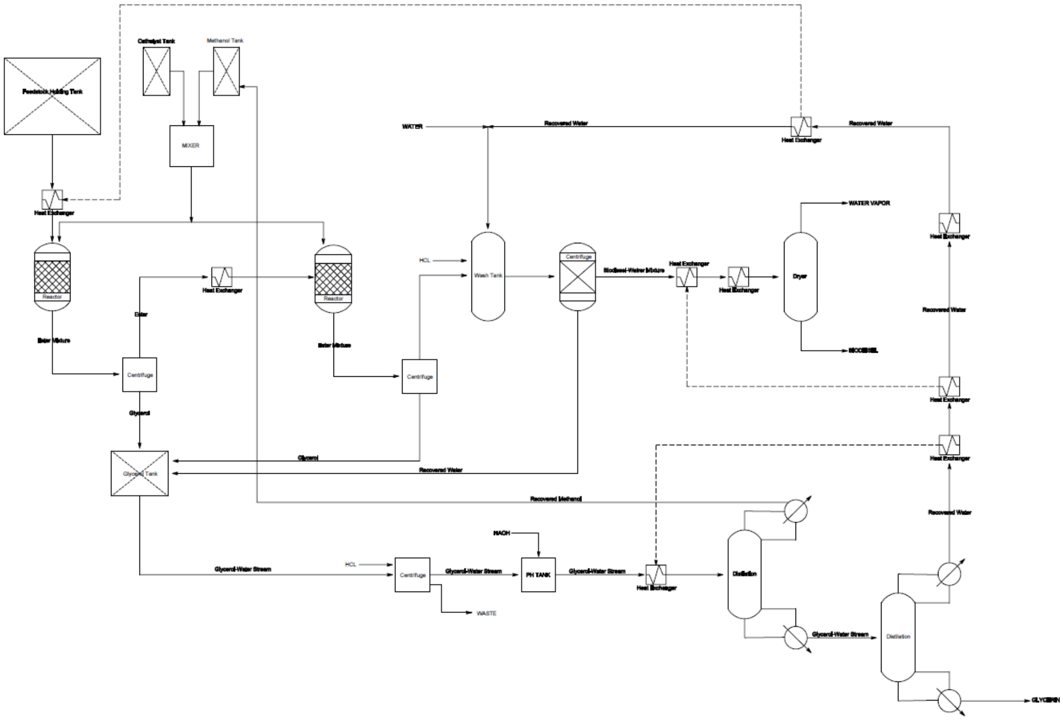

Figure 4. 2. Process flow Diagram of Biodiesel production model.
(Source : Personal data)

The production of the biodiesel consisted of three processing sections:

1. Transesterification process, in which the vegetable oil is subject to chemical transesterification in order to produce the fatty acid methyl in which is the biodiesel product and the co-product of glycerol.

2. Purification process, in which the methyl esters produced from the transesterification are refined to meet the standard specification.

3. Glycerol Recovery process

4.2.1. Transesterification Stage

Transesterification begins the mix of the oil which uses catalyst to achieve continuous reaction in a reactor. Following the continuous reaction in the reactor, a centrifugation of the reaction is employed to separate between the methyl ester product and glycerol-rich product which is later sent to the glycerol recovery unit for the glycerol recovery process. The methyl ester which still contains unreacted methanol, vegetable oil, and catalyst is then sent into a second reactor. In this reactor the crude ester product is removed from the reactor at a rate equal to that of reagent addition.

The Mixture of the Methyl esters, Glycerol, catalyst and unreacted substrates exiting the second reactor is fed to a continuous centrifuge which again separate the methyl ester product with the glycerol rich product. Then the Impure Methyl ester product goes to the biodiesel refining process for dehydration and purification.

4.2.2. Biodiesel Purification Stage

The Impure or crude methyl ester that which already been separated from the glycerol product is washed with water to neutralize the catalyst and convert any soaps to free fatty acids to reduce their emulsifying tendencies. Then the biodiesel product is entering a centrifugal pump to separate the biodiesel product from the aqueous phase. Before the crude methyl ester (biodiesel) are stored in the Biodiesel Tank, it goes through a vacuum dryer. This is done to lower the content of water that may still be in the biodiesel

4.2.3. Glycerol Recovery Stage

The amount of Glycerol-high product that was generated from the Transesterification and the Biodiesel Purification Process are collected in a Glycerol collection Tank. The collected mixtures are then treated with hydrochloric acid (HCl) to form free acids, allowing removal by Centrifugal Pump. The Glycerol that goes through the Centrifugal pump is then neutralized by using caustic soda in PH adjustment tank. The neutralized stream of Glycerol then goes into Distillation process to recover methanol to be used into the transesterification process. After it goes through a distillation process to recover methanol content, it goes through a final distillation process to reduce the water content from the Glycerol mixture.

