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TECHNO-ECONOMIC ANALYSIS IN ESTABLISHMENT OF BIODIESEL INDUSTRY FROM *NYAMPLUNG* SEED *(Calophyllum inophyllum* L.)

ANALISIS TEKNO-EKONOMI PENDIRIAN PABRIK BIODESEL DARI BIJI NYAMPLUNG *(Calophyllum inophyllum* L.)

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ABSTRAK

Krisis dunia yang terjadi dalam dekade terakhir berimbas pada kelangkaan bahan bakar minyak (BBM). Konsumsi bahan bakar melebihi produksi bahan bakar mengindikasikan perlunya pengembangan energi alternatif. Salah satunya adalah dengan menggunakan biji Nyamplung yang diolah menjadi biodiesel. Nyamplung (*Calophyllum inophyllum* L.) merupakan tanaman yang banyak ditemukan di pesisir pantai. Nyamplung adalah salah satu bahan biodiesel alternatif yang memiliki potensi besar untuk dikembangkan untuk mengatasi masalah kelangkaan BBM. Keuntungan dari biji Nyamplung sebagai bahan baku biodiesel adalah biji kering Nyamplung memiliki rendemen yang tinggi (sekitar 70%) dan penggunaannya tidak bersaing dengan keperluan pangan. Tujuan dari penelitian ini adalah untuk menganalisis aspek tekno-ekonomi pendirian industri biodiesel dari biji Nyamplung. Lingkup penelitian meliputi tekno-ekonomi, aspek pasar dan pemasaran, aspek teknis dan teknologi, aspek manajemen dan organisasi, aspek lingkungan, aspek hukum, dan aspek valuasi dan komersialisasi, serta aspek keuangan. Industri biodiesel direncanakan akan berlokasi di Banyuwangi dengan kriteria seleksi yang terkait dengan *Analytical Hierarchy Process* (AHP) dan kapasitas industri 1000 L per hari dengan bahan baku sebanyak 4500 kg per hari. Setelah penilaian yang mendalam dari semua aspek, dapat disimpulkan bahwa industri biodiesel dari biji Nyamplung layak untuk direalisasikan.

Kata kunci: tekno-ekonomi, nyamplung, industri biodiesel

ABSTRACT

World crises that occurred in the last decades indicated the scarcity of fuel. Fuel consumption is unbalanced with fuel production so it needs the development of alternative sources of energy. One of them is to use nyamplung seed. Nyamplung (Calophyllum inophyllum L.) is one of the biodiesel alternative raw material that has a large potential to be developed to overcome the problem of scarcity of fuel. The advantages of nyamplung as raw material for biodiesel are the dry seeds have high yield (approximately 70%) and its use does not compete with food purposes. The purpose of this study was to analyze techno-economic aspect of biodiesel industry establishment of nyamplung seed. Scope of research included techno-economic on the market and marketing aspects, technical and technological, management and organization, environmental, legal, valuation and commercialization, as well as financial aspects. This biodiesel industry is planned to be located in Banyuwangi, Indonesia with the selection criteria associated with using Analytical Hierarchy Process and the industrial capacity of 1000 liters per day with raw materials as much as 4500 kgs per day. After the assessment of all aspects, it can be concluded that the industry of biodiesel from nyamplung seed is feasible to be established.

Keywords: techno-economic, nyamplung, biodiesel industry

INTRODUCTION

Nyamplung (*Calophyllum inophyllum* L.) is a plant from family Clusiaceae that can be easily found around the coast of Sumatra, Java, Bali, Nusa Tenggara, and Papua (Hastanti *et al*., 2012). It has a medium-sized to large evergreen tree that averages 8–20 m (25–65 ft) in height with a broad spreading crown of irregular branches. The tree supports a dense canopy of glossy, elliptical leaves, fragrant white flowers, and large round nuts. It grows along coastal areas and adjacent lowland forests, although it occasionally occurs inland at higher elevations (Friday and Okano, 2006). Nyamplung has a wide distribution in the world. It can be found in eastern Africa (from Kenya to northern Mozambique), Madagaskar and other Indian Ocean islands, tropical Asia, nothern Australia and the island of Pacific Ocean (Louppe *et al.*, 2008). In Indonesia, the area of nyamplung reach 255 thousand ha. Nyamplung plant grows and spreads naturally in Indonesia. It also regenerates easily and bears fruit throughout the year that shows a high survival capacity to adapt in

**Penulis untuk korespondensi*

the various environment, and so this plants are relatively easy to cultivate.

