Opportunities for the Development of The Oleochemical Industry of Coconut Products

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Abstract. Coconut commodities that have been processed into copra or oil are less strategic to develop because they compete with palm oil and other vegetable oils such as soybean oil, sunflower nuts. As a result, the price of coconut oil, although the upward trend, but fluctuates greatly. To minimize the effects of price fluctuations, it is necessary to diversify utilization and processing. In addition to being edible oil, coconut oil can be further processed into oleochemical products. Important oleochemical products are fatty acids, fatty acid methyl esters, fatty acid alcohols, and glycerin. A possible problem is competition with Asia Pacific countries that are also developing the oleochemical industry. This paper aims to present technological introductions of some high economic value oleochemical products such as fatty acids, fatty acid methyl esters, fatty acid alcohols, and glycerin. Systematic writing approach in the form of a review based on literacy as a secondary data source. The oleochemical industry entering the industry 4.0 era is quite prospective to be developed in Indonesia to achieve the optimal economic value of coconuts in terms of availability of raw materials and technological innovation, technical excellence, employment, and domestic and foreign market opportunities.

1 Introduction

The agricultural sector is still classified as a leading sector in building the economy in Indonesia, its contribution to the national economy is still dominant at around 30-35 %. More than 90 percent of the business in this sector is managed by farmers who until now the acquisition of value from various products is still limited to a few primary products. Therefore, the income of farmers in this sector is still very low, not comparable with the potential resources available to produce a variety of competitive products and higher economic value [1,2].

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Developing countries today are trying to develop industries that process raw materials into finished goods through the application of technology. Industrial development with high technology, namely the era of industry 4.0 is aimed at increasing the added value of products produced, meeting the needs of domestic industry results, and saving foreign exchange.

In Indonesia, the term conventional and non-conventional coconut processed production is known. Conventional coconut processed industries include copra, crude coconut oil (CCO), and coconut cooking oil. The production of non-conventional coconut preparations includes desiccated coconut, coconut flour, and oleochemicals, such as fatty acid, fatty alcohol, glycerin, and glycerol.

In the decades until 1970, the development of consumption of conventional processed products in the country to a level that can no longer be met by domestic production. In that period, consumption growth was 4.9% per year, while production growth only reached 4.0% per year. It was this circumstance that prompted the government to apply wisdom to increase production [3]. However, when coconut production increases, the price of conventional processed products, namely copra and coconut oil tend to decline following changes in the world market. This problem becomes more complex because palm cooking oil which was previously complementary in domestic trade changed to be competitive because the price is Cheaper [4].

Thus, copra and coconut oil as raw materials for coconut cooking oil face challenges in marketing. The competitiveness of coconut oil is inferior to other vegetable cooking oils, such as soybean oil, corn oil and rape oil in foreign markets. Such developments caused the policies that had been implemented earlier did not reach basil as expected. Therefore, it is necessary to develop a new dimension of Coconut Development Policy in general and its processed products.

Coconut oil is the result of the main coconut processing in Indonesia and is generally consumed as a food ingredient. The role of coconut oil as a meal is estimated to be increasingly displaced by the presence of other vegetable oil sources such as soybean oil, corn oil, peanut oil, and palm kernel oil. Coconut oil can be obtained through wet and dry extracts [5,6,7,8]. Changes in public consumption Poia developed countries and developing countries from the consumption of coconut oil to other vegetable oils with higher saturated fatty acid content and the campaign against tropical vegetable oils, increasingly shifting the role of coconut oil as a dietary oil.

In addition, if the production of coconut oil is only intended as a feeding oil, the possibility of price fluctuations is very large on farmers ' income. This is due to competition between coconut oil and other vegetable oils. As a result, the guarantee of increasing farmers ' income becomes uncertain. With this problem, it is necessary to think about the possibility of other uses of coconut oil as a raw material for other industries.

Coconut oil can not only be used as cooking oil but can be processed further into certain products known as oleochemicals [9,10]. This product has a higher economic value than cooking oil. Oleochemicals are compounds or products obtained as a result of the process of separation or breakdown and further reaction of oils and fats. Oleochemicals consist of fatty acid compounds, glycerin, fatty acid methyl esters, alcoholic fatty acids, amines, and derivatives of these compounds.

