The Improvement of Technology Utilization in The Framework of the Competitiveness and Sustainability of Indonesia Palm Oil Industry

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Abstract

Indonesian palm oil industry will have high competitiveness if there is a balance and sustainability of the industrial structure between the upstream-midstream-downstream will be achieved because the maximum added value and stability of the industry. Existing conditions of the use of technology, policy evaluation and technology utilization program in the processed oil palm industry needs to be mapped in order to increase the competitiveness and sustainability of the Indonesian oil palm industry. The purpose of this study is to support the improvement of the competitiveness and sustainability of the palm oil industry in Indonesia through the use of mapping technology on a national palm oil industry, especially in upstream and midstream industry. Primary data is obtained from the result of field survey through interviews, observations, questionnaires and Focus Group Discussions (FGD). While secondary data is obtained from relevant institutions at the Central, Provincial and Regency/Municipality levels. Gaps technology used on the Indonesia palm oil industry today, compared with ideal conditions that have developed in the industry done. Gap analysis was carried out to the five standard benchmarks namely processing technology, energy, environment, human resources, financing, and research. Results of the analysis shows that the type of technology used is still dominant with 'semi- mechanical technology'. In order to develop the use of technology in the palm oil industry will require improvements in aspects of Technology and Environmental Management System, Product Development and Technology Cooking Oils (Indonesian Branded). Some of the action plan is to be implemented include continuous sterilizer, gasification, methane capture, recovery tanks, recovery β-carotene, ISPO Implementation, vitamin A fortification, mandatory SNI for cooking oils and Indonesian Branding.

Keywords
Oil palm, technology assessment, upstream-midstream industry, benchmarking.

1. Introduction

Indonesia's being the largest producer of palm oil (crude palm oil) has puts the palm oil industrial sector as the leading national flagship, priority, and strategic sector. In the future, the palm oil will be able to become Indonesia's flagship commodity, on accounts of (a) its deep industrial structure, (b) Indonesia's supportive natural resources, (c) abundant human resources, and (d) human resource's competitive productivity. The national palm oil industry will be highly competitive if the balance and sustainability of the industrial structure in the upstream-downstream sectors are achieved. Building such an industry, Indonesia will attain a maximum added value and industrial stability.

Compared to Malaysia (Mahat, 2012), the structure of palm oil processing industry in Indonesia is still more dominant in the upstream sector. For that reason, the government seeks to revitalize the downstream industries through the palm oil downstream revitalization program. The revitalization of the palm oil industry will be more focused and targeted when it is supported by a comprehensive database, which can reveal the characteristics of national palm oil upstream-intermediate-downstream industries. Among the important database is the characteristic of the use of technology and other supporting aspects. Thus, a comprehensive mapping of the use of technology in the palm oil industry becomes relevant for the improvement of the competitiveness and sustainability of the palm oil processing industries nationwide.

Technology Assessment (TA) is an interactive and communicative scientific process, which aims at contributing to the formation of public and political opinion on the social aspects of science and technology (Bechmann et al., 2007). Basically Technology Assessment is a comprehensive and systematic study to analyze and evaluate the positive and negative impacts of the introduction and application of technology, identify the social impact implicated by the application of technology, and review the program or the policy of technology application. Technology Assessment is also a comparative study of the region's technological competitiveness, especially in high-tech sector that can provide an important reference point for research and technology policy and industrial policy (Lehoux & Williams-Jones, 2007).

The activities of assessment technologies basically provide an assessment to several factors: 1) processing factor, 2) equipment factor, 3) energy factor, 4) premises factor, and 5) environment factor. Taking into account the factors for increasing the competitiveness and sustainability of Indonesian palm oil processing industry, the writer makes an adjustment to the aspects that will be studied: 1) the technological aspects of production, 2) the energy aspects, 3) the human resource aspect, 4) the environmental aspects 5) the production cost aspects, and 6) the Research and Development (R & D) aspect (May et al., 2015).