The recovered water during the Biodiesel Purification Process and Glycerol Distillation can be used and are recycled back into Biodiesel Purification process for the washing of the Methyl Ester mixture Purpose. Heat exchangers included to recover the heat from each condensation.

The model of the Process flow diagram in Figure 4.3 is meant to be used for assessing the effects on estimated biodiesel production costs of changes in feedstock and glycerol prices, chemical or process technology that are used, or in equipment specified for the facility. The model is flexible and meant to be use as a tool in estimating the capital cost and the operating cost of the facility. Based on Figure 4.1 of the biodiesel production processes the Equipment necessary for Biodiesel Production Plant for each of the processing sections are as follow.

Table 4. 1 Biodiesel Plant Production Equipment

No.	Item	Description
1	Reactor Pre-heater	Tranesterification Equipment
2	Biodiesel Reactor	Tranesterification Equipment
3	Centrifuge	Tranesterification Equipment
4	Methanol Storage Tank	Tranesterification Equipment
5	Catalyst Storage Tank	Tranesterification Equipment
6	Methanol/ Catalyst Mixer	Tranesterification Equipment
7	Biodiesel Wash Tank	Biodiesel Purification Equipment
8	Centrifuge	Biodiesel Purification Equipment
9	Pre-heater	Biodiesel Purification Equipment
10	Heater	Biodiesel Purification Equipment
11	Vacumm Dryer	Biodiesel Purification Equipment
12	GlycerolCollection Tank	Glycerol Recovery Equipment
13	Glycerol Distillation System	Glycerol Recovery Equipment
14	Methanol Distillation System	Glycerol Recovery Equipment
15	PH Adjustment Tank	Glycerol Recovery Equipment
16	Centrifuge	Glycerol Recovery Equipment
17	Fatty Acid Storage Tank	Glycerol Recovery Equipment
18	NAOH mix Feeder	Glycerol Recovery Equipment

4.3. Biodiesel Storage Time

The maximum permissible duration of storing the biodiesel product where the chemical properties and the nature of the biodiesel has not been totally degraded due to the oxidation process can be seen from the acid number. The higher the acidity number means that the biodiesel quality is degrading. The increase amount of acid value during the storage time can be approached with the equation.

$$y = 0.0012x^2 - 0.0052x + 0.0609 \quad (7)$$

Whereas:

Y : The acid value
X : Storage time period

By using the formula, the maximum time of the storage of the biodiesel can be predicted. With the standard of the allowable acidity value of biodiesel of 0.5, it can be predicted that the maximum time for storing biodiesel may not exceeding 21 weeks.

4.4. Economic Analysis

Based on the necessary equipment needed that are shown in Table 4.1 The capital cost can be summarized. The model is flexible, and is meant for use in assessing the effects on estimated biodiesel production costs of changes in feedstock and glycerol prices, in chemical or process technology employed, or in equipment specified for the facility.

4.4.1. Cost Analysis

Based on the necessary equipment needed that are shown in Table 4.1 The capital cost can be summarized. The model is flexible, and is meant for use in assessing the effects on estimated biodiesel production costs of changes in feedstock and glycerol prices, in chemical or process technology employed, or in equipment specified for the facility. Based on the process flow diagram shown in Fig. 4.1, capital and production costs were calculated. Capital costs are summarized in Table 4.2. The cost parameters of the biodiesel production can be split into the annual biodiesel production cost which include the oil extraction and the biodiesel production, and the Investment costs. The Investment costs can be characterized as the capital costs for the costs of the equipment necessary for the production, the land acquisition assets and the associated infrastructure labor costs. As for the Annual Biodiesel production costs, it is divided into two category which are the Annual Oil Extraction and the Annual Biodiesel Production.

