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Internalization of Environmental Externalities: Processing Palm Waste into Renewable Energy

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ABSTRACT

In 2021, the European Union issued a lawsuit at the World Trade Organization (WTO) regarding the halt in palm oil exports. The European Union Parliament considers the palm oil industry in Indonesia to be one of the triggers of deforestation, degradation and other environmental problems. Based on data from the Central Statistics Agency in 2019, the area of oil palm plantations in Indonesia reached 14.3 million hectares and the area of oil palm plantations in the Riau Province was 2.7 million hectares (Yanti and Lestari 2020). This is based on the high demand for oil from palm oil and its derivative products which has an impact on negative externalities due to the extraction process carried out. The Palm Oil Fresh Fruit Bunches (FFB) production process produces many products such as Crude Palm Oil (CPO) and Palm Kernel Oil (PKO). Crude palm oil (CPO) production plays an important role in both the local-global environment and socio-economics. In this case, Internalization of Externalities is needed to minimize dirty oil (palm oil waste) which is detrimental to third parties from the management process carried out. Based on the case study of Panyabungan Village, the externality value for liquid palm oil waste is IDR 146,194,433,- after internalizing the externalities, we get a Total Economic Value (TEV) of IDR 627,602,359,- with the liquid waste and solid waste aspects of palm oil in three locations namely; Jambi, Bengkulu and Kalimantan. As a preventive form of assessing externalities, economic and environmental studies also include a SWOT analysis to develop strategies for the sustainability of palm oil in Indonesia.

Keywords: Externalities, fresh fruit bunches, internalization, palm oil, sustainability.

INTRODUCTION

In 2021, the European Union issued a lawsuit at the World Trade Organization (WTO) regarding the halt in palm oil exports. The European Union Parliament considers the palm oil industry in Indonesia to be one of the triggers of deforestation, degradation and other environmental problems. Deforestation is a problem for major countries in the world. Based on data from the Central Statistics Agency in 2019, the area of oil palm plantations in Indonesia reached 14.3 million hectares and the area of oil palm plantations in the Riau Province was 2.7 million hectares (Yanti and Lestari 2020). In 2019, foreign exchange generated from the palm oil sector was recorded at US$20.2 billion, an increase of $1.6 billion (Ayu KP 2021). This means that palm oil provides benefits in the form of increased foreign exchange for Indonesia. However, it is a common fact that the palm

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oil business contributes significantly to deforestation in countries such as Malaysia and Indonesia (Hendriani *et al.* 2023). According to the investment management institute, Indonesia is the largest producer and exporter of palm oil in the world. However, Indonesia is the country that emits the most greenhouse gases, followed by the United States and the People's Republic of China (Hendriani *et al.* 2023).

In the past 10 years, most of the non-oil palm plantations throughout Indonesia have been converted into oil palm plantations (Ziaulhaq 2022). The forest area reached 119.7 million hectares, the deforestation area was 68.1 million hectares, while the area of oil palm plantations was only 597 thousand hectares or only around 0.9 percent of the deforestation area (PASPI 2014). The increasing amount of land being converted into oil palm plantations results in the resulting large number of externalities. Externalities arise when impacts on the environment that result in social costs and benefits are not considered by the person or group of people who cause these impacts (Utami 2018). Meanwhile, the palm oil fresh fruit bunches (FFB) production process produces main products such as crude palm oil (CPO) and palm kernel oil (PKO). Palm oil producers are required to produce more oil. With the high demand for petroleum from palm oil and its derivative products, this has an impact on negative externalities due to the extraction process carried out.

Potential sources of waste resulting from palm oil processing (extraction) can also be used as energy. Fresh fruit bunches (FFB) produce main products in the form of crude palm oil (CPO) and palm kernel oil (PKO). The results of Crude Palm Oil (CPO) management produce liquid waste and solid waste. Solid waste is in the form of TKKS, fiber waste and ash. Meanwhile, liquid waste can be used as POME. Palm oil activities give rise to externalities in the form of waste. Most of the waste produced is liquid waste which comes from the extraction of the main product crude palm oil (CPO) and if it is not utilized it will cause environmental pollution. However, externalities resulting from these activities are often ignored and not taken into account in the cost components of an activity (Utami 2017).

