

## Community-Based and Eco-Friendly Palm Oil Industry Waste Management Model: for Community Business

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### ABSTRACT

This study aims to formulate strategy and model for managing the palm oil industry solid waste. The sample was taken by conducting purposive sampling; it included the community around the industry that represented the existing socio-culture, and some company employees. The data collection techniques were Interview, Observation, and Focus Group Discussion (FGD). The data analysis of the palm oil industry waste management policy strategy was carried out by using SWOT. Then, a community-based and eco-friendly palm oil industry waste management model was formulated. The results revealed that the community that processed the palm oil industry waste was internally weak, but it still had some opportunities. The recommended strategy is conservative. Community-based solid waste management requires the involvement and role of various parties such as government, private sector, the role of technology, researchers, and social media. The government can give its support through regulations and facilitation to improve the ability of human resources in mastering waste utilization technology. Meanwhile the private sector can be the catalyst to build brand image and brand awareness.

**Keywords:** Briquette, industry, palm oil waste, compost.

### INTRODUCTION

Palm oil generates one of the dominant vegetable oils that is produced globally, accounting for a quarter of global consumption and around 60% of the international trade in vegetable oils [1, 2]. It is estimated that 74% of global use of palm oil is for food products and 24% is for industrial purposes. The overall palm oil production capacity has grown up to 128%; it has risen significantly by 58 tons per year over the past decade due to an increase in global population and oil consumption. Around 85% of palm oil production is concentrated in Indonesia and Malaysia [3]. The economic contribution of the palm oil industry in Indonesia cannot be underestimated due to the fact that the industry contributed US \$ 17.6 billion in exports in 2012. Despite many other potential industries, the palm oil industry has made Indonesia as the leader in world exports and a contributor to the country's foreign exchange.

The constant increase in demand for crude palm oil and palm kernel oil has greatly affected the different rates of oil prices in the world markets [4].

West Sulawesi Province is one of the second largest palm oil producers in Eastern Indonesia. West Sulawesi has great potential in palm oil plantations with an area of 72,506 hectares producing 226,178 tons. There is a rapid growth of palm oil mills in Pasangkayu Regency as evidenced by the establishment of various oil palm companies. The development of palm oil agroindustry is an intriguing issue to be observed. On the one hand, this development has given a positive effect, particularly increasing the income of palm oil farmers and entrepreneurs involved in the agroindustry, but on the other hand there are many negative problems that arise such as environmental damage; the damage is due to forest clearing prepared for palm oil plantations that produces waste in the form of empty fruit bunches, fibers, and shells that have not been appropriately utilized [5]. The factories are the party responsible for the negative impacts of waste, they must be able to process waste in an integrated way. Various attempts have been made to process and increase the economic value of palm oil solid waste [6].

The expansion and increase in the area of palm oil plantations happen at the same time with an increase in the number of processing industries which rises the amount of waste produced. This is due to the increasing weight of the palm oil mill waste that has to be disposed. Waste generated from the palm oil processing will make several negative impacts on the environment in terms of both the quantity and the quality of natural resources, and the environment itself. The negative impacts of waste generated from an industry become the responsibility of the mills; they are demanded to be able to process waste in an integrated way and involve the community. Utilization of waste into materials that are profitable or have high economic value is carried out to reduce the negative impacts on the environment and create an eco-friendly industry [7].

The utilization of waste into a product can reduce the environmental damage and have positive impacts on the factory and surrounding communities. By performing that action, a mill can minimize the negative impacts of palm oil waste and optimize the positive impacts on the community. The community involvement is required in maintaining sustainability. The community can actively participate in preserving the surrounding environment. Various community participations as the parts of community involvement in utilizing palm oil solid waste can support the environmental sustainability and improve the quality and quantity of the environment. Related to the background, this study aims to examine the strategy of managing the palm oil industry solid waste and formulate a model of community-based and eco-friendly palm oil industry management.

## RESEARCH METHOD

### Research Period and Site

This research was carried out in April to October 2018. It was conducted at the palm oil processing mill of PT. LSS in Pasangkayu Regency, West Sulawesi Province. The research site was chosen purposively by considering that it is the largest palm oil processing mill in Pasangkayu Regency with an area of 10,000 Ha. The company is engaged in the Palm Oil Plantation (*Elaeis Guineensis Jacq*) proven by the Right to Cultivate Permit (HGU) No.55/HGU/BPN/96. The area of cultivation is 2,825.93 Ha, and core and plasma plantation are 3,570 Ha. The land clearing has been carried out since 1990 (Survey and Land Clearing Phase) and harvesting was begun in 1995. Production Activity Process includes processing

fresh fruit bunches (FFB) at the mill site that generates main products such as CPO and kernels, and by-product such as solid waste in the form of EFB, shells, fibers, and wastewater (POME).

In 1996, a palm oil processing mill (Crude Palm Oil) producing CPO and Kernels was built on an area of 3 hectares. It has been operated since November 1996 with an installed capacity of 40 tons of FFB/hour. In 2013, the mill production has been increased into 60 tons of FFB hour. For this reason, the company first obtained an Environmental Permit No. 85 of 2013 concerning the revision/addendum of EIA document No.107/ANDAL/RKL-UPL/BA/VIII/96. The mill area consists of 60% Mineral Land and 40% Peat Land flown by two rivers namely Wike River and Kuma River.