CPO industry is an industry that is built closer to the source of available raw materials, which are palm oil plantations since the raw material gets damaged easily (perishable) and bulky. Accordingly, the palm oil processing primary industry is mostly built in Sumatra, Kalimantan, Sulawesi to Papua. Oil derivative industry starting from the refinery, butter, soap, and other consumer goods, are industries that should typical be built near the market. Since the largest market, based on the population, is on Java Island, the downstream oil derivative industry for Consumer goods is to be built on Java Island.

The general objective of the research is to support the increase of competitiveness and sustainability in the palm oil processing industry in Indonesia. The specific objectives of this study are as follows:

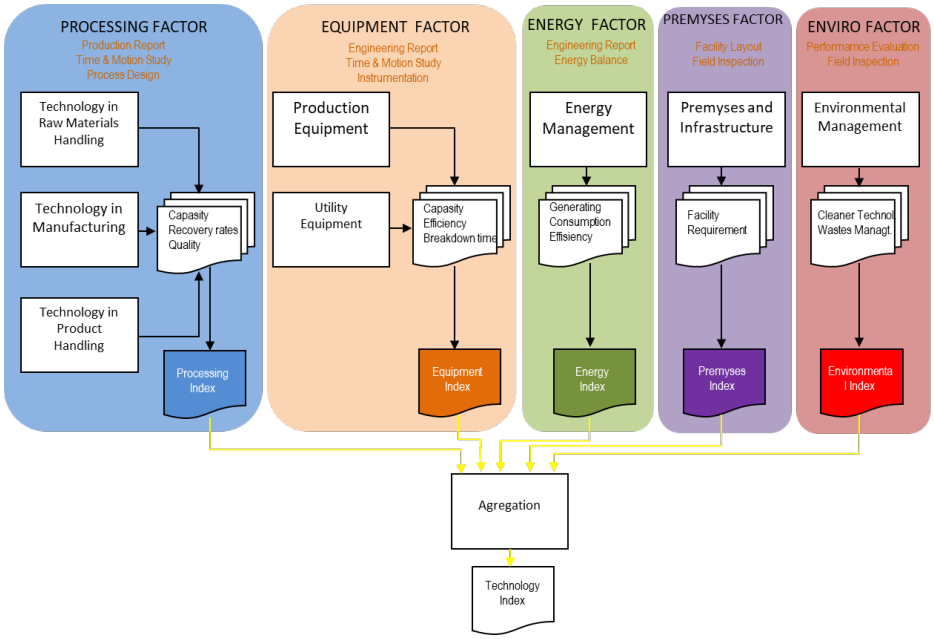
1) To map the use of technology in the palm oil processing industry in Indonesia, especially in the upstream and intermediate sectors.
2) To perform a standard benchmarking on the use of technology in the palm oil processing industry, especially in the upstream and intermediate sectors.

2. Research Method

The data used in this study consists of primary and secondary data. Primary data was obtained from the results of field surveys, interviews, and questionnaires from palm oil processing industries. Secondary data was obtained from the relevant agencies, internet browsing, and best practices in the palm oil processing industry. Field surveys were conducted purposively to represent the streams of palm oil industries (upstream-downstream). In this study, the provinces of North Sumatra, Riau and East Java were selected.

Stages of research conducted include 1) *Technology Assessment*, the method is used to assess the extent to which technology utilization in the palm oil processing industry has managed to increase the productivity of the palm oil processing industry and the extent to which the modernization of the technology has been attained and 2) *Benchmarking analysis* is used to attempt to analyze the standardized use of technology in the palm oil processing industry based on the desk study.

The assessment of the existing conditions on the use of technology refers to the six aspects of technology assessment: 1) human resource aspect, 2) environmental aspects, 3) energy aspects, 4) cost aspect, 5) production aspects, and 6) R & D aspects. Each technology evaluation indicator was assessed using Likert 5 scale evaluation (5 = very high; 4 = high; 3 = moderate; 2 = low; and 1 = very low). Further, the range of each class interval is specified [(5-1)/5=0.8]. The index classification of technology utilization for the palm oil processing industry is categories to High Level, Medium Level, and Low Level.



