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BUILDING A RESILIENT AND SUSTAINABLE PALM OIL VALUE CHAIN IN SOUTH PAPUA PROVINCE, INDONESIA

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ABSTRACT

The oil palm industry in South Papua Province, particularly in the Merauke and Boven Digoel Regencies, possesses significant economic potential, contributing substantially to both regional GDP (Gross Domestic Product) and national revenue. Despite this potential, the region faces complex challenges related to inequality, sustainability and indigenous community rights. This study aimed to analyze the value chain structure of the oil palm commodity and to formulate development strategies that are resilient, socially equitable and environmentally sustainable. A mixed-methods approach was employed, integrating quantitative and qualitative techniques, with Value Chain Analysis (VCA) serving as the primary analytical framework. Respondents were selected through purposive sampling and included representatives from government agencies, plantation companies, local communities, farmers, collectors, and non-governmental organizations (NGOs). Data were collected through in-depth interviews utilizing structured questionnaire, Focus Group Discussions (FGDs), field observations and secondary sources. The research revealed a vertically integrated supply structure dominated by large corporations. The value chain analysis exposed a concerning asymmetrical distribution of profit, as evidenced by Palm Oil Mills (POMs) capturing 56.2% of the total value added—significantly higher than the 21.7% received by farmers. From an environmental perspective, maintaining ecological integrity remains an urgent necessity. Nevertheless, several industry actors have adopted the Roundtable on Sustainable Palm Oil (RSPO) and Indonesian Sustainable Palm Oil (ISPO) standards and implemented zero-waste initiatives through the conversion of biomass waste into biochar and biogas. The primary social challenge stems from the insufficient implementation of the Free, Prior, and Informed Consent (FPIC) principle in relation to indigenous communities. To address these challenges, this study proposes six strategic actions: (1) restructuring institutional relationships to ensure parity among stakeholders, (2) strengthening farmer cooperatives and enhancing capacity-building programs (3) institutionalizing a mandatory FPIC protocol, (4) establishing transparent local Fresh Fruit Bunch (FFB) markets, (5) creating inclusive multi-stakeholder forums for governance and conflict resolution and (6) promoting sustainable land management practices while expanding RSPO and ISPO certification.

Key words: oil palm industry, value chain analysis, sustainability, South Papua, Profit distribution

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INTRODUCTION

The agricultural sector currently serves as a key pillar of Indonesia's economy, as evidenced by its substantial contribution to the national GDP. In the first quarter of 2025, Indonesia's agricultural sector's contribution to the national GDP reached 10.52% [1, 2]. The performance of the agricultural sector is primarily driven by the plantation subsector, which in 2023 contributed Rp 811.30 trillion, or 41.98% of the total agricultural GDP, significantly surpassing other subsectors. This dominant contribution continued into the first quarter of 2025, where the plantation subsector remained the main support with 42.1% of the total agricultural GDP [1, 2, 3].

Palm oil is a crucial commodity within the plantation subsector [4, 5]. This commodity is a major source of foreign exchange for the country, derived from both product exports and import substitution through the biodiesel program [6, 7, 8]. The foreign exchange value from palm oil continues to rise due to steady increases in production and export volume, reaching US$49.3 billion in 2022 [57]. In 2023, high palm oil exports were the primary factor behind the plantation subsector's trade surplus, contributing 75.80% of total exports, a much larger share than other plantation commodities [1, 3, 9-12].

The rapid growth of Crude Palm Oil (CPO) production has positioned Indonesia as the global leader in the palm oil market. By 2016, Indonesia held a 59% share of the world's CPO production. This expansion is a response to rising global demand for vegetable oil, driven by population growth and the expanding biofuel demand [7, 8, 13-21]. The importance of palm is also tied to global food security, climate change efforts and bioenergy production due to its remarkably high yield of 4.17 metric tons per hectare per year, which is far greater than other oil crops. The affordability of palm oil also makes it an economically appealing option for consumers worldwide [8, 10, 11, 17, 22, 23].

The use of palm oil and its derivatives is crucial for various sectors, contributing to economic growth and providing essential products. Palm oil, sourced from the fruit of the oil palm tree, is a versatile raw material for the food industry (cooking oil, margarine), oleochemicals (soaps, detergents, cosmetics), and biofuels (biodiesel). Its superior properties, such as high stability and neutral taste, make it a primary choice in processed foods [24]. In oleochemicals, palm oil is converted into fatty acids and glycerin for everyday products. Additionally, palm oil is processed into biodiesel, a renewable fuel that helps reduce emissions. The agriculture-bioindustry model also promotes sustainability and increases industry revenue [25, 26, 27, 28].

Palm oil biomass, which consists of parts of the tree such as fronds, trunks, empty fruit bunches, and palm kernel shells, is a potential source of renewable energy [4, 9, 17, 29, 30]. This biomass can be processed into various bioenergy products like briquettes, biochar and biogas, which support a sustainable energy system [10, 11, 28-34]. Furthermore, liquid waste from the palm oil industry can also be utilized to produce biogas, and integrating this system with mill waste treatment can increase economic efficiency while reducing environmental impact [29, 30, 35, 36].

According to 2024 data from Palm Oil Agribusiness Strategic Policy Institute (PASPI), Indonesia has 16.8 million hectares of oil palm plantations with an annual production capacity of 50 million tons of palm oil, distributed across 26 provinces [37]. South Papua, with 60,803 ha of oil palm trees in 2019 is a significant contributor to Indonesia's GDP on Papua Island [37]. Most of this land is controlled by large private corporations, both domestic and foreign, which have invested heavily in the palm oil industry due to the region's suitable lowland geography.

The development of palm oil in South Papua faces risks related to industrial profitability and socio-environmental impacts. Land conflicts are often triggered by land conversion that disregards the customary rights of local communities. Therefore, reforms in governance and policy are necessary to secure the rights of communities and farmers. To achieve sustainability, the industry must adopt a comprehensive strategy that integrates ecological management, social justice, and economic viability. Strategic planning, based on a deep understanding of internal and external conditions, is crucial to ensure the industry's future in this region is more sustainable and resilient [37-42].

The supply chain is a system that integrates all business processes from upstream to downstream to deliver products to consumers efficiently and on time, while maintaining profitability. The main challenge in managing a supply chain is the high level of complexity and uncertainty at each stage, which can decrease performance if not handled well. This performance decline can be very detrimental to a company, especially in a competitive market, as it can lead to customer dissatisfaction and loss of customers [43, 44]. This drives company management to implement Supply Chain Management in their operations.

Supply Chain Management (SCM) plays a crucial role in the operations of a modern company, ensuring a smooth flow of materials and information from upstream to downstream. The effectiveness of supply chain management directly influences a company's ability to meet customer demand, control costs and improve competitiveness [45]. In the context of the palm oil industry in South Papua Province, supply chain management becomes even more complex given the unique geographical characteristics, limited infrastructure and socio-economic dynamics [46]. South Papua Province, as a region rich in natural resources, has great potential for the development of the palm oil industry. This potential needs to be supported by an efficient and sustainable supply chain management system, capable of integrating all activities from seed procurement, planting, harvesting, processing, to the distribution of final products to the market [47].