As a step to change the wasted waste process into something useful and beneficial, treatment is needed that can change costs into opportunities by changing what was originally external costs into internal benefits. This handling can be done through Internalization of Externalities. Internalization of external costs is the process of including these costs in the price of a product or service, so that all costs related to production or consumption are reflected in the market price (Fauziyah 2024). This effort is carried out as a form of accountability for the impacts produced by liquid waste from Palm Oil by providing compensation. The compensation given is not in the form of direct cash costs, this is based on the fact that compensation in the form of money given directly to the polluted party is not an alternative solution to reduce the pollution that occurs. As a form of prevention that can be done, namely by; (1) Examining Palm Oil externalities, (2) Analyzing the internalization of externalities (3) Developing strategies for internalizing externalities.

MATERIALS AND METHODS

This paper is presented using secondary data collection methods obtained from literature, libraries, previous theses, journals, the Central Statistics Agency (BPS) and other sources of information that relate to and support the writing of this paper. The secondary data required includes; (1) Data on the largest palm oil producers in the world, (2) Types of palm oil, (3) Biodiesel needs, (4) Area and production of Indonesian palm oil, (5) Indonesian energy consumption per sector, (6) Percentage of FFB derived capacity, and other supporting data.

Analysis (SWOT) is carried out as a form of formulating and developing strategies to strengthen the strength of the Indonesian Palm Oil market at the global level, weaknesses in the palm oil process-

ing process from upstream to downstream in Indonesia, Opportunities for derivative products produced from palm oil waste, Threats that will occur in the future regarding the environmental impacts resulting from Palm Oil.

The SWOT Matrix can compile and develop 4 types of strategies, namely (A'la 2019): (1) SO (strenghts-opportunities), (2) WO (weaknesses-opportunities), (3) ST (strenghts-threats), (4) WT (weaknesses-threats). Another analysis tool uses Internalization of Externalities. Externality Internalization is the process of incorporating external values (losses) experienced by third parties into production costs. Apart from that, it can also be used as an analytical tool in developing strategies for utilizing palm oil into new, renewable energy. The economic benefit method is also used to complement the value and benefits of renewable energy originating from palm oil waste processing. Economic benefits are benefits that are measured and obtained directly.

Literature Review

Oil palm (*Elaeis guineensis*) is a perennial plant native to humid tropical regions in West and Central Africa that grows between 10 degrees north latitude and 10 degrees south latitude. (Nkongho *et al.* 2015). Palm oil consists of two species, namely Elaeis guineensis, originating from Africa and *Elaeis oleifera* originating from America (Sudaryanti 2017). Oil palm can grow well in a temperature range of 22–33 °C or an average of 27 °C; rainfall 1250–3000 mm per year; even distribution throughout the year (dry months less than 3 months); The length of light required for oil palms is 6 hours per day and the relative humidity is 50–90 percent (PASPI 2014).

Oil palm plants were imported from Africa to Indonesia in 1884 and then placed in the Bogor Botanical Gardens (Sudaryanti 2017). For the maintenance process, oil palm plants go through three phases, namely seeding (±1 year), maintenance of immature plants (1–4 years) and maintenance of mature plants (4–25 years) (PASPI 2014). Oil palms produce Fresh Fruit Bunches (FFB) which begin to be harvested at the age of 4 years and producton increases as the age of the oil palm increases (PASPI 2014). The peak of FFB production is generally at the age of 8–16 years and is replanted again after the age of 25 years (PASPI 2014).

After producing Fresh Fruit Bunches (FFB), oil palm fruit has economic value. Palm oil is a palm tree that produces food oil, industrial oil and biodiesel (vegetable fuel) (Silitonga *et al.* 2020). Palm kernel shells can be used as fuel and carbon, while palm kernel dregs can be used for animal feed, as well as mesocarp fiber can be processed into medium density fiber-board and processed into food and non-food products (Kurniawan 2012). Palm oil has the highest advantages as an oil producer. Oil productivity per hectare of oil palm can produce around 4.5 tons of oil (PASPI 2014). Crude palm oil (CPO) production plays an important role in both the local-global environment and socio-economics. With the high demand for palm oil in Indonesia, this has resulted in the expansion of palm oil plantations. Oil palm plantations result in various Negative impacts on the environment, such as deforestation, biodiversity and climate change. If not managed well, the expansion of oil palm plantations will continue to destroy forests that should be protected. With so many negative externalities arising from these plantations, it is worth considering the environmental costs resulting from the losses incurred. According to Smith in Sofiana, environmental policy must be given more attention, not only showing concern by monitoring local conditions but also broader international conditions such as global ecological balance, damage to the ozone layer and the greenhouse effect. According to Virdausya, the act of consumption or production of one party has an influence on other parties and no compensation is paid by the party causing it or compensation received by the affected party is called an externality. The theory of externalities in Economics began with the publication of a book entitled The Economics of welfare written by Arthur Pigou