Based on its raw material oleochemical consists of two types. Oleochemicals are naturally processed from fats / oils derived from plants and animals. While synthetic oleochemicals are produced from fuel oil (petrochemical).

In developed countries such as countries in Western Europe and the United States oleochemical industry has developed since the 1950s, while in the Asian region later in the 1980s. Until now in the Philippines there are 4 pioneering factories that produce oleochemicals with coconut oil as raw material and in Malaysia there is a factory that processes palm kernel oil into oleochemical compounds [11].

Until now the era of the 2000s in Indonesia oleochemical industry has not developed, whereas opportunities for development are quite good when viewed in terms of raw material potential and market opportunities both domestically and abroad. In this paper will be presented the extent of the possibility of development of oleochemical industry in Indonesia in terms of the potential of raw materials and market opportunities.

2 Methods

The Data used in this writing is secondary data and analyzed as a whole using a simple descriptive analysis. The writing material is carried out through the review of relevant data and information from various study results published in various publications, such as books, journals presentation materials from various webinars, virtual conferences, proceedings, and other publications including electronic media and print media.

3 Results and discussions

3.1 Oleochemical product description and its utilization

Refined products of coconut oil belonging to lauric oil is one of the main raw materials in the processing of oleochemical compounds due to the distribution of C atomic chains owned by coconut oil. Some oleochemical products include fatty acids, alcoholic fatty acids, fatty acid methyl esters, glycerin that still contains water and its derivatives (Figure 1).

3.1.1 Fatty acids

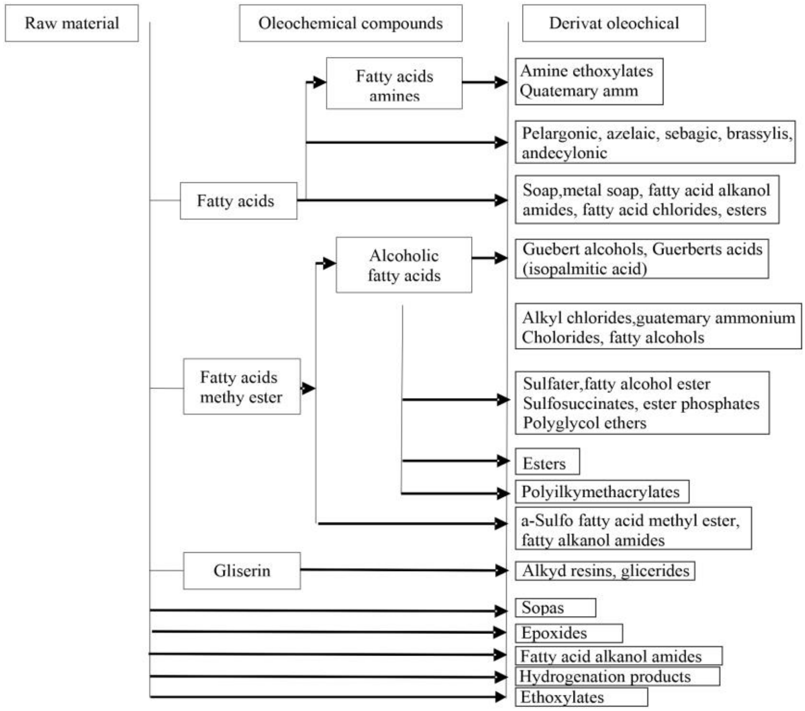

Fig. 1. Oleochemical products and their derivatives. [12]

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This compound is a basic oleochemical product. Through the process of hydrolysis with the help of water coconut oil is broken down into fatty acids. Approximately 84-86% of hydrolyzed coconut oil will break down into fatty acids [13]. Distillation and fractionation are the advanced processing stages of fatty acids. Through this stage, fatty acids are broken down into fatty acids with C6-C10 and C12-C18 atoms [14]. The process of producing fatty acids from coconut is presented in Figure 2. Fatty acids are used in the processing industries of alcoholic fatty acids, amines, esters, soaps, plastics, detergents, cosmetics, paints, rubber, tires, textiles, leather, paper, lubricants, and others.