An analysis of the palm oil supply chain in South Papua requires a deep understanding of the various elements involved, including farmers, collectors, palm oil mills, distributors and end consumers. The palm oil supply chain begins with the provision of quality seeds, which are the foundation for the productivity of oil palm plantations [48]. Superior seeds ensure optimal harvest yields and increase land use efficiency [49]. The seed distribution process must be carried out in an accountable and transparent manner to increase the trust of stakeholders [49]. The next stage involves the planting and care of oil palms, which requires Good Agricultural Practices (GAP) to maximize yields and minimize environmental impact. In feedlot businesses, with nutritional technology, various local feed resources can be used to make feed with good quality and low prices [50]. After the oil palms reach harvest age, the fruit is harvested and transported to the palm oil mill. The palm oil mill processes the fruit into crude palm oil and palm kernels. These products are then distributed to various markets, both domestic and international. Effective supply chain management ensures the smooth flow of products from the plantation to the mill and to the market, minimizing delays and losses. Supply chain management involves the planning, control, and coordination of all activities related to the procurement, storage and distribution of products [47].

Previous studies have intensively examined structural inequality from a juridical-normative perspective, revealing weaknesses in the protection of customary land rights, violations of the Free, Prior and Informed Consent (FPIC) principle and manipulative practices in Environmental Impact Assessments (AMDAL). These findings reflect the dominance of economic interests over the protection of indigenous rights within the framework of land reform implementation in South Papua [51]. However, such studies remain limited to legal and regulatory dimensions and have not comprehensively analysed how these agrarian conflicts affect the dynamics of the oil palm value chain—for instance, the impacts of licensing barriers on the supply chain, logistics costs, or commodity prices. Moreover, they have yet to explore the broader socio-economic dimensions of structural inequality beyond the legal context, such as disparities in market access, capital, and technology among industry actors. Therefore, the present study complements these earlier works by providing a more holistic political economy and sustainability perspective.

MATERIALS AND METHODS

The research was conducted in January-July 2025. The research was carried out in the oil palm industrial area of South Papua Province, namely Merauke Regency and Boven Digoel Regency. The location of the research was determined based on the direct or indirect impact on regional economic activities, the socio-cultural of the local community, and the impact on the environment.

The research for this study employed a combination of quantitative and qualitative methods to gain a comprehensive understanding of the sustainable development strategy of the palm oil industry in South Papua. Quantitative data collected and analysed in the study include: 1). FFB volume at the farmer level and Crude Palm Oil (CPO) at the Palm Oil Mills (POMs) level, 2). Transaction documentation, namely official records from direct smallholders or institutions related to oil palm farmers and mills for the selling price of FFB and CPO in each value chain, 3). Financial statements involving profit margin data in each value chain for its marketing channels, Physical volume in the amount of FFB traded at the farmer level to at the mill, 4) Distance and time from the transportation of FFB to POMs, 5). Infrastructure conditions and means of transportation for FFB and CPO. Furthermore, the qualitative data collected includes stakeholder perceptions of the palm oil industry value chain.

Respondents were determined using a purposive sampling approach with an error tolerance limit of 10%. The selection criteria are based on the respondents' knowledge and competence in agricultural development strategies in accordance with the regulations stipulated in Law Number 41 of 2009 and Government Regulation Number 12 of 2012. Respondents from local government agencies were selected based on the relationship between their main tasks and functions. Respondents from local government agencies are the Central Statistics Agency (BPS), the Department of Agriculture, Food Crops and Plantations, the Social Service, the Office of Investment and One-Stop Integrated Services, and the Districts of the palm oil industry area.

The data collection methods employed in this study included in-depth interviews (IDIs), focus group discussions (FGDs), and field observations. The number of participants for the in-depth interviews was determined using Yamane's (1967) sample size formula, which estimates the required sample size based on the total population of relevant stakeholders and a predefined level of precision. Based on this calculation, the study conducted 199 in-depth interviews, involving respondents from various stakeholder groups across the study area. In addition, two FGDs were organized, involving a total of 50 participants, to complement the interview data and strengthen qualitative triangulation. The FGD participants consisted of six representatives from six local government agencies, two representatives from non-governmental organizations, thirty-five community representatives from seven districts, and seven representatives from seven palm oil companies. The explicit reporting of the number and composition of IDIs and FGDs is provided to enhance methodological transparency, in accordance with the reviewer's recommendations.

In-depth interviews and FGDs used structured questions to stakeholders, namely local governments, oil palm plantation companies, local communities, plasma smallholders, independent oil palm farmers, collectors and non-governmental organizations. The selection of the sample in this study was based on the need to obtain a comprehensive representation of key actors within the value chain and governance of the palm oil industry in the study area. In-depth interview (IDI) respondents were purposively selected to ensure the inclusion of informants with in-depth knowledge, direct experience, and strategic positions related to the issues examined. Meanwhile, FGD participants were chosen to reflect the diversity of perspectives across government agencies, civil society organizations, local communities and private companies. This sampling approach was adopted to ensure that the collected data captures the economic, socio-cultural, and environmental dynamics comprehensively, thereby enhancing the validity of the research findings. The FGDs were conducted to explore and assess key factors through structured discussions with stakeholders who play a role in the context of this study. Furthermore, field observations aimed to obtain an actual picture of the problems or conflicts of the palm oil industry, as well as the condition of the infrastructure and transportation equipment for FFB and CPO. In this study, secondary data were obtained from various quantitative and structured sources, particularly statistical reports issued by official institutions. Meanwhile, secondary information was collected from policy documents and scientific publications, which provide qualitative explanations, analytical context, and in-depth interpretations of the issues under investigation.

Data analysis was conducted using the Value Chain Analysis (VCA) method, a strategic analytical framework used to examine a company's internal activities and identify sources of competitive advantage [52]. This method categorizes all company activities into two groups: primary activities and support activities. Primary activities are directly related to product creation, including inbound logistics, operations, outbound logistics, marketing and sales and services. In contrast, support activities refer to functions that facilitate and enhance the effectiveness of primary activities, encompassing firm infrastructure, human resource management, technology development and procurement. Value Chain Analysis enables the palm oil industry to gain a comprehensive understanding of how value is created at each stage of the business process. The analysis results are used to identify opportunities for optimization in both cost reduction and product differentiation. Based on these findings, strategies for sustainable palm oil industry development and value chain

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strengthening will be formulated through process mapping and customer journey mapping.

RESULTS AND DISCUSSION

South Papua Province Palm Oil Commodity Value Chain

Based on Figure 1 presented below, the configuration of the palm oil commodity supply chain in South Papua Province shows a vertically integrated structure with specific institutional characteristics. At the upstream level (upstream), the identification of the primary source of FFB in South Papua Province is from the "Company FFB" which includes core and plasma plantations. This stage is the initial stage of production involving oil palm cultivation and harvesting activities [53]. Uniquely, the plasma plantation here is fully managed by the company, with the implementation of a mechanism for the distribution of Residual Business Results (RBS) of 80% for corporate entities and 20% allocated to customary or clan rights owners, facilitated through a cooperative mechanism. The existence of Cooperatives as intermediary institutions in this system reflects a collaborative approach that facilitates the participation of local communities in the palm oil value chain. According to Hidayat et al. [54], such an institutional model can improve smallholder access to markets and technology, albeit with a different level of control compared to traditional PIR systems. This partnership model demonstrates the adoption of a nucleus-plasma which are tightly integrated by the company [55], but with a return of benefits clause to local communities that may reflect sensitivity to the issue of customary land rights in the region. This approach reflects adaptation to the social structure and land tenure that is typical in Papua [56].