### **Research Sample**

The sample in this study was purposively chosen (purposive sampling). It consisted of manager, heads of production department, and employee of solid waste processing department. While the sample of the community around the palm oil industry was determined based on the socio-cultural area of the community, it was purposively chosen based on 6 (six) ethnic groups namely the Mandarese, Buginese, The Makassarese, The Javanese, The Sasak (Lombok people), and The Balinese. The sampling of the community based on the ethnicity of 30 people was determined by proportional sampling. The next source of informants was the Village Head with consideration of knowing the exact problems that existed in the research site. The data used in this study comprised of primary and secondary data. The data collection techniques included Interview, Observation, and Focus Group Discussion (FGD).

### **Data Analysis**

The method of the study was a survey research. A survey research is observation or investigation to obtain information on problems in a particular area [8]. The survey research method aims to find out a community and eco-friendly palm oil industry waste management system. Survey research is one of the research methods used to obtain a general description of a population characteristic that is described by the sample. According to [9] survey research is a research that takes samples from one population and uses questionnaires as a primary data collection tool.

Descriptive analysis was used to examine the community-based palm oil industry waste management, and problems and attempts to optimize community-based environmental management aspect. The analysis of the palm oil industry waste management policy strategy was performed by using SWOT, Furthermore, a community-based and eco-friendly palm oil industry waste management model was formulated.

## **RESULTS AND DISCUSSION**

### **Impacts of Palm Oil Mill**

Impact is a change caused by an activity. An investment in development activities has the potential of giving an impact (impact is an effect which brings both positive and negative things). The concept of impact is defined as the influence of the emergence of human activities in development on the environment including human. Related to the previous statement, [10] explained that basically the development goal is to increase the level of people welfare; however, development activities cause unplanned side effects beyond the target that is called impact. An impact can be biophysical, social, economic, and cultural that affect the goals to be achieved.

The existence of the mill gives several positive impacts including increasing farmers' incomes and improving the welfare of rural communities. Besides, it also has some negative impacts such as causing water pollution and air pollution due to waste.

## Community Involvement in Waste Management

The increasing activities of palm oil processing mill will have several negative impacts on the preservation of the surrounding environment; so that community involvement is required to control and manage the environment [11, 12]. The environmental problems occur if there are some changes in the environment that directly or indirectly can have negative impacts on the health and well-being of humans and other living things. Five tribes around the mill that utilize palm oil mill waste can be seen in Table 1.

**Table 1. Tribe-based community involvement in palm oil solid waste management**

| No. | Tribe                        | Utilization of palm oil solid waste   |
|-----|------------------------------|---|
| 1.  | The Mandarese                | The people utilize solid waste in the form of oil palm fronds as a mixture for animal feed since it has adequate nutrition for livestock, especially cattle, goats and others to maintain the quality.  |
| 2   | The Buginese                 | The people utilize solid waste in the form of empty fruit bunches as compost. Using fertilizer derived from palm oil waste enables the farmers to reduce the operational costs on purchasing chemical fertilizer.   |
| 3.  | The Javanese                 | The people utilize solid waste in the form of shell kernel which is processed into Charcoal Briquettes. Charcoal briquettes are charcoal made from other types of charcoal that are crushed and pressed as needed with starch mixture. The purpose of making charcoal briquettes is to increase the burn period, save costs, and find alternative fuels. The Benefits of charcoal briquettes are cheap, economical, safe, and environmentally friendly. |
| 4.  | The Sasak<br>(Lombok people) | The people utilize empty fruit bunches as pesticide. Oil palm empty fruit bunches are arranged and spread on the embankment path and lorry path with weeds and grass. This natural pesticide is used to kill weeds and grass. So, it no longer depends on chemicals as primary ingredients in reducing the growth of weeds and grass  |
| 5.  | The Balinese                 | The people use shell as a raw material for hand-made crafts such as ring band.  |

In the daily life, each tribe can process palm oil waste into processed products made by other tribes. For example, the Balinese not only process palm oil waste into rings but also process it into other forms such as charcoal briquettes. Other tribes also can process waste into other forms other than mentioned in the previous table.

## Analysis of Internal-External Factors of Palm Oil Industry Waste Management

Analysis of community-based palm oil industry waste management strategy was carried out using strengths, weaknesses, opportunities, and threats (SWOT) analysis. Identification of internal factors that will become strengths and weaknesses, and identification of external factors that will become opportunities and threats is required.

### *Identification of Internal Factors: Strengths*

#### **a. Surrounding Community**

The surrounding community is an important part in the process of decision making, implementation of activities, utilization of development results, and evaluation. It determines the sustainability of a company's activities development. The community also determines the welfare and betterment of the quality of life that can be obtained by the community as well as

the acquisition of economic benefits that can be obtained from the impact of company activities. Therefore, the surrounding community is the most influential thing for the sustainability of a company's activities whether the company is around the community environment [13]. The Pasangkayu community plays a significant role in the management and utilization of solid waste into a product that can be used and is safe for the environment and health by eliminating and or reducing the hazardous nature of such waste. Surrounding community has positive expectations and high motivation for palm oil industry waste management.