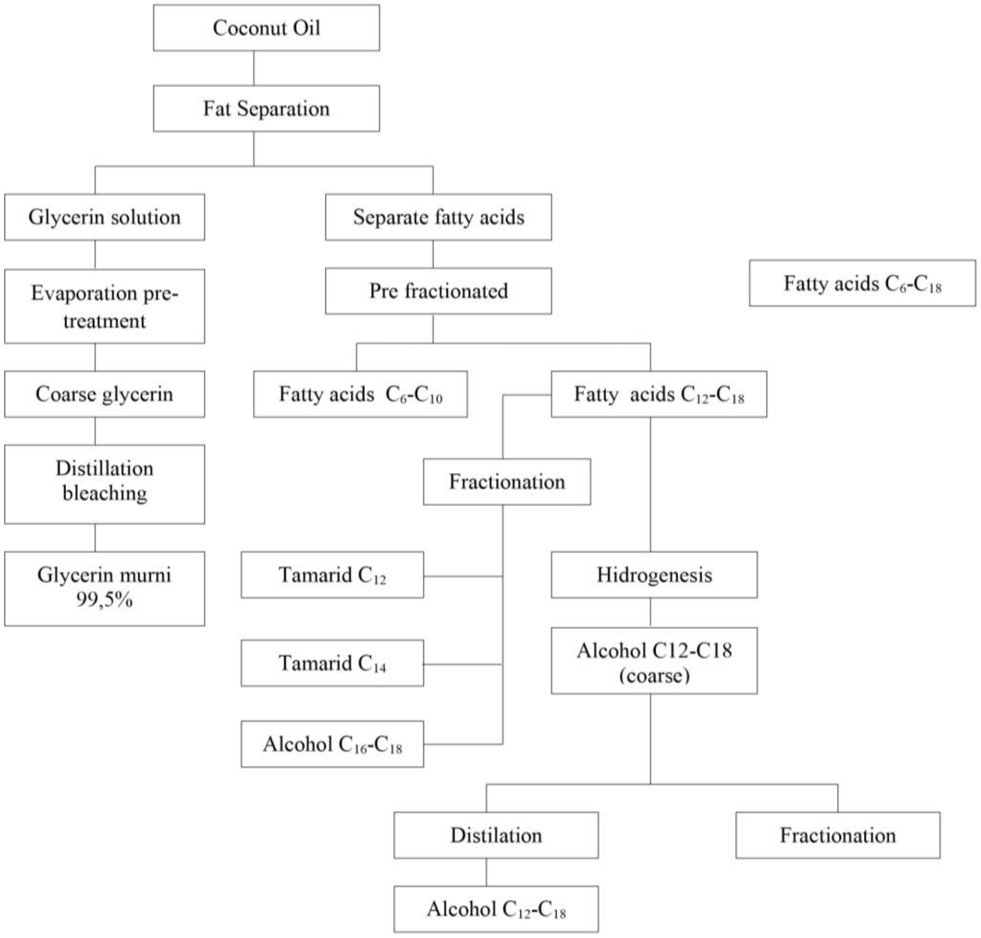

Fig. 2. The Process Of Producing Fatty Acids From Coconut. [15]

3.1.2 Fatty acid methyl esters

This compound is an intermediate product of fatty acids to become compounds such as alcoholic fatty acids. Fatty acid methyl esters can be obtained through the process of transesterification of fats / oils or the process of esterification of fatty acids [16]. The processing of this compound is presented in Figure 3.

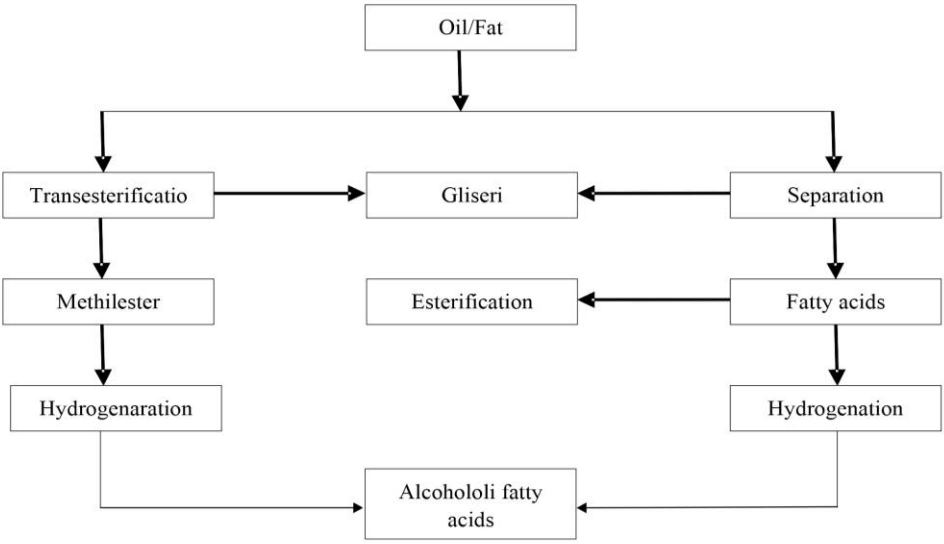

Fig. 3. The process of fatty acid alcohol production. [15]

