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The Nature and Management of Sustainable Palm Oil Supply Chains

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ABSTRACT

There is high demand for palm oil, which is widely used in food products, cosmetics, cleaning products and biofuels. The sustainability of oil palm farming is still controversial, because different interpretations of sustainability have resulted in conflicts that arise during the production process. The study aims to investigate the economic, social and environmental dimensions aimed at building a sustainable palm oil supply chain. The research was conducted using interviews, field observations and literature studies of palm oil industry supply chain actors to explore the challenges and opportunities associated with achieving supply chain traceability, as well as the consequences of these efforts. The findings of this research highlight the difficulties faced by downstream buyers and upstream producers resulting from traceability problems of fresh fruit bunches. The participation of independent smallholders is a matter of debate in the palm oil agroindustry supply chain. It is necessary to monitor their performance and provide training and assistance to them in order to create a sustainable palm oil supply chain from upstream producers to downstream industries. Additionally, this study highlights the potential negative consequences that may arise from well-intentioned initiatives to promote socio-economic development related to sustainable palm oil production. These conclusions provide a valuable contribution to the existing literature on sustainable supply chain management by examining the influence of stakeholders with diverse objectives on behavior in complex palm oil supply chains.

1. INTRODUCTION

The demand for palm oil has increased significantly, establishing it as the prevailing vegetable oil in international markets. As of September 2023, the annual production of palm oil reached 74.2 million MT [1]. The expansion of the palm oil sector is propelled by the rising need for cost-effective food products, and the growing utilization of palm oil for vegetable oil, cosmetics, cleaning products and bioenergy [2, 3]. Palm oil contains unique fatty acids making it increasingly valuable for various uses [4].

Oil palms have significantly higher productivity than other commercially cultivated oil crops, such as sunflower, soy, and rapeseed, with yields per hectare up to 3.5 – 10.5 times higher [5, 6]. Additionally, palm oil's production costs are relatively lower than other vegetable oils. Consequently, it is unsurprising that palm oil the most economical and competitive vegetable oil in the market. The primary locus of commercial palm oil cultivation are Indonesia and Malaysia. Collectively Indonesia and Malaysia, account for 82.44% of global palm production (44 million MT and 19.71 million MT). Palm oil has emerged as a significant commodity in the economic advancement of multiple nations [1]. There are several advantages associated with the palm oil sector for both the producing countries and independent smallholders. These benefits include enhancements in infrastructure, healthcare, and educational opportunities [7-9]. Palm oil agriculture has emerged as a means of subsistence for certain smallholders [10]. However, the practice of oil palm cultivation is often considered to cause several environmental, social, and economic concerns [11]. From an environmental standpoint, land clearing for the development of oil palms is linked to forest burning which causes a deforestation, reduction in habitat of native plant and animal species, biodiversity loss, etc [9, 12]. Moreover, land clearing and oil palms cultivation also result in changes in land use and the loss of ancestral territories of indigenous communities [13-16]. The excessive and improper application of chemical fertilizers and pesticides have been identified as significant contributors to climate change and natural pollution [17].

Development of oil palms is not the only cause of widespread deforestation. Instead, oil palm farming serves as a means of utilizing land after logging activities have occurred as a result of other business activities [14]. Although the economic benefits associated with palm are persuasive, it is important to note that these justifications fail to align with most firm's supply chain management requirements and operational practices. Currently, industries, especially

multinational industries, face significant impacts if they are deemed involved in environmental or ethical issues related to their business activities or the main resources on which they depend [16, 18]. Strict supervision continues to be carried out on every company business activity related to the environment and society [19].

Particularly in the European Union market share, there is a strong emphasis on applying the concept of sustainability to palm oil plantations and the agroindustry. Palm oil plantations and agroindustry business activities in Indonesia are often in the spotlight because they are deemed not to implement Good Agriculture Practices and RSPO sustainability principles throughout their supply chain. Apart from that, the long and complicated palm oil agroindustry supply chain, starting from plantations, agents/collectors, palm oil processing factories, and distribution to consumers, means that traceability and transparency of raw material sources are considered insufficient [20].