#### **b. Well-developed Human Resources Relations**

Pertaining to the problem of environmental pollution, an industry can have tremendous impact on people's lives by causing environmental damage. Therefore, it should be cleverly treated in order to overcome the impact. Furthermore, mutual relations between the government, society, and the environment must always be developed in order to remain a harmonious and dynamic state. The participation of the community and the government is needed to support the continuity of the relations. Well-developed human resources relations will prevent disruption, problems, or destruction due to pollution [14]. There has been excessive amount of solid waste produced by the mill. Therefore, the people are able to manage and utilize solid waste easily and establish well community relations in managing palm oil solid waste.

#### **c. Amount of Solid Waste**

The expansion and increase in the area of palm oil plantations happen at the same time with an increase in the number of processing industries which rises the amount of waste produced. This is due to the increasing weight of the palm oil mill waste that has to be disposed. Waste generated from the palm oil processing will make several negative impacts on the environment in terms of both the quantity and the quality of natural resources, and the environment itself. However, if the waste is managed properly, it will give positive impacts on the company and the surrounding community; the community can utilize the waste to be made into products that have economic value and do not pollute the environment [15]. Pasangkayu has a large amount of palm oil solid waste and it is ready to be processed into various products.

#### **d. Benefits of Solid Waste**

Utilization of waste into materials that are profitable or have high economic value is performed to reduce negative impacts on the environment and create an eco-friendly industry. The characteristic of agricultural industry waste, especially palm oil industry, is having high organic matter content. The content of organic matter can be used for the growth of oil palm. Palm oil industry waste can be utilized on oil palm plantation land to avoid environmental pollution and fulfill fertilizer needs [16]. Utilization of waste into some products can reduce environmental damage and have some positive impacts on the company and surrounding community.

#### **e. Company Support**

At first, the main purpose of the company was to seek maximum profits for its shareholders. However, over a period of time, the company has faced demanding pressures for playing a more concrete social role to improve the welfare of the surrounding community and other stakeholders. In essence, the company is required to carry out social obligations to many stakeholders, more than economic responsibility. The social obligation can be a direct interaction with labor and consumers as well as indirect interaction with the community who lives around the site. This view emphasizes that a single orientation to shareholders is not sustainable since it ignores the variety of other parties involved in the system and the business cycle of the company.

In order to reduce the amount of solid waste, the company as the producer fully supports the processing and utilization of solid waste. The company has opened the access to the community, so that the community can easily get the solid waste. The company also shows its support by using public transportation services from the collection point to the processing site and oil palm plantations.

### ***Internal Factors: Weaknesses***

#### **a. Community Innovation**

Another problem related to waste is there is no synchronization (innovation) between those who can utilize waste with the industry that produces waste. Economically, all waste can be processed into other products to increase economic value and benefits, that is, not only for industry actors, but also for the parties concerned with waste [17]. The community has not had a new breakthrough in managing and utilizing palm oil solid waste as a commodity with high sale value yet. Facilities and infrastructure, specifically road, have not been adequately available and not reached all parts of the potential area yet. Some of the area's internal access to the main roads have not opened yet. Lack of innovation and infrastructures is a barrier to solve the problems on waste.

#### **b. Community Skills and Knowledge**

According to [18], the basic problem of waste treatment and management is the lack of knowledge, especially skills of the community. The low awareness of the company and the community towards waste treatment and management becomes the highlight. Therefore, lack of knowledge and skills of Pasangkayu community in the management and utilization of solid waste is considered as a weakness. The limited funds owned by the community to manage palm oil solid waste also become weaknesses and obstacles in the utilization of palm oil waste.

Increasingly growth of large industries and careless society pose more problems including environmental problem. Those changes result in piles of waste that is not disposed properly [19]. Lack of interest in treating waste and lack of knowledge to overcome existing waste problems, especially in the community environment around the mill, have not been resolved optimally and those become the major problems [20].

#### **c. Lack of Interest**

The community consists of different people with different perspectives. Awareness strategy can be used to shape the same interests and goals. The definition of Community Understanding according to [21] is the ability or knowledge of the community to distinguish, describe, restate, give examples, and explain. Then, the definition of Public Will is a drive from within that is conscious, based on consideration of thoughts and feelings, as well as the whole person who causes activities directed at achieving certain goals related to the needs of someone's personal life. While the definition of Community Income according to [22] is an income derived from the service or the use of production factors in private or in groups which results can be in the form of money or other materials. Stakeholders must take responsibility in providing an understanding to the community about the benefits of participating in protecting/preserving the environment to anticipate damage that can cause natural disasters. In this case, it develops knowledge and understanding to increase people awareness of waste management participation. If the community has better understanding of the importance of waste management in the environment, they will acquire more knowledge. If they are highly motivated, they will be more aware of the importance of palm oil waste management. In Pasangkayu area, people who have the will to manage and utilize solid waste are still limited.