The average calculation of the technology index assessment for each indicator use the following formula: Technology Index = Total Score/Maximum Score.

The analysis of benchmarking is one of the quality improvement efforts in the context of improving the standard that has been achieved (Amina, 2012). In other words, benchmarking is an activity to establish new standards. This activity is aimed to see the extent of the policy on the use of technology in the palm oil refinery industry compared with the best practices at the national, regional, or world level.

Basically, benchmarking is a constant search and application of truly better practices, which leads to superior competitive performance. Benchmarking is a perpetual and systematic process to compare company efficiency with other companies and organizations that have demonstrated excellence in terms of productivity, quality, and practices. Benchmarking basically implies the study of processes for the purpose of imitating them in the company environment with necessary modification suited to the prevailing situation and conditions, aiming to achieve improvement and refinement (Hacker & Kleiner, 2000).

3. Results and Discussion

3.1 The Upstream-Midstream of The Palm Oil Industry In Indonesia

The good prospect for trading palm oil commodities in the world trade of vegetable oils has encouraged Indonesian government to increase the development of oil palm plantations. The development of oil palm plantation sub-sectors in Indonesia can not be separated from the government policies that provides incentives, especially the ease of licensing, and the investment subsidy for the construction of smallholders using the PIR-Bun system and in opening new areas for big private plantations.

The development of palm oil business in Indonesia today can be grouped into 3 (three) industrial streams, namely upstream, midstream, and downstream, which are slightly shifted, in which the supply of raw material for PKO has been included as the upstream industry.

The upstream palm oil industries that have grown in Indonesia today are the industries of Crude Palm Oils (CPO), Palm Kernel Oils (PKO), and Palm Kernel Expeller that are used as raw materials for animal feed. The processing industries for palm oil wastes, such as old trunks; empty fruit bunches; and shells are still commercially undeveloped. It's due to that fact that the processed palm oil waste is currently more profitable to be utilized as an energy source.

The processing of fresh fruit bunches to obtain crude palm oil (crude palm oil, CPO) and palm kernel was conducted through the following sequence: 1. Transporting fruits to the plant, 2. Boiling fruits (sterilization), 3. Stripping fruits off the bunches and digesting, 4. Oil extraction. The data collection survey in the upstream palm oil industry was conducted in the crude palm oil industry.

Not all palm oil industries process kernels; some directly sell to other companies. After being dried, palm kernels are merely kept in a bin with a maximum maintained moisture content of 10%. Almost all company groups have Palm

Kernel Oil factories (PKO), which process palm kernels into palm oil. Generally PKO plants are built to absorb oil kernels from several other factories in the company groups. PKO Manufacturers will generally utilize the byproduct called Palm Kernel Expeller (PKE) as raw materials for animal feed.

The assessment results of the technology utilization index in the upstream and midstream palm oil industry using six aspects of the assessment are presented in Table 1.

Table 1 Index of technology utilization in the upstream and midstream Indonesia palm oil industry

Assessment Aspect	Upstream palm oil	Midstream palm oil
Production Technology	8.6842	8.6842
Energy	2.3684	1.8421
Environment	2.2105	2.0263
Human Resources	2.2368	2.2368
Production Costs	3.8684	3.5000
Research	1.2632	1.0526
Final Index	20.6316	19.3421
Utilization Status	High Level	Medium Level

The status of technology utilization in the upstream and midstream palm oil industry in Indonesia compared to the development of palm oil processing technology available today can be shown in Figure 1.