Fatty acid methyl esters have a lower liquid point and are less corrosive and more resistant in color during storage than fatty acids. This compound can be further processed into derivatives such as alkanol amide, methyl ester sulfo-fatty acids that can be obtained through the sulfonation process. Methyl esters of fatty acids and their derivatives can be used as surfactants for food and non-food ingredients. In the Philippines fatty acid methyl esters have been tried as a substitute for diesel oil.

3.1.3 Alcoholic fatty acids

Alcoholic fatty acids can be produced/processed from natural and synthetic fats / oils. Natural fats / oils can be sourced from vegetable oils and animal fats while synthetic materials used are petroleum. Production of alcoholic fatty acids from synthetic materials since 1979/1980 began to decrease and manufacturers began to switch to using vegetable fatty acids (especially oils classified as lauric oil) as raw materials. This is because the production of alcoholic fatty acids from natural ingredients does not require raw materials in large quantities/volumes and energy during processing and the cost of processing is cheaper than using petroleum as a raw material for processing alcoholic fatty acids.

Through the hydrogenation process the fat / oil is first broken down into fatty acids and fatty acid methyl esters. This process takes place at a pressure of 300 bar with a processing temperature of 250 C when using fatty acid methyl esters and 300 C when using fatty acids. United Coconut Chemical, Inc. in the Philippines, alcoholic fatty acids are processed through a process known as the lurgi process, namely the hydrogenation of fatty acids from coconuts, especially those with C12-C18 atoms. The stages of the reaction proceed as follows:

1. Esterification : Fatty acids + Alcohol --------> Wax-ester + Air

2. Hydrogenation : Wax ester + Hydrogen --------> Alcohol + Alcohol
   Fatty acids + Hydrogen --------> Alcohol + water
   $R\text{-}COOH + 2\ H_2$ --------> $R\text{-}CH_2 – OH + H_2O$

Schematically the processing of alcoholic fatty acids is presented in Figure 3. Alcoholic acid obtained from the hydrogenation process still contains water and the remnants of esters so that it still requires further distillation and fractionation.

3.1.4 Glycerin

This product is a byproduct of processing fatty acids and methyl esters from fats/oils. Like other oleochemical products, glycerin can be obtained from natural or synthetic sources of oil. In the process of splitting fats / oils into fatty acids and methyl esters of fatty acids, glycerin obtained can reach 15%. The glycerin obtained is still in the form bound with water. To obtain pure glycerin, the oil separation tank is added Na-aluminate and acid treatment is then filtered. Finished the coarse glycerin filtration process still needs to be evaporated through 3 stages of evaporation. Then filtered in a vacuum state, then treated bleaching and filtered with activated charcoal. At the end of the filtration stage can be obtained glycerin for food grade and pharmaceutical grade 99.5%.

Glycerin is used as a raw material in the pharmaceutical, cosmetic, ester, food, resins, cellulose, polyols, polyurethane, tobacco, and nitration industries [17,18].

3.2 Oleochemical industry development opportunities and challenges

3.2.1 Availability of coconut oil raw materials

Coconut oil products are one of the mainstays of Indonesia which until now only used as food ingredients can be processed into oleochemical compounds. To what extent the role of coconut oil for the oleochemical industry in Indonesia is largely determined by the availability of coconut oil as a raw material. The availability of coconut oil is determined by the area of coconut plantation, the amount of coconut production, the amount of coconut consumption both fresh coconut consumption and processed into copra and coconut oil [19].

Coconut acreage in 2000 covering an area of 2,550,150 ha with production reaching 2,650,000 tons of copra equivalents. In 2014, the area of coconut is estimated at 3,750,000 ha with an estimated production of 2,850,000 tons of copra equivalents. From coconut production in 2014, the number of real copra is estimated at 1,280,000 tons with coconut oil production of 850,845 tons. Coconut oil exports in 2014 reached 550,000 tons so that the allocation in the country as much as 650,750 tons.