## ***External Factor: Opportunities***

### **a. High Demand for Compost**

Current degradation of agricultural land resources is generally associated with low organic matter content and fertilization that is not offset by the use of organic fertilizer. Thus, adding organic material to the soil through organic fertilizer can be an alternative solution to overcome this problem [23]. Improvement of soil biological properties is needed because compost will increase the population and diversity of soil biota, especially those that have a positive effect on soil conditions [24]. A healthy lifestyle or back to nature idea has become a new trend in society. The public is increasingly aware that the use of chemicals can actually have negative effects on human health and the environment; therefore, there are many requests for organic fertilizer or compost for cultivating rice or agricultural commodities [25]. Organic fertilizers are sought after and the demand is very high in the market. Organic fertilizer business is one of the most profitable businesses; the price of organic fertilizer is still above the average and promising, especially in the Pasangkayu area. Having oil palm and agricultural commodities is beneficial for Pasangkayu community since they have an opportunity to process palm oil waste to into compost for fulfilling the high demand.

### **b. Development of Alternative Fuels Products**

Energy is a basic human need, which continues to increase following the level of life. Liquid fuel (BBM) holds a highly dominant position in meeting national energy needs resulting in a decrease in crude oil production and high world crude oil prices which greatly affect the capacity of the development budget [26]. Up to this time, liquid fuel in Indonesia is still subsidized by the state (through the state budget), so that it becomes a significantly heavy burden for the government. To reduce the burden of these subsidies, the government is trying to reduce dependence on fuel oil energy by finding and developing other energy sources that are affordable and accessible. Utilization of new and renewable energy sources needs to be developed since the role and price of fuel continues to increase and soar and a substitute for sustainable energy source is required. Various methods are used to determine the potential of energy resources that can be developed [27].

The use of agro-industrial waste as a raw material for briquettes is considered strategic to substitute fuel that is currently soaring; kerosene and LPG gas which is used daily by lower class. The briquettes produced from palm shell charcoal are more environmentally friendly because they do not produce toxic gas emissions.

### **c. Government Policy**

The community and the government must participate in the decision making, management and supervision processes in the field of waste management, especially in the industrial area (Xue, 2013). The procedure for community participation in waste management can be done by considering the characteristics and social and cultural settings of each region. Referring to the previous explanation, it certainly becomes an obligation and the right of everyone both individually and collectively, as well as community groups, entrepreneurs, and other components of society and in particular government support by making policies that are appropriate for the community and companies as intermediaries [28]. The existence of community participation and government support will help the utilization of palm oil solid waste in Pasangkayu area. These will be a great opportunity for development of the palm oil company area. The community is supported by the local government with full delegation from the Regent to the Agency of Investment.

#### **d. Technology Advancement**

Technological advancement will occur following the scientific development. Every innovation is designed to provide positive benefits for human life. Technology also provides many conveniences, such as being a new way of doing human activities. Humans have enjoyed various benefits of technological innovations. Technological breakthrough in the field of palm oil waste utilization is one of the numerous technological advances in the development and innovation of palm oil waste management. One of the palm oil waste utilizations is being used for animal feed; the type of feed made from oil palm is the Palm Kernel Expeller (PKE). During 2014, PKE exports subject to quarantine measures reached 1,388,020 tons. PKE is processed into powder and can be used as a mixer for livestock feed, especially dairy cows. Based on the latest data, the price of PKE is IDR 800,000 per ton. Indonesia's palm oil mills began producing PKE in 2010 by targeting the New Zealand market. Now, the market has expanded to South Korea, China, Vietnam, the Netherlands and Thailand. Technological advancement also optimizes the use of palm oil waste for animal feed.

#### **e. Increasing Community's Interest in Organic Products**

Organic food is healthier because it is safe from chemical hazards and has more diverse nutritional content and bioactive components, some products even have higher content [29]. Several previous studies mentioned the role of demographic characteristics (gender, age, education, occupation, residence, income level, ethnicity) in the commitment to purchase eco-friendly healthy products ([30, 31].therefore, the community's interest in using organic (natural) agricultural products is increasing. This is in line with the trend of healthy lifestyles, especially in large cities, that are starting to increase because many people are beginning to understand the negative effects of inorganic (chemical) use. Organic farming produces sufficient, safe and nutritious food so as to improve public health especially in Pasangkayu Sulawesi.

#### ***External Factor: Threats***

##### **a. Decreasing Waste Volume**

In industrial companies or group businesses, raw material is one of important elements that needs special attention in terms of planning and management. If there is no raw material, production activities cannot run smoothly. Raw material can be obtained from local purchases, imported purchases, or self-processed[32]. Raw material is one of the most important production factors. Lack of raw materials can result in the cessation of the production process due to the limited material to be processed. Therefore, if the volume of waste is too limited, the community does not have materials that must be processed as the source of community livelihood. Another impact is the production of processed palm oil solid waste is decreasing. With the decreasing volume of waste, it will pose new problems related to employment that has been created in the utilization of palm oil industry solid waste.

