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POLICY STRATEGIES IN PLANNING ADAPTATION OF THE SUSTAINABLE PALM OIL INDUSTRY IN MERAUKE REGENCY PAPUA PROVINCE OF INDONESIA

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ABSTRACT

In the Papua region, the expansion of the palm oil industry increased by up to 71% from 2011 to 2019, with the largest affected area located in Merauke regency. The objective of this research is to develop policy strategies with impact simulations related to economic, socio-cultural, and environmental issues for the sustainability of the palm oil industry with or without a moratorium on further expansion of land area. This study employs a system dynamics approach. The dynamic system is carried out through conceptual development, model specification, model verification, scenario development, and validity testing by measuring the absolute percentage error (MAPE). Model development and validation were carried out using PowerSim v.7 software. The policy scenario is simulated from the palm oil expansion policy beguan in 2018, until the research year ends in 2030. The validated results, forming the basis for simulations, exhibit high accuracy with a MAPE of less than 5%. The percentage deviations of 4.21% for production and 0.28% for land area is observed based on actual data from 2018 to 2022. The simulation of a 20% expansion scenario shows a significant increase in production to 1 million metric tons per year but also a 1.3% rise in waste generation, with an average waste volume of 350,000 tons per year. The expanded area will experience a 50% increase in the labor force to meet the higher production demand. The proposed comprehensive strategy includes regional contract regulations, diligent monitoring of land clearing, community empowerment, and indigenous peoples' involvement. It also promotes smallholder plantations, the utilization of waste for energy, and alternative markets for crude palm oil (CPO). Conversely, the dynamic model scenario with a moratorium on land expansion resulted in a production output of 600,000 metric tons, slower job market growth, and a 1.3% increase in waste generation, with an average waste volume of 195,000 tons per year. The strategy proposed uses proper waste processing, production adjustments, regulation of community rights and boundaries, resource development, and involvement of local palm farmers. These simulations offer valuable insights for sustainable decision-making, emphasizing the need to balance economic growth, environmental protection, and community well-being in the development of the palm oil industry.

Key words: dynamical system, moratorium, palm oil, scenario strategy, sustainability

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INTRODUCTION

Investing in the plantation sector has the potential to provide benefits to investors and have a positive impact on economic growth and the well-being of the community. This investment can create numerous job opportunities, open up broad business prospects and develop remote or isolated areas by providing the necessary education and healthcare facilities [1]. By investing in selected regions, the proposed expansion project will build and develop the required infrastructure according to the needs. This will yield long-term benefits for the local community, as it improves access to education and healthcare services. Additionally, this investment will also drive economic growth by increasing plantation production and stimulating other related sectors. One of the plantations that exists in Indonesia and has a significant impact is palm oil.

The presence of the palm oil industry in Indonesia has both positive and negative impacts. Positive impacts of the palm oil industry include the creation of additional livelihood options for the communities surrounding the plantations, which ultimately contributes to the overall economic growth of rural communities[2–4] . It also helps reduce poverty among farming and non-farming households [5]. However, there are also negative impacts associated with the palm oil industry. These include land grabbing, conflicts, low income among communities living near the industry and poverty [6,7]. The fertilizer application of palm oil can have a negative effect on the soil, and the land clearing methods, such as burning forests, can destroy habitats for animals, wildlife, and microorganisms in the area [3,8]. The palm oil industry can cause damage and pollution to the surrounding residential environment, affecting conditions such as roads, drainage and clean water [7,9]. In addition, land conversion or the shift in land use for industrial purposes can trigger conflicts.

Expansion of palm oil plantations in Indonesia has a tendency to shift to forest areas that are still large, namely in the Papua region [10,11] which has a potential area of 316,553.07 km^2, with the widest area being Merauke regency, 47,406. 90 km^2 [12]. Rich in timber forests, the Papua region experienced a 29% increase in deforestation that occurred from 2001 to 2010, and increased to 71% from 2011 to 2019, so that the average deforestation that occurs is approximately 34,918 Hectares annually, as shown in Figure 1.Therefore, deforestation an important concern for the palm oil industry which cannot be separated from its negative effects [13].

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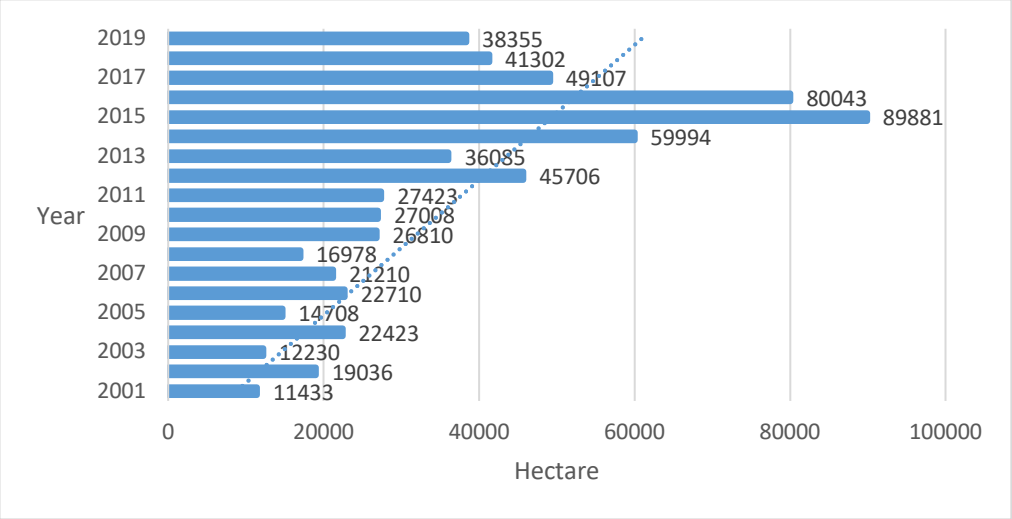