Energy is a vital element in economic development. With the increasing world population and the rising living standards, the global energy demand is steadily increasing (EIA, 2006). Viswanathan (2006) stated that the standard of living of the people of any country is considered to be proportional to the energy consumption by the people of that country. In one sense, the disparity one feels from country to country arises from the extent of accessible energy for the citizens of each country. Unfortunately, the world energy demands are mainly met by the fossil fuels today. Uneven geographical distribution of fossil fuel sources as well as limited ability to acquire and also control the production and supply has raised to many issues and disparity in living standard. The energy consumption has been increasing and it will triple by the year of 2025. Therefore, the energy exploitation and utilization should be based on the sustainable development and better ecological environment, so that attain the harmonization of society, economy, energy, and sustainable environment meets the needs of the present without compromising the ability of future generations to meet their own needs (Dincer, 1998; Wang and Feng, 2003).

World energy crisis that occurred in the last decade caused a significant impact on the declining of fuel resources. It has encouraged the development of alternative energy from renewable resources. Nationally, the consumption of fossil fuel has increased, for example, it was 26.9 billion liters in 2004 and it was estimated to be 34.71 billion liters in 2010 (Soerawidjaya, 2005). The advantages of biodiesel as an alternative source of energy are its portability, ready availability, renewability, higher combustion efficiency, lower sulfur and volatile content, higher cetane number and higher biodegradability (Demirbas, 2008). However, alternative sources of biofuel derived from terrestrial crops such as sugarcane, soybeans, maize, and rapeseed compete with food supply, contribute to water scarcity, and precipitate forest devastation. In this way, the sustainability of biofuel will depend on the development of viable, sustainable, and advanced technologies that not commercially available (Ribeiro and da Silva, 2012).

Nyamplung is a potential raw material biodiesel production due to: it is non-edible, containing high kernel oil (65%), profusely fruits (3,000–10,000 seeds/tree/year), tolerant to marginal environmental conditions (acidity, salinity, drought and temperature) and requires little maintenance (Azam *et al*., 2005; Sahoo *et al.*, 2006; Hathurusingha and Ashwath, 2007). In addition to non-edible nature, the advantages of nyamplung dry seed as biodiesel feedstock is its high oil yield which can reach 70% by solvent extraction (Forest Research and Development Agency, 2008). These conditions indicate a great opportunity for establishing industries of nyamplung biodiesel on a large scale. Therefore, a comprehensive study is needed prior to develop a factory of industrial scale. One of importance aspect of the analysis is techno-economic aspect. The result of analysis to be used as a reference for decision making of nyamplung biodiesel industry establishment.

The objectives of this study were to analyze the techno-economic feasibility of biodiesel industry establishment of nyamplung (*Calophyllum inophyllum* L.). The focuses were are technical and technological aspects, financial aspects and valuation and commercialization of technology aspects, and assessment of market and marketing aspects, management and organizational aspects, legal aspects and environmental aspects.

METHODOLOGY

Techno-economic analysis methods can be classified as dynamic and static approaches according to whether the time value of money is considered or not. There are some steps that must be followed in relation to problem analysis and examination of aspects relate to industrial design. These stages are data and information collection, data processing and analysis, technical and technological analysis, financial analysis, valuation and commercialization of technology analysis, market and marketing analysis, management and organizational analysis, and environment and legal analysis.

Collection of Data and Information

Collecting data and information is the initial stage of research to find bases of analysis for establisment of biodiesel industry from seed of nyamplung. Data and information also required to support problem solving and decision making process. Data collected include primary and secondary data from various sources including the Agency for Forestry Research and Development, SBRC (Surfactant and Biodiesel Research Center), PT Tracon Industries and Ministry of Industry.

Data Processing and Analysis

Data were processed using computer softwares. Analysis performed includes qualitative and quantitative analysis as follows:

Technical and Technological Aspects

Technical and Technological analysis include determining production capacity and location, selection of process technology, machinery and equipment, mass and energy balance, and layout planning (production space and layout of the plant).

A multi-attribute technique of Analytical Hierarchy Process (AHP) was used to determine the location of the plant. It is a method of analysis

through pair wise comparisons and relies on the judgments of experts to derive priority scales. The scales represent intangible measurement in relative terms. The comparisons are made using a scale of absolute judgments that represents how much more; one element dominates another with respect to a given attribute. The judgments may be inconsistent, and how to measure inconsistency and improve the judgments, when possible to obtain better consistency is a concern of the AHP. The derived priority scales are synthesized by multiplying them with assigned priority of their parent nodes and adding for all such nodes (Saaty, 2008).

Selection of the type of production process technology was based on its easyiness and estimate cost. Selection of machinery and equipment was based on the selected technology and production processes. Mass balance was prepared to identify flow rate, and input and output of each material component in each process. Energy balance was prepared to trace and calculate the flow and requirement of energy in each and whole processes. AR-Chart was used to identify and calculate flow of materials, layout design and space requirement.