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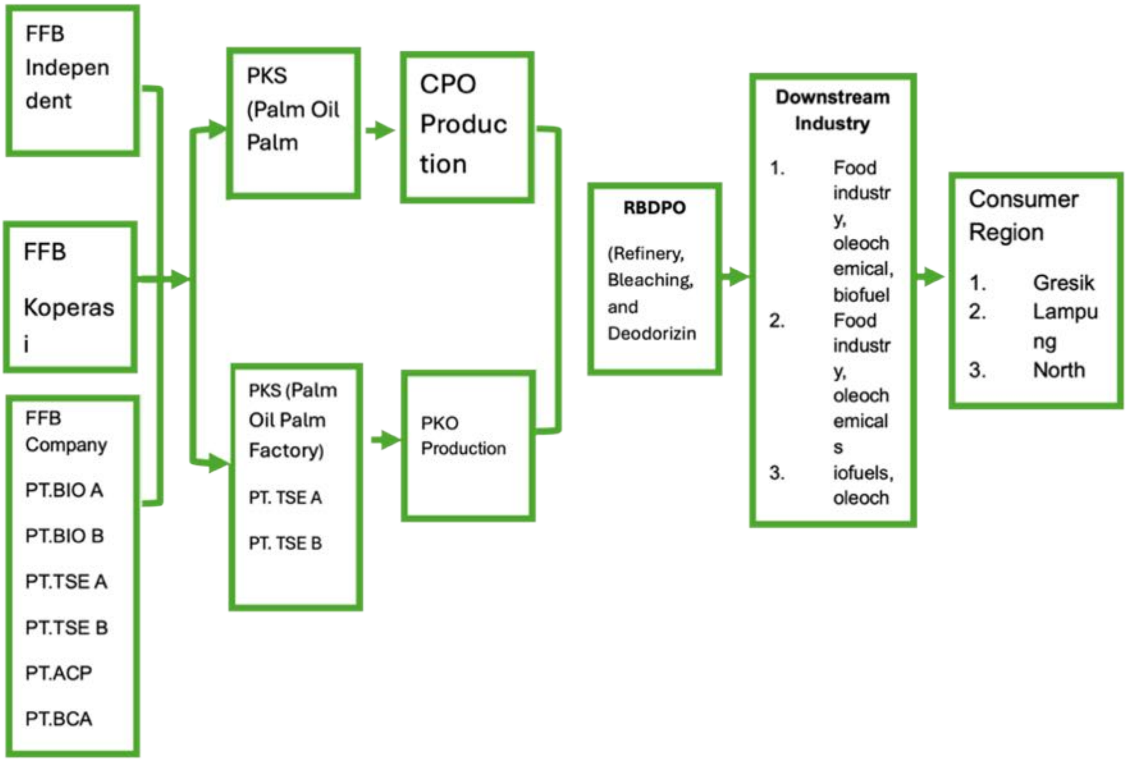

Figure 1: Configuration of Palm Oil Product Flow in South Papua Province

Based on primary data collected through surveys, interviews, and Focus Group Discussions (FGDs), this study finds that the palm oil supply chain in South Papua Province is highly vertically integrated and dominated by corporate actors, with relatively limited direct participation by independent smallholders. The study involved 50 respondents, consisting of 38.5% company representatives and mill managers, 28.8% cooperative and collector representatives, 21.2% plasma and independent farmers, and 11.5% customary landowners, complemented by two FGDs. Survey results indicate that 100% of Fresh Fruit Bunches (FFB) processed by mills originate from company-managed nucleus and plasma plantations, and 92% of farmer respondents reported that plasma plantations are fully managed by companies, leaving farmers and customary landowners without direct operational control. This arrangement contrasts with PIR systems in Sumatra, where farmers retain greater managerial autonomy.

FGD findings reveal that the profit-sharing mechanism (SHU) allocates 80% of net returns to companies and 20% to customary landowners through cooperatives. Although 87% of customary landowners reported receiving economic benefits, 64% indicated limited understanding of the SHU calculation mechanism, highlighting transparency concerns. Nevertheless, 71% of FGD participants perceived this scheme as preferable to one-off land compensation, as it provides recurring benefits. Institutionally, 76% of respondents identified cooperatives as the main intermediary institutions; however, 58% of farmers stated that cooperatives have limited influence over pricing and production decisions, reinforcing corporate dominance. Spatially, 83% of respondents confirmed that activities are concentrated in Merauke and Boven Digoel Regencies, enhancing logistical efficiency but also creating unequal infrastructure access for farmers located farther from mills (62%). Overall, 74% of non-corporate respondents agreed that the current configuration constrains farmer autonomy and bargaining power, indicating the need for policy interventions to strengthen participation, transparency, and equity within the supply chain.

The configuration of the oil palm commodity supply chain in South Papua Province demonstrates a vertically integrated structure with distinct institutional characteristics. At the upstream level, the primary sources of Fresh Fruit Bunches (FFB) in the province originate from "company-managed FFB," which includes both nucleus estates and plasma plantations. This stage represents the initial phase of production, involving cultivation and harvesting activities [53]. Uniquely, plasma plantations in this region are fully managed by the companies, implementing a profit-sharing mechanism in which 80% of the net proceeds (SHU) is allocated to the corporation, while the remaining 20% is distributed to customary landowners or clans through cooperative arrangements. The presence of cooperatives as intermediary institutions reflects a collaborative approach that enables local community participation within the oil palm value chain.

The vertical integration seen in the diagram (Fig. 1) shows that the mill not only serves as an independent processing unit, but also as an integral part of a larger production system. Direct connectivity between FFB sources and FFB sources shows operational efficiency that can reduce transaction costs and improve quality control of raw materials. Integration models like this can improve supply chain efficiency and reduce the risk of supply uncertainty, although it can pose challenges in terms of flexibility and diversification of raw material sources.

The geographical distribution shows the concentration of activity in a given region. The location of oil palm cover in the South Papua region is found in several districts, namely Merauke and Boven Digoel with a distribution pattern that is clustered and collaborative. This distribution pattern optimizes logistics efficiency and facilitates the development of industrial supporting infrastructure. Table 1 presents the data on oil palm plantation processing facilities in Merauke Regency for 2025. The data show that there are seven palm oil companies operating in the region, with a total installed processing capacity of 124,407.23 tons per year. The presence and operation of these processing plants form an integral part of the regional economic development strategy, particularly within the priority sector–based approach adopted by the provincial government for the 2025–2029 development period.

In Table 1, Data on Oil Palm Processing Plants in Merauke Regency for 2025, the production capacities of palm oil companies illustrate the diverse scales of operations they manage. Internusa Jaya Sejahtera Ltd. has the largest capacity, processing 45 tons of FFB per hour from a single mill unit. Dongin Prabhawa Ltd. operates two mill units with a combined capacity of 150 tons of FFB per hour, producing both CPO (Crude Palm Oil) and CPKO (Crude Palm Kernel Oil). These variations in capacity reflect differences in investment levels and target markets among companies in developing the downstream palm oil industry.

The actual production volume indicates varying levels of capacity utilization across companies. Total production reached 48,940.47 tons, comprising different types of processed palm oil products. Bio Inti Agrindo Ltd. contributed significantly, producing 21,559 tons of CPO from three mill units with a total capacity of 75 tons of FFB per hour. The quality of the resulting products meets consistent standards, with 100% raw material content. All companies maintain maximum raw material quality, demonstrating the application of modern processing technology.