Figure 1: Annual Deforestation in the Papua Region

The Merauke Regency itself is home to the largest palm oil industry with foreign direct investment status, mainly from Korindo Group and Daewoo International Corporation. These companies have subsidiaries engaged in palm oil plantations and processing mills for Crude Palm Oil (CPO) located in various districts within Merauke Regency. According to the report from the Central Bureau of Statistics (BPS) in 2018, the total area of land opened for cultivation from 2017 to 2018 was 38,149.10 hectares. This land is distributed across the districts of Ngguti (11,631.05 hectares), Jagebob (403 hectares), Muting (15,672.05 hectares), and Ulilin (10,443 hectares)[14]. The expansion of palm oil plantations in the context of developing the palm oil industry in Merauke Regency has impact on the economy, socio-culture, and environment [15,16]. Economic improvements also come with environmental consequences, including reduced water quality [15], animal populations [17], and increased waste produced by the palm oil industry.

However, this can have positive impact if there is cooperation between the government, the private sector and the community in implementing plantation management policies that are economically, socio-culturally and environmentally sustainable. This research attempts to simulate the impacts related to economic, socio-cultural and environmental issues on the sustainability of the palm oil industry in Merauke Regency following the implementation of a moratorium in 2018. The moratorium was in accordance with the instruction of the President of the Republic of Indonesia, No. 8 of 2018, which aimed to postpone and evaluate permits for new oil palm plantations and enhance the productivity of the existing palm oil plantations.

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MATERIALS AND METHODS

In this study, a dynamic system was used to determine the factors that have an influence on the internal and external aspects of the palm oil industry and by conducting simulations on these factors to get the best or optimal policy [18]. A system thinking approach was used to understand economic, socio-cultural and environmental relationships that have an impact using a causal loop diagram [19].

The dynamic system was carried out through conceptual development, specification model, model verification, and scenario development [20]. Policies were formulated based on general rules, which were derived from information comprising four aspects: current conditions, projected conditions, responsiveness speed and corrective actions. These policy scenarios aim to address influential factors within a specific timeframe, considering their impact on the palm oil industry [21,22].

The policy scenario was simulated from the oil palm expansion policy which began in 2018, until the research year end in 2030. This was done by focusing on the variables that are very influential in the palm oil industry to modelling an industry path that is economically and socio-culturally sustainable, centred on local wisdom and culture, and also takes account of ecological problems that affect local communities as well as the extent of their impact on the people of Merauke Regency.

The conceptual development was based on variables obtained through the primary data collection, which was specifically through in-depth interviews with industry management representatives and local government agencies responsible for palm oil development (such as the Department of Agriculture and Horticulture, the Department of Social Affairs, the Department of Trade, the Department of Environment, Ulilin District, the Department of Capital Investment and the Integrated One-Stop Service Agency). In addition, input from local non-governmental organizations, customary community institutions in Merauke Regency, and 16 heads of families representing a total of 27 households in Ulilin District. It also considered the nearest area to the industry. Purposive sampling [23] is used to select the household heads who posses informative knowladge or experience in the development of palm oil industry in Merauke Regency and those directly living in the industrial area itself. A questionnaire was used consisting of open-ended questions and closed-ended statements, utilizing a Likert scale for measurement with levels ranging from 1 = not influential to 5 = highly influential.

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Secondary data were obtained through information from government agencies related to palm oil industry policies and general data information at the Central Statistics Agency, as well as through literature reviews that were tailored to research needs in the form of reports, databases and information obtained from the official website of the palm oil industry in Merauke Regency [24]. The development and validity of the model were carried out using the PowerSim v.7 software [25,26] and checking for deviations from the real system by comparing the graphical and statistical data results generated by the simulation model for the years 2018 to 2030. Policy scenarios were generated based on theory and testing for the most influential factors in the palm oil industry system.

Validity testing of the model can be done by using simple statistics to measure the relative mean error of the absolute percentage error (MAPE). This statistical test has a relative error measure value within a tolerance of 5–10%. Therefore, the test can be used to assess the suitability of actual data against simulations. Mean Absolute Percentage Error (MAPE) is expressed as a percentage and provides an understanding of how [26] well the predictions align with the actual values. A lower MAPE indicates a more accurate forecasting model, while a higher MAPE indicates a greater deviation between predicted and actual values [27].

$$\text{MAPE} = \frac{1}{n} \sum_{t=1}^{n} \left| \frac{X_t - F_t}{X_t} \right| \times 100\% \quad \text{.....(1)}$$

with :
n = Number of observations
X_t = Actual Data
F_t = Forecast/Simulated data value

The policy model was implemented under the assumption of a 20% increase in land area or available land resources, in the absence of a government moratorium on land expansion. This allows for the evaluation of land intensification efforts, which can have a direct impact on the productivity of Crude Palm Oil (CPO) production. Additionally, the model considers changes in livelihood patterns and consumption habits, as well as factors such as clean water availability and agriculture. Each of these factors is interconnected and contributes to the overall economic, socio-cultural, and environmental sustainability of the palm oil industry.

RESULTS AND DISCUSSION

Palm oil industry, government and community systems in relation to economy, socio-cultural and environment issues

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The problem identification process requires a comprehensive analysis of the complex relationships and interactions between the palm oil industry and the local communities. It also involves a thorough evaluation of the impacts resulting from industry investments considering government regulations. This assessment places specific emphasis on various critical aspects, including the economic ramifications [28,29], socio-cultural dynamics [30–32], and the importance of ecological and environmental sustainability [33]. These considerations were restricted to the geographical boundaries of the Merauke regency area, with a special focus on the context of investing in oil palm plantations and encouraging the establishment of a sustainable palm oil industry.

The expansion of the palm oil industry in the Merauke regency area brings about significant agrarian changes that have far-reaching socio-economic and environmental consequences [11]. To gain a comprehensive understanding of these linkages and impacts, the application of causal loop analysis proves invaluable. Using this analytical approach, the complex interconnections and causal relationships resulting from the palm oil industry can be unravelled and visualized.