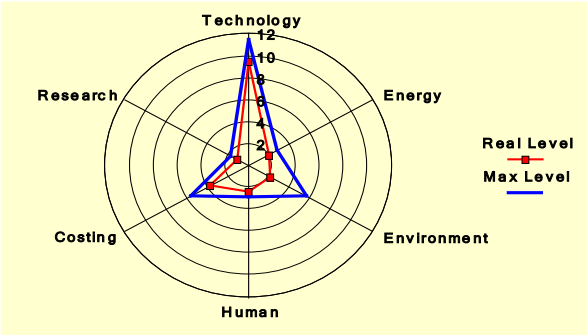


Figure 1 Mapping of technology utilization in palm oil industry

Cooking oil is one of the primary finished products produced from palm oil fruits. Palm oil can be obtained from two types of crude oil, namely Crude Palm Oil (CPO) and Crude Palm Kernel Oil (PKO). The processing of CPO into cooking oil also produces a number of economically valuable byproducts, including stearin (the raw material for margarine), and Palm Fatty Acid Destillation (PDFA). Obtaining the byproducts of CPO processing is one of the investment attractiveness of CPO cooking oil industry, in addition to cooking oil being produced (olein) is unsaturated, which is so far known to be very good for health.

Cooking oil industry is one of the downstream activities of the palm-based agricultural industry. Cooking oil from the palm industry, which is called Olein RBD (Refined Bleached Deodorized Palm Olein), is made of CPO as the raw material. The process of cooking oil produces RBD Stearin (Refined bleached deodorized stearin) as a byproduct, and PFAD (Palm Fatty Acids Destillation). Cooking oil production from CPO is conducted through stages, refining, fractionation, packaging, and packing. Refining stage consists of degumming, bleaching, deodorization, and fractionation.

The survey on the midstream palm oil industries were conducted to cooking oil industries. A number of industries in Indonesia separate olein and stearin. Subsequently, stearin is utilized as a downstream product. Integrated factories are commonly found on the island of Java, while factories in Sumatra mainly carry out fractionation.

3.2 Evaluation on Technology Mapping in Upstream-midstream Palm Oil Industry

Palm oil industry is experiencing a very high pressure in the international market regarding environmental issues. Palm plantation was allegedly built on converted forest land and grown with plants that have poor water-absorption characteristics. Various standard were attempted, which leads to environment-friendly palm oil, and on account of this, the initiative of Round Table on Sustainable Palm Oils (RSPO) and the Indonesian Sustainable Palm Oils (ISPO)

came into being. RSPO and ISPO standards do not specify the technical aspects of production in the industry but are directed to the Good Manufacturing Practices (GMP).

The Initiative of the *German Society for Technical Cooperation* (GTZ) on the projects of Industrial Pollution Prevention and Control in Thailand, compiled a guide in the production system which can be referred to as the standard production of palm oil factories. Nevertheless, the publication launched in 2006 needs to be adjusted to the current condition in the oil industry.

3.3 Ideal Standard for Palm Oil Industrial Technology

As a matter of fact, it is not easy to set the standards of production technology in the palm oil industry comprising upstream midstream, and downstream industries. Table 2 presents a general guidance on the standard enhancement of palm oil production aspects which aim at achieving eco-efficiency through a set of adjusted indicators.

Table 2 The standard of efficiency improvements in production technology of palm oil production