Implementing sustainability throughout the supply chain of palm oil cultivation business activities is considered to be an important thing in supply chain management [21]. Including sustainability in supply chain management is of utmost importance, as it constitutes a fundamental aspect of both risk and supply chain management [22]. This is because it is a fundamental aspect of risk and supply chain management. Starting an environmentally friendly supply chain that avoids risk from upstream, especially the supply of main raw materials to downstream processing. In the global agri-food sector, independent smallholders in developing nations commonly engage in upstream activities. Previous research has indicated that smaller organizations within supply chains frequently encounter challenges in fulfilling the requirements and adhering to the production standards set by larger downstream organizations [23-25]. This phenomenon has also been observed among small-scale oil palm producers [26].

The need for affordable conventional palm oil is substantial throughout Asia, specifically in India, Tiongkok, Pakistan, and Bangladesh, collectively representing over 40% of the global palm oil reserves [1]. Nevertheless, there has been a lack of enthusiasm among downstream enterprises in these nations when it comes to procuring certified sustainable palm oil [14, 27, 28]. Consequently, managing supply chains originating from, and predominantly serving, the requirements of developing nations is a significant problem for European enterprises. This study investigates the strategies certain companies employ to effectively mitigate supply chain risks and safeguard their reputation by utilizing product certification to endorse the sustainability of their palm oil goods. This study focuses on examining the actions, outcomes, and effects associated with implementing supply chain custodians and the traceability of goods.

Research shows that SCM can improve palm oil organizational sustainability by addressing environmental issues and supporting responsible production [29, 30]. The intricacy of palm oil supply chains requires a thorough understanding of all participants, from growers to consumers, and how their interactions affect sustainability [31].

Evaluating the effectiveness of current certification programs, such as the Roundtable on Sustainable Palm Oil (RSPO) and Malaysian Sustainable Palm Oil (MSPO), that support sustainable producer practices is crucial. These certification systems reduce the environmental implications of palm oil production, such as deforestation and biodiversity loss [32, 33]. Studies reveal that these certificates are not widely adopted, especially in emerging economies such as China and India, where palm oil demand is increasing [34, 35]. This emphasizes the need to examine certification impediments and ways to increase consumer awareness and willingness to pay for certified sustainable palm oil [36, 37]. The report also examined the socioeconomic effects of sustainable palm oil supply chains. Sustainable supply chain management improves palm oil production and the livelihood of smallholders and local communities [38]. Stakeholder participation and collaboration are required to alleviate environmental, social, and economic hazards of palm oil production's [39, 40]. To create more robust and sustainable palm oil supply chains, this study adopts a comprehensive approach that incorporates the interdependence of these aspects.

This study proposes a sustainable supply chain management paradigm that combines palm oil industry-specific risk-management measures. This article analyzes sustainable practices, evaluates certification schemes, examines socioeconomic impacts, and proposes a risk management approach. These aim to advance sustainable palm oil supply chain discourse and promote global sustainability goals.

2. RESEARCH CONTEXT

Previous studies provide empirical data, organizations may experience significant negative consequences due to sustainability concerns within their supply chains [41].

Thus, the proficient management of risk in global supply networks is essential. Supply chain risk management includes not just supply chain security but also a variety of social and environmental aspects, such as the source of raw materials and production techniques [42]. Failure to effectively mitigate these risks can result in many consequences, including receiving criticism, facing unwanted publicity, being subjected to legal action, and ultimately experiencing a decline in corporate operations [43]. Sustainable Supply Chain Management (SSCM) has gained traction as a burgeoning strategy to effectively address environmental and ethical concerns within supply chain operations [44]. Socially Sustainable Supply Chain Management (SSCM) encompasses the harmonization and consolidation of social, environmental, and economic objectives of many stakeholders throughout the supply chain [45]. This approach aligns with the triple-bottom-line concept. This topic has garnered significant attention in academic circles and has been the subject of extensive scholarly investigation over the past 20 years [41-43].

The successful integration of tangible sustainable supply chain management (SSCM) practices is intricately connected to the process of improving stakeholder awareness [9, 46]. The authors proposed that stakeholders influence sustainable supply chain management (SSCM) through a three-stage process [47]. First, stakeholders contribute to developing awareness regarding sustainability issues, through internal learning or external sources such as the media and others. Second, stakeholders must embrace a sustainability objective that corresponds with the heightened consciousness. Finally, stakeholders contribute to adopting sustainable practices such as product certification. It is important to recognize that the pressure from stakeholders that raises awareness of a problem may not always come from those stakeholders that can determine sustainability objectives or implement particular SSCM strategies. The case of Greenpeace's prominent

campaigns against European palm oil users exemplifies the situation and its resulting outcomes. These campaigns prompted criticisms of the subsequent remedial SSCM measures implemented by various parties [25, 48].