##### **b. Falling Demand for Palm Oil in the Global Market**

The European Commission has determined the new criteria for the use of palm oil as raw material for biodiesel production in European Union countries in the Delegated Regulation Supplementing Directive of the EU Renewable Energy Directive II (RED II). In the new regulation, palm oil is categorized as an 'unsustainable' product or cannot be used as biodiesel material. The decision emerged in response to an agreement from 28 European Union countries which highlighted the problem of deforestation due to massive oil palm cultivation. The European Union believes that the new criteria are in accordance with the rules set by the World Trade Organization (WTO), an institution in the United Nations (UN) which handles international trade affairs [33]. However, this regulation poses a serious threat. If half the



demand for palm oil from Europe decreases, there will be a deficit in the amount of palm oil solid waste that causes loss of income sources for people who rely on processing palm oil solid waste.

### **c. Level of River Water Pollution**

The significant use of water for some community's activities such as industrial, domestic, commercial and agricultural activities highly pollute the water. Those activities produce various waste materials and wastewater that enter the waters. Waste materials and wastewater will change the water quality and affect living resources such as animal, plant and microorganism [34].

The activities that cause impacts on river water and ditches components/parameters are operational activities of the plantation/maintenance of immature oil palm plants; such activities include fertilizing, controlling pests and plant diseases. The use of fertilizers and pesticides will have an impact on the life of aquatic biota. The existence of an oil palm plantation company will change the biological components (flora and fauna) of secondary forests in the plantation site. It changes the composition of vegetation and animals in the forest due to the development activities of oil palm plantations. A palm oil mill produces a large amount of wastewater from milling processes. If there is no appropriate treatment for liquid waste, it can cause serious environmental pollution [35].

### **d. Level of land pollution on plantations**

Sustainable growth and use of palm oil industry has always been associated with the environment because it is a land intensive industry. Any unplanned development will cause degradation of the forest system, loss of habitat including plants and animals, extreme degradation of land and pollution (water and air) due to the use of large amounts of pesticides and herbicides to maintain plantations [36].

In Pasangkayu, the impact of palm oil companies on the physical and biological environment of several construction activities will gradually lead to a micro climate in the area around oil palm plantations. One of the impacts of microclimate is changing air temperature and humidity. This happens due to physical and biological changes that occur as a result of construction activities such as land clearing and construction of plantation facilities.

### **e. Health Impact for the Community**

Palm oil mills have produced adverse environmental impacts (such as climate change and the greenhouse effect) due to excessive emissions and deforestation levelling up the concentrations of pollutant gases. The danger of excessive air pollution due to production that is not environmentally friendly has become common in Malaysia and Indonesia [37] Air emissions from diesel engines have several health implications including cardio-respiratory disorders, pulmonary edema [38], eye irritation, central nervous system disorders, drowsiness, coughing and other respiratory diseases [39]. Palm oil mills in Pasangkayu also use diesel engines for their productions. The waste can affect the health of the community around the factory due to processed waste, factory smoke, noise and so forth.

A summary of internal and external factor analysis can be seen in table 2.

**Table 2. Summary of internal and external analysis of palm oil solid waste management.**

| <i>Category</i> | <i>Fact</i>  | <i>Empirical study source</i> |
|-----------------|--|-------------------------------|
| Strength        | Local communities<br>Well-developed HR relations<br>Amount of solid waste<br>Benefits of solid waste<br>Company support  | [13, 14, 16, 40]              |
| Weakness        | Community innovation<br>Facilities and infrastructure<br>Community skills and knowledge<br>Availability of waste management fund<br>Lack of interest                                       | [17-21] [22]                  |
| Opportunity     | High Demand for Compost<br>Development of Alternative Fuels Products<br>Government Policy<br>Technological Advancement<br>Increasing Community's Interest in Organic Products              | [23-27, 29-31, 41]            |
| Threat          | Decreasing waste volume<br>Falling Demand for Palm Oil in the Global Market<br>Level of river water pollution<br>Level of land pollution on plantations<br>Health impact for the community | [4, 32, 34-36, 38, 39]        |

Based on the internal and external factors, alternative planning strategies for palm oil waste management are formulated. Alternative waste management strategies can be seen in the matrix in Table 3.