Financial Aspects

Financial aspect analysis are to determine investment, benefit and cost and income and outcome comparison. The parameters of financial analysis were originated from previous analysis ie. production capacity, market target, technology used, equipment alternatives, number of employees, supporting facility and projected price. This analysis includes cost requirement both investment and production and financing structure in accordance with prevailing interest rate. Then, the analysis continued to cover income acquired plan, profit and loss and cash flow. The investment criteria were: net present value, internal rate of return, benefit cost ratio, break even point, payback period and sensitivity analysis.

Valuation and Commercialization of Technology Aspect

Valuation analysis and commercialization of technology include vision, mission, customer selection, differentiation and control, scope of product and activities, value capture for profit, value for talent and business model. Business models are important factors as determinants of profits made from innovation. A usual innovation with great business model innovation is more profitable than a common business model.

Valuation is an activity to achieve the goal by performing predictions or results to be obtained. Valuation is useful in preliminary analysis, financing, business development, and joint and acquisition activities. According to Goenadi (2000), commercialization is a series of efforts for development and marketing of a product or a process of development and application of this process in the production activities. This activity is a series of fairly complex, involving various aspects such as economic policy, human resources, investment, time, market and environment.

Market and Marketing Aspect

Market and marketing aspects include potential market analysis, market share analysis and strategy determination. Husnan and Muhammad (2000) stated that the market and marketing aspects analysis of a project aimed to describe potential available market for the foreseeable future, market share that can be gained, and market growth in future. The market analysis determines the quantity, characteristic and growth of total product demand, description of product and selling price, market situation and competition (Edris, 1993). Some important aspects that should be considered are condition of the product in present time, past and present demand of products, composition of demand in every market segment, projection of future product demand and possibility of competition in the market (Sutojo, 1996).

Management and Organizational Aspect

Management and organizational aspect is an analysis to detemine organization type that suitable for industry under consideration. Beside that, it determines human required resources with their position, job description and suitable qualification.

Environmental and Legal Aspect

Environmental aspect involves analysis of environmental impacts and their mitigation. Legal aspect defines suitable business entity and fulfillment the terms and conditions prior to establishment of industry.

RESULTS AND DISCUSSION

Technical and Technological Aspects

Based on technical and technological aspects, it can be known initial design of invesment cost. Technical analysis is related to project input (product) and possible connection in a project and identification of difference information during planning and implementing phase (Hasnan and Muhammad, 2000). Technology for production of renewable fuels from nyamplung seed are being developed with special reference to reducing dependence on imported petroleum, decreasing greenhouse gas emissions, and improving national security (Pham *et al.*, 2010).

Raw Material

It was estimated that a possible constraint faced by the industrial scale for producing biodiesel from nyamplung seed would be availability of the

feedstock. The advantage of nyamplung seed as raw material for biodiesel production is its very high potential production when compared to jathropa. The productivity reach 20 tons/ha/year containing relatively high oil range between 50-70%. Average jatropha productivity is 5 tons seed/ha/year with oil content is between 40-60% (Forestry Research Agency, 2008).

Capacity

Production capacity of biodiesel industry was obtained from scaling up study. The scaling up was undertaken in laboratory scale research at SBRC. The results suggested that scale of biodiesel capacity was 288,000 liter/year or 1,000 liter/day. This scale was also supported by the raw material production.

Location

The site was chosen from four alternatives according to potential supply of raw materials and closeness to markets. The alternatives were Kedu, Banyuwangi, Cilacap, and Ciamis. The result of AHP with the score from experts is shown in Figure 1. The results show that the most important criterion in determining location of nyamplung biodiesel industry was the availability of raw material (score of 0.374) compare to other factors. In addition, nyamplung seed is freshable so it is easy to decay rapidly then the plant must be closeed to raw material production sites.

The most influential actor in the establishment of the biodiesel factory was the industry with score of 0.34. The industry performs many activities such as processing, supervising and organizing, so that it is the executor. The second important actor was the investor. Together with improving social welfare, the primary objective in establishing the industry was to gain optimum profit (score of 0.49).

Following analysis of important factor, actor and objective, Banyuwangi was chosen for location of the factory. The reason was simply logic, Banyuwangi has abundant raw material, so the factory could operate at minimum cost and optimum profit.

Production Process

Production process of biodiesel consists of some steps include pre-treatment and biodiesel processing phases. Overall processes of nyamplung biodiesel production at laboratory scale is shown in Figure 2.