To tackle sustainability concerns effectively, corporations are required to proactively anticipate and alleviate potential negative repercussions by implementing SSCM [27]. One strategy is to obtain sustainability certification from third parties to validate sustainable management practices for supply chain actors. Certification schemes are extensively relied upon by both corporations and consumers to evaluate the fulfillment of sustainability standards. Nevertheless, the risk management aspect of SSCM can pose significant difficulties within intricate global supply chains, especially for palm consumers who operate across vast geographical areas and collaborate with supplier countries that exhibit diverse political and cultural disparities.

The management of global supply chains in alignment with sustainability standards, prioritizing the traceability of goods, can present significant challenges, particularly when addressing the complexities of obtaining consensus among numerous stakeholders [22]. The insufficiency of supply chain standards may be attributed to the challenges associated with effectively managing global supply chains by the established standards [49]. Media and supply chain stakeholders consistently emphasize sustainability concerns, compelling firms to confront these concerns [50]. Nevertheless, despite acknowledging the existence of challenges and implementing strategies such as SSCM, several enterprises still lack comprehensive mechanisms to assess the fulfillment or accomplishment of their supply chain requirements [51]. The use of both decoupling and loose coupling strategies in the context of business policy and practice might pose significant risks to SSCM, potentially resulting in adverse environmental impacts and harm to reputation [52]. Consequently, the implementation of proactive SSCM has emerged as a crucial element in the operations of large corporations, particularly those that adhere to formal management systems based on the concept of ongoing enhancement.

Implementing proactive supply chain sustainability and corporate social responsibility (SSCM) initiatives and policies necessitates a holistic approach by supply chain participants [52]. Sustainability issues are often considered very complex because they involve subsystems at various scale levels, and there is no single point of view for their measurement and analysis. Sustainability issues cannot be solved with a simple approach. All entities involved in a supply chain can either support or impede the integration of sustainability principles into supply chain management [53]. The impact of establishing supply chain standards in agri-food production extends beyond the physical characteristics of the commodity as it also influences operational dynamics and structural organization the supply chain's [54, 55]. This concept pertains to the notion that supply networks can be characterized as intricate systems [56]. The implementation of proactive measures by stakeholders to manage and regulate the supply chain and its components can result in unforeseen outcomes. Hence, engaging in diligent surveillance of all emerging consequences of supply chain management (SCM) and being prepared to adapt techniques to achieve management objectives is imperative. This proactive approach is essential to manage supply chain networks effectively [56]. Attaining the necessary preparedness and Sustainable Supply Chain Management (SSCM) requires a comprehensive and extensive comprehension of all dimensions of sustainability, not just environmental sustainability.

Zimon et al. [51] stated that there is still a lack of specific studies on industry SSCM. Additionally, there is a need for further understanding of the trade-offs that may develop in supply chains when conflicting 'triple-bottom-line' SSCM objectives are achieved [57]. Considerable literature exists on the environmental and ethical aspects of supply chains [58]. However, there appears to be a dearth of discourse on the interplay between sustainability and formal supply chain risk management for specific individuals [59]. There is a deficiency in the literature on explicitly mentioning sustainability and social concerns. There is a need to improve our comprehension of the interplay between the environmental and social aspects of sustainability in supply networks, with a specific focus on developing nation supply chains [60]. The existing literature on sustainable product supply chains is limited in its comprehensive comprehension, primarily because of inadequate connections among various research communities that have engaged with this subject matter [61].

3. SUSTAINABLE CERTIFICATION FOR PALM OIL

In light of the perpetual evaluation undertaken by prominent corporations to safeguard their brands against detrimental publicity [62] and the imperative to enhance standards and bolster the industry's reputation, multiple initiatives have been devised for the palm sector. Indonesian Sustainable Palm Oil (ISPO) and Malaysian Sustainable Palm Oil (MSPO) are two government mandated schemes emphasizing the socioeconomic development components of sustainability. Voluntary initiatives exist within the third sector, encompassing a broader scope of sustainability objectives, such as Roundtable on Sustainable Palm Oil (RSPO), International Sustainability and Carbon Certification (ISCC).