Table 4. 2 Capital Cost

Biodiesel Production Capital Cost	Cost	Count	Total Cost
Storage Facilities			
Crude Glycerol Storage Tank	$ 8,000.00	1	$ 8,000.00
Biodiesel Storage Tank	$ 12,000.00	1	$ 12,000.00
Processing Equipment			
Methanol storage tank	$ 1,365.00	1	$ 1,365.00
Catalyst Tank	$ 28,000.00	1	$ 28,000.00
Methanol Catalyst Mixer	$ 7,840.00	1	$ 7,840.00
Reactor Pre Heater	$ 6,720.00	2	$ 6,720.00
Reactor	$ 156,800.00	2	$ 156,800.00
Centrifuge	$ 104,832.00	2	$ 104,832.00
Biodiesel Wash Tank	$ 39,200.00	1	$ 39,200.00
Vacum Dryer	$ 17,124.00	1	$ 17,124.00
Water Removal Heater	$ 2,240.00	1	$ 2,240.00
Water Removal Pre-Heater	$ 10,080.00	1	$ 10,080.00
Glycerol Collection Tank	$ 6,720.00	1	$ 6,720.00
Methanol Distillation system	$ 106,400.00	1	$ 106,400.00
Glycerol Distilation System	$ 246,400.00	1	$ 246,400.00
PH Adjustment Tank	$ 6,720.00	1	$ 6,720.00
Fatty Acid Storage Tank	$ 11,200.00	1	$ 11,200.00
NAOH mix Feeder	$ 5,600.00	1	$ 5,600.00
Facilities Installation			
Machinery Installation	$ 28,000.00	1	$ 28,000.00
Electrical Installation	$ 21,000.00	1	$ 21,000.00
Total			$ 826,241.00

Table 4. 3 Annual Oil Extraction

Item	Cost		Count		Total Cost
Raw Material	$0.00	/ton	55	$	-
Feedstocks					
Utilities	$0.10		1451.06	$	140.17
Electricity					
Labor	$2,940.00	/person	1	$	2,940.00
Administration	$2,940.00	/person	1	$	2,940.00
Production	$2,940.00	/person	1	$	2,940.00
Maintenance	$2,940.00	/person	1	$	2,940.00
Storage	$2,940.00	/person	1	$	2,940.00
Maintenance					
Maintenance Supplies	$3,490.00			$	3,490.00

Table 4. 4 Annual Biodiesel Production

Item	Cost		Value		Total Cost
Raw Materials					
Soybean oil	$736.03	/ton	961.0	$	707,326.93
Methanol	$430.00	/ton	249.9	$	107,440.12
Catalyst	$2.07	/ton	1270.2	$	2,631.77
Hydrochloric Acid (HCl)	$196.00	/ton	1	$	196.00
Sodium Hydroxide	$441.00	/ton	1	$	441.00
Utilities					
Electricity	$0.10	/kWh	57660.17	$	5,569.97
Natural Gas	$0.05	/kWh	422841.25	$	20,837.62
Water	$0.25	/ton	1230.08	$	301.37
Labor					
Administration	$2,940.00	/Person	1	$	2,940.00
Production	$2,940.00	/Person	1	$	2,940.00
Maintenance	$2,940.00	/Person	1	$	2,940.00
Storage	$2,940.00	/Person	1	$	2,940.00
Maintenance					
Maintenance Supplies	$7,772.41			$	7,772.41
	Total			$	864,277.19

This analysis calculates a final biodiesel production cost of US$ 864.277.19. Raw materials costs constitute the greatest component of overall production costs, and of these the cost of the soy oil feedstock is the biggest contributing factor, itself constituting 90% of the overall production cost.

4.4.2. Total Cost Summary

The total cost of the biodiesel production plant, including the investment cost and annual cost are shown in Table.4.5. The analysis calculated the final biodiesel production cost of $ 1.54/L.

Table 4. 5 Summary of the total cost of Biodiesel Plant

Total Capital Cost		
Land and Infrastructure Cost	$	150,000.00
Oil Extraction Capital cost	$	83,900.00
Biodiesel Production Capital Cost	$	826,241.00
Total	**$**	**1,060,141.00**
Total Annual Production Cost		
Annual Cost of Oil Extraction	$	15,390.18
Annual Biodiesel Production Cost	$	863,975.82
Total	**$**	**879,365.99**
Biodiesel Production Cost (/lt)	**$**	**1.54**

Raw materials constitute the greatest cost of overall production costs which is 90%, and of those the cost of the Feedstock oil in this case the Soybean Oil is the largest contribute factor, almost 82% of the overall production cost. The large contribution of feedstock cost to the cost of biodiesel highlight the potential value of low-cost vegetable oil alternatives to the improvement of the biodiesel plant economic viability. Concerning the Investment cost the analysis resulted in the total cost of the investment of $ 1,060,141.00 The Biodiesel production cost constitute the biggest cost of 77% of the total investment cost. Based on the total capital cost that is $1,060,141, the loan capital with the proportion of 70:30 (%).