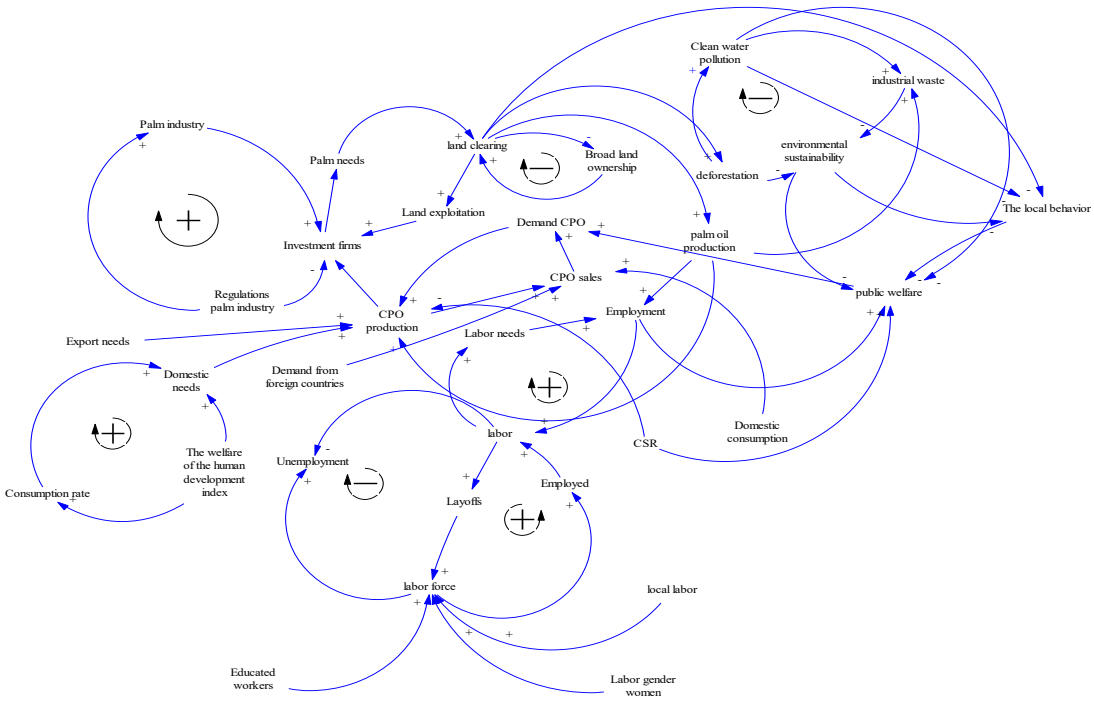

Figure 2: Causal Loop Diagram between the Palm Oil Industry, Government and Society and the Impact on Economic, Socio-Cultural and Ecological (Environmental) Aspects [33]

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Figure 2 provides a visual representation of the interconnections between the impacts generated by industrial development and their associations with key components. Specifically, the diagram illustrates a causal loop that encompasses the interrelationships among industry, government, and society. The results of interviews and research conducted by Khatun *et al.* [33] serve as a frame of reference for factors affecting the sustainability of the palm oil industry, which can be developed using a causal approach. These factors include aspects such as the presence of the industry involved in the production of crude palm oil (CPO), the area of land allocated for the production of fresh fruit bunches (FFB), the amount of FFB supplied, the labor employed by the company, and the waste generated as a by-product of the industry.

The government plays a vital role in shaping policies and regulations related to the palm oil industry, investment facilitation and land allocation for palm oil cultivation [34]. At the same time, the involvement of local communities with industry has significant implications for their welfare, both through the utilization of natural and human resources, especially in the context of their particular community[35]. In addition, the government is responsible for monitoring companies' adherence to established en vironmental and social standards, resolving land conflicts between the palm oil industry and local communities, and promoting social inclusion and empowerment through policies supporting sustainable palm oil industry development.

The impact of the palm oil industry on the local community extends beyond economic factors and has profound social and cultural consequences. While palm oil development can generate employment opportunities, increase income, and enhance access to infrastructure and public services, it can also trigger changes in values, consumption patterns and social dynamics within the local community. Moreover, the utilization of natural resources and the local workforce in the palm oil industry hold critical significance in the pursuit of sustainable development.

Therefore, a comprehensive understanding of the complex interactions between the palm oil industry, government and local communities is essential to formulate balanced and sustainable policies. The policy should seek to optimize economic benefits, environmental sustainability and improve social welfare for all stakeholders involved. Achieving this goal requires in-depth research and careful consideration of the relationship between the palm oil industry, government agencies and local communities.

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System dynamics scenarios for palm oil industry

The analysis of the impact and its connection to the challenges faced by the palm oil industry in the Merauke regency area utilized a dynamic system model approach. This approach aimed to construct a model for the development of a sustainable palm oil industry that encompasses economic, socio-cultural and ecological or environmental aspects. To model and understand the system, a simulation system was employed, utilizing scenario activities or processes for sensitive variables that can influence the system (with main variables considered as stock flow).

A flowchart was created to illustrate the relationships among three key elements: (1) the sustainable palm oil industry development system, (2) the government's regulations regarding the palm oil industry at the local government level, and (3) the community's welfare level, considering its relationship to the economy, socio-cultural dynamics and environmental sustainability. This flowchart provides a visual representation of how these elements are interconnected.

By employing a system approach, the simulation was able to examine the complex dynamics and interdependencies within the palm oil industry. It considered various activities and processes associated with sensitive variables that have the potential to impact the system's functioning. The use of main variables as stock flow further enhanced the understanding of how changes in these variables can influence the overall system dynamics. Overall, this analysis and simulation approach provide valuable insights into developing a sustainable palm oil industry in the Merauke regency area, considering its economic viability, socio-cultural implications, and ecological or environmental sustainability.

