

Sustainable cocoa supply chain in East Java, Indonesia: potential and risk identification

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Abstract. Despite the significant role of cocoa in the economy, cocoa farmers well-being remains low. The current cocoa production process concentrates on downstream activities, primarily procuring raw materials without processing or fermentation, which results in a lack of added value in the supply chain. Smallholder plantations contribute the most to cocoa production but face obstacles due to limited knowledge, technology, and institutional support. Government initiative programs aimed at enhancing cocoa's export potential suggest integrating sustainability aspects into the cocoa supply chain. East Java, with regions and potential for cocoa plantations, becomes a prospective province to apply the cocoa sustainability concept. Conducting studies to understand the potential, opportunities, risks, and threats within the cocoa supply chain is needed. The main objective of this study is to identify the potential and strengths within the cocoa supply chain while addressing weaknesses and anticipating threats. The results show in the SWOT analysis, that 8 variables were strengths, 14 variables were weaknesses, 9 variables were opportunities, and 10 variables were threats. The classification of variables in SWOT analysis shows that farmer actors have higher weaknesses and threats. So that risk identification for farmer actors is analyzed to determine mitigation strategies that can be implemented.

1 Introduction

Cocoa production in Indonesia holds a significant role as a key contributor to raw material supply. In 2022, Indonesia's cocoa land area totaled 1,611,014 hectares, ranking second globally in cocoa plantation size [1]. Ivory Coast takes the lead with the largest cocoa plantations at an average of 2.64 million hectares, making up about 26.04% of the world's total cocoa plantation area, while Indonesia contributes 17% [2]. However, Indonesia's cocoa production ranks fifth globally, trailing behind Ivory Coast, Ghana, Cameroon, and Nigeria. This subpar productivity is attributed to Indonesia's reliance on smallholder plantations for cocoa production, where limited knowledge and technology hinder yields [3]. This problem makes the value chain in the cocoa supply chain rather low.

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Developing country such as Indonesia, can optimize the existing agricultural patterns by introducing innovation from upstream to downstream to amplify the value chain. Value chains that solely encompass the upstream stage yield meager added value [4]. Shifting agricultural potential from upstream to downstream can augment product marketability and bargaining power [5]. Fostering downstream agricultural commodities embodies a production activity that aligns with sustainability principles, involving not only agricultural players but all stakeholders. The cocoa value chain predominantly centers around cocoa beans. Most cocoa beans traded globally adhere to a linear economic model, in which cocoa beans serve as the basis for chocolate-related products [6]. This approach evidently yields lower selling prices compared to cocoa derivative goods. However, the inclination toward quick profits in farming practices presents a hurdle in Indonesia's cocoa agro-industry development.

Issues within Indonesia's cocoa supply chain extend beyond low-value chains, encompassing several problems across the spectrum from upstream to downstream. In cultivation, cocoa trees often exhibit low productivity due to haphazard planting practices, insufficient maintenance, and aging trees, collectively leading to diminished yields [7]. During the cocoa fruit processing phase, inadequate control over the fermentation and drying processes poses a risk of decreased quality due to microbial and fungal contamination. The fermentation stage is particularly susceptible to aflatoxin production. Research by Asrul [8] revealed that aflatoxin content in cocoa beans surpassed WHO thresholds—farmer level (104,798 ppb), collecting traders (61,305 ppb), and exporters (47,737 ppb). This deficiency results from a lack of knowledge and oversight across all stakeholders, notably agricultural and plantation services, throughout the cocoa supply chain's execution.

In previous research, research related to the potential for cocoa development in Indonesia began to be widely carried out [2, 7]. However, the majority of these investigations only delved into partial advantages, particularly those related to the economy. It is imperative to conduct more comprehensive analyses encompassing overall desirability aspects, including economic, social, environmental, technical, and institutional dimensions. This article delves into the exploration of the sustainable cocoa supply chain in East Java, aiming to uncover its potential benefits and inherent risks. By identifying the potential and risks, this article seeks to shed light on opportunities for sustainable development and highlight vulnerabilities that require strategic intervention. Through a comprehensive analysis that considers economic, environmental, social, technical, and institutional dimensions, a holistic understanding of the current state of the cocoa supply chain will be established.