Prevention & Control
Raw materials must be processed within 72 hours
a. Steam pressure and time must be controlled. The use of continuous strelizer facilitates control system. *b.* Steriliser condensate should not be mixed with waste water from the oil compartment
Bunches that still bear fruits must be collected and re-sterilized
The pressure should be controlled in order to extract oil from the fibre maximally and minimize the breaking of the kernels
Vibrating screen should be in good condition
The oil retention time in the settling tank must be controlled to prevent an increase of Free Fatty Acid
Rinse water should always be checked and should Desander must be washed and scheduled
Decanter should be used; Decanter must be checked and washed on schedule basis
Condensate must be separated from waste water
At least more than one separator should be added to the system
The use of water should be minimized The use of detergents should be minimized
Washing and cleaning water must be collected or skinner must be used as the routine control; equipment inspected, maintained, and repaired
stainless Steel
Preventive Maintenance System
ISO 9001:2008
Good Manufacturing Practices
The requirement for water content and FFA correspond to the SNI standard
The separation process of gum and a number of contaminant compounds from the CPO
The removal process of dyes using bleaching earth
The elimination of short chain fraction of fatty acids, ketones and aldehydes
Fat that does not melt at room temperature, the stearin fraction, is solidified in the crystallization tank.
Using a large tank for settling stearin and separating the liquid fraction olein as cooking oil
Installation of filters to filter impurities in oil
The Consumer pack cooking oil industries add a special tank for the fortification of Vitamin A. The government plan the implementation of mandatory SNI on Vitamin-A-fortified cooking oil
Manufacturing own plastic bottles, to prevent dirt in the bottles.
Filling using automated machines (automatic filling) with some additional filters
Putting oil packaging into cartons to allow for further handling

3.4 Gap Analysis on Technology Utilization

The gap in technology used on the palm oil industry today, compared with ideal conditions that have developed in the industry is conducted by assessing the results of the field survey. The gap analysis was conducted towards the five benchmarking standard, namely processing technology, energy, environment, human resources, financing, and research.

3.4.1 Analysis on the Utilization of Technology of Production Process

An assessment of the technological aspects of the production process shows that in the upstream palm oil industry, the technology used can still be improved. A number of machine units in some industries built before 2000 need to be rejuvenated.

The most important note is given to the units of sterilization process, where most oil palm companies are still using a model of vacuum vessel whereas the technology was not efficient because of its wasteful nature of raw materials, labor, and time. In addition to that, the technology is also highly risky to the safety and the security of products.

A number of oil extraction machines need rejuvenation given that the treatment of the machine units is quite risky. The screw press extraction machine often experienced problems with the hydraulic system so that the control processes are not optimal.

The use of equipment made of Stainless Steel in the CPO industry is actually not urgent, given that the CPO is processed into food (cooking oil), and non-food (fuel). Nevertheless, it is recommended that some equipment components that are in contact with CPO products be made of stainless steel.

The packaging of upstream industry products are still vulnerable to leaking, whether intentional or not. Various cases of contamination during transportation remains a serious threat to CPO, PKO, and PKE. The amount of commercially packaged cooking oil compared with the bulk oil is still balanced so that the chance for product security in the refinery industry remains equal with that of pollution. Downstream industrial products such as margarine are much more secured because the company has implemented a hygienic packaging system.

The production management system throughout the oil processing industry has been relatively good. Provisions of the Ministry of Agriculture, which stipulates that the industry apply ISPO in 2014, has introduced the oil industry to a well-organized management system. Meanwhile, the application of compulsory SNI to cooking oil products also encourages the implementation of quality management system in the refinery industry.

3.4.2 Analysis on the Utilization of Energy Management Technology

The energy management technology in the upstream palm oil industry is already very good and efficient. Nowadays even some upstream palm oil industries have been able to share the electrical energy produced with the surrounding community. Nonetheless, problems are still encountered in the transportation using fuel subsidies, though it was perpetrated by irresponsible parties. The midstream and downstream palm oil industries are still highly dependent on fossil fuels.

The utilization of methane gas from the remainder of wastewater treatment is still in early trial stages. To utilize the method in a number of industries, a dome was installed on an aerated pond. Utilization of methane gas amassed was also limited to burning for simple non-production applications, such as for welding.

Some industries putting a concern with energy savings have started installing light sensors in lighting, particularly for roads and buildings that need to be lit only at night. Downstream industries are more concerned with the matter given that electricity generation uses fuel oil sources, while the upstream industry seems not too concerned.

3.4.3 Analysis on the Utilization of Environmental Management Technology

The great pressure from the international world over the environmental aspects of Indonesian palm products has aroused great enthusiasm in all those who are involved in the oil industry to take a heed to environmental sustainability. After the RSPO initiative, the government of Indonesia presently requires the industries to apply ISPO in 2014.