To facilitate the simulation, the flow diagram is converted into a cause-and-effect diagram using Powersim v.7 software. This diagram is structured into three distinct aspects that exert influence on the sustainable palm oil industry. The first aspect is the production aspect, which is primarily carried out by the palm oil industry. It encompasses crucial components such as the production of Crude Palm Oil (CPO), which significantly impacts the overall dynamics of the industry. The second aspect is the land area aspect, which considers the influence of investment permits granted by the government for palm oil production. This component plays a pivotal role in determining the available land area allocated for palm oil cultivation and development. The third aspect focuses on community well-being, considering the influential component of the local workforce. The welfare and livelihoods of the community, particularly those directly involved in or affected by the palm oil industry, are assessed to gauge the overall well-being within the community.

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In addition, the environmental aspect is also considered in the simulation. It highlights the essential component of the local community's need for clean water within the context of the palm oil industry in the Merauke Regency. This component carries substantial influence in assessing the sustainability of the industry from an environmental perspective. The simulation commenced in 2018 and extends until 2030, aligning with the productive lifespan of oil palm trees. Throughout the simulation, the focus remains on sustainable palm oil production and the land area dedicated to production. This comprehensive approach enables a more holistic understanding of the interplay between these aspects and their implications for the sustainable development of the palm oil industry in the Merauke Regency.

By using the quantification of variables and assumptions for the initial data values in 2020 or earlier, using the available data, the assumptions used were as follows:

1. The area of oil palm plantations is 80,201 ha, based on data from BPS (Central Statistics Agency) Merauke Regency 2020
2. Deforestation rate of 1,355% from 8,455 ha to 114,594 ha from 2011 to 2020, or approximately the last 10 years
3. The number of workers was 119,908 (in 2018) from the estimated total workforce in the palm oil industry in Merauke Regency
4. The total population of Merauke Regency in 2018 was 223,389 people
5. The level of consumption of cooking oil based on the average consumption per capita per week according to the national socio-economic survey was 0.9 tonnes/individu/year (data from Central Bureau of Statistics for 2020-2021)
6. The crude palm oil (CPO) production is 9 tonnes/ha/year for the average production of private oil palm plantation companies
7. The production process of processing fresh palm fruit bunches in the modern palm oil industry generally involves efficient extraction, resulting in solid waste of approximately 35%–40%. [36]
8. The government's moratorium entails the postponement and evaluation of permits and allocations for smallholder plantations in the conversion of forests for palm oil plantations that have not yet been implemented, amounting to 20% in the Merauke district area
9. Forest area experiencing deforestation of 123,049 ha (in 2021) based on the Indonesian coalition monitoring Papua's forest policy.

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Model Validity

The simulation model's accuracy has been extensively evaluated using actual data from the Central Statistics Agency of Merauke Regency, covering a period of five years,from 2018-2022. The test results demonstrate a high level of accuracy, with a Mean Absolute Percentage Error (MAPE) of less than 5%. Specifically, the MAPE values for production and land area expansion are 4.21% and 0.29%, respectively. These values indicate that the simulation model closely depicts or accurately represents the real conditions, as per the criteria of the MAPE test model. Where the MAPE value is less than 5%, it indicates that the simulation model for the research period from 2018 to 2030 provides an accurate representation of actual conditions. Integration of actual data into the model strengthens its validity and increases its usefulness in forecasting and scenario analysis related to the palm oil industry in the Merauke Regency area [37].

Flowchart of simulation model of palm oil industry, government, and community of Merauke regency linkages between economy, socio-culture and environment

The stock flow diagram was constructed to analyse the complex dynamics among the industry, government, and society, considering economic, socio-cultural and environmental factors, within the timeframe of 2018-2030. This diagram serves as a predictive tool to assess various scenarios and policies for the sustainable development of the palm oil industry in the Merauke regency. Examining the stock flow diagram reveals the interconnectedness of population dynamics and the demand for cooking oil and/or crude palm oil (CPO). These factors influence the need for CPO inventory and the expansion of palm oil plantations, aligning with Indonesia's objective of meeting domestic CPO demand for processing industries like food products, oleochemicals and bioenergy, while also catering to export markets. These interrelationships have direct implications for land and workforce requirements in the plantation and palm oil industry sectors of the Merauke district [38]. By comprehending the intricate links depicted in the stock flow diagram, stakeholders can gain valuable insights into the long-term sustainability and development of the palm oil industry, enabling informed decision-making and policy formulation to maximize economic benefits, preserve socio-cultural integrity and ensure environmental responsibility.

The interconnected stock flow diagram reveals that the development of the palm oil industry has implications beyond economic factors. It also influences the Human Development Index (HDI), which serves as a vital indicator of the population's overall well-being and life expectancy. The HDI provides insights into the health,

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social and economic conditions within the palm oil industry area in Merauke district. Factors such as healthcare infrastructure, conflicts, poverty, limited access to healthcare and the prevalence of diseases contribute to changes in the HDI. It is crucial to consider these socio-economic aspects alongside the ecological impact resulting from the expansion of palm oil plantations to meet the increasing demand for fresh fruit bunches and palm oil production (CPO) [39].

The simulation takes into account a 12-year period starting from 2018, assuming that the oil palms reach their maximum productivity in terms of fresh fruit bunches (FFB) yield per hectare [40]. This timeframe allows for an assessment of the potential outcomes and impacts associated with the development of the palm oil industry in Merauke district. By considering both the socio-economic factors reflected in the HDI and the ecological consequences of palm oil plantation expansion, stakeholders can gain a comprehensive understanding of the complex dynamics and make informed decisions to promote sustainable development in the region.