The consumption of oil and fat from coconut in the country is estimated at 8.5 /capita/year so that the total consumption of oil and fat from coconut is 1,240,830 Tons. Of the total consumption of 650,750 tons is coconut oil from copra and the rest as much as 950,950 tons of fresh coconut or equivalent 1,650,255 tons of copra. So, the total consumption of oil and fat from coconut in 2014 as much as 2,950,155 tons of copra equivalents. With a production of 2,850,000 copra equivalents, in 2014 it is expected that there will be a shortage of coconut as much as 90,080 tons of copra equivalents. This calculation does not include the consumption of young coconut.

From the data stated it turns out that for the development of oleochemical industry is still needed efforts to increase coconut production in order to ensure the availability of raw materials for coconut oil. Coconut production increased with a growth rate of 4.5% per year has not been able to offset the growth rate of coconut consumption for food purposes by 5.5% per year in the period 2000-2014.Increased production of palm oil and palm kernel is expected to support the availability of raw materials because of its ability as a substitute for oil/ fat consumption for foodstuffs.

3.2.2 Market Outlook

Exact Data on the consumption of coconut oil for non-food needs in the country have not been obtained. However, with the development of domestic industries that use oleochemicals as raw materials such as the pharmaceutical industry, pharmaceuticals, cosmetics, detergents, paint materials, textiles, leather, and others, it is estimated that the demand for oleochemicals in the country is increasing. Most of the domestic oleochemical needs are still imported.

Based on data from 2000, World coconut oil consumption increased by 3.5% per year. In the period 2000-2014 the consumption of coconut oil in the countries of Africa, America, Eastern Europe, and Western Europe is projected to increase successively 6.1%, 1.2%, 5.9%, and 0.4%. In 2014, coconut oil consumption in Africa is projected to be 151,550 MT, America 857,700,800 MT, Eastern Europe 3,200,580 MT, Western Europe 65,590 MT (BPEN, 2015). In 2014, the United States imported 550,500 MT of coconut oil and 650 500 MT of Western Europe. Of the amount imported, 80% is used for foodstuffs and 20% for non-food (oleochemical industry). The United States was a pioneer in the oleochemical industry followed by Western Europe. The Philippines, Malaysia, and Japan began to develop the oleochemical industry starting in the 1980s [20].

In Western Europe in the period above 2000 it is estimated that the production of fatty acids increases with a growth rate of 1-5%, fatty acids methyl esters 4%, fatty acids alcoholic 3%, glycerin 4%, and fatty acids amines 5% per year. The growth of oleochemical production is enough to keep pace with the needs of Western Europe alone.

For the Asia Pacific region, the oleochemical outlook is reflected in the following data [21]:

1. The production of fatty acids in Japan from 2000-2014 increased by an average of 3.2% a year. The need for 2014 is around 250,100 tons and in 2020 it is estimated to range from 350,000-450,000 tons. This increase is due to the increased use of detergents. The production capacity of fatty acids in Japan is currently less than 300,000 tons. In 2020, it is estimated that the Japanese market will lack fatty acids around 5-10,000 tons. Although Malaysia has a fatty acid industry with a capacity of 200,000 tons/year, but most of its production is exported to Europe.
2. Producers of alcoholic fatty acids in the Asia Pacific region are Japan and the Philippines. The amount of production of Japan and the Philippines is about 55,000 tons/year. Meanwhile, consumption growth in Asia Pacific ranges from 4-8% a year. With this consumption growth rate, in 2000 the region will experience a shortage of alcoholic fatty acid supply of 200,000-300,000 tons/year. Therefore, TCR has a considerable opportunity to establish a new alcoholic fatty acid industry with a total capacity of about 70,000 tons / year. Ideal economies of scale for a fatty acid/alcoholic fatty acid plant of 25,000-30,000 tons/year. On this basis, to meet the needs of alcoholic fatty acids in the Asia Pacific region in 2020, there is an opportunity to establish at least 3-4 factories with a capacity of 25,000 tons/year.
3. The production of fatty amines in Japan in 2014 was above 20,000 tons / year, while the demand in the last 2014 increased by an average of 12% per year. By 2020, the demand for Amine fatty acids is expected to increase by an average of 8% per year. With this level of increase, the needs in 2020 are above 55,000 tons / year. Therefore, in the Asia Pacific region open opportunities to develop Amine fatty acid plant with a total capacity of 30,000-40,000 tons/year.
4. Another important type of oleochemical is metal stearates which are used mainly for PVC industrial purposes. Its current production capacity is estimated at 20,000 tons/year. Meanwhile, the total demand in the Asia Pacific region in 2020 is estimated to range from 40,000-60,000 tons per year.