Among the various palm oil certification schemes available, one of the globally recognized schemes is RSPO. RSPO is considered to address a broader scope and interrelated dimensions of sustainability, encompassing social, environmental, and economic factors [63]. The RSPO was established through collaboration between palm oil companies, consumer goods companies, retailers, banks and investors, and non-governmental organizations to promote sustainable palm oil production. The certification standards of the RSPO are designed based on performance indicators encompassing a range of guiding principles. These principles include a dedication to transparency, responsible treatment of employees, and consideration of the well-being of individuals and communities impacted by palm oil growers and mills [63].

Membership in the RSPO is voluntary and can be joined by all organizations. To market Certified Sustainable Palm Oil (CSPO) or certified palm fruit kernels, various entities such as smallholders, estates, plantations, and mills must undertake an external audit. This audit evaluates their compliance with Roundtable's 69 performance indicators and overarching Principles & Criteria [64]. After a thorough audit and certification process, CSPO, which is produced by a mill, can be integrated into the supply chain of palm products through one of four distinct methods. Each method requires independent certification to adhere to the supply chain standards set by the RSPO, which is separate from the Principles and Criteria standard. This certification ensures that end users can rightfully assert that their product is genuinely

CSPO or contributes to the support of CSPO. There are four distinct supply chain possibilities: 1) Certified Sustainable Palm Oil (CSPO) is derived from plantations and mills that have received certification from the RSPO, where the identity of each activity in the supply chain can be traced. This type of palm oil is technically segregated from non-CSPO palm oil during production until it is ready for use as a specific product. This feature enables end-users to track the entire production process of their palm products, thereby providing transparency. Additionally, it empowers Consumer Goods Manufacturers (CGMs) and retailers to assert product sustainability; 2) Certified Sustainable Palm Oil obtained from a producer holding certification from the RSPO has been combined with palm oil from other RSPO-certified producers. CSPO oil was carefully segregated from non-CSPO oil at all stages of production and distribution to ensure product integrity. While end-users possess a certain level of confidence regarding the physical certification of the sustainable material they have acquired, they lack precise knowledge regarding the producer of the purchased goods. Individuals that utilize segregated CSPO, its derivatives, and/or kernel-based items can assert that their products incorporate certified sustainable palm oil; 3) Certified Sustainable Palm Oil blended with non-CSPO oil in a certain proportion. The users of this palm oil are authorized to assert their contribution to the production of CSPO up to a specified amount; 4) Green Palm certificates or RSPO Credits, where the RSPO certifies independent smallholders and assigns a single certificate for each metric ton of palm oil produced. Buyers of these products are certified and permitted to express their support for the development of CSPO. However, it cannot be guaranteed that the palm product used by a downstream producer is cultivated sustainably or socially responsible.

4. RESEARCH APPROACH

The research methodology was carried out through literature studies, field observations, and interviews with respondents from several palm oil mills and companies that use palm oil products. This analysis focuses on examining their involvement in the production and distribution of certified sustainable palm oil. Then, an evaluation of the practice of implementing sustainability in the business activities of these companies was carried out. Several structured and semi-structured interviews were conducted with palm oil supply chain actors. The respondents used were 25 people consisting of independent smallholders, collecting agents (FFB brokers), DO holders, palm oil mills based in Riau Province and Bengkulu Province (Indonesia's), palm oil-based downstream industries. In addition, a series of interviews were conducted with key policyholders (Governmental and Non-Governmental) who have an important role in the environmental and social impacts of palm oil farming but are not directly involved in the supply chain. It is worth mentioning that several interviewees occupied roles within organizations that operate across multiple tiers of the supply chain, thereby providing insights into each tier they were involved in.

Considerations in selecting respondents were: 1) having a perspective regarding the regulatory framework, environmental standards, and social impact studies in the palm oil supply chain; 2) having expertise and credibility regarding palm oil sustainability; 3) having insight and influence in palm oil sustainability practice policies; 4) having involvement in the palm oil supply chain.

The research stages use a systems approach. Organizational analysis method called the systems approach uses system characteristics as the starting point for analysis. The results of interviews with sustainable palm oil supply chain actors were then analyzed and classified with the help of software by qualitative research procedures [65-68].