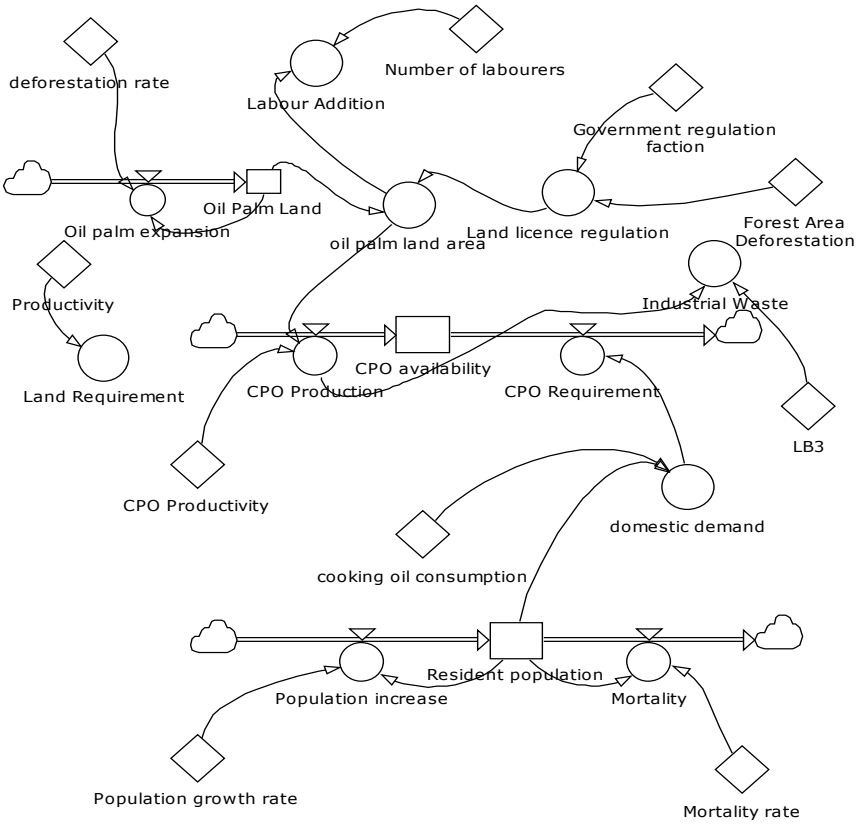

Figure 3: Dynamic Model Formulation

Due to the moratorium pressure since 2018, the palm oil industry is facing challenges in postponing expansion or adding new production areas. It can be said

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that companies have not fully met the potential and opportunities for empowering the local community through the implementation of a 20% smallholder plantation scheme. Consequently, full ownership of palm oil land remains in the hands of the companies, and the involvement of the local community is limited to temporary or contractual daily labor rather than being part of the smallholder farmer community within the core plantation.

The negative aspects of the expansion of oil palm plantations carried out by companies trigger agrarian conflicts and forest fires in traditional land clearing using local labour, which results in haze, which has an impact on the issuance of government regulations in the form of a moratorium on oil palm plantation permits for both companies and oil palm farmers [41].

Even though the palm oil industry in Merauke Regency has not implemented a smallholder core plantation, the issues faced by the community in the palm oil industrial areas still have a dual impact on the regional economy, particularly in terms of employment opportunities and the dispersion of the local population. This affects both local palm oil farmers outside the companies in terms of income enhancement and the purchasing power of the community. These factors have significant macroeconomic implications for the national economy and also influence the social and economic well-being of the communities surrounding the palm oil companies [42].

Community members impacted by the concession were relocated by the palm oil industry company to a new area, where they joined other indigenous communities. This resettlement has presented difficulties for household production, specifically in terms of accessing sago, a crucial staple food for the local Papuan community. As a result, conflicts have emerged between the original residents of the resettled area, and the migrants displaced by the new plantations. In addition, the issue of taking land with inappropriate compensation or making decisions that do not involve local governments and families (not involving women in the family) has an impact on social conflict in the future [31].

The entry of the palm oil industry has also resulted in the loss of some of the potential that the region has, including: pollution of rivers by palm oil plantation industry waste, which has an impact on the reduced use of rivers as a source of drinking water, cooking, washing, and fishing; changes in the loss of forest functions for hunting, medicinal plants, and sacred places; and loss of local food such as sago due to the land being used as oil palm plantations. So socio-

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culturally, there is the loss of ethnic identity and the preservation of local customary values [43].

Expansion rate scenario assuming no additional palm oil expansion of 20% for smallholder core plantations or plantation land against industry adaptation resulting in CPO production.

In the simulation results for the expansion rate without the addition of 20% of land due to the moratorium, the industry is assumed to only use the industrial land that has been permitted by the government. From the simulation, industrial adaptation can be carried out by taking into account several impacts that arise, as mentioned below.

Economic Impact

The simulation results show that with the expansion rate of the palm oil industry without additional land permits, there will be an increase in total production for the next 12 years, coupled with population growth, which affects the amount of domestic CPO consumption. It was found that the industry was able to meet and have sufficient supply of CPO and was even still able to meet demand outside of domestic demand.