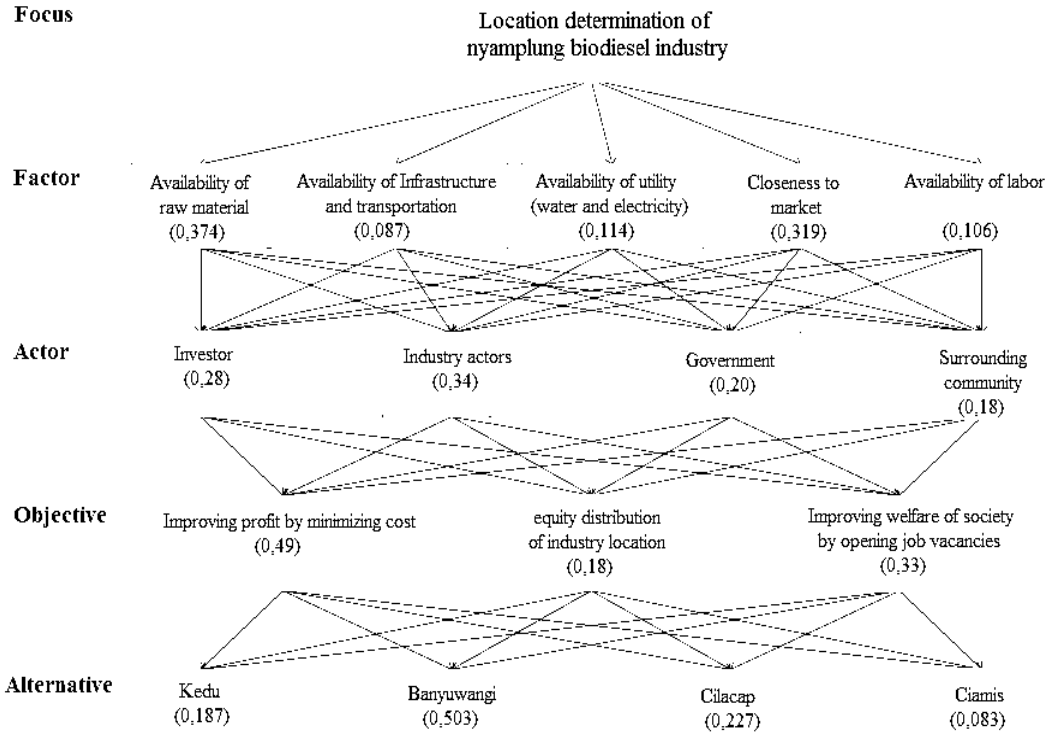

Figure 1. Results of AHP for industry location determination

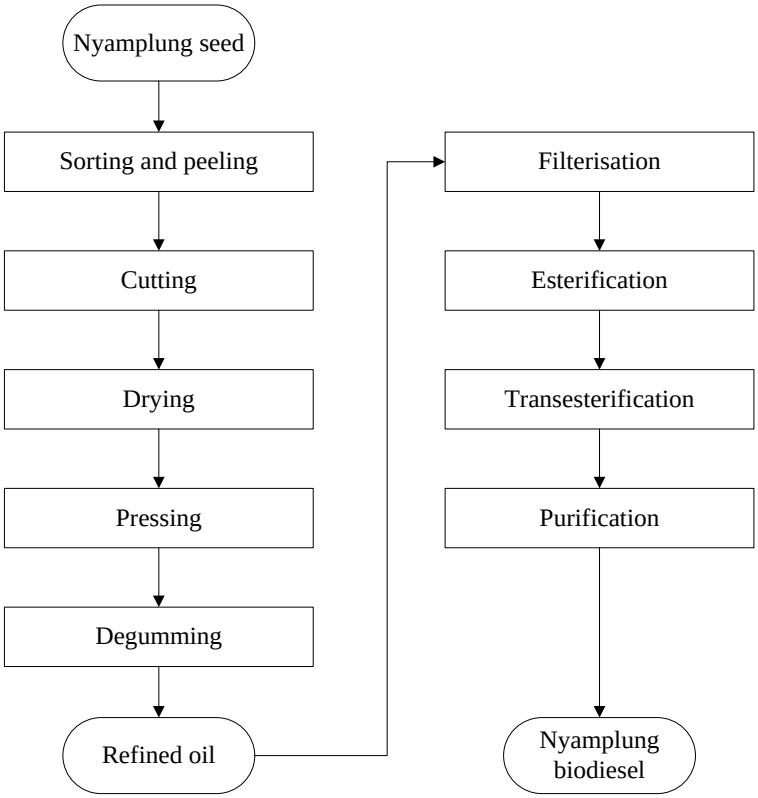

Figure 2. Overall processes of nyamplung biodiesel production

Mass balance below was the result of data processing from various source i.e. laboratory scale experiment at SBRC, Institute of Forestry Research and Development, and other sources. Pre-treatment step was begun with the preparation of 4,500 kg raw material (nyamplung fruit). It was broken by breaking machine and the skin of fruit was separated by separator machine. The yield was 60% of seed and 40% of waste. The separated seeds then were chopped by chopping machine (100% yield), then the chopped seed were dried in vibrating fluidized bed drier at 70^{o}C for 2 hours which yield was 85% dry seed. The dried seeds were taken out from drier and put into pressing machine.