Table 4. 6 Credit Scenario

Credit Scenario

Description	**Percentage**		**Total**
Self- FInancing	30%	$	318,042.30
Bank Loan	70%	$	742,098.70
	100%	$	1,060,141.00

In this research, the scenario was carried out within the 5-year loan period with fixed installments and interest payments are paid monthly during the borrowing period. The loan recapitulation is shown in Table 4.5 the detailed calculations will be included in the appendix.

Table 4. 7 5-year Loan repayment scenario

Year	Interest(%)	Interest ($)	Loan Re=Payment ($)	Total Loan repayment ($)
1		$89,051.84	$148,419.74	$237,471.58
2		$89,051.84	$148,419.74	$237,471.58
3	12%	$89,051.84	$148,419.74	$237,471.58
4		$89,051.84	$148,419.74	$237,471.58
5		$89,051.84	$148,419.74	$237,471.58

Table 4.8. shows the net return from producing a liter of biodiesel. According to the total cost for producing a liter of biodiesel from soybean was $1.54/Liter. Accounting the selling price of a of the meal produced from the oil extraction process it was worth $0.34/Liter of meal and the selling of the biodiesel product and the glycerin co-product worth $0.70/Liter and 0.60/Liter respectively. Taking the market price of biodiesel is $0.70/Liter, the net return from producing biodiesel was $0.10/Liter of biodiesel

Table 4. 8 Summary of the total cost of Biodiesel Plant

Category	Cost	
Biodiesel Revenue (/L)	$	0.70
Meal Revenue	$	0.34
Glycerin Revenue (/L)	$	0.60
Total Revenue (/L)	$	1.64
Total Cost (/L)	$	1.54
Net Return (/L)	**$**	**0.10**

4.5. Economic Feasibility Parameter

The Discussion of the analysis aims to determine the feasibility of the Biodiesel Plant, which will be tested using four economical parameters.The value of the Parameter are:

- Net Present Value (NPV)

The life cycle of the investment was chosen to be 10 years and the method that is used for the evaluation was the Net

Present Value (NPV) with the discount rate of 8%. It is assumed that each three operational years of the plant, there will be a 5% increase in the production costs as well as the biodiesel selling price. Various values have been given to biodiesel selling prices, in order to investigate the behavior of NPV. The plant would be accepted if the NPV>0. In this case the NPV value of $2,349,375.18. For that this project is acceptable because the NPV>0

- Internal Rate of Return (IRR)

  The Internal Rate of Return has a value of 19%. The value of the IRR of the project is higher than the discount factor of the project which is 8%. Depend on that this project is acceptable.

- Payback Period (PP)

  Payback period for this Biodiesel Production facility is 2.37 year

- Profitability Index (PI)

  The PI that of the Project has a value of 3.079. Because the PI is more than one PI>1.00 then the project is acceptable

- Net Benefit-Cost Ratio (Net B/C)

  Net Benefit cost that are obtained from the analysis is equal to 1.85. Looking at the value of the Net Benefit Cost that is 1.85, the project is acceptable because the Net B/C>1.

CHAPTER V
CONCLUSION & SUGGESTION

5.1. Conclusion

Based on the analysis and the discussion that has been done, the conclusions are as follow

1. The necessary Equipment for Biodiesel Production facility is based on the three stages of the production. And those stages include the Transesterification stage, the Biodiesel purification stage, and the glycerol recovery stage.
2. The maximum time of storing the biodiesel can be predicted by knowing the acidity value. The approach can be made by using the formula y=0.0012x^2-0.0052x+0.0609 to predict the maximum storage time of biodiesel. By using the following formulas, the maximum time of storage for biodiesel may not be exceed 21 weeks of storage..
3. Raw Materials cost constitute the greatest cost of the overall production cost with 83% of the total production and the 73% are contributed from the cost of the soybean oil.
4. The contribution of the feedstock cost in this case the soybean oil to the overall cost shows the importance of a low-cost feedstock oil for improving the economic viability of the plant.
5. The loan period can be extended if more profits would be achieved. That way, once the biodiesel production facility is operating it could bring profits. However, the loan interest should also be noted. In this case choosing the smallest loan interest among domestic banks, both state-owned banks and private banks.
6. The economic feasibility study of the biodiesel production has a total cost of investment of $ 1,970,341. With the Net present value (NPV) $2,349,375.18.; Internal rate of Return (IRR) of 19%, the payback period (PP) of 2.37 year; and the Profitability index (PI) of 3.079.
7. Based on the financial projections that has been carried out, with the estimation that has been fulfilled, the project to make a biodiesel production facility provides a positive contribution so that it is feasible to be implemented.