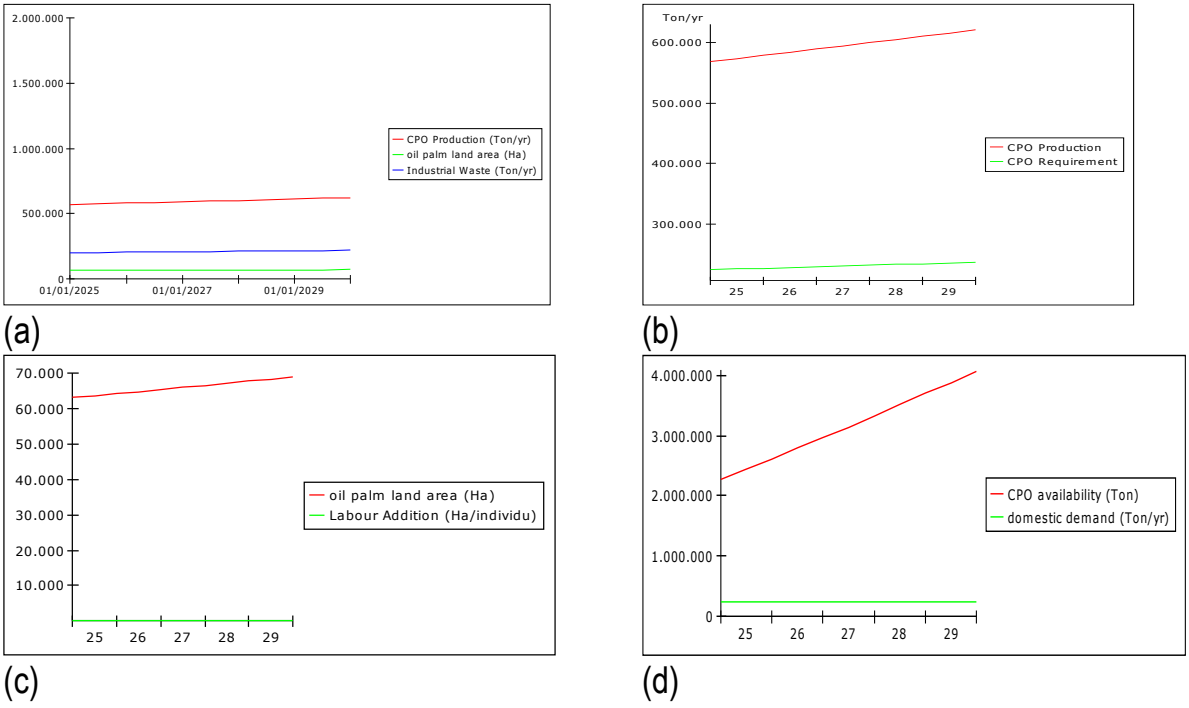

Figure 4: Expansion rate without 20% addition to palm oil industry at Merauke Regency

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Socio-cultural impact

As without the expansion of the palm oil cultivation land area, there will be no increase in employment opportunities. Industry can only maintain the number of workers who have met the needs in accordance with the area of land and industry for the next 12 years. This affects the absorption of the number of local and non-local productive workers which includes gender equality in the use of labour in the palm oil industry. Because the addition of labour depends on increasing the area of palm oil plantation, that is, one hectare can only add at least one worker. With a workforce of 119,908 employees in the palm oil industry sector in Merauke Regency in 2018, there was not much increase due to the absence of palm oil plantation expansion (Figure 4.c).

Ecological/environmental impact

This increase in waste is in line with the continued increase in CPO production, which means that the deforestation rate will continue and generate waste from industry and plantations with an average increase of 1.3% per licensed land expansion before the 2017 moratorium. The assumption is the increase in land area and the amount of hazardous waste produced annually for a production period of 12 years (the productive age of oil palm), the rate can be seen in Figure 4.a.

Expansion Rate Scenario: assuming a 20% increase in oil palm expansion for smallholder core plantations or plantation land, resulting in CPO production 20% land expansion, or no moratorium, allows the palm oil industry (as a monoculture sector) to increase CPO production. With the associated economic benefits, community welfare, and socio-cultural and environmental (socio-ecological) impacts [44], the industry needs to consider the following impacts:

Economic impact

By conducting a simulation, a significant increase in CPO production and expansion of land allows for a high availability of CPO. From the simulation results, it can be seen in comparison, the increase in CPO production is above 900 thousand tons/year, it could even reach more than 1 million tons/year in the 12th year. This is the potential for the development of the palm oil industry in the Papua region which still has land potential. The amount of production is still far behind in the central areas of the palm oil industry, such as Sumatra and Kalimantan, with an average production of 5-8 million tons annually [45].

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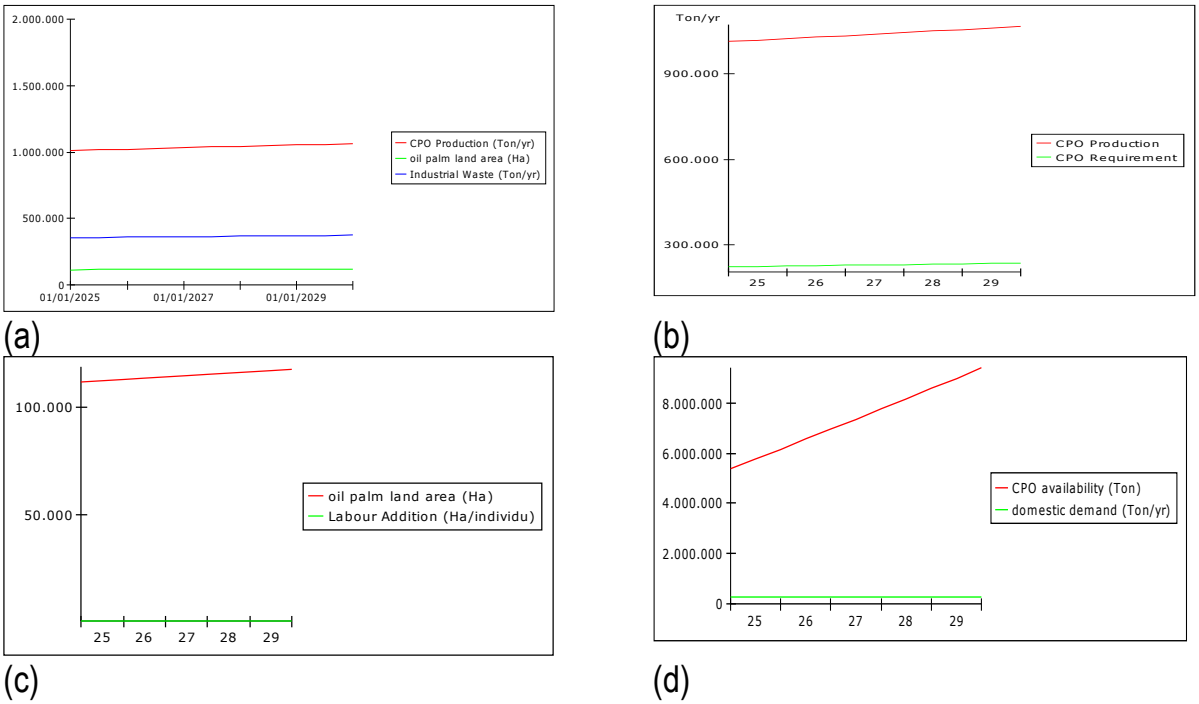