Pressing machine isused to squeeze oil form the seeds. The type of pressing machine is screw press expellers with yields obtained were 57% oil and 43% cake. Degumming process is then performed by degumming machine to remove the resin by additionof 0.3% acid phosphate and the yield obtained was 95% of clean oil and 5% of dirt screening results. After degumming process and free fatty acid analysis, the processing of biodiesel was begun.

The processing of biodiesel was started by esterification process which is a reaction for ester formation from carboxylic acid and methanol with a temperature of 60°C for one hour, the yield obtained by the esterification process was 90%. After that, the transesterification process was executed. It is an alcohol exchange reaction from an ester by using methanol and potassium hydroxide (KOH) at 60°C for one hour, the yield obtained was 95% of crude biodiesel. The last process was washing process with water and citric acid, and then followed by vacuum drying to obtain pure biodiesel which is 95% (1000 L). The total power capacity needed was 95 kWh and the operating load was 76 kWh.

Layout

The used layout type is product based type (*Layout by Product*) within which the machinery is arranged based on the process flow with continous movement in a line. To save that space, the pattern for material flow in production space is zig zag due to long production flow of biodiesel production.

The building for biodiesel industry consists of production and non-production rooms. Overall rooms for the biodiesel production are raw material warehouse, waste treatment room, packaging room, final product warehouse, supporting material warehouse, production room, generator room, and water storage, laboratory, office, praying room, toilet, clinic and lavatory. Space required was 442.5 m^2 with allowance 15% which was provided for material handling activity, worker mobility, etc. Non-production area was 450 m^2, so the total space

for biodiesel from nyamplung seed industry was 892.5 m^2.

There are several material flow patterns in production space, namely: straight line flow pattern if the production process is short and simple, “L” shape flow pattern if there is limitations on buildings size, “U” shape flow pattern if in flow and out flow in same location, “O” shape flow pattern if the raw materials and products are placed in one chamber, and "S" shape flow pattern (zig zag) if the production flow is long. Good material flow will automatically reduce costs and ultimately will improve productivity. Material flow pattern in biodiesel production space is of "S" shape flow pattern (Figure 3).

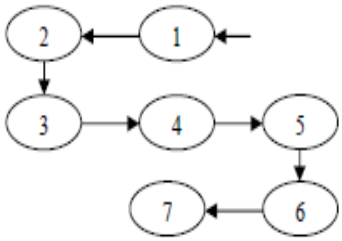

Figure 3. Material flow pattern in nyamplung biodiesel production

Notes:
1 : Peeling machine
2 : Cutting machine
3 : Drying machine
4 : Pressing machine
5 : Degumming machine
6 : Refining, esterification and transterification machine
7 : Destilation machine for Nyamplung oil purification

Activity Relationship

Generally, in setting the design of layout is used one of several merhods, for example Activity Relationship Chart and Travel Chart. Activity Relationship Chart is a method that links the activities in pair so the relationship between all activities can be indetified. The Activity Relationship Chart is shown in Figure 4.