5.2. Suggestion

From the analysis that have been carried out the conclusion that have been obtained; the suggestion can be given for the bachelor thesis are as follow

1. For the Equipment of the biodiesel production facility can be replaced by the same equipment but with a different price to reduce the capital cost of the investment.
2. To make sure that the biodiesel quality is still allowable to be used, the acid number should not exceed the allowable standard of o.8 mg KOH/g Biodiesel.

3. Selection of state-owned banks or private banks that have different loan ratios and interest rates.
4. Selecting a low-cost raw material for the biodiesel production may have the influence to improve the economic viability.
5. For reducing the capital investment cost investor should focus on reducing the equipment.

References

Ahmad, M., Khan, A. M., Zafar, M., & Sultana, S. (2011). *Biodiesel from Non Edible oil Seeds: a Renewable Source of Bioenergy.* Islamabad.

Balat, M., & Balat, H. (2010). *Progress in Biodiesel processing.*

BI. (2014). *Pola Pembiayaan Usaha Kecil.* Batam: Bank Indonesia.

Jakeria, M., Fazal, M., & Haseeb, A. (2014). Influence of different factors on the stability of biodiesel. *A review ,Renewable andSustainable Energy Reviews*, 154-163.

Kara, K., Ouanji, F., Lotfi, E. M., Mahi, M. E., Kacimi, M., & Ziyad, M. (2017). Biodiesel production from waste fish oil with high fre fatty acid content from Morocan fish-Processing Industries. *Egyptian Journal of Petroleum*.

Pavan , P., Venkanna, B. K., Mudhol, B., & Pavan, K. (2015). Performance characteristic of diret injection diesel engine running on mackerel fish oilbiodiesel/ diesel fuel blend. *International Journal of Scientific& Engineering Research, Volume 6,Issue 1*.

Saifuddin, M., & Boyce, A. (2017). Biodiesel Production from fish waste and Evaluation of Engine Performance. *Sains Malaysiana*, 1771-1778.

Sathiyagnanam, A., & Saravan, C. (2011). Experimental Studies on the combustion Characteristics and Performance of a Direct Injection Engine fueled with Biodiesel/Diesel Blend with SCR. *World Congress on Engineering.*

Vasudevan, P. T., & Briggs, M. (2008). Biodiesel Production-current state of the art and challenges. *J. Ind Microbiol Biotechnol*, 421-430.

APPENDIX 1
CAPITAL EXPENDITURE

a. Land acquisition and Infrastructure Cost

Desired Facility Capacity	**5,000**	
Period	**10 Years**	
Land and Infrastructure Cost		**Cost**
Land Acquisition	$	100,000.00
Construction Cost		
Office and Administration	$	50,000.00
Organizational Cost		
Total	***$***	***150,000.00***

b. Equipment cost

Biodiesel Production Capital Cost		**Cost**	**Count**		**Total Cost**
Storage Facilities					
Crude Glycerol Storage Tank	$	8,000.00	1	$	8,000.00
Biodiesel Storage Tank	$	12,000.00	1	$	12,000.00
Processing Equipment					
Methanol storage tank	$	1,365.00	1	$	1,365.00
Catalyst Tank	$	28,000.00	1	$	28,000.00
Methanol Catalyst Mixer	$	7,840.00	1	$	7,840.00
Reactor Pre Heater	$	6,720.00	2	$	6,720.00
Reactor	$	156,800.00	2	$	156,800.00
Centrifuge	$	104,832.00	2	$	104,832.00
Biodiesel Wash Tank	$	39,200.00	1	$	39,200.00
Vacum Dryer	$	17,124.00	1	$	17,124.00
Water Removal Heater	$	2,240.00	1	$	2,240.00
Water Removal Pre-Heater	$	10,080.00	1	$	10,080.00
Glycerol Collection Tank	$	6,720.00	1	$	6,720.00
Methanol Distillation system	$	106,400.00	1	$	106,400.00
Glycerol Distilation System	$	246,400.00	1	$	246,400.00
PH Adjustment Tank	$	6,720.00	1	$	6,720.00
Fatty Acid Storage Tank	$	11,200.00	1	$	11,200.00
NAOH mix Feeder	$	5,600.00	1	$	5,600.00
Facilities Installation					
Machinery Installation	$	28,000.00	1	$	28,000.00
Electrical Installation	$	21,000.00	1	$	21,000.00
Total				$	826,241.00