Figure 5: Expansion Rate with 20% Addition policy to CPO Production, Waste, and Demand in Merauke Regency

Socio-cultural impact

The increase in the expansion area of palm oil plantations allow for an increase in the absorption of local and non-local workers, as can be seen in Figure 5.c, an increase of up to 50%. However, there is a need for policies to control and pay attention to the relationship between labour and work safety, family involvement as workers, wage labour [1] and making efforts to avoid negative effects of non-local workforce in order to empower local communities to avoid protracted conflicts in the palm oil industry. The involvement of both the government and the industry is crucial to acquiring high-quality human resources that meet the standards of palm oil companies in the Merauke Regency area.

Ecological/environmental impact

Expanding palm oil plantations by 20% poses a risk of increasing waste generation. This is primarily due to the elevated production levels expected over the 12-year productive lifespan of palm oil trees during the expansion simulation. To address this issue, effective waste management practices must be established and enforced by both the government and the palm oil industry. Long-term waste neutralization processes are crucial in this regard [46]. These processes should include the implementation of waste reduction standards, appropriate waste treatment methods, and rigorous monitoring of compliance verification through inspections and third-party inspections. Community participation should also be

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encouraged as an independent oversight mechanism to ensure transparency and accountability in waste management practices. Additionally, the industry must take responsibility for waste control by maximizing waste utilization, adopting environmentally friendly practices, and investing in liquid waste treatment technologies to minimize adverse environmental impacts. Countries like Malaysia have demonstrated the efficacy of technological efficiency changes in transportation and production to reduce greenhouse gas emissions from biomass industries sourced from renewable palm oil [47]. Therefore, by adopting comprehensive waste management strategies, the palm oil industry can mitigate the potential negative consequences associated with waste generation and promote sustainable practices that safeguard the environment and the well-being of local communities.

Policy strategies in sustainable palm oil industry adaptation planning in Merauke Regency

The development of the palm oil industry is closely linked to land expansion for plantations and the waste generated from this industry. For instance, in the production forests of Sanggau regency, West Kalimantan, the expansion of palm oil plantations is closely tied to decentralized regional decision-making regarding permits for plantation expansion [48]. Therefore, in an adapted scenario for the palm oil industry that accommodates a 20% increase in plantation area, it encourages stakeholders in the industry to improve waste management practices and implement regulations for managing palm oil industry waste.

On the other hand, the need for labour along with the increase in land area, allows the addition or absorption of labour, whose arrangements need to be overseen from both the community and the government in increasing the use of local human resources.

Therefore, the company's strategy is needed in the development of land area due to the government moratorium as follows:

1. Establish regulations with the government for the use of land area contracts with local communities and the use of local labour in increasing oil palm FFB production that benefits both the community and the company [49].
2. Conduct joint monitoring of socio-political rights, ownership rights and land boundaries, workers' rights and the environment in managing the oil palm industry [50]. A joint supervision with the government and the community as well as support from community organizations on the impact of deforestation

or the transfer of community land used in the development of oil palm plantations by companies.

3. Involve indigenous communities and the government in industrial management, especially in the gradual land use according to investment permits granted by the government [51].
4. Implement smallholder plantations with company support, which involves purchasing fresh fruit bunches (FFB) under mutually beneficial contracts, to ensure economic, social, cultural and environmental benefits for companies, communities and the government.[52].
5. The crude palm oil (CPO) marketing alternatives and maximum utilization of waste for renewable energy such as bio-diesel which has a promising global market share [53].