2 Methods

In this study, comprehensive methods will be conducted to understand the potential and risk within the cocoa supply chain in East Java, Indonesia as a research subject. The cocoa supply chain of smallholder plantations especially will be discussed in this paper. Research design conduct to explain the overall research design, which could be a combination of qualitative and quantitative approaches [9]. These comprehensive methods are used to gather relevant data for analyzing the potential risks within the cocoa supply chain using primary and secondary data. Primary data including field observations and interviews, to describe the design among key stakeholders, such as cocoa farmers, processors, traders, and local communities and interviews conducted with experts, government officials, industry representatives, and other relevant individuals. Secondary data using literature review and existing reports data to detail the scope and depth of the literature review conducted to understand existing knowledge about cocoa supply chains, sustainability, and risks in the

region [10]. By combining primary data collection methods such as surveys, interviews, and field observations with the collection of relevant secondary data, the study aimed to create a comprehensive and multi-dimensional understanding of the potential and risks within the cocoa supply chain in East Java, Indonesia. This approach facilitated a well-rounded analysis that takes into account the perspectives of key stakeholders and incorporates existing knowledge from various sources.

2.1 Data analysis

The process of data analysis will involve the integration of both SWOT analysis and risk identification techniques. This integration is designed to provide a comprehensive method that delves deeper into the SWOT analysis, specifically focusing on the aspects of weaknesses and threats within the supply chain [11]. The intention behind this integration is to offer a more detailed elaboration, enabling a thorough exploration of deficiencies and potential threats present in the supply chain dynamics.

2.1.1 SWOT analysis

SWOT identification will conduct to analys the data to highlight the Strength, weaknesses, opportunities, and threats of cocoa supply chain [11].

- Strengths to identify strengths of the cocoa supply chain in East Java, include factors like favorable climate, traditional knowledge, local community engagement, or existing support programs.
- Weaknesses, based on gathered data, identify weaknesses within the cocoa supply chain. These could include challenges like inadequate infrastructure, limited access to credit, poor post-harvest handling, or low technological adoption.
- Opportunities to evaluate the external factors that could potentially benefit the cocoa supply chain. This might involve exploring emerging markets, increasing demand for sustainable products, or the potential for value addition through local processing.
- Threats to examine potential threats that might impact the cocoa supply chain's sustainability. Consider factors such as climate change effects on crop yield, market competition from other cocoa-producing regions, or shifts in consumer preferences.

2.1.2 Risk identification

Based on the deficiencies and threats identified in the SWOT analysis, proceed to conduct a detailed risk identification process. The identified potential risks in the cocoa supply chain will arise from deficiencies within the multi-dimension aspects of sustainable management (economics, social, environmental, technical, and institutional) [9].

2.1.3 Mitigation strategies

Mitigation strategies are created referring to the results of an integrated SWOT analysis and risk identification will be provided to support the implementation of cocoa supply chain sustainability (for example economic, environmental, social, technical and institutional).

3 Result and discussion

3.1 Cocoa supply chain in East Java

East Java is one of the producers of cocoa commodities after Sulawesi and Sumatra. The potential for development is increasing every year, which can be seen in Table 1. The table shows several areas in East Java that produce cocoa in 2018-2022. It can be seen that in several regions there have fluctuation in production activities. However, the most extreme occurred in the cities of Nganjuk and Malang which experienced a decline of more than 50%. This can happen due to extreme weather or a decrease in farmers' interest in cultivating cocoa, because if you look more closely at the area of cocoa plantations in the East Java area, it tends to be stable. Indeed, in some areas, there has been a decline, but in many areas, it tends to remain the same. According to [12], this happened because the cocoa planting model was dominated by smallholder plantations, in addition to climate change and low selling prices, farmers tended to switch to other commodities.

Table 1. Production and area of cocoa plantations in East Java.

Regency	Plantation of Cocoa Plantation (tons)					Area of Cocoa Plantation (Ha)				
	2018	2019	2020	2021	2022	2018	2019	2020	2021	2022
Banyuwangi	8.054	8265	8.246	7.800	8.017	10.176	10.256	10.274	9.590	9.824
Blitar	3.127	3.291	3.290	3.290	3.178	5.086	5.086	5.090	4.967	4.895
Jember	3.064	3.124	3.125	2.993	2.957	4.029	4.029	4.029	4.029	3.862
Tulungagung	1.250	1.274	1.251	2.940	1.013	1.829	1.733	1.730	1.701	1.630
Kediri	3.120	3.208	3.145	2.896	2.804	4.260	4.260	4.255	4.313	4.135
Nganjuk	1.002	1.008	1.026	2.890	927	2.571	2.571	2.571	2.559	1.942
Pacitan	2.486	2.584	2.675	2.690	2.751	5.948	5.559	5.562	4.888	5.631
Malang	1.825	1.895	1.928	2.105	1.721	3.883	3.979	3.972	3.771	3.867
Trenggalek	2.716	2.896	2.850	2.180	2.821	4.355	4.104	4.125	3.669	4.201