APPENDIX 2
OPERATIONAL EXPENDITURE

a. Oil Extraction Operational Expenditure

Item	Cost		Count	Total Cost
Raw Material	$0.00	/ton	55	$ -
Feedstocks				
Utilities	$0.10		1451.06	$ 140.17
Electricity				
Labor	$2,940.00	/person	1	$ 2,940.00
Administration	$2,940.00	/person	1	$ 2,940.00
Production	$2,940.00	/person	1	$ 2,940.00
Maintenance	$2,940.00	/person	1	$ 2,940.00
Storage	$2,940.00	/person	1	$ 2,940.00
Maintenance				
Maintenance Supplies	$3,490.00			$ 3,490.00

b. Biodiesel Production Expenditure

Item	Cost		Value	Total Cost
Raw Materials				
Soybean oil	$736.03	/ton	961.0	$ 707,326.93
Methanol	$430.00	/ton	249.9	$ 107,440.12
Catalyst	$2.07	/ton	1270.2	$ 2,631.77
Hydrochloric Acid (HCl)	$196.00	/ton	1	$ 196.00
Sodium Hydroxide	$441.00	/ton	1	$ 441.00
Utilities				
Electricity	$0.10	/kWh	57660.17	$ 5,569.97
Natural Gas	$0.05	/kWh	422841.25	$ 20,837.62
Water	$0.25	/ton	1230.08	$ 301.37
Labor				
Administration	$2,940.00	/Person	1	$ 2,940.00
Production	$2,940.00	/Person	1	$ 2,940.00
Maintenance	$2,940.00	/Person	1	$ 2,940.00
Storage	$2,940.00	/Person	1	$ 2,940.00
Maintenance				
Maintenance Supplies	$7,772.41			$ 7,772.41
Total				$ 864,277.19

APPENDIX 3
FEASIBILITY ANALYSIS

a. Cash flow

No.	Description	Year 1				Year 2	
1	**Income**						
	Meal sales	IDR	**13,825,000,000.00**	$	967,750.00	Rp	**13,825,000,000.00**
	Glycerin Sales	IDR	**1,782,857,142.86**	$	124,800.00	Rp	**1,782,857,142.86**
	Biodiesel Sales	IDR	**5,211,712,000.00**	$	364,819.84	Rp	**5,211,712,000.00**
	Total Income	IDR	**20,819,569,142.86**	$	1,457,369.84	Rp	**20,819,569,142.86**
2	**Spending**						
	Oil Extraction Operational Cost						
	Operating Cost (Exclude Labor)	IDR	**65,859,611.66**	$	4,610.17	Rp	**65,859,611.66**
	Labor Cost	IDR	**14,000,006.00**	$	980.00	Rp	**14,000,006.00**
	Biodiesel Production Operational Cost						
	Operating Cost (Exclude Labor)	IDR	**12,184,167,071.38**	$	852,891.69	Rp	**12,184,167,071.38**
	Labor Cost	IDR	**12,483,984.00**	$	873.88	Rp	**12,483,984.00**
	PPN 10%	IDR	**2,081,956,914.29**	$	145,736.98	Rp	**2,081,956,914.29**
	Total Ispending	IDR	**14,278,607,969.66**	$	999,502.56	Rp	**14,278,607,969.66**
3	**Investment Cost**						
	Oil Extraction Equipmentl Cost	Rp	**1,198,571,431.57**	$	83,900.00	Rp	-
	Biodiesel Production Equipment Cost	Rp	**11,520,585,714.29**	$	806,441.00	Rp	-
	Land and Infrastructure Cost	Rp	**2,142,857,142.86**	$	150,000.00	Rp	-
	Total Investment	Rp	**14,862,014,288.71**	$	1,040,341.00	Rp	-
4	**Loan**						
	Bank Loan	Rp	**10,601,410,002.10**	$	742,098.70	Rp	-
	Government Subsidue	Rp	-	$	-	Rp	-
	Total	Rp	**10,601,410,002.10**	$	742,098.70	Rp	-
5	**Expenditure**						
	Annual Payment	Rp	**3,392,451,200.67**	$	237,471.58	Rp	**3,392,451,200.67**
	Total Expenditure	Rp	**3,392,451,200.67**	$	237,471.58	Rp	**3,392,451,200.67**
Open-Year Balance		Rp	-	$	-	-Rp	**11,713,504,316.19**
End Year Balance		-Rp	**11,713,504,316.19**	$	(819,945.30)	-Rp	**8,564,994,343.67**
Net Cash Flow		-Rp	**11,713,504,316.19**	$	(819,945.30)	-Rp	**8,564,994,343.67**