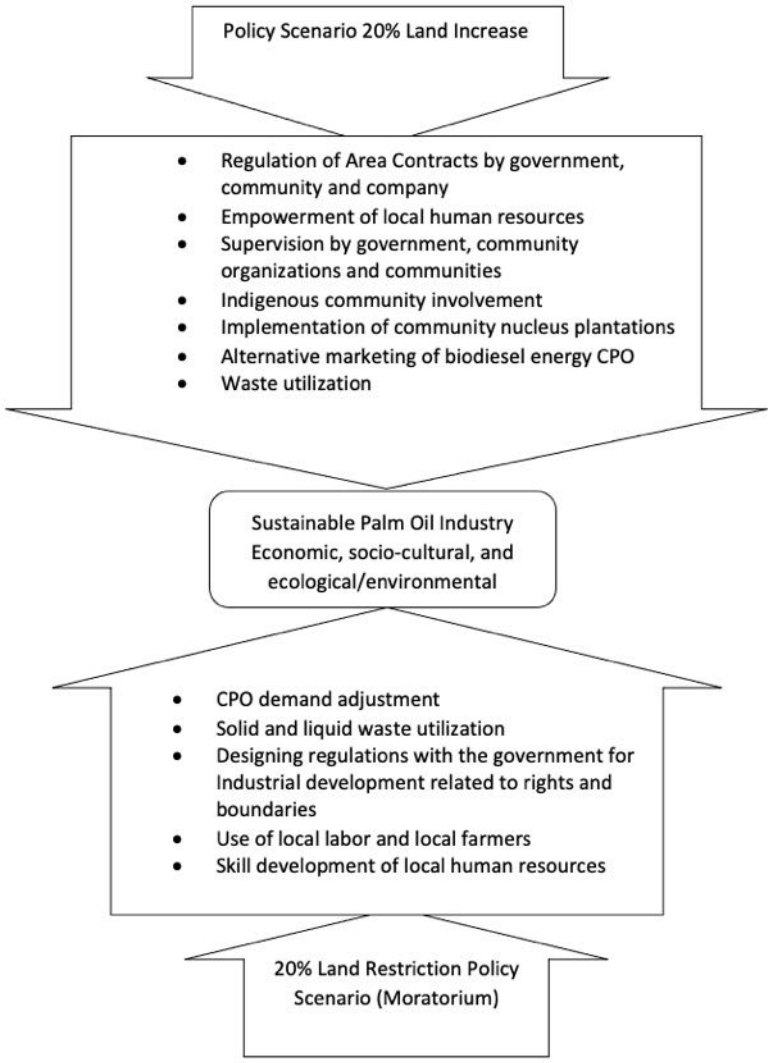

Figure 6: Adaptation Strategy of palm oil industry in Merauke Regency

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However, such measures will also have consequences on production of crude palm oil (CPO), as there is less growth in amounts available for export. From a socio-cultural perspective, the land restriction approach can result in reduced job opportunities available due to limited job opportunities, but reduced forced resettlement of populations into other areas. This will result in no expansion of demand for labourers on the plantation, and require less forced resettlement of subsistence farmers into areas with existing farmer populations

Therefore, a company strategy is needed in development if land area development is not enforced due to a government moratorium as follows:

1. The palm oil industry demonstrates flexibility in adjusting its demand for Crude Palm Oil (CPO) based on the processing capacity of the industry and the available land area for production. This dynamic approach allows the industry to adapt the level of CPO consumption to meet the demands of both domestic and international markets. The role of demand management is crucial to maintaining the industry's competitiveness and meeting the global demand for palm oil products. By closely monitoring and carefully analyzing market demands, the industry can optimize its production and distribution strategies, ensuring efficient resource allocation while meeting the diverse needs of consumers both locally and internationally [54].
2. Carry out production by maximizing FFB and CPO production and utilizing solid and liquid waste for renewable energy and environmental preservation [55].
3. Utilizing local farmers and local workers as well as working with local governments to maximize resources and encourage increased skill capabilities in the palm oil industry which supports the growth of the industry and industrial areas [7].
4. Collaborating with local governments to design regulations that can guarantee the implementation of company activities and safeguard the rights of local communities or local customs, especially with issues of land use and territorial boundaries to reduce prolonged conflicts that affect the sustainability of oil palm in Merauke regency [30].

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CONCLUSION, AND RECOMMENDATIONS FOR DEVELOPMENT

The choice of adding or not adding 20% of oil palm land in Merauke Regency has risks from an economic, socio-cultural, and environmental perspective. Without expansion, there will be challenges to meet domestic and export demand for crude palm oil (CPO), considering the production capacity is approximately 600,000 tons per year. Utilization of local resources can help optimize the availability of labour and raw materials. Implementing a waste management and processing system to utilize palm shells as soil fertilizer for the palm oil industry and local farmers, as well as promoting initiatives to utilize palm oil waste as a source of renewable energy, is an important consideration.

On the other hand, implementing a 20% additional land policy can significantly increase production and employment. However, this requires strict regulations and responsible land clearing agreements. The increase in industrial waste is estimated to be around 1.3% of the remaining land expansion and can be efficiently treated in accordance with government waste management regulations under the supervision of industry, government, and society. Empowering local resources, implementing smallholder plantations, and addressing the impact on the environment and deforestation are of utmost importance. Government oversight and involvement of indigenous communities are also essential in implementing the Smallholder Core Plantations (SCP) concept to meet the land expansion needs of the industry while supporting local farmers and communities and to mitigate potential impacts on the economy, socio-cultural aspects, and the environment.

Policy recommendations include implementing strict government regulations and contractual agreements for responsible land clearing to minimize negative impacts. It is essential to have government oversight and involve indigenous communities in the decision-making process. Empowering local human resources and prioritizing long-term human resource development are crucial steps. Implementing the Smallholder Core Plants (SCP) concept can fulfill 20% of the industrial land expansion needs that have been granted permits before the moratorium, thereby supporting smallholder farmers and local communities. Developing efficient waste management and treatment systems, promoting initiatives to utilize palm oil waste as a renewable energy source, exploring alternative markets for palm oil, and reducing dependence on domestic and export demand are also important aspects to be considered.

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Table 1: Results of simulation model validation test

Years	Production (Tons)		Oil Palm Land (Ha)	
	Actual Data (Xt)	Simulation Data (Ft)	Actual Data (Xt)	Simulation Data (Ft)
2018	56063	500320	75928	55591
2019	78211	509734	80200	56637
2020	78211	519271	80200	57969
2021	170461419	528932	80200	58770
2022	170461419	538719	80200	59857
MAPE	4.21 %		0.29 %	

Source : Data Processing (2022)

Table 2: Economic Statement for the Community

Statement	1	2	3	4	5
The palm oil industry affects the economy of the people in the Merauke Regency area					
The palm oil industry affects the availability of facilities and infrastructure in the Merauke Regency area					
Industry influences production behavior in the Merauke Regency area					
Regency area Industry is very influential on human resources (labor and education level) in the Merauke Regency area					

1 = not influential to 5 = highly influential

Table 3: Cultural and Social Statement for the Community

Statement	1	2	3	4	5
The palm oil industry affects the level of poverty in society Industry influences cultural patterns in people's livelihoods					
Industry influences the cultural and social patterns of people in local communities					
The palm oil industry affects local community					
Employment opportunities and gender (especially women in local communities)					
Industry affects community land ownership					

1 = not influential to 5 = highly influential

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Table 4: Environmental Statement for the Community

Statement	1	2	3	4	5
Industry affects the degradation of clean water sources in industrial areas					
Industry affects the fulfillment of irrigation access on production land in industrial areas					
Industry affects the fulfillment of clean water in industrial areas					

1 = not influential to 5 = highly influential

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