The upstream industries integrated with palm oil plantations are required to apply the principle of ISPO (Indonesian Sustainable Palm Oil) in which the aspect of environmental sustainability is very vital. Midstream and downstream industries previously met environmental requirements since most of these industries are built in the EIA-mandatory areas (Environmental Aspect Assessment).

Environmental aspects related to waste discharges into the bodies of water, soil contamination, and air emissions in the oil industry are thoroughly evaluated. Emphasis is preferred to emissions into the air where the oil industry allegedly provides impartial balance of CO2. Certification of CO2 mitigation efforts in the oil industry has been developed and a number of industries keep working on it.

The aspect of resource use in the palm oil industry in question is the balance of the use of water (water balance). When evaluated in the manufacturing industry, the use of water looks normal and balanced, but when it involves the calculation of water capture of palm trees, the resource use becomes unbalanced and wasteful.

The environmental management system had already been met by several downstream industries, while upstream and midstream industries implement it as part of ISPO or RSPO requirements. All in all, environmental aspects are more emphasized in the upstream palm oil industry in Indonesia.

3.4.4 Analysis on the Utilization of Technology in Labor Management

The use of technology in labor management and labor involvement in the use of technology are important aspects to be evaluated. The availability of technology cannot be separated from the role of labors. Technology transfer appears to have run so well in the palm oil industry, where in overall industries surveyed, almost all technologies are operated by the Indonesian workers.

3.4.5 Analysis on the Utilization of Technology in Cost Management

The use of technology in managing costs was conducted to study the extent to which the use of technology in the palm oil industry affect the financing. The evaluation is associated with the cost structure of production, profitability, and the policy of selling price. The evaluation results are presented in Table 8.

3.4.6 Analysis on the Utilization of Technology in Research Management

The use of technology in the management of research was conducted to study business resilience and the sustainability of the palm oil industry. Indonesian oil companies generally have had internal research institutes, where research, especially in the downstream industries has been intensified. While research institutes or divisions in the upstream and midstream industries have not conducted research on product development intensively although institutes or divisions are already formed. The upstream industries conducted more research on increasing the yield with a focus on raw materials.

Palm oil industry in Indonesia conduct less research on process technology, where the overall processing technology is "given" by the machine manufacturing countries. This is not surprising due to the fact that the technological development of industrial machinery is slow in Indonesia. A similar phenomenon also occurs in almost all industries in Indonesia.

4. Conclusion

Palm oil upstream industry which has grown in Indonesia is currently the industry's crude palm oils (CPO), palm kernel oils (PKO), and palm kernel expeller as raw fodder. Palm oil waste processing industry such as old trunks, bunches of empty shells, and have not grown commercially. Almost all group companies have a PKO factory processing seeds of palm kernel oil becomes. Generally the PKO factory built to absorb the oil from the nuclei of several other mills in the group. Manufacturer of PKO will generally utilize by-product called Palm Kernel Expeller (TCE) as a raw material for animal feed.

The logging industry survey amongst (mid stream) palm oil is done on cooking oil industry. According to the characteristics of its industrial products, cooking oil and stearin derivative dominant island of Java. Cooking oil industries in the region Sumatran mostly do the delivery in the form of bulk (bulk) and not do the packaging for consumer pack. Industry who do packaging for consumer pack would add vitamin A fortification of stages and generally add more filters to filter the oil before it is packaged.

The position of the utilization of technology in the upstream industry oil palm in Indonesia compared with the development of palm oil processing technologies that are available today are at a High level, while in the industry between palm oil are at the level of the Medium. The results of research to successfully map the standard utilization of technology in the industry of processed between upstream and midstream palm oil processing. The results of the gap analysis shows the largest gap the utilization of technology found on the aspects of the management of research development, environmental management, and energy management.

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