Economical Parameter			
NPV	NPV > 0	**$ 2,819,314.60**	acceptable
IRR	IRR > HR	**22%**	acceptable
PP	PP < masa keekonomian	**2.27**	acceptable
PI	PI > 1,00	**3.698**	acceptable
Net B/C	Net B/C > 1,00	**2.22**	acceptable
BEP		**$ 457,867.28**	
BEP		**315536**	liter
		316	ton

		Year 3				Year 4				Year 5	
$	967,750.00	Rp	**13,825,000,000.00**	$	967,750.00	Rp	**13,825,000,000.00**	$	967,750.00	Rp	**13,825,000,000.00**
$	124,800.00	Rp	**1,782,857,142.86**	$	124,800.00	Rp	**1,782,857,142.86**	$	124,800.00	Rp	**1,782,857,142.86**
$	364,819.84	Rp	**5,211,712,000.00**	$	364,819.84	Rp	**5,211,712,000.00**	$	364,819.84	Rp	**5,211,712,000.00**
$	1,457,369.84	Rp	**20,819,569,142.86**	$	1,457,369.84	Rp	**20,819,569,142.86**	$	1,457,369.84	Rp	**20,819,569,142.86**
$	4,610.17	Rp	**65,859,611.66**	$	4,610.17	Rp	**65,859,611.66**	$	4,610.17	Rp	**65,859,611.66**
$	980.00	Rp	**14,000,006.00**	$	980.00	Rp	**14,000,006.00**	$	980.00	Rp	**14,000,006.00**
$	852,891.69	Rp	**12,184,167,071.38**	$	852,891.69	Rp	**12,184,167,071.38**	$	852,891.69	Rp	**12,184,167,071.38**
$	873.88	Rp	**12,483,984.00**	$	873.88	Rp	**12,483,984.00**	$	873.88	Rp	**12,483,984.00**
$	145,736.98	Rp	**2,081,956,914.29**	$	145,736.98	Rp	**2,081,956,914.29**	$	145,736.98	Rp	**2,081,956,914.29**
$	999,502.56	Rp	**14,278,607,969.66**	$	999,502.56	Rp	**14,278,607,969.66**	$	999,502.56	Rp	**14,278,607,969.66**
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	237,471.58	Rp	**3,392,451,200.67**	$	237,471.58	Rp	**3,392,451,200.67**	$	237,471.58	Rp	**3,392,451,200.67**
$	237,471.58	Rp	**3,392,451,200.67**	$	237,471.58	Rp	**3,392,451,200.67**	$	237,471.58	Rp	**3,392,451,200.67**
$	(819,945.30)	-Rp	**8,564,994,343.67**	$	(819,945.30)	-Rp	**5,416,484,371.15**	$	(379,153.91)	-Rp	**2,267,974,398.63**
$	(819,945.30)	-Rp	**5,416,484,371.15**	$	(379,153.91)	-Rp	**2,267,974,398.63**	$	(158,758.21)	Rp	**880,535,573.89**
$	(599,549.60)	-Rp	**5,416,484,371.15**	$	(379,153.91)	-Rp	**2,267,974,398.63**	$	(158,758.21)	Rp	**880,535,573.89**

		Year 6				Year 7				Year 8	
$	967,750.00	Rp	**13,825,000,000.00**	$	967,750.00	Rp	**13,825,000,000.00**	$	967,750.00	Rp	**13,825,000,000.00**
$	124,800.00	Rp	**1,782,857,142.86**	$	124,800.00	Rp	**1,782,857,142.86**	$	124,800.00	Rp	**1,782,857,142.86**
$	364,819.84	Rp	**5,211,712,000.00**	$	364,819.84	Rp	**5,211,712,000.00**	$	364,819.84	Rp	**5,211,712,000.00**
$	1,457,369.84	Rp	**20,819,569,142.86**	$	1,457,369.84	Rp	**20,819,569,142.86**	$	1,457,369.84	Rp	**20,819,569,142.86**
$	4,610.17	Rp	**65,859,611.66**	$	4,610.17	Rp	**65,859,611.66**	$	4,610.17	Rp	**65,859,611.66**
$	980.00	Rp	**14,000,006.00**	$	980.00	Rp	**14,000,006.00**	$	980.00	Rp	**14,000,006.00**
$	852,891.69	Rp	**12,184,167,071.38**	$	852,891.69	Rp	**12,184,167,071.38**	$	852,891.69	Rp	**12,184,167,071.38**
$	873.88	Rp	**12,483,984.00**	$	873.88	Rp	**12,483,984.00**	$	873.88	Rp	**12,483,984.00**
$	145,736.98	Rp	**2,081,956,914.29**	$	145,736.98	Rp	**2,081,956,914.29**	$	145,736.98	Rp	**2,081,956,914.29**
$	999,502.56	Rp	**14,278,607,969.66**	$	999,502.56	Rp	**14,278,607,969.66**	$	999,502.56	Rp	**14,278,607,969.66**
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	-	Rp	-	$	-	Rp	-	$	-	Rp	-
$	237,471.58	Rp	-	$	-	Rp	-	$	-	Rp	-
$	237,471.58	Rp	-	$	-	Rp	-	$	-	Rp	-
$	(158,758.21)	Rp	**880,535,573.89**	$	61,637.49	Rp	**7,421,496,747.09**	$	519,504.77	Rp	**13,962,457,920.28**
$	61,637.49	Rp	**7,421,496,747.09**	$	519,504.77	Rp	**13,962,457,920.28**	$	977,372.05	Rp	**20,503,419,093.48**
$	61,637.49	Rp	**7,421,496,747.09**	$	519,504.77	Rp	**13,962,457,920.28**	$	977,372.05	Rp	**20,503,419,093.48**