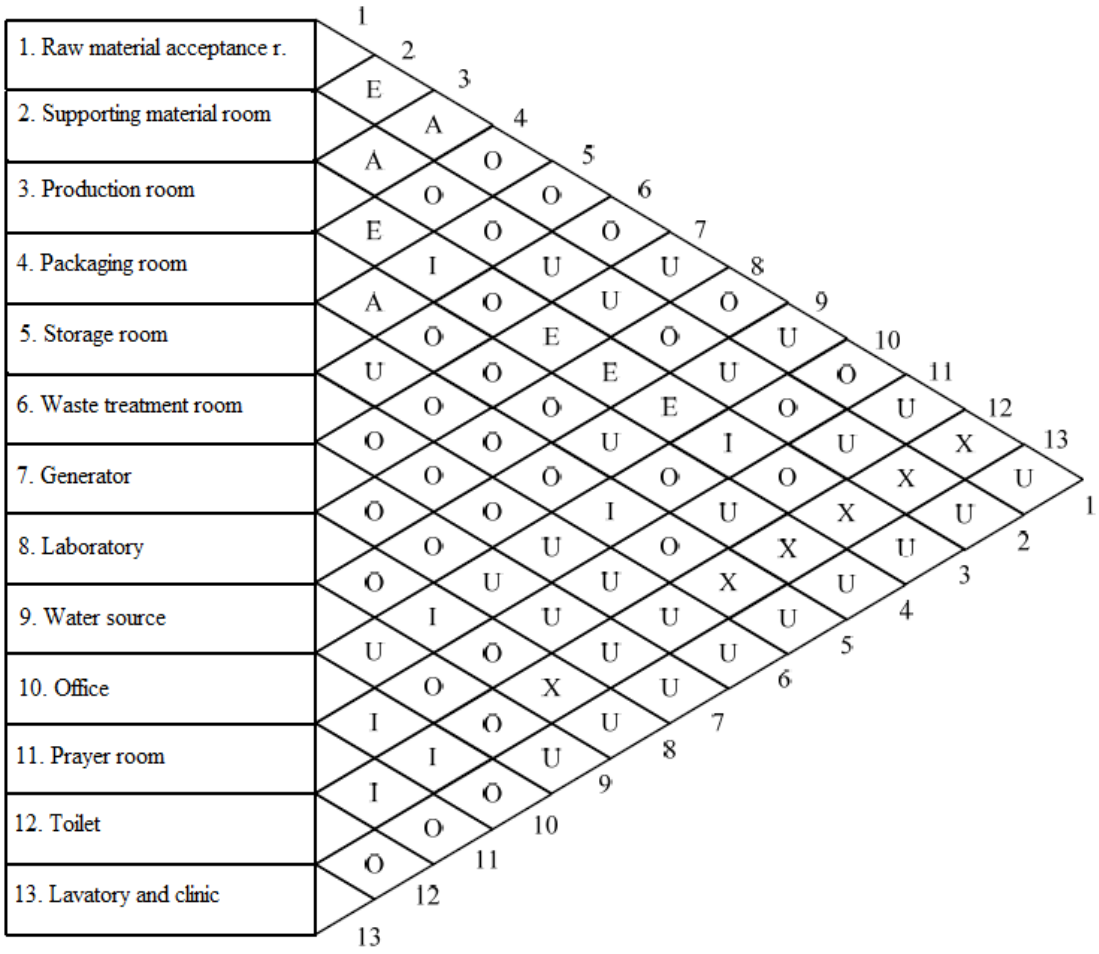

Figure 4. Activity relationship chart of nyamplung biodiesel industry

Financial Aspect

In cost estimation, assumptions are needed as the base for cost determination. The assumtions were: economic project life 10 years, salvage value of building 50%, land 100%, machine 10% with maintenance 0.5% and insurance 0.5%, vehicle 20%. Production target in first, second, and third time and so on were 80%, 90%, and 100% respectively.

The results of financial analysis show that investment cost needed to establish the factory is Rp. 2,329,271,000 and working capital is Rp. 308,304,000. The detailed costs are shown in Table 1.

Table 1. Investment detail (in thousand rupiah)

Component	Value
1. Fixed capital	
-Pre-investment	135,000
-Buildings	513,875
-Supporting facilities	18,450
-Machines and equipments	1,375,767
- Stationery	14,750
-Contingency	102,892
-Interest rate along development	168,537
2. Working capital	308,304
Total	2,637,575

Investment funding sources are bank loans and the owner. Debit to Equity Ratio (DER) or the applicable portion of funding is 65% of the bank and 35% of the borrower. Loan payment period for investments is six years, while for working capital is 4 years with an interest rate of 12%. Repayment of loan principal and interest begin in the first year with the same principal payments each year. Funding structure can be seen in Table 2.

Table 2. Funding structure (in Thousand Rupiah)

Credit Type	Investment Need	Self Capital (35%)	Loan (65%)
Fixed Invesment	2,329,271	815,245	1,514,026
Working Capital	308,304	107,906	200,398
Total	2,637,575	923,151	1,714,424

Profit and loss statement showed that the profit increased from year to year. The profit earned in the first year is Rp 598,991,000 in the second year Rp 671,677,000 and in the third year and so forth is Rp 837,566,000. This is because of the interest payments decreasing each year and at the end of sixth year, the interest of capital invesment was completely paid. Table 3 shows projection of profit and loss.

Assessment of investment criteria used were NPV, IRR, B/C ratio, and PBP method. Table 4 shows the result of these feasibility criteria. Based on the criteria, the establisment of biodiesel from nyamplung industry is feasible. NPV shows positive number, IRR is higher than interest rate, net benefit cost ratio is more than 1 and paybackperiod is 4.7 year. These all indicate that the establishment of biodiesel industry from nyamplung seed is feasible and provide high profit.

Sensitivity analysis of important process parameters shows their relative effects on the production cost and on the potential for cost reduction for raw material (Sasner *et al*., 2008). Based on Table 5, the industry is not feasible to be established when there was an increase of raw materials price to 60% or decrease in selling prices by 20.8%. It means that the industry is not sensitive enough to raw material cost and selling price, so it is quite safe for investment.