**Table 3. Matrix of SWOT Analysis of Palm Oil Solid Waste Management**

| People in Charge for Processing Palm Oil Industrial Waste  | <b>Strengths (S)</b>  | <b>Weaknesses (W)</b>  |
|--|---|--|
|  | • Local communities (S1).   | • Community innovation (W1)  |
|  | • Well-developed HR relations (S2).   | • Facilities and infrastructure (W2)   |
|  | • Amount of solid waste (S3)  | • Community skills and knowledge (W3)  |
|  | • Benefits of solid waste (S4).   | • Availability of waste management fund (W4)   |
| • Company support (S5).                                    | • Lack of interest (W5).  |  |
| <b>Opportunities (O)</b>                                   | <b>SO Strategy (Strengths-Opportunities)</b>  | <b>WO Strategy (Weaknesses- Opportunities)</b>   |
| • High Demand for Compost (O1)                             | 1. Involving the community in waste management. (S1, S2, S5, O3, O5)<br>2. Educating the community about handling waste. (S1, S3, O1, O2, O4)<br>- Aggressive, Grasping the Opportunities | 1. Developing and applying appropriate technology. (W1, W2, W4, O2, O3)<br>2. Educating and developing human resources (operators) (W3, W5, O1, O4, O5)  |
| • Development of Alternative Fuels Products (O2).          |   |  |
| • Government Policy (O3)                                   |   |  |
| • Technological Advancement (O4)                           |   |  |
| • Increasing Community's Interest in Organic Products (O5) |   |  |
| <b>Threats (T)</b>   | <b>ST Strategy (Strengths-Threats)</b>  | <b>WT Strategy (Weaknesses-Threats)</b>  |
| • Decreasing waste volume (T1)                             | 1. Optimizing human resources (S3, S5, T3, T4, T5)<br>2. Optimizing waste management. (S3, S4, S5, T1, T2)  | 1. Developing partnership patterns with private companies in waste management. (W4, T1, T2, T3, T4, T5)<br>2. Improving evaluation of waste management. (W5, T1, T2, T3, T4, T5)<br>3. Conducting public health checks periodically (W5, T5) |
| • Falling Demand for Palm Oil in the Global Market (T2)    |   |  |
| • Level of river water pollution (T3)                      |   |  |
| • Level of land pollution on plantations (T4)              |   |  |
| • Health impact for the community (T5)                     |   |  |

The SWOT matrix created four possible alternative strategies, namely the SO strategy (strengths-opportunities), the WO strategy (weaknesses-opportunities), the ST strategy (strengths-threats) and the WT strategy (weakness-threats). The following are the alternative strategies for managing palm oil waste obtained from the SWOT matrix:

### **S-O Strategy**

S-O strategy; (1) The company engages the community in handling waste. It can be conducted by optimizing the potential of solid waste in the form of shells, bunches, fibers, etc. as an economic material. Waste can be used as organic fertilizer (compost) for farming activities in oil palm plantations. The community wants to be directly involved in solid waste management process. In addition, the community expects the company and the government to be guided in waste treatment. (2) Community development in handling waste performed by company is expected to build more environmental wisdom, so that managing waste becomes economically valuable. Waste management should be carried out jointly between the company and surrounding communities since the frequency of waste production is continuously increasing. In order for waste management activities to be carried out in an effective manner, the community needs guidance from the company and the local government. The community is expected to grasp opportunities to get maximum results. In this modern era, more business competition is caused by advances in technology that is increasingly developing even better. Therefore, the community needs an aggressive strategy, which is to develop existing strengths, and increase and maintain existing opportunities. This strategy can be done through approaches to the community.

### **1) W-O Strategy**

W-O Strategy is as follows: (1) Development and application of appropriate technology; The community minimizes waste pollution by reinventing wastewater treatment plant (WWTP) technology through the improvement of supporting facilities and infrastructure by involving the surrounding community both directly and indirectly towards a beautiful and clean environment. (2) Educating and developing human resources, especially the community around the industry. HR development activities are not only limited to internal human resources in the company, but also involving the community around the factory by creating a healthy environment movement.

### **2) S-T Strategy**

S-T Strategy; Optimizing human resources and waste. Management. According to applicable laws on the environment, each company is required to spend 5-10% of the company's profits for community development activities. Waste produced by the company requires serious response, especially handling the negative impacts for the surrounding community.

### **3) W-T Strategy**

W-T Strategy; Developing partnership patterns with private companies in waste management. It can be performed by collaborating with research institutions and private companies on waste management and treatment technology so that the waste does not pollute the surrounding community's environment.

### **4) Waste Management Strategy**

Based on the results of the identification of internal and external factors, the quality of the variable's performance was determined as a weight value and rating of the interests of developing community-based and eco-friendly palm oil industry waste management. The rating value for each factor was shown by a scale from 4 (outstanding) to 1 (poor). Rating values for strength and opportunity factors were positive (greater opportunity is given 4 points, small opportunity is given 1 point). The rating value for weaknesses and threats indicated the opposite, which was negative. Based on the provisions of the rating and weight values, IFE (Internal Factor Evaluation) and EFE (External Factor Evaluation) matrix were arranged by detailing all strengths and weaknesses. The matrix is shown in Table 4 and 5.