The economic aspect shows a substantial contribution to regional revenue. At least 40% of the locally generated revenue (PAD) of Merauke Regency and Boven Digoel Regency is attributed to the palm oil industry [57, 58]. Total product shipments reached 25,658,844 tons in the reporting month, indicating a very large volume of trade. This economic contribution strengthens the position of the palm oil industry as a leading sector within the regional economic structure.

In Table 3, Added Value of Oil Palm Plantation Production in Merauke Regency, the average prices of processed products vary depending on location and product type. Crude Palm Oil prices range from IDR 13,728 to IDR 15,074 per kilogram, depending on the delivery destination. Crude Palm Kernel Oil prices reach IDR 22,505 per kilogram, reflecting the added value of derivative products. These price variations are influenced by transportation factors and differing regional market demands. The existence of 10 mills owned by various corporate entities (such as BIO Ltd., TSE Ltd. Group, etcetera) indicates fragmentation of ownership at the primary processing level, but in aggregate shows significant processing capacity. However, the density of POMs in South Papua Province is relatively lower when compared to the concentration of very dense POMs in Sumatera and Kalimantan [5, 55]. On both islands, it is not uncommon to find companies that adopt a full vertical integration model, operating plantations, mills and refinery facilities in one geographic or regional cluster. This model minimizes internal logistics costs and optimizes operational efficiency from upstream to downstream [55].

In the downstream and distribution stages, this configuration consists of several more complex processing and distribution stages. The POMs produces semifinished products in the form of Crude Palm Oil (CPO) and Palm Kernel Oil (PKO) which are forwarded to Refinery, Bleaching and Deodorizing Palm Oil (RBDPO) for further refining processes. The final stage is the distribution of the final product to consumers, both for the domestic and export markets. The Crude Palm Oil and PKO products from South Papua Province are distributed to RBDPO which is spread across several key locations outside Papua, namely Gresik, Lampung, Bitung, Pulau Laut and Bontang. This cross-island distribution indicates that South Papua Province does not have adequate downstream refinery capacity, thus requiring an extensive maritime logistics scheme using ships. This condition is in contrast to Sumatera and Kalimantan, where the presence of more abundant and geographically integrated refinery facilities allows advanced processing processes to be carried out with lower transportation costs and shorter time, thereby improving the overall supply chain efficiency.

The configuration of the palm oil supply chain in South Papua compared to the Sumatera region shows different characteristics, especially in terms of smallholder ownership and participation structures. In Sumatera, the people's core plantations abbreviated as PIR system is more dominant where farmers have greater autonomy in managing their land. The percentage of independent oil palm farmers in Sumatera is 30.4%, while Papua accounts for 1% of the total national land area (6.72 million ha). Furthermore, the percentage of independent farmers in Sumatera is 35%, while Papua accounts for 2% of the total national land area (2.6 million farmers). This means that the ratio of land area to independent farmers in Sumatera is 30 times larger and more numerous than in Papua. This condition is different because the Sumatera region has a long history of oil palm plantation development with the participation of smallholders reaching around 40% of the total national oil palm production [3]. Independent farmers in Sumatera have higher flexibility in determining their FFB cultivation practices and marketing choices. The cooperative system in Sumatera tends to function as a facilitator of access to production and marketing inputs, rather than as a mechanism for the distribution of RBS as in South Papua. The participation of local farmers in the supply chain in South Papua is relatively limited, with large corporations tending to develop plantations on a large scale. This centralized structure reflects the different models of oil palm plantation development in Papua.

The logistics and infrastructure aspects in Kalimantan show comparative advantages compared to South Papua. Better transportation connectivity and the availability of supporting infrastructure create higher efficiency in the supply chain. Better market accessibility in Kalimantan allows for diversification of marketing channels and healthier competition between industry players. In contrast, South

Papua faces geographical and infrastructure challenges that limit flexibility in supply chain configuration.

Implications related to sustainability and infrastructure also show fundamental differences. South Papua Province, as a relatively new area of palm oil expansion, is faced with unique challenges related to sustainability issues. The expansion of plantations in this region has the potential to trigger concerns about the conversion of primary forests that have high conservation value, as well as potential conflicts with indigenous peoples regarding land rights [60]. Therefore, the implementation of responsible cultivation and processing practices and sustainability certification schemes is crucial from an early stage. Meanwhile, in Sumatera and Kalimantan, sustainability issues have been a major focus of global discussion for decades, with incidents of deforestation, forest fires, and land conflicts that have triggered the strict implementation of certification schemes such as the Roundtable on Sustainable Palm Oil (RSPO) and Indonesian Sustainable Palm Oil (ISPO) as a standard requirement in the supply chain. Companies that have implemented sustainability practices include Bio Inti Agrindo Ltd, while other companies operating under the Tunas Sawa Erma Group and Agro Central Prima Ltd. have also begun processing both solid and liquid waste into biochar and biogas products. Finally, industrial supporting infrastructure, such as road networks and port facilities, in South Papua Province is still in the development stage and is not as optimal or as consolidated as in Sumatera and Kalimantan, which already have mature infrastructure to support large volumes of commodities and efficient logistics flows.

Based on Table 1, data on oil palm plantation processing and marketing plants in Merauke Regency for March 2025 show the operations of seven companies with a total of ten factory units spread across various strategic locations. The installed processing capacity varies substantially across companies, ranging from 3 tons of Fresh Fruit Bunches per hour at Agrinusa Persada Mulia Ltd. to 150 tons per hour at Dongin Prabhawa Ltd. This wide range reflects the heterogeneity of operational scales within the regional palm oil processing industry. The level of utilization of installed capacity shows varying operational flexibility, where several facilities such as Bio Inti Agrindo Ltd. operates three estates with used capacity adjusted to the availability of raw materials and market conditions.

Total CPO production reached 48,940.47 tons with the dominant contribution from Dongin Prabhawa Ltd. amounted to 11,754.98 tons and Agrindo Bio Inti Ltd. with a combination of three estates produced 21,559 tonnes, while CPKO's production showed more limited but consistent volumes from several major producers. The entire production process applies Merauke quality standards with a purity level of 100%, showing the consistency of the implementation of regional standards that

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have been set to maintain product quality in the national supply chain. The source of raw materials comprehensively comes from the Merauke area with a total requirement of 124,407.23 tons, indicating a strong vertical integration between the plantation and processing sectors at the local level.

The product distribution shows a geographical diversification that includes Gresik, Lampung, Bitung and Bontang with a total shipment volume of 25,658,844 kg, reflecting a wide market reach and adequate logistics capabilities to serve various regional and national market segments. The price structure shows a range between IDR 13,728 to IDR 22,505 per kilogram with an average of IDR 14,600 per kilogram, this variation reflects differentiating factors such as product quality, logistics costs, market conditions, and the pricing strategy of each company. The efficiency of converting FFB into the final product shows varying levels of optimization between facilities, with some companies achieving conversion ratios that are in line with modern palm oil processing industry standards. Overall, this data shows that the palm oil processing industry in South Papua Province has achieved a substantial level of operational maturity with significant production capacity, consistent quality standardization, integrated supply chain integration, and distribution networks covering various strategic areas in Indonesia. This indicates a solid foundation for sustainable industrial development in the South Papua Province region.