5. RESULTS

This research refers to: 1) the oil palm supply chain scheme; 2) logistics supervision in the sustainable palm oil supply chain, 3) implementation of sustainability principles in the palm oil supply chain.

The palm oil supply chain is recognized as quite complicated and lengthy. It is widely acknowledged that the complexity of this problem arises due to the large number of supply chain actors involved and users of palm oil products and derivatives in limited quantities compared to large quantities of crude oil [16]. Utilizing small quantities of ingredients creates challenges in effectively handling large quantities of ingredients and implementing a certified sustainable palm oil supply chain. This difficulty is further exacerbated by many intermediaries between palm oil producers and processing factories in production zones. This causes the tracing of the origin of the fruit not to be adequately recorded (Figure 1).

Palm oil agro-industry supply chain scheme in Indonesia (Figure 2). Palm oil mills obtain Fresh Fruit Bunches (FFB) from plantations, schemed smallholders (partners), and independent smallholders. Then, the FFB from the company's oil palm plantations is transported by the company's fleet or partner fleets to the palm oil mill. FFB from schemed smallholders is transported by large agents with delivery contracts (DO Holders). FFB originating from independent smallholders is collected by the FFB broker and handed over to DO Holders. Then, the DO Holders transport the FFB to the palm oil mill for processing into crude palm oil and kernel products. Next, the products are distributed for further processing by downstream industries or exported to CPO-importing countries. In some areas, FFB not received by palm oil mills will be sent to small - HACPO (High Acid CPO) mills. Based on field observations, we can see that in Indonesia's palm oil supply chain, several certified mills only accept FFB from their own plantations or partner smallholders (schemed smallholders) to maintain traceability of the identity of the origin of the FFB. However, many palm oil mills also receive fruit from independent smallholders through their DO holders. This requires strict supervision and sortation when receiving the FFB at the palm oil mill. DO holders need to have a record of the identity of the origin of their FFB and evaluate the performance of their supplier FFB brokers and independent smallholders. This needs to be done to maintain traceability and quality of FFB received by palm oil mills.

The utilization of CSPO in a certified supply chain makes it easier to identify sources, production methods, and responsible parties involved in the palm oil industry (Figure 1). Consequently, these options have gained popularity among prominent European brands such as Unilever, Nestlé, etc. [43]. The motivation behind this phenomenon can be attributed to the inclination to effectively handle the intricacies, potential hazards, risks, and uncertainties inherent in traditional supply

chains. To address potential environmental and ethical concerns that may attract adverse negative campaigns, stakeholders recognized the value of implementing a sustainable supply chain as a means to showcase the sustainability of a palm product. Nevertheless, when considering technical aspects, the intricate nature of global palm oil supply networks can lead to producers' assertions of traceability being potentially unreliable.

All supply chain actors must undergo audits and certification from upstream to downstream. However, smallholders often face significant challenges in adopting sustainable practices, primarily driven by financial constraints, perceived limitations in meeting certification requirements, and a lack of awareness. Moreover, smallholders do not have the technical capability to obtain individual certification, which consequently restricts their access to a CSPO supply chain independently. This is due to the limited availability of funds to finance enhancements in cultivation practices as well as the costs associated with necessary the audit and certification procedures.

Palm oil mills need to proactively provide training and resources to independent smallholders, enabling them to obtain sustainability certifications, such as RSPO and ISPO. In return, independent smallholders commit and partner to sell their FFB only to mills that assist. However, because no obligation or coercion for palm oil mills have helped smallholders to obtain their FFB supplies from smallholders if they have sufficient supplies from their own plantations, it is feared that this could exacerbate the reluctance of smallholders to implement or maintain environmentally friendly agricultural practices. The program's success in providing training and resource assistance to smallholders in supporting the implementation of sustainability requires the support of all parties, not only the palm oil mills, the Government, and related agencies but also the enthusiasm and participation of the smallholders themselves. Smallholders often show a lack of enthusiasm in complying with the criteria mandated by the certification program because they think they will not gain financial benefits from the program [69]. Strict sanctions need to be given to supply chain actors who do not apply sustainability principles in their business activities to make achieving a sustainable palm oil supply chain easier. Apart from that, it is also necessary to provide more value to independent smallholders who perform well and produce quality FFB by providing more reasonable prices to continue to motivate independent smallholders to apply sustainability principles to their business activities.