(1920). In the book, Pigou explains that externalities occur when economic activities affect third parties who do not have direct involvement in the economic transaction. Externalities are generally divided into two, namely positive and negative externalities (Dzaki and Sugiri 2015): 1). Positive Externalities will have a beneficial impact on the recipient of the externality. Profits can be made an impact. 2). Negative externalities will have a detrimental impact on the recipient of the externality. This loss means that people who receive externalities will incur additional costs to cover the perceived losses. In this topic, the problem of Palm Oil is included in Negative Externalities. As the amount of damage to the environment increases, the marginal cost of damage due to pollution will also increase. One step that can be taken is to include the costs of environmental pollution due to palm oil processing into the production process. Production prices after including environmental pollution costs will have implications for production prices which will increase. This process is called Internalization of Externalities. Economists have shown that when externalities exist, markets will not be efficient unless these external costs are internalized and economic agents take these costs into account when making decisions (Štreimikienė 2016). In general, the internalization of environmental externalities can be evaluated at different levels along the value chain (Høst-Madsen *et al*. 2014) and later it can be compared between one Palm Oil location and another.

Based on the Figure 1, the external costs borne by society are in the d-e-q*-f area, while the consumer surplus is in the a-b-c area where the surplus does not yet reflect the social surplus. However, if the company carries out waste management, the company will optimize output when the Marginal Social Cost (MC(q)+k) is the same as the Marginal Social Benefit (MC(q)+k =MSB). In the graph above, the internalization of external costs is shown with a quantity that was originally –k to k+A. Based on West Kutai Regency regional regulation (Perda) number 17 of 2009 article 4, regarding waste water quality management. Every person in charge of a business and/or activity that will utilize and/or dispose of waste water is obliged to meet the quality standards for the disposal and/or utilization of waste water in accordance with the provisions of statutory regulations.

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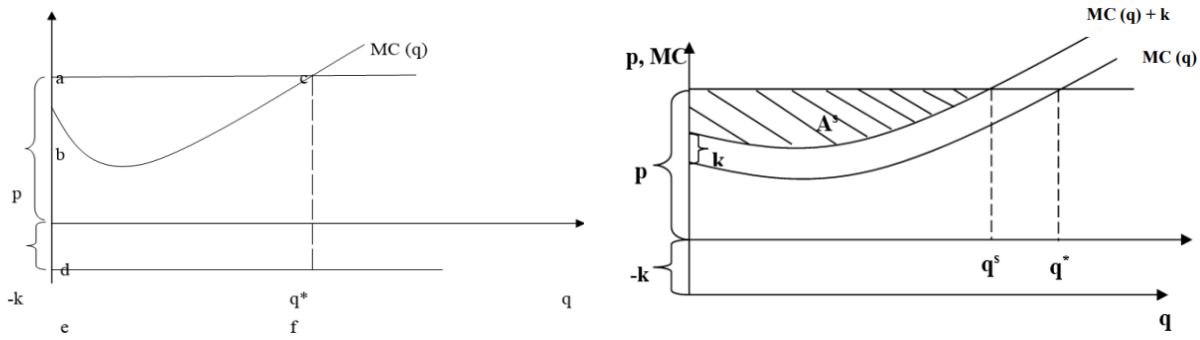

(a) (b)