Actor Analysis and Institutional Relationships

Table 2 and Figure 2 show the role of each actor, the institutional relationships and the challenges faced. First, independent farmers play a fundamental role in the supply chain as producers of FFB. However, their institutional relationships tend to be weak. This weakness is manifested in the challenges faced, namely low FFB prices and minimal access to capital. The phenomenon of low prices for independent farmers is often caused by inferior bargaining positions in the presence of large buyers, the inability to carry out initial processing, and limited market information. Limited access to capital hinders farmers from adopting new technologies, increasing productivity, or engaging in sustainable cultivation practices. This condition creates economic vulnerability for independent smallholders in the palm oil supply chain structure.

Second, the core company has a crucial role in plasma development and FFB processing. The institutional relationship between the core company and its plasma partners is relatively strong. The strength of this relationship is usually based on long-term contracts and technical and financial support from companies to plasma farmers [61]. Nonetheless, the main challenge associated with core companies is market dominance. This dominance can arise through control over mills, access to downstream markets, and large production capacity, which in turn can affect the FFB price structure at the farmer level and limit healthy competition. Oligopolistic market structures are often a hallmark of the palm oil industry where a few large companies control a large share of the market.

Third, Collectors/Koperasi act as a liaison between farmers, especially independent farmers, and POMs or other parties in the supply chain. The characteristics of the institutional relationship of Collectors/Cooperatives are informal. This informality, while flexible, often triggers the challenge of price inequality. Collectors/Cooperatives can take advantage of information asymmetry and weak farmers' bargaining positions to set lower purchase prices, while selling at higher prices to POMs, resulting in disproportionate profit margins. The role of Collectors/Cooperatives that are not properly regulated can hinder transparency and fairness in FFB transactions.

Finally, indigenous peoples are identified as landowners in the context of oil palm plantation development. Institutional relationships involving indigenous peoples are often vulnerable to conflict. This vulnerability arises from differences in perceptions of land ownership, lack of meaningful consultation Free, Prior, and Informed Consent (FPIC), and unfulfilled promises regarding compensation or partnerships. A key challenge for indigenous peoples is the lack of involvement in decision-making and resource management, even though they are the original owners of the land. This minimal involvement can result in economic and social marginalization, as well as the escalation of agrarian conflicts between indigenous communities and plantation companies. Therefore, mechanisms for recognition of customary land rights and meaningful participation are crucial to achieve social sustainability in the palm oil industry.

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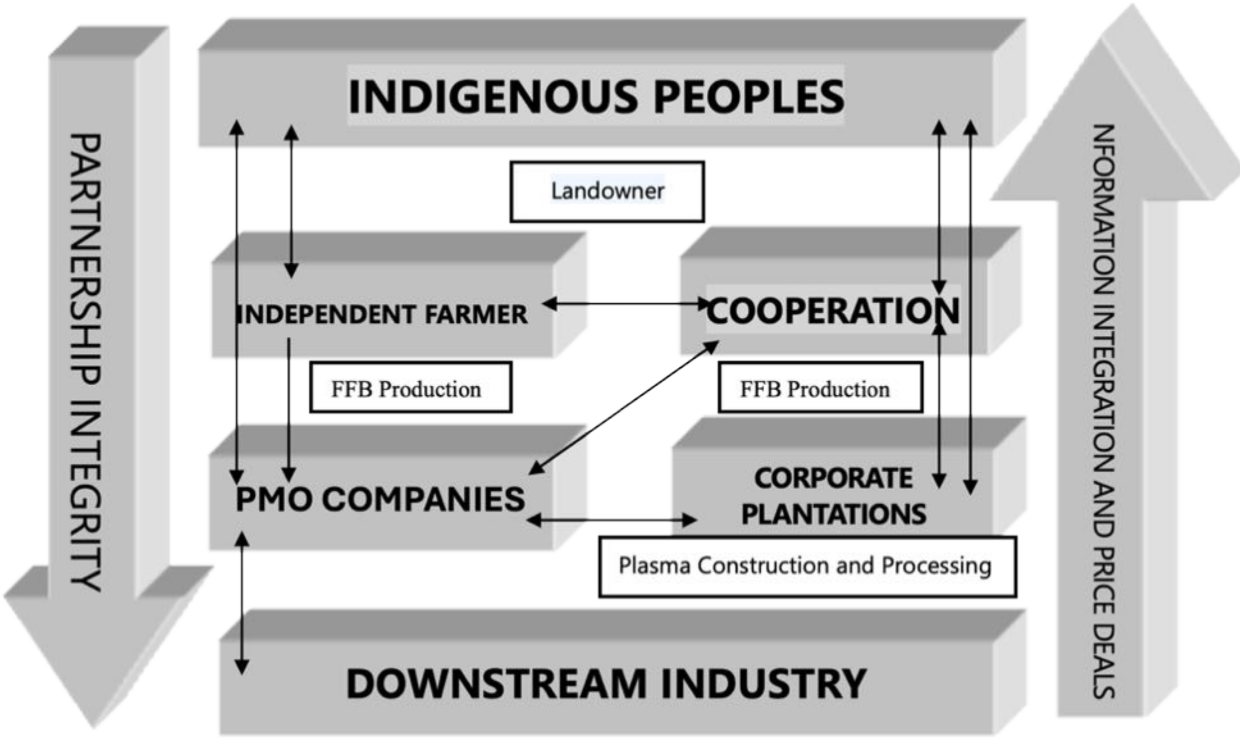

Figure 2: Integrated Structure of Oil Palm Plantation Supply Chain in South Papua Province (Source: Primary Data (2025))

Value-Added Margin Analysis

The value-added analysis in the palm oil supply chain, conducted using data from the 2020–2025 research period, serves as an important instrument for understanding how economic benefits are distributed across each stage of production. The data presented describe the structure of costs, revenues, and profit margins at three key stages in the palm oil supply chain in Merauke Regency namely the farmer (FFB) level, collectors/cooperatives and palm oil mills (POMs) (Table 3).

As indicated in Table 3, the calculation at the farmer level does not include a purchase price because farmers are the primary producers. Therefore, the margin was calculated as the difference between the selling price and the production cost. Based on this calculation, the margin amounted to IDR 541.42, derived from a selling price of IDR 3,041.42 minus a production cost of IDR 2,500. The percentage of added value was calculated using the formula (Margin/Selling Price × 100), resulting in an added value of 21.66%.

At the Collector level, the Margin value (Selling Price - Purchase Price - Production Cost) is IDR. 3,600 – IDR. 3,041.42 – IDR.150 amounting to IDR. 408.58 and the percentage (%) of Added Value (Margin/Selling Price × 100) is IDR. 408.58/IDR. 3,600 × 100 of 13.43%.

At the Company Level (POMs) the margin value (Selling price - Purchase price - Production cost) is IDR.14,600 – IDR.3,600 – IDR.2,800 amounting to IDR.8,200.00, and the percentage (%) of Added Value is (Margin/Selling Price × 100) IDR. 8,200/IDR.14,600 × 100 with a yield of 56.16%.

At the upstream stage of the supply chain, oil palm farmers in Merauke Regency showed their role as primary producers of Fresh Fruit Bunches (FFB) with a simple economic structure, while making an important contribution to the creation of initial value. The average selling price of FFB received by farmers is IDR 3,041.42 per kilogram, with a production cost of IDR 2,500.00 per kilogram. These costs include garden maintenance, harvest labour, plantation internal transportation, and other supporting inputs. Thus, the absolute profit margin received by farmers is IDR 541.42/kg, or equivalent to 21.66% of the selling price. This margin shows that although farmers are early actors in the value chain, they still face limitations in obtaining optimal added value due to weak bargaining positions and dependence on market prices.