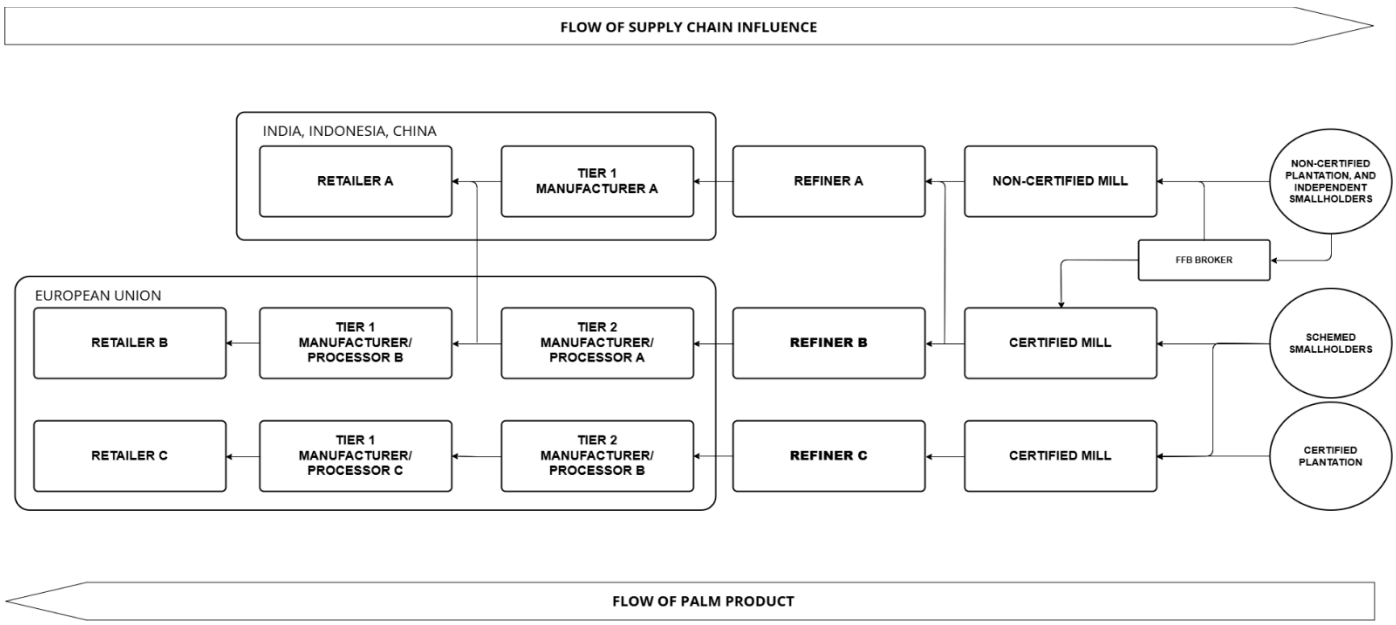

Figure 1. Palm oil supply chain schematic globally

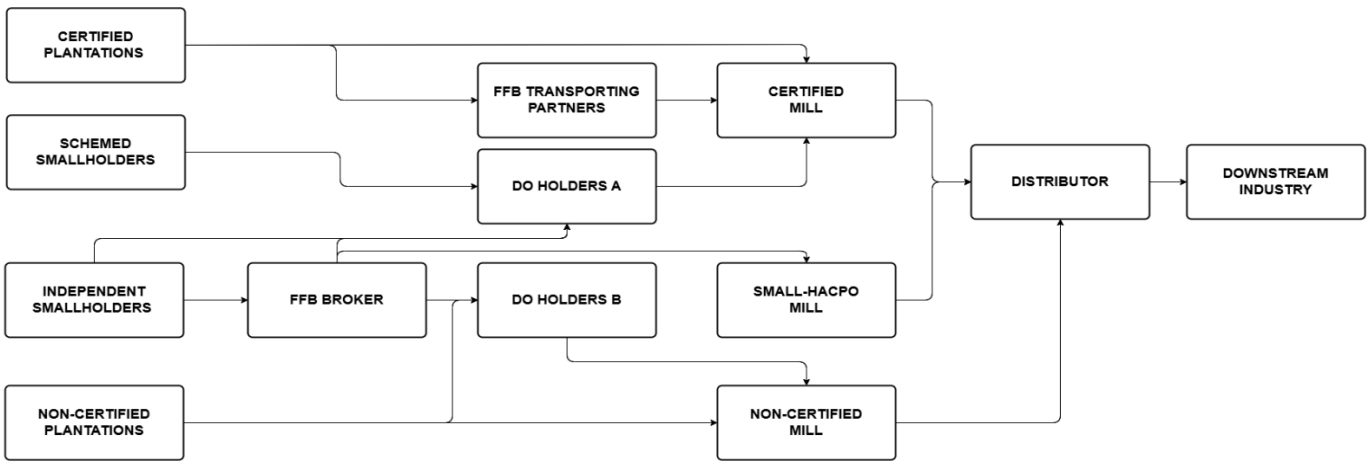

Figure 2. Palm oil supply chain in Indonesia

Even though the palm oil supply chain is quite complex and lengthy and has various challenges, the right strategy is needed to build a chain of control that is "traceable" and sustainable. It requires the participation of all parties, both those directly involved in the supply chain and those not, as well as strict regulatory support from the Government to realize a sustainable palm oil supply chain. Industrial complexity and supply chain management (SCM) risks often arise due to the untraceability of the identity of FFB from independent smallholders in the supply chain. The worsening of this problem is caused by the emergence of oil palm fruit traders, who often do not record and evaluate the performance of independent smallholders both in terms of the quality of the FFB produced and the cultivation practices that independent smallholders use. For example, whether the smallholders carry out planting activities in designated protected forest areas, violate protected forest boundaries, or show inadequate land management practices, etc. Tracing the identity of the origin of TBS is important. The validity and accuracy of the certification of processed palm oil products is determined by how capable the company is of tracing the identity of the origin of its raw materials in the supply chain. The lack of openness and thoroughness in searches raises concerns among consumers. It is also tricky for certification bodies to check the traceability of raw materials considering the complexity of the palm oil supply chain. This is a challenge in accurately tracing the source of palm oil raw materials, giving rise to doubts regarding verifying of traceability claims in this sector. Palm oil companies must build and create systems to track the flow of goods. This practice can potentially prevent 'problematic' supply chain actors from participating in the supply chain. Greater attention must be given to independent smallholers by providing direct support to smallholders throughout the supply chain both financially and knowledgeably to achieve a sustainable palm oil supply chain successfully.

6. DISCUSSION

Attention is needed to the complexities and challenges of the palm oil supply chain. These factors are important in ensuring supply chain sustainability and are fundamental components of palm oil in a sustainable supply chain framework.