	Year 9		Year 10	
$ 967,750.00	**Rp 13,825,000,000.00**	$ 967,750.00	**Rp 13,825,000,000.00**	$ 967,750.00
$ 124,800.00	**Rp 1,782,857,142.86**	$ 124,800.00	**Rp 1,782,857,142.86**	$ 124,800.00
$ 364,819.84	**Rp 5,211,712,000.00**	$ 364,819.84	**Rp 5,211,712,000.00**	$ 364,819.84
$ 1,457,369.84	**Rp 20,819,569,142.86**	$ 1,457,369.84	**Rp 20,819,569,142.86**	$ 1,457,369.84
$ 4,610.17	**Rp 65,859,611.66**	$ 4,610.17	**Rp 65,859,611.66**	$ 4,610.17
$ 980.00	**Rp 14,000,006.00**	$ 980.00	**Rp 14,000,006.00**	$ 980.00
$ 852,891.69	**Rp 12,184,167,071.38**	$ 852,891.69	**Rp 12,184,167,071.38**	$ 852,891.69
$ 873.88	**Rp 12,483,984.00**	$ 873.88	**Rp 12,483,984.00**	$ 873.88
$ 145,736.98	**Rp 2,081,956,914.29**	$ 145,736.98	**Rp 2,081,956,914.29**	$ 145,736.98
$ 999,502.56	**Rp 14,278,607,969.66**	$ 999,502.56	**Rp 14,278,607,969.66**	$ 999,502.56
$ -	**Rp -**	$ -	**Rp -**	$ -
$ -	**Rp -**	$ -	**Rp -**	$ -
$ -	**Rp -**	$ -	**Rp -**	$ -
$ -	**Rp -**	$ -	**Rp -**	$ -
$ -	**Rp -**	$ -	**Rp -**	$ -
$ -	**Rp -**	$ -	**Rp -**	$ -
$ -	**Rp -**	$ -	**Rp -**	$ -
$ -	**Rp -**	$ -	**Rp -**	$ -
$ -	**Rp -**	$ -	**Rp -**	$ -
$ 977,372.05	**Rp 20,503,419,093.48**	$ 1,435,239.34	**Rp 27,044,380,266.67**	$ 1,893,106.62
$ 1,435,239.34	**Rp 27,044,380,266.67**	$ 1,893,106.62	**Rp 33,585,341,439.86**	$ 2,350,973.90
$ 1,435,239.34	**Rp 27,044,380,266.67**	$ 1,893,106.62	**Rp 33,585,341,439.86**	$ 2,350,973.90

AUTHOR BIOGRAPHY

Author was born in Bogor, 10th June 1996. Author is a first child of two siblings of Mr Adri Budiman & Mrs Verrya Siti Khaeriah. Author took the elementary school at SD Al-Azhar 27 Cibinong (2001-2008), and junior high school at SMPI Al-Azhar 19 Cibubur (2008-2011) and senior high school at SMA Labschool Cibubur (2011-2014). Author active in Pencak Silat activity during junior high school and baseball and Futsal during senior high school. During college, the author was active in a variety of activities, one of which was the committee of the 2016 and 2017 ITS Expo and , where from those activities author got many experiences and achievement. Besides non-academic activities, the author has also carried internship, internship was carried out at PT BATAMEC (2017) and at PT Technip Indonesia (2019)