Figure 1 (a) Free market conditions before the internalization of external costs, (b) Free market conditions after internalization of external costs.
(Folmer 2000)

waste measurement results for BOD and COD values are above the maximum limit, the waste must not be disposed of directly into the environment (Sitepu 2021). However, if the BOD and COD values are below the maximum levels, the waste may be disposed of into the environment. Before liquid waste is discharged directly into the environment, it is necessary to first process the liquid waste so that it does not pollute the environment (Sitepu 2021). In this case, there are already maximum limit regulations for the waste water released. Based on West Kutai Regency regional regulation (Perda) number 17 of 2009 article 5, persons in charge of businesses and/or activities are prohibited from giving dirty oil extracted from the IPAL pond (after deoiling pond) to third parties. In this case, internalization of externalities is needed to minimize dirty oil (palm oil waste) which is detrimental to third parties. Based on the regulation of the minister of energy and mineral resources of the Republic of Indonesia No. 24 of 2021, biodiesel financing funds are oil palm plantation funds which are collected, administered, managed, saved and distributed by the fund management agency for the purpose of covering the shortfall between the market index price of oil type fuel. Diesel with the market index price of biodiesel type BBN.

In this case, funds for liquid waste management are produced for the use of Biodiesel has been collected and there are institutions that manage it. For this reason, an internalization of externalities study is needed which can be a recommendation for related institutions to minimize the environmental impacts felt by third parties.

Palm Oil Waste Externalities

Palm oil in the form of fresh fruit bunches (FFB) produces two main products in the form of crude palm oil (CPO) and palm kernel oil (PKO). With the various extraction processes produced, crude palm oil (CPO) produces liquid waste which can then be utilized as POME. Apart from that, crude palm oil (CPO) also produces waste in the form of solid waste (fiber, EFB, ash). Along with progress and the amount of research carried out, innovations are starting to emerge regarding the use of palm oil waste. The process of processing palm oil from upstream to downstream generally produces waste in the process.

The total loss due to externalities that occurred was IDR 146,194,433.00/year (Utami *et al.* 2018). Meanwhile, based on research conducted by Afifah (2016) regarding palm oil solid waste at PT. Sandabi Indah Lestari, North Bengkulu. The direct use value obtained from the sale of palm oil solid waste is idr 350,186,914.47/ month, and the indirect use value is IDR 167,954,040/month, so obtained a total economic value of IDR 518,140,954.47/ month (Afifah 2016). From these 2 cases it can be compared that every palm oil in Indonesia produces waste. Solid and liquid waste is waste that is often found and can have economic value if it is managed and internalized to reduce third party losses.

RESULTS AND DISCUSSION

Internalization of External Costs of Palm Oil Waste

Based on the estimates for each component of liquid waste and solid waste (external costs), the following is an estimate of the internalization of external costs components. Obtained total economic value (TEV) of IDR 627,602,359 with aspects of liquid waste and solid waste in palm oil in three locations, namely; Jambi, Bengkulu and Kalimantan. In the process of processing palm oil from upstream to downstream generally produces waste in the process. Starting with fresh fruit bunches (FFB) which are produced and divided into 3 cores in FFB, namely flesh, core, and shell. From this fruit, many by-products are produced and often produce waste in the form of solid and liquid. In this paper, waste conversion from a total of 112533.22 tonnes of fresh fruit bunch (FFB) is presented to produce 88,706.80 m^3 of POME waste. If this waste is converted into electrical energy, it will produce an economic profit of IDR 6,903,173. Meanwhile, 1 ton of FFB can produce 5,569.82 mg/L of POME which can be used to make biodiesel. And if converted into

economic value, it will produce a profit of IDR 12,382/L. However, in the process of making biodiesel a catalyst is needed to accelerate the manufacturing process through transesterification. The second liquid waste is kernel waste, which produces 65 kg from a total of 1 ton of palm oil FFB. Kernel waste can be used as energy at a selling price of IDR 1,692/kWh. Solid waste has many management alternatives such as fertilizer, biopellets, boiler fuel and others. In conversion into boiler fuel, 1 ton FFB can obtained 0,005 ton shell and 0,135 ton fibre.

SWOT Development as a Form of Internalization of Externalities

As a preventive form of assessing the externalities of economic and environmental studies, a SWOT analysis was created to develop a strategy for the sustainability of palm Oil in Indonesia. In this paper there is not only an analysis model but also a SWOT analysis with the matrix in Figure 3.

Table 2 Internalization of external costs.