With the rapid economic growth of Asia Pacific countries due to industrial development, it is estimated that the demand for oleochemicals in this region is increasing. To anticipate the increase in demand, Indonesia can be one of the producers of oleochemicals besides the Philippines, Japan, and Malaysia. Overall World oleochemical consumption is expected to increase by about 3-5% per year, so that by 2020 the world needs will reach 5.6-7.5 million tons a year.

Based on the data presented, the development of oleochemical industry in Indonesia is very prospective when viewed from the prospects of the domestic market, Asia Pacific region and the world market as a whole

3.2.3 Oleochemical industry advantages and problem

Oleochemical industry is very likely to be applied in Indonesia in the review of several aspects of technical excellence and employment. [12]. suggests some of the advantages of oleochemical industry is as follows:

1. The industry has long developed so that various process technologies have developed and have been mastered.
2. The products produced are very diverse with various uses so that production adjustments can be made in the event of price fluctuations or demand for one product.
3. Very flexible in producing a product depending on the raw materials available.
4. A relatively simple processing process that makes it easy to produce a wide spectrum of products.
5. Friendly to the environment because it uses natural raw materials. The handling of oleochemical materials is controlled and does not harm the environment. Residues can be recycled or destroyed without causing problems. Oleochemical industry will not have problems with the demands of Eco labeling on each product produced.
6. Allows it to be applied on an intermediate scale especially for intermediate oleochemicals (Oleochemical intermediate) and their derivatives.
7. Guarantee the availability of raw materials because this industry can use various sources of vegetable oil raw materials from coconut, palm, soybean, tallow, and others.

Although the oleochemical industry is a capital-intensive industry with the application of high technology, it does not mean that this industry does not absorb labor. New labor fields will be open in at least three areas, namely the raw material processing industry (coconut oil), the basic oleochemical producing industry, and the oleochemical derivatives producing industry. Thus, the oleochemical industry is classified as broad-based industry, where the necessary raw materials are produced by small industries that absorb a lot of Labor [22].

Problems that must be anticipated in the development of oleochemical industry in Indonesia is competition with other oleochemical producing countries. Now there is a tendency of coconut-producing countries in the Asia Pacific region such as the Philippines, Malaysia, India, Sri Lanka actively deepening the structure of the coconut processing industry. These countries like Indonesia no longer want to export coconut oil raw materials but try to export finished goods that will add value to their products. In the 2000s the Philippines exported 150,550 MT of oleochemicals.

The massive development of the oleochemical industry in this region is feared to cause overproduction which ultimately affects the price of oleochemicals itself. To overcome the above problems in the country, the development of oleochemical industry must be in an agribusiness system that can ensure production efficiency and guarantee the domestic market. The development of oleochemical industries should also be followed by the development of domestic industries that utilize oleochemicals. The linkages of oleochemical industry development in an agribusiness system are presented in Figure 4.

Broadly speaking, the oleochemical agribusiness system consists of coconut oil producers as raw material for oleochemical processing, basic oleochemical producers who process coconut oil into basic oleochemical, producers of oleochemical derivatives and consumers in this case industries that use oleochemical derivatives in processing products such as textile, leather, cosmetics, pharmaceuticals, detergents, and others. The role of farmers is as a producer of coconut raw materials for coconut oil processing.