Collectors or intermediary traders act as a liaison between farmers and processing companies. They buy FFB from farmers at a price of IDR 3,041.42/kg and resell it to the company at a price of IDR 3,600.00/kg. With a relatively low operational cost of IDR 150.00/kg which includes external transportation, sorting costs and packaging, the collector obtained an absolute profit margin of IDR 408.58/kg. Although this absolute margin is not as large as that received by farmers, the relative added value generated reaches 13.43%. This reflects that collectors continue to play an efficient role in distribution logistics even though the added value they generate is moderate.

Palm oil companies or POMs are the main actors in the downstream process, with the ability to transform from FFB to CPO. With the purchase price of FFB raw materials of IDR 3,600.00/kg and the selling price of CPO of IDR 14,600.00/kg, the company was able to create a substantial added value. The production cost incurred for the processing process is IDR 2,800.00/kg, including energy costs, factory labour, equipment maintenance, and product packaging. The company's absolute profit margin reached IDR 8,200.00/kg, or around 56.16% of the selling price. This high percentage of added value shows the company's dominance in mastering technology and economic value.

This value-added structure emphasizes the inequality in the distribution of margins between supply chain actors. Companies dominate with the highest margins and added value, while farmers and collectors get a much smaller portion. This reflects a hierarchical market structure, where actors with high investment and technological capacity dominate the distribution of value.

In the context of justice and sustainable development, this inequality demands policy interventions that are in favor of strengthening the position of farmers and the role of collectors. Measures such as the establishment of farmer cooperatives, facilitating access to production technologies, and increasing price transparency at the collector level can help improve the distribution of value in the supply chain. Meanwhile, companies are also encouraged to play an active role in fair partnership schemes based on proportionate profit sharing. Overall, this value-added analysis shows the importance of an integrative approach in building a fair, efficient, and sustainable palm oil supply chain in Merauke Regency.

Just In Time (JIT)

The accuracy of product delivery can be seen from the distance and travel time from the farm to the mill, the mill to the port, the type of fleet used, and the infrastructure. Transportation distance has the potential to be one of the determining factors for productivity due to the degradation of FFB quality during transportation and high logistics costs.

Data on the distribution of the transport distance of FFB from independent farmers to mills in South Papua show three main categories that reflect the heterogeneity of farmers' accessibility to processing facilities (Figure 3). The average distance shows a value of 19.14 km which indicates a significant logistical challenge for most independent farmers. The farthest distance reached 34.87 km, which shows the presence of farmers with limited accessibility to processing infrastructure (Figure 4). This condition is different from the conditions in Sumatera and Kalimantan where more mature infrastructure allows for more efficient mileage [36].

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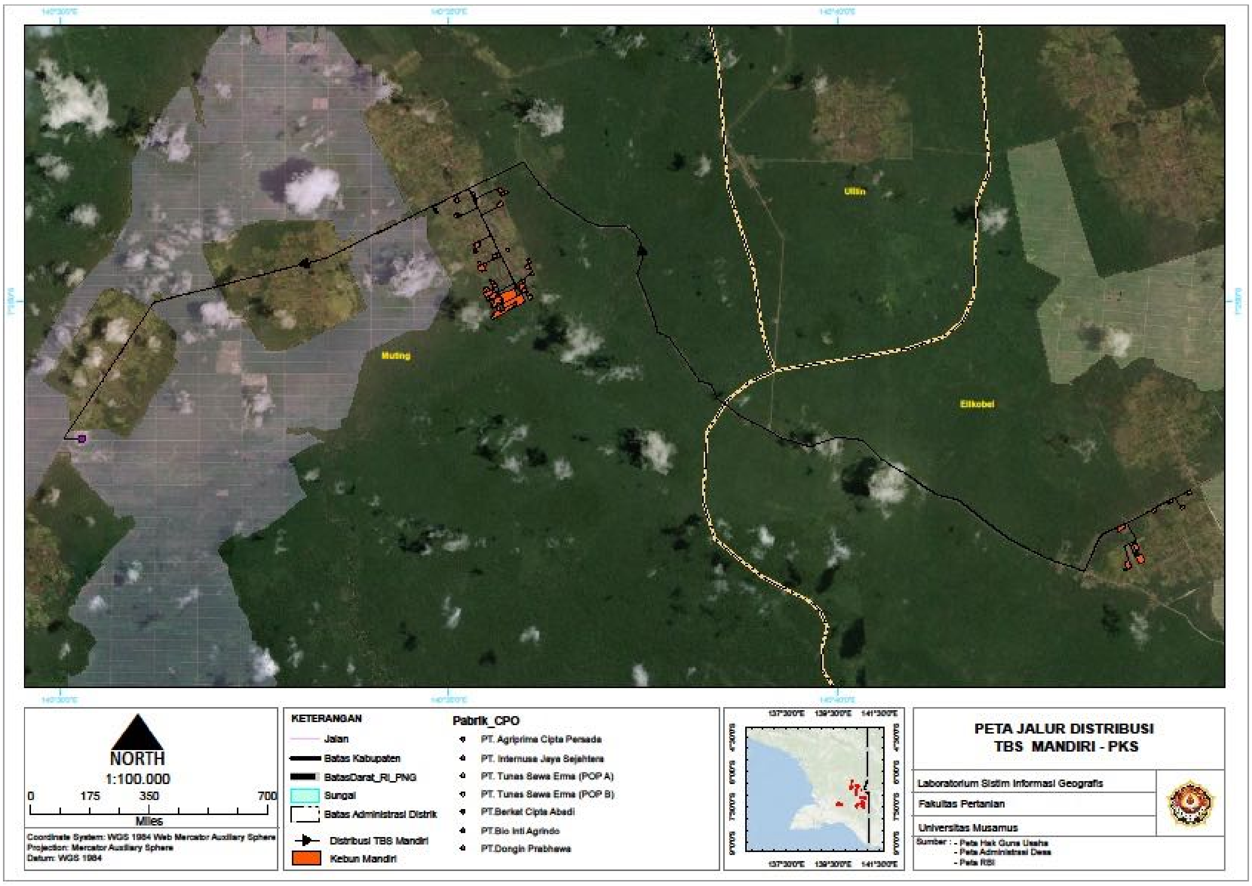