Benefit Components	Total Economic Value (Rp/year)
External Cost of Palm Oil Waste:	
a.Liquid Waste (Jambi)	Rp 146.194.433
Total	**Rp 146.194.433**
Economic Benefits of processed waste:	
a. Direct Use Value of Solid Waste (North Bengkulu)	Rp 350.186.914
b.Biodiesel sales value	Rp 70.317.839
c.Electricity utilization value	Rp 60.903.173
Total	**Rp 481.407.926**
TEV	**Rp 627.602.359**

Secondary Data (author's preparation)

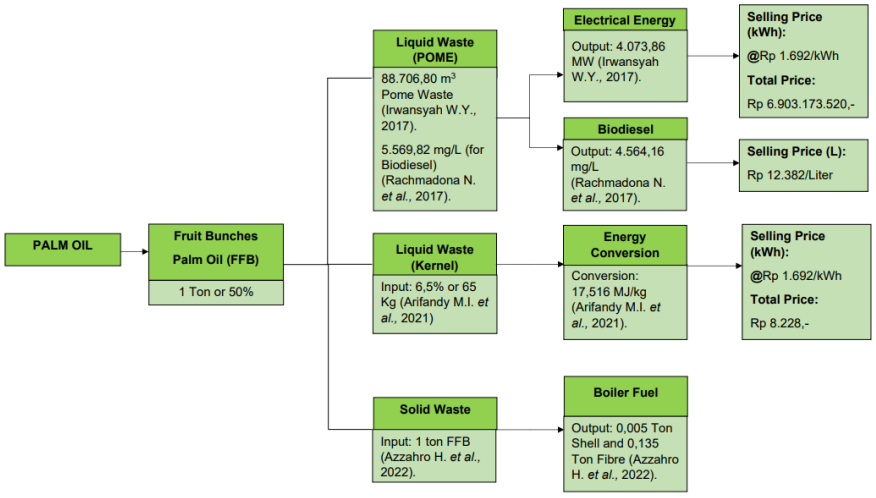

Figure 2 Oil palm tree.

Internal Factors and External Factors	**Strength (S)**	**Weakness (W)**
	(a) There are maximum limit regulations for waste water released (COD and BOD). (b) There are already oil palm plantation funds collected by the Fund Management Agency. (c) There are already sanctions for factories that carry out processes that pollute the environment beyond specified limits.	(a) The Market Index Price (HIP) of Biodiesel Vegetable Fuel (BBN) in Indonesia is still quite expensive. (b) Limited infrastructure in terms of adequate equipment such as ponds for the transesterification process in liquid waste (c) Minimal education and training
Opportunity (O)	**Strategy (SO)**	**Strategy (WO)**
(a) High market demand (b) Potential for utilizing solid waste and liquid waste into by-products with economic value (c) Utilization of environmentally friendly energy sources originating from waste	(a) Tighten existing regulations and review regulations related to environmentally friendly palm oil waste management processes (b) Monitoring and evaluating palm oil mills that have managed waste into economically valuable products (c) Facilitate adequate infrastructure	(a) Conduct further studies and research regarding the utilization of palm oil waste by using more affordable tools and materials in order to reduce selling prices (b) Conduct training and education regarding the process of managing palm oil waste by products with economic value (c) Facilitate adequate infrastructure to support the palm oil waste management process
Threat (T)	**Strategy (ST)**	**Strategy (WT)**
(a) Competition for alternative products that are more affordable and environmentally friendly in the global market (b) The impact of climate change affects palm oil production	(a) Strengthen education regarding the importance of using environmentally friendly products by strengthening relevant government regulations (b) Applying practices by conducting studies on all aspects, especially climate predictions during the harvest season.	(a) Develop a pricing strategy that is profitable for exporting countries and increases interest for importing countries (b) Make further studies to diversify environmentally friendly palm oil products.

Figure 3 SWOT analysis.

CONCLUSION

The palm oil industry in Indonesia is one of the triggers for deforestation, degradation and other environmental problems. The increasing amount of land being converted into oil palm plantations results in the resulting large number of externalities. In this case, Internalization of externalities is needed to minimize dirty oil (palm oil waste) which is detrimental to third parties from the management process carried out. Based on the case study of Panyabungan Village, the externality value for liquid palm oil waste is IDR 146,194,433,- after internalizing the exter nalities, we get a total economic value (TEV) of IDR 627,602,359,- with the liquid waste and solid waste aspects of palm oil in three locations namely; Jambi, Bengkulu, and Kalimantan.

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