Complexity refers to the complexity or difficulty of a system related to the number of actors involved in the supply chain [70, 71]. The impact of interdependence between supply chain actors, and their relationships with external entities such as government and society, exhibits a complex and intricate nature and impacts the entire supply chain. The pressures faced by palm oil buyers have given rise to supply chain certification platforms tailored to their needs. However, platforms designed to address these ecological and ethical issues often cause difficulties and impact the broader supply chain system. The challenges mentioned above are further exacerbated by the complexity of managing the palm oil supply chain.

The palm oil sector is a prominent illustration of the complex interplay between cultural, ethical, and regulatory factors, especially in supply chains and sustainability. Currently, there are differences in interpretations regarding sustainable palm oil between the Indonesian government and European Union regulations. The Indonesian government want to promote its domestic and global palm oil products, with a special focus on the Indian market. However, the current definition of sustainability current sustainability practices is considered incompatible with the European Union's market share. This misalignment can have negative impacts on many stakeholders. Certain businesses emphasize sustainability and are enthusiastic about demonstrating their dedication to environmental and social accountability. The substitution of palm oil with alternative feedstocks may not solve environmental problems, as this would require greater land and resources to produce equivalent amounts of oil used worldwide. Today, it is clear that the palm oil sector is still present, indicating the increasing importance of establishing and implementing sustainable practices in this industry despite the controversy surrounding it.

The recommended approach for mitigating supply chain risks through SSCM is to prioritize traceability of raw materials' identity along with applying sustainability principles to each supply chain actor. The absence of traceability due to technical limitations in monitoring palm products and fractions may raise concerns among end users. Implementing better and more accountable agricultural procedures requires financial resources, which is often an obstacle for oil palm independent smallholders. The absence of additional compensation or significant added value for CSPO producers has reduced motivation to implement sustainability principles that are standardized and required by European market share. Moreover, there are still buyers from other countries willing to buy palm oil products that have not been certified.