Figure 3: Map of the Distribution Path of FFB for Independent Farmers

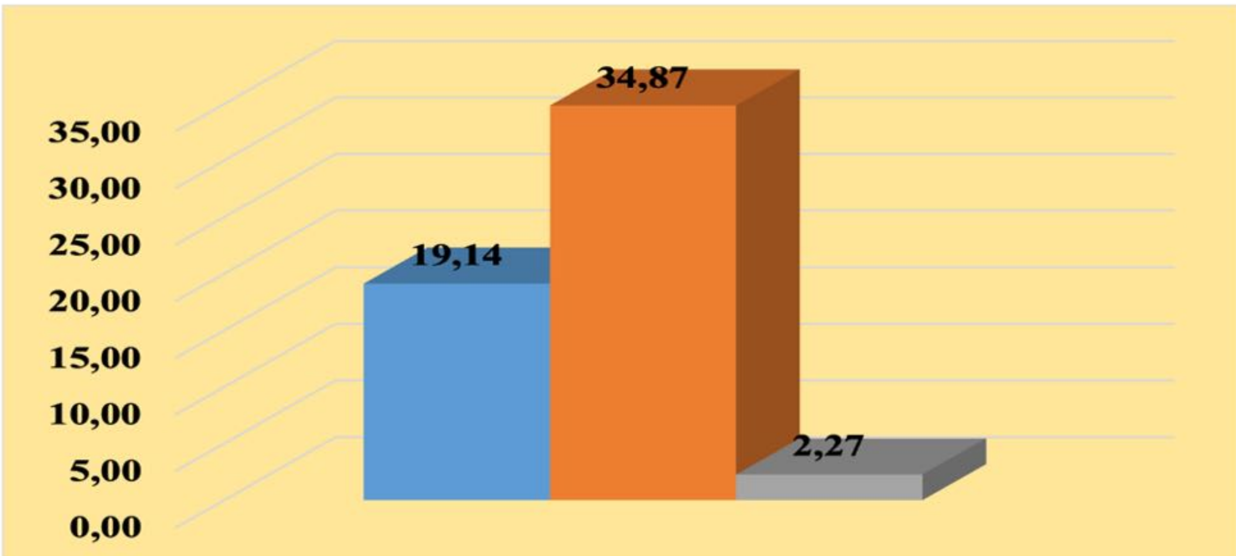

Figure 4: Distance of FFB from Independent Farmer Gardens to POMs

The nearest distance of 2.27 km shows the presence of farmers with strategic positions that provide a competitive advantage in terms of cost efficiency and quality of FFB. The extreme variation in distances between 2.27 km and 34.87 km reflects significant spatial disparities in the development of oil palm plantations in South Papua. This is in contrast to the situation in Central Kalimantan where studies show a more structured CPO transportation distance with an average of 626 km for distribution to ports [21, 27].

Research in Jambi, Sumatera, shows that decentralization policies and socio-economic factors affect the dynamics of oil palm land use, which ultimately has implications for the efficiency of transportation distances [4, 21]. The more developed infrastructure in both regions allows for better supply chain optimization compared to South Papua.

The frequency distribution shows the concentration of farmers in the medium and long distance categories which indicates the accessibility challenges experienced by the majority of independent farmers. The geographical condition of South Papua, which is still in the infrastructure development stage, creates higher access inequality compared to mature regions such as Sumatera and Kalimantan. Farming contracts between companies and local communities have been used in Indonesia for more than 20 years to engage smallholders in the growing oil palm industry [12]. This system is more effective in Sumatera and Kalimantan due to the availability of supportive transportation infrastructure. Many studies show that smallholders of oil palm have played an important role in Indonesia's CPO production for decades but productivity lags behind compared to large plantations [55]. The long transport distance in South Papua has the potential to exacerbate this productivity gap due to the degradation of FFB quality during transportation and high logistics costs, for more details can be seen in the map of CPO and PKO distribution routes in the South Papua provincial area.

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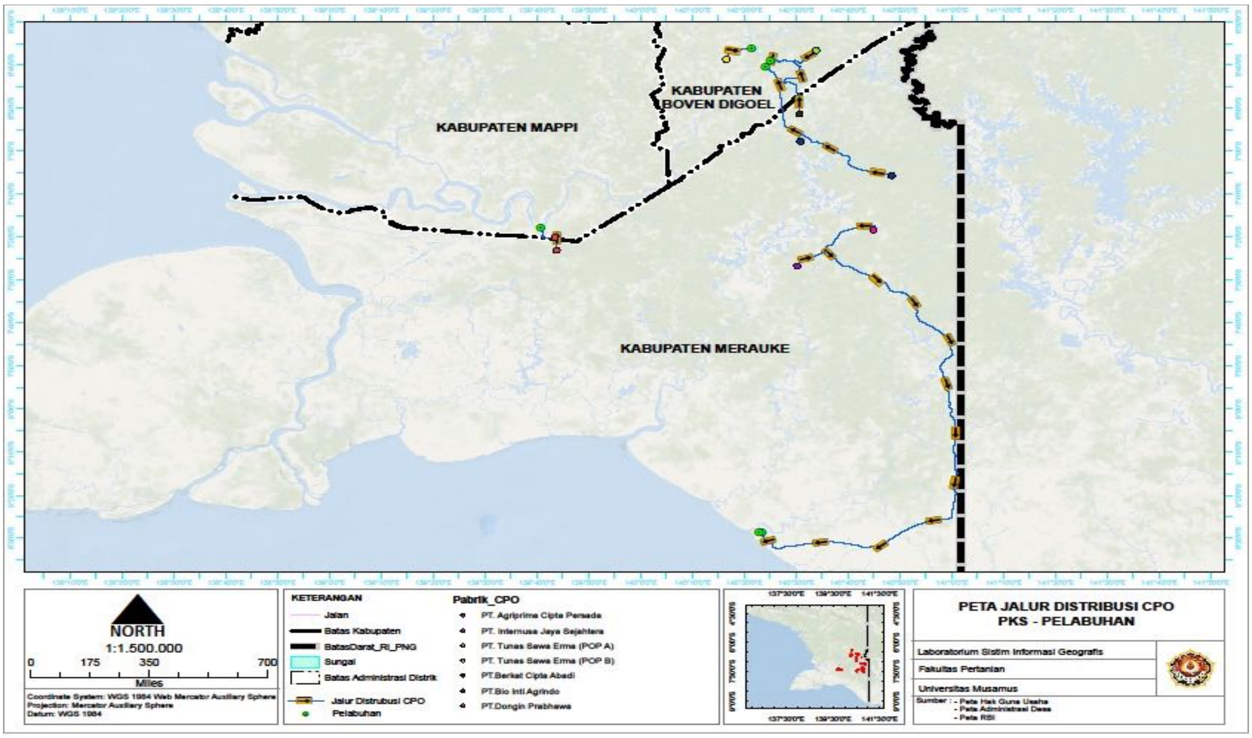