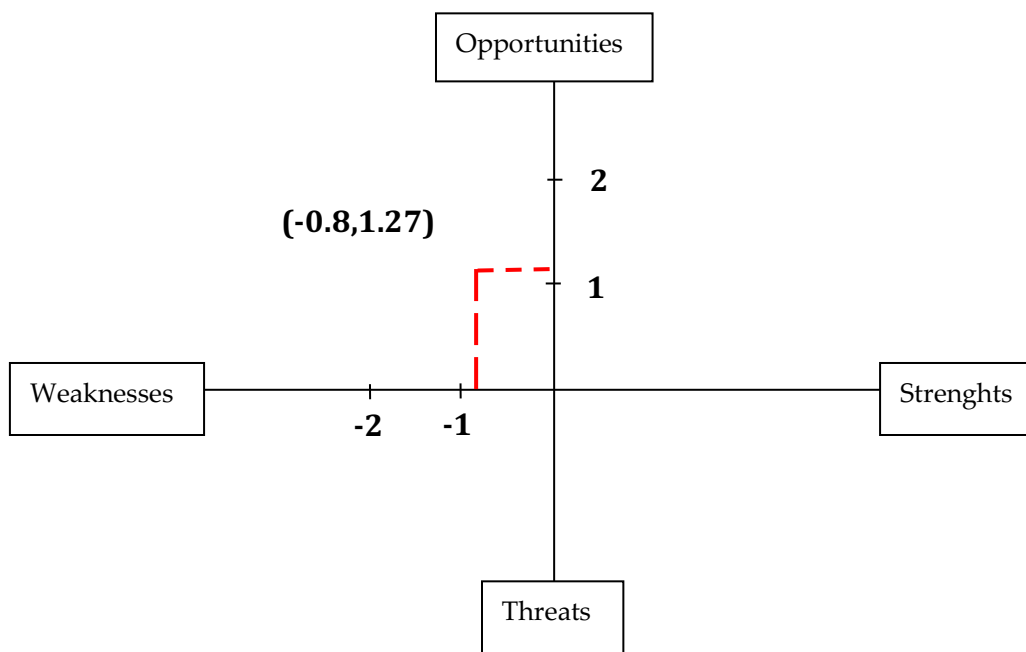
**Table 4. IFE (*Internal Factor Evaluation*) Matrix**

| No                 | Internal Factor                | Weight | Rating | B x R | Category |
|--------------------|--------------------------------|--------|--------|-------|----------|
| <u>Strengths:</u>  |                                |        |        |       |          |
| 1                  | Local communities              | 0.05   | 3      | 0.15  |          |
| 2                  | Well-developed HR relations    | 0.05   | 3      | 0.15  |          |
| 3                  | Company support                | 0.10   | 4      | 0.40  |          |
| 4                  | Benefits of solid waste        | 0.05   | 1      | 0.05  |          |
| 5                  | Amount of solid waste          | 0.15   | 4      | 0.60  |          |
| <u>Weaknesses:</u> |                                |        |        |       |          |
| 1                  | Community innovation           | 0.15   | -4     | -0.60 |          |
| 2                  | Facilities and infrastructure  | 0.15   | -3     | -0.45 |          |
| 3                  | Community skills and knowledge | 0.10   | -4     | -0.40 |          |
| 4                  | Funds availability             | 0.15   | -4     | -0.60 |          |
| 5                  | Lack of interest               | 0.05   | -2     | -0.10 |          |
| Total              |                                | 1.00   |        | -0.80 |          |

**Table 5. EFE (*External Factor Evaluation*) Matrix**

| No                    | External Factor                                     | Weight | Rating | B x R | Category |
|-----------------------|---|--------|--------|-------|----------|
| <u>Opportunities:</u> |   |        |        |       |          |
| 1                     | High Demand for Compost                             | 0.10   | 3      | 0.30  |          |
| 2                     | Development of Alternative Fuels Products           | 0.15   | 4      | 0.60  |          |
| 3                     | Government Policy                                   | 0.10   | 4      | 0.40  |          |
| 4                     | Technological Advancement                           | 0.10   | 3      | 0.30  |          |
| 5                     | Increasing Community's Interest in Organic Products | 0.20   | 4      | 0.80  |          |
| <u>Threats:</u>       |   |        |        |       |          |
| 1                     | Decreasing waste volume                             | 0.20   | -4     | -0.80 |          |
| 2                     | Falling Demand for Palm Oil in the Global Market    | 0.10   | -3     | -0.30 |          |
| 3                     | Level of river water pollution                      | 0.01   | -1     | -0.01 |          |
| 4                     | Level of land pollution on plantations              | 0.02   | -1     | -0.02 |          |
| 5                     | Health impact for the community                     | 0.02   | -1     | -0.02 |          |
| Total                 |   | 1.00   |        | 1.27  |          |

Based on the IFE matrix the x-axis was -0.80 and from the EFE matrix the y-axis was 1.27 so that  $(x, y) = (-0.80, 1.27)$  was in quadrant III (negative, positive). The position implies that community that processed the palm oil industry waste is weak internally, but it still has opportunities. The recommended strategy is conservative. It indicates that the company needs to review the resources internally for managing waste. Then, the company still has the opportunity to use external resources to handle waste problems. The position of this strategy is listed in Figure 1.



**Figure 1. Strategy Position in the SWOT Quadrant**

Based on Figure 1, it explains that the position of the strategic quadrant is in quadrant III. This position shows that the palm oil solid waste management has many weaknesses, but on the other hand also has many opportunities. This position is a strategy of stability or consolidation which aims to reduce the existing weaknesses by utilizing the opportunities. The strategy required includes the development of community capacity and institutional waste management.