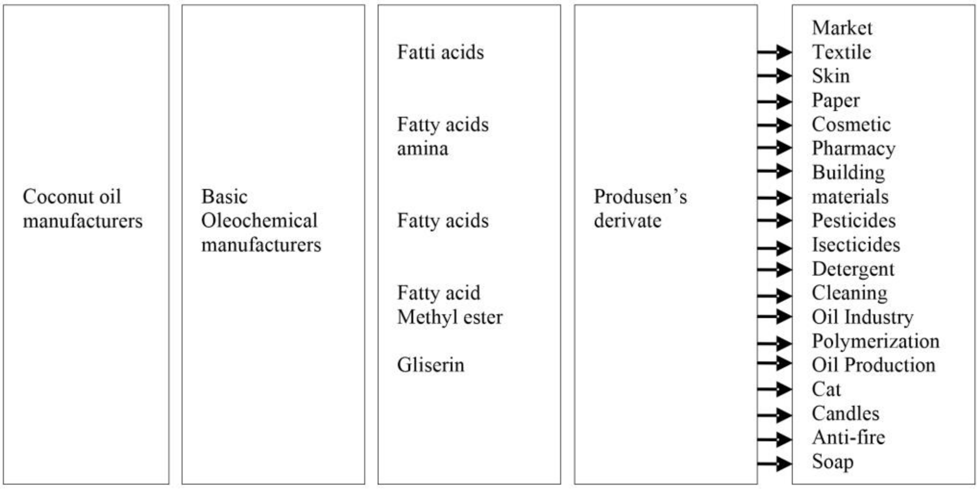

Fig. 4. Oleochemical Agribusiness System.

In addition to strategic problems as stated above, there are important things to be anticipated and can be a determinant of readiness and a must mastery of high precision digital technology in the industrial era 4.0. Understanding that technology should be considered as a system, that is, a set of units and activities that are interrelated and communicate with each other. As a system, technology has goals and objectives that must be achieved so that the components in it are interrelated and the influence of the environment it is necessary to control the appropriate management system. According to [23], there are four components of technology, namely (1) human ware, (2) info ware, (3) Orga ware, and (4) techno ware. Techno ware is an object that includes physical facilities in the form of machines or all equipment that can increase human physical strength and can control the course of the activity process. Human ware is related to human abilities themselves such as skills, expertise, knowledge, and creativity that play a role to realize greater benefits from natural resources and technological resources for productive purposes. Info ware is a set of fact documents such as design, specification, blueprint, operation manual, maintenance, and repair that serves to speed up the learning process and can save resource utilization and time. Orga ware is an institution or institution that coordinates all productive activities of a company to achieve organizational goals such as networking, grouping, circles, and other organizing techniques.

The capability level is characterized by the presence of (a) the ability to use and control technological devices (techno ware); (b) the ability to plan operations including aspects such as production planning and scheduling, quality assurance and Inventory Control; (c) the ability to provide information and network support for operations; (d) the ability to carry out preventive, routine and component-level repairs; (e) the ability to locate and troubleshoot problems quickly (troubleshooting). The capability level is characterized by the presence of (a) the ability to use and control technological devices (techno ware); (b) the ability to plan operations including aspects such as production planning and scheduling, quality assurance and Inventory Control; (c) the ability to provide information and network support for operations; (d) the ability to carry out preventive, routine and component-level repairs; (e) the ability to locate and troubleshoot problems quickly (troubleshooting).

The strategy of mastering technology based on Habibie's philosophy in is to start from the end and end from the beginning. Stages of mastery of technology according to the philosophy starts from the stage of mastery of production technology, the stage of design and integration of technology that has been mastered; the stage of technology development and integration of competitive technology in the world; and the stage of obtaining the ability to carry out basic research or the creation of generic technology to support the stage of technology development. This means that the process of technology formation, the process of presentation and communication, as well as the popularization of technology in the context of Industry 4.0 largely determine the success of technology transfer and its application at the user level.

4 Conclusions

Oleochemicals and their derivatives are used as raw materials for the cosmetic industry, toilet items, detergents, bath soaps, rubber finished goods, pharmaceuticals, plastics, and fibers, and candles. Other benefits are as an emulsifier, plasticizer, stabilizer, booster, depressant, lubricant, water retention, skin softener, surfactant, and others.

The oleochemical industry entering the industry 4.0 era is quite prospective and very possible and has the opportunity to be developed in Indonesia in order to achieve optimal economic value from coconuts in terms of raw material availability, technical excellence, employment, and domestic and foreign market opportunities.

Obstacles that may be faced and need to be anticipated proportionally are competitors of Asia Pacific countries that simultaneously develop oleochemical industries. To ensure the market for oleochemicals, the development of this industry must be followed by the development of domestic industries that utilize oleochemical products.

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