Table 3. Profit and loss projection (in thousand rupiah)

Year	Revenue	Production Cost	Operational profit	Tax	Net profit
1	2,455,142	1,624,441	830,701	231,710	598,991
2	2,762,035	1,827,496	934,539	262,862	671,677
3	3,068,928	2,030,551	1,038,377	294,013	744,364
4	3,068,928	1,994,259	1,074,669	304,901	769,768
5	3,068,928	1,957,967	1,110,961	315,788	795,173
6	3,068,928	1,927,686	1,141,242	324,873	816,369
7	3,068,928	1,897,405	1,171,523	333,957	837,566
8	3,068,928	1,897,405	1,171,523	333,957	837,566
9	3,068,928	1,897,405	1,171,523	333,957	837,566
10	3,068,928	1,897,405	1,171,523	333,957	837,566

Table 4. Investment feasibility criteria

Criteria	Value
NPV	Rp 1,402,610,000
IRR	22%
Net B/C	1.60
PBP	4.7 year

Table 5. Sensitivity analysis

Change	Investment Criteria			
	NPV	IRR	Net B/C	PBP
A	Rp 727,936,000	17%	1.31	5.7
B	Rp 218,967,000	14%	1.1	6.8
C	Rp (17,761,000)	11.87%	0.99	7.5
D	Rp 6,532,000	12%	1	7.5
E	Rp (213.000)	11.9%	0.99	7.5

Notes**:** A = Capacity addition due to steaming process; B = Increasing of raw material value as much as 50%; C = Increasing of raw material value as much as 60%; D = Decreasing of selling value as much as 20.7%; E = Decreasing of selling value as much as 20.8%.

BEP calculation can be seen in Table 6. It is known that smallest value of BEP is at normal condition which is production without steaming process. Steaming process increases BEP as much as 7.04%. Similarly, BEP also increase following the increase of raw material price. For increasing of raw material price as much as 50%, BEP increase as much as 25.91%, whereas for increasing of raw material value as much as 60%, BEP increase as much as 32.80%. The BEP will also increase if there is decreasing in selling value, decreasing of selling value as much as 20.7% will increase BEP as much as 15.79% and decreasing of selling value as much as 20.8% will increase BEP as much as 15.89%.

Table 6. BEP value

Scene	BEP (Rp 000)	Capacity (L)
Normal condition	823,601	288,000
A	881,559	304,416
B	1,036,965	288,000
C	1,093,773	288,000
D	953,662	288,000
E	954,501	288,000

Valuation and Commercialization of Technology

Vision of industry is "Becoming a prominent integrated biodiesel company to overcome fuel scarcity and to give maximum benefit to stakeholders", whereas the mission of industry are:

1. To develop potency of venture company in agroindustry sector.
2. In long term, company try to build nyamplung plant processing company.
3. To have active role in improving agroindustial product competitiveness.

Market segmentation is the separation of the business market to group of buyers according to the type of products that require a specific and distinct marketing mix. Different way could separate these markets based on profiles of each market segment, and the determination of the attractiveness of each segment. Market segmentation of biodiesel product is public and industrial users who are using biodiesel as fuel to run the production process. Classification is also possible according to geographic segmentation. The segmentation variable used is the national territory.

In line with market segmentation, some segments are considered to be potential to enter. Determination of the target market is based on the strengths of each segment. Target marketing of biodisel is more focused on domestic consumers with large society with a spesific package.

One important element of marketing strategy is positioning, how to put the benefits of the product in accordance with the wishes of consumers. By placing excellence in the minds of consumers, it will foster consumer satisfaction at the same time will differentiate the product from its competitors in the minds of target market. Positioning of biodiesel is as a product made from nyamplung seeds as raw material with a good quality, high degree of purity, and sound sustainability.

Value creation for profit gain is conducted among others by product development method and by continuous and sustainablity production, continuous renewing marketing strategy, expanding the target market, and promotion for new

product. Meanwhile, value for talent in the company is conducted by giving provision of welfare assurance to employees, rewards, prize, bonuses and conducting regular work training to the employees

Market and Marketing Aspect

Kotler (2002) suggested that to enter the market, it is necessary to estimate the potential market for its resources and penetration. The potential market is the number of consumer which has specific interest to some offers.

At this time, approximately 25% of domestic oil demand is fufilled by the import of fossil fuel. Diesel fuel consumption can be seen in Table 7. The government has issued the National Energy Policy among others increasing the use of biofuel around 2% of total national fuel consumption by 2010, then it will be increased to 5% in 2025 and assigning to Department of Forestry to play role in providing raw material of biofuel, including giving lisence to utilize forest land, especially for non-productive land (Forest Research and Development Agency, 2008). Those policies indicate potential market for biodiesel. It is acceptable to assume that this biodiesel will fulfill ± 0.1% of available potential market.

Product strategy is to be prepared properly by a company associated with the product position in markets. The right strategy will put the company in a competitive position that is superior to its competitors. Marketing mix strategies would be applied by selling the biodiesel as additive ingredients of oil and good looking and easy handling packaging to make it more practical to be used. For pricing strategy is related to the influence of production capacity that is concerned. The use of machinery and equipment and the use of raw material and additives should be precised to ensure that the production is efficient, optimum cost and quality.