Applying sustainability principles to business activities and providing training to supply chain actors will be much cheaper and more effective than building the administrative and logistical oversight framework required to monitor certified FFB products throughout the supply chain. Apart from that, by applying the principles of sustainability and providing training to each supply chain actor, especially those upstream, we can avoid the potential for eliminating individuals who are considered detrimental in the supply chain. This approach allows supply chain actors to meet the standards required by certification bodies and European Union market share consumers. However, it is also necessary to pay attention because often, the certification standards set do not pay enough attention to the ability of small companies and independent smallholders to meet these criteria.

Traceability of raw materials is a potential solution to overcome the sustainability problems of the palm oil supply chain. However, its application in complex palm oil supply chains will not be optimal unless full compliance with standards exists. The complex characteristics of the palm oil supply chain require appropriate sustainable palm oil supply chain governance, support and cooperation between stakeholders, continuous monitoring, and flexible management techniques to overcome the changing difficulties faced by the palm oil sector. Implementing sustainable practices in the palm oil supply chain goes beyond compliance with environmental regulations. It requires consideration of the diverse interests of stakeholders involved in production and distribution [31, 41].

The research underscores the importance of a comprehensive strategy for sustainability that integrates environmental, social, and economic aspects. The Triple Bottom Line (TBL) approach is pertinent in this context, as it underscores the necessity of harmonizing profit, social equity, and environmental sustainability within palm oil supply chains

[29, 72, 73]. The significance of certification schemes, such as the RSPO and ISPO, is essential for fostering transparency and accountability in the supply chain [36]. These frameworks assist in alleviating adverse environmental effects, while enhancing the socioeconomic circumstances of smallholders and local people engaged in palm oil production [38, 39].

Nevertheless, the research recognizes certain limitations in the existing comprehension and execution of sustainable practices within palm oil supply chains. A significant difficulty is the variance in implementing sustainability standards among various regions and stakeholders, which results in disparate levels of compliance and efficacy [74]. Dependence on voluntary certification systems prompts inquiries on their efficacy [75, 76].

7. CONCLUSIONS

Certified Sustainable Palm Oil (CSPO), which originates from a supply chain whose raw material suppliers include independent smallholders, is often the subject of disputes. Large downstream industries, and users of palm oil, criticize sustainability certification for this type of palm oil mill, because it often fails to prove the origin of the FFB palm oil.

Applying sustainability principles to all supply chain actors, providing training to smallholders, and monitoring the performance of farmers and FFB brokers/DO holders are recommended to create a sustainable supply chain from upstream to downstream. The ability to trace the origin of FFB is also seen as a potential solution to overcome the sustainability problem of the palm oil supply chain. The complex characteristics of the palm oil supply chain require appropriate sustainable palm oil supply chain governance, support and cooperation between stakeholders, continuous monitoring, and flexible management techniques to overcome the changing difficulties faced by the palm oil sector. The implementation of sustainable practices in the palm oil supply chain goes beyond compliance with environmental regulations and requires consideration of the diverse interests of stakeholders involved in production and distribution. SSCM and risk management practices are used to mitigate the negative effects campaigns about palm oil product. However, some companies use sustainable supply chains as a sign of their ethical and accountable behavior. This method has advantages, but may exclude smaller and more vulnerable supply chain components from premium-priced markets.

The accessibility of certification standards to smaller enterprises and smallholders has been debated. Smaller entities are in developing nations and consist mostly of impoverished rural residents. The benefits of oil cultivation can be exploited to transform individuals and families. Thus, the exclusion or restricted access of certain individuals to buyers raises ethical difficulties that transcend the three pillars of sustainability: practical, financial, or ethical. Given their importance in palm oil production, it may be more important to involve smallholders than exclude them. The above insights demonstrate the reactivity and proactivity of sustainable supply chain strategies, contributing to the debate over "regulation without government."

Additional empirical research is needed to verify the findings of this study and to understand the complex dynamics of palm oil supply chains from different geographical perspectives. An investigation into the ability of supply chain standards to transcend global corporate cultures and stimulate the desire for sustainably manufactured commodities may have far-reaching academic and practical implications for palm oil and sustainable supply chain management (SSCM).

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