### **Community-based Palm Oil Industry Waste Management Model**

Based on SWOT analysis and the resulting strategy, community-based palm oil solid waste management requires the involvement and role of various parties. The government, private sector, role of technology, researchers, and social media are needed to develop a management model. In general, it is explained as follows:

a. Government

explained that the government is a study of how to be able to exercise its power of authority; so, it can regulate the existing system within an institution in order to control and run them in harmony. The definition of government in the narrow sense is an organ/tool of the state that is entrusted with the task of government or implementing the law. The government, in this case the Pasangkayu Regency Government, has a role in facilitating the granting of licenses to the community to manage solid waste. Furthermore, the community reports the results of solid waste management to the government.

b. Technology

Technology is required in the management of solid waste to facilitate the community in the process of waste management into products that have high use and sale value. This is in accordance with the explanation of [42] who mentioned that technology is a form of process that increases added value. The running process can use or produce certain products, where the product produced is not separate from other existing products.

c. Training

Training is a series of individual activities to increase skill and knowledge so as to be able to have professional performance in the fields.

It is highly recommended to conduct a community training on palm oil solid waste management. It is expected that after participating in the training, the community will be able to process palm oil solid waste. The community should be able to increase the values and functions of the solid waste so that the service life can last long. The results of the palm oil solid waste management have a very high economic value and the products can even be sold overseas.

d. Private Sector

Entrepreneurs are people who have independent nature, view, creativity, innovation, resilience, and courage to bear the risks that may arise when managing businesses and various activities that can bring success. There is cooperation between the public and the private sector in selling processed products from palm oil solid waste, where the community acts as a supplier to supply goods and then the private sector plays the role in selling these goods to market consumers.

e. Social Media

Believes that social media is a platform that is able to facilitate various activities such as integrating websites, social interaction, and community-based content creation. Through social media services, the media can facilitate content, communication and conversation. Then, the users can co-create, manage, edit, comment, tag, discuss combining, connect, and share content.

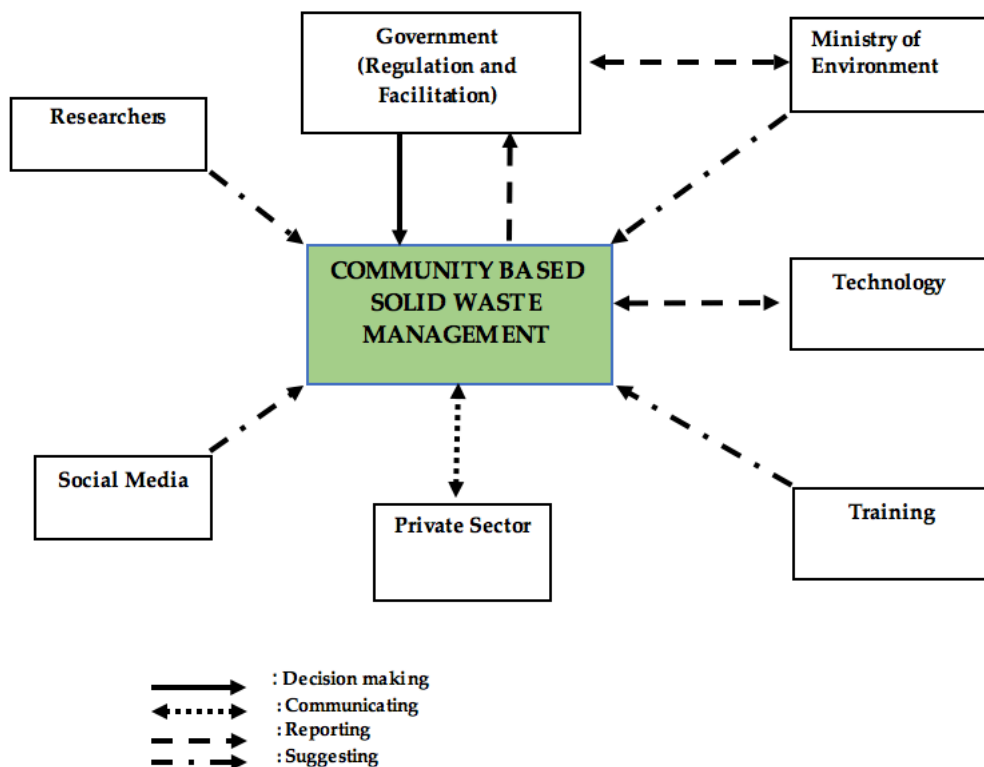
If the social media are used wisely, they can be used as the promotional media, business tools, and means of sharing. Promotion through social media is done to introduce and invite others to enjoy their products. Social media are also a good stepping stone to develop a business.

Social media are also often used for sharing information that is useful for many people, from one person to many others. By sharing this information, it is expected that many people will find out information on a national and international scale.

f. Researchers

From the results of research conducted by researchers, useful suggestions and strategies that can be used in developing community-based solid waste management are obtained.

Community-based palm oil solid waste management model can be seen in Figure 2.



**Figure 2. Community-Based Solid Waste Management**

### CONCLUSION

The results of the SWOT analysis indicated that the community managing the palm oil industry waste was weak internally, but it still had some opportunities. The recommended strategy is conservative, meaning that it needs to reconsider internal resources, but has the opportunity to deal with the waste problem. Community-based solid waste management requires the involvement and role of various parties comprising of the government, private sector, role of technology, researchers, and social media. The government can support by implementing regulation and giving facilities to improve the ability of human resources in the mastery of waste utilization technology and the private sector can be the catalyst to build brand image and brand awareness.

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