Figure 5: Map of CPO and PKO Distribution Lines from POMs to Port

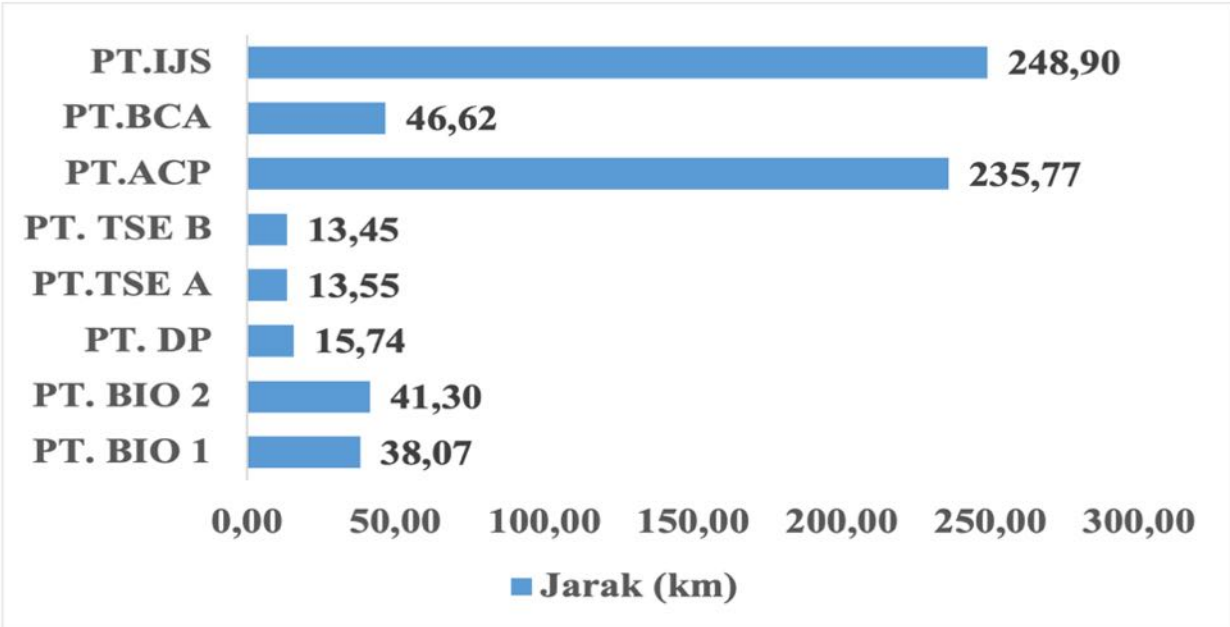

Figure 6: Mileage of CPO and PKO Products from POMs to Port

The data presented in Figure 6 shows that the variability of mileage between the mill and the port shows a significant difference. The longest mileage was recorded by PT. IJS with 248.90 km, followed by PT. ACP with 235.77 km (Fig. 6). Both companies have a much greater distance to the port compared to other companies.

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Meanwhile, PT. BCA and PT. BIO 2 also has a relatively long distance, although it is not comparable to the previous two companies, which are 46.62 km and 41.30 km, respectively (Fig. 6).

The category of the closest distance to the port is dominated by POMs which is located below 40 km. Three POMs show a very short distance, namely PT. DP (15.74 km), PT. TSE A (13.55 km), and PT. TSE B (13.45 km). This short distance could theoretically contribute to operational efficiency and reduce transportation costs. This shows that there is a significant geographical disparity in the determination of the location of the POMs to the port infrastructure, which has implications for the company's supply chain and logistics.

This condition indicates the existence of POMs groups with different geographical advantages. Companies such as PT. TSE A, PT. TSE B, and PT. DP have more optimal logistics access because of the very close distance to the port. On the other hand, companies such as PT. IJS and PT. ACP faces more complex logistical challenges, both in terms of time and cost, due to very long distances. This distance distribution reflects the various location determination strategies and challenges faced by each mill in the distribution process of CPO and PKO.

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

The palm oil industry in South Papua, particularly in Merauke and Boven Digoel Regencies, represents a significant economic opportunity with substantial contributions to regional GDP and national foreign exchange earnings. The research reveals a vertically integrated supply chain structure dominated by large corporations, characterized by sophisticated processing capabilities totaling 124,407.23 tons annual capacity across seven companies operating ten factory units. However, this configuration demonstrates pronounced structural inequalities that fundamentally limit the equitable distribution of economic benefits among key stakeholders, particularly independent farmers and indigenous communities who remain marginalized despite their critical roles in land provision and primary production.

The value chain analysis exposes a concerning asymmetry in profit distribution, with palm oil mills capturing 56.16% of added value while farmers receive only 21.66% despite bearing substantial production costs and risks. This disparity is exacerbated by weak institutional relationships, limited access to capital and technology for independent farmers, and the dominance of informal market mechanisms controlled by collectors. The geographical challenges inherent to South Papua's infrastructure development further compound these inequities, with transportation distances ranging from 2.27 to 34.87 kilometers creating additional logistical barriers that disproportionately affect smaller producers and contribute to quality degradation and increased operational costs.

Indigenous peoples, as customary landowners, face systematic exclusion from decision-making processes despite their fundamental stake in the industry's development. The absence of meaningful implementation of Free, Prior, and Informed Consent (FPIC) principles has resulted in land tenure conflicts and social marginalization, undermining the industry's long-term social sustainability. The current partnership schemes remain predominantly top-down, with weak bargaining positions for local actors and inadequate protection of customary land rights, creating potential for ongoing agrarian conflicts and threatening the industry's social license to operate.

From a sustainability perspective, the current industry trajectory, in addition to production expansion and economic profitability, is beginning to focus on environmental and social sustainability. Compliance with certification standards such as the Roundtable on Sustainable Palm Oil (RSPO) and Indonesian Sustainable Palm Oil (ISPO) has become an integral requirement in the supply chain. This certification serves as an important indicator of environmental and social compliance. Several companies have taken proactive steps in implementing sustainability, as demonstrated by PT. Bio Inti Agrindo. Furthermore, operational sustainability initiatives are also evident in companies under the auspices of PT. TSE Group and PT. ACP, which have initiated innovative efforts in zero-waste management. These initiatives have integrated waste management by converting solid and liquid waste into environmentally friendly end products: biochar for soil improvement and biogas as an alternative energy source.

All strategic recommendations in this study are directly grounded in the empirical findings, which reveal four major issues in South Papua’s palm oil industry: value chain dominance by large corporations, unequal added value distribution, weak social tenurial protection for indigenous communities, and uneven ecological sustainability practices.

The evidence of farmers receiving only 21.66% of added value, limited access to capital and technology, and dependence on informal markets supports the need to revitalize cooperatives and establish transparent FFB markets. Likewise, the marginalization of indigenous landowners and the absence of FPIC justify the recommendation to mandate Free, Prior, and Informed Consent protocols.

The study’s findings on fragmented institutional relationships and top-down partnerships necessitate integrated cross-sectoral governance and multi-stakeholder forums. Finally, the uneven adoption of RSPO/ISPO standards and zero-waste innovations forms the basis for enforcing ecological sustainability through no-deforestation standards, HCV (High Conservation Value) protection, and mandatory waste-management technologies. In sum, the proposed reforms respond directly to the economic, social, governance, and environmental gaps identified in the value chain analysis.

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Table 1: Merauke Regency Oil Palm Plantation Processing Plant Data in 2025

Number	Company	Number of Factories (Units)	Capacity (Tons FFB/Hour)	CPO Yield (Ton)	CPKO Results (Tons)
1	PT. Bio Inti Agrindo	2	75	80.845	0
2	PT. Dongin Prabawa	2	150	14.503,23	2.859,70
3	PT. Berkat Cipta Abadi	1	75	0,00	0
4	PT. Agriprima Cipta Persada	1	60	19.106,00	8.301,00
5	PT. Agrinusa Persada Mulia	1	3	9.953,00	0
6	PT. Internusa Jaya Sejahtera	1	45	0	0
7	PT. Papua Agro Lestari	0		0	0
		Sum		124.407	11.161

Source: Merauke Regency Horticultural and Plantation Food Crops Office, 2025

Table 2: Actors, Institutional Relationships, and Challenges

Actor	Role	Institutional Relations	Challenge
Independent farmer	Produksi TBS	Weak	Low prices, minimal access to capital
Core companies	Plasma construction, processing	Strong	Market dominance
Collectors/Cooperatives	Liaison	Informal	Price inequality
Indigenous	Landowner	Vulnerable to conflict	Minimal involvement

Source: Primary data processing, 2025

Table 3: Added Value of Oil Palm Plantation Production in Merauke Regency

PeIDR	Purchase Price (IDR/kg)	Selling Price (IDR/kg)	Production Cost (IDR/kg)	Margin (IDR/kg)	% Added Value
Farmer	-	3.041,42	2.500,00	541,42	21,66%
Collector	3.041,42	3.600,00	150,00	408,58	13,43%
Company	3.600,00	14.600,00	2.800,00	8.200,00	56,16%

Source: Primary Data Processing Results, 2025

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