The main strategy of marketing is by establishing sales organization to sell products directly to consumer and to distributor for retailing. Promotion strategies are focused on utilization of public media that are familiar to customer. Some facilities are consumer advertising in catalog, television and newspaper to provide consumers with specific promotion.

Management Aspect

Organizational structure in an industrial processing has the authority to make decision for factory operation and smooth production. Husnan and Muhammad (2000) stated the scope of management should be carefully considered are project implementation, project schedule, project actors which are conducting research in every aspect and management in operation. Management in operation consists of organizational structure, position description, number or employee, board of directors member and detail of employee.

A good operational management will be able to meet all policies and objectives. Management expertise is a major factor in the success of industrial management. According to Sutojo (2000), the appropriate manpower and quality can be obtained by knowing: description of the type of work or the basic tasks required to run industrial operations, organizational structure needed to carry out tasks in an efficient company.

Employment consist of direct and indirect labor make up the total of 26 persons. Direct labors are employees that are directly involved in the production process, while indirect labors are employees that are not direclty related to production process. Direct labors are production operator, laboratory assistant, factory workers, while indirect labors are general manager, head of factory, quality control and office staff. Working hour of operator and factory worker are three shifts; the first is from 7:00 to 15:00 hours, the second is from 15:00 to 23:00 hours and the third is from 23:00 to 7:00. For those other than factory worker and operator, the working hour is from 08:00 to 17:00.

Environmental Aspect

Umar (2005) stated that environmental aspect determines the feasibility of project. Bodiesel production generates liquid waste, solid waste and gas waste. Solid waste that is generated from this biodiesel factory is generally produced in stripping and pressing process which is the form of nyamplung seed cake. This solid can be made into charcoal briquettes, other than waste is in the form of the shell can be used as furnace fuel in the drying process, thereby reducing the cost fuel requirements.

Table 7. Diesel fuel consumption in trasportation sector in year of 1995-2010

Year	Transportation (billion liter)	Total (billion-liter)	Portion (%)
1995	6.91	15.84	43.62
2000	9.69	21.39	45.29
2005	13.12	27.05	48.5
2010	18.14	34.71	52.27

Sumber: Soerawidjaja (2005)

Liquid waste generated from production processes such as methanol, glycerol and water. Waste of methanol is to be recycled for reuse in the next production process. Glycerol will be sold as a byproduct.

Gas waste which is produced by biodiesel industry from seed of nyamplung come from production process, generator and vehicle emmision. The company utilizes the use of exhaust fan to control the gas and other air pollutant.

Legality Aspect

The corporate form that is suitable for biodiesel industry is a Limited Liability Company. The selection is based on therelatively big capital investment. In terms of government regulation, the government has issued policies that support the development of biodiesel in Indonesia. In addition, the government has established a National Task Team of Biodiesel. The policy encourages and such industry as biodiesel in Indonesia. The government considers that biodiesel is a new commodity and the development will involve many parties. The policy is outlined starting from highest ranking law (Energy Laws), Presidential Decree, Presidential Instruction, Declaration and the product of National Task Team of Biodiesel.

In terms of taxes, biodiesel industry is inseparable from the obligation imposed tax. Determination of income tax based on the Tax Law No.17 of 2000, which profits under Rp 50 million is taxed at 10% of revenues. If revenues between Rp 50 million to Rp 100 million, then it is taxed 10% of Rp 50 million plus 15% of the rest. Then, if income is above Rp 100 million, it is taxed at 10 percent from Rp 50 million plus 15% of Rp 50 million and added by 30% of the rest.

CONCLUSIONS AND RECOMMENDATION

Conclusions

The analysis shows that there is a big potential market for biodiesel. The current need for fuel continues to increase while the supply is decreasing, so it is clear that new alternative energy sources is needed. Biodiesel is marketed as additive substances in the form of simple, good looking and easy handling packaging. The suitable location, amongst the given alternative is Banyuwangi, East Java, Indonesia. At the current cost assumption, the selling price of biodiesel is about Rp 6.500/L with the margin of 5%.

The establishment of biodiesel factory from nyamplung seed is feasible with value of criteria NPV is Rp 1,40261 billion, IRR is 22%; B/ C ratio is 1.60; and property tax for 4 years and 8 months. The factory will gain additional benefit from utilization of by product (seed cake of nyamplung processed into charcoal briquettes and glycerol to soap bars).

Sensitivity analysis shows that the industry becomes not feasible when the raw material price increase by 60% or the decrease of selling value amount by 20.8%. The establisment of biodiesel industry should be supported by the utilization of by product during production process.

Recommendation

The feasibility of establishment of the biodiesel factory would be realized given that all technical aspects should be fulfilled, especially for the design of machinery and equipment in order to minimize costs. A more advance analysis of environmental aspects is needed both physical and social environmental assessment. A more funding source should be identified and analyzed to ensure that the chosen investment scenario give the best result.

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