Source: Statistics Indonesia (2023)

According to Statistics Indonesia, The total cocoa land area in East Java spans 57,020 hectares. Among these, smallholder plantations dominate, covering 70% of the area, equivalent to 40,184 hectares. State-owned plantations account for 21%, encompassing 12,229 hectares, while the remaining 9% constitutes private plantations, covering 4,608 hectares. This model closely resembles the prevailing cocoa planting patterns observed in other regions such as Sulawesi and Sumatra, where smallholder plantations significantly contribute to cocoa output [13]. This particular approach benefits small communities by offering a source of livelihood. However, it tends to lack in terms of quality due to the haphazard nature of cocoa tree planting. Smallholder farmers often choose to plant cocoa trees in their backyards or on unused land to supplement their income. Consequently, proper cultivation practices are often disregarded. Naturally, this negligence affects both the quality and quantity of the cocoa harvest [14].

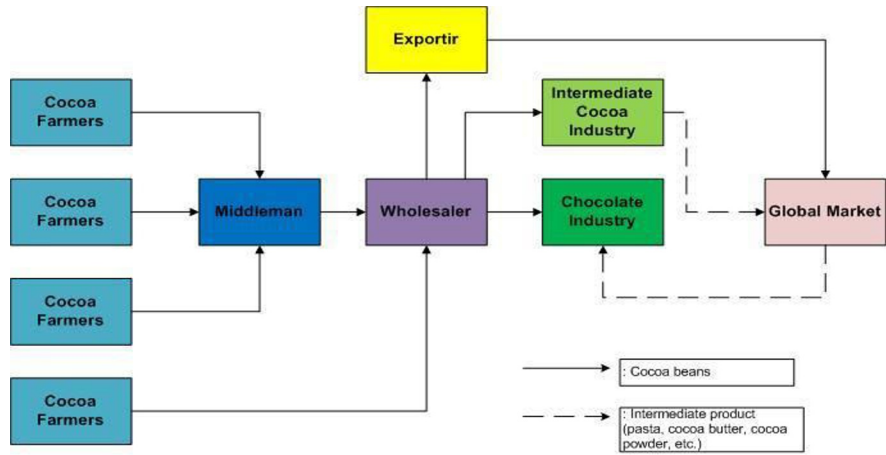


Fig. 1. Cocoa supply chain in East Java.

Given cocoa's status as an export commodity, the establishment of a sustainable supply chain management system is imperative to ensure that trading activities benefit all stakeholders within the supply chain. The cocoa supply chain is shown in Figure 1, with the stakeholders including cocoa farmers, middlemen, wholesalers, exporters, the cocoa industry, the intermediate cocoa industry, and the global market. Nonetheless, in practice, farmers often switch to commodities with higher market values. The prevalent trading pattern involves the sale of cocoa pods or unfermented cocoa beans [12], [15]. This preference stems from the perception that the fermentation process is time-consuming and that the price difference between fermented and unfermented beans is minimal. In the interest of swift income generation, farmers opt to sell in the form of whole fruits or non-fermented seeds. Unfortunately, this practice diminishes the quality of the resulting cocoa beans. Considering both the existing potential and potential risks in supply chain operations, it is crucial to undertake a SWOT analysis to assess the cocoa supply chain comprehensively.

3.2. SWOT analysis

There exists the potential for the cocoa supply chain to evolve by adopting sustainable agricultural practices. The integration of sustainability into the cocoa supply chain is still underway to some extent, thus necessitating a comprehensive and meticulous examination of the entire cocoa supply chain. Employing a SWOT analysis that takes into account both internal and external factors of the cocoa supply chain is anticipated to yield pivotal insights that can be either upheld or enhanced during implementation, thereby reaping benefits from the integration of sustainable principles [16]. The concept of sustainability offers reciprocal advantages across multiple dimensions—economic, social, environmental, technical, and institutional—for the participants in the supply chain, encompassing a broad spectrum rather than focusing on just a singular facet or two. As a result of the observation, interview, and literature studied, this SWOT-oriented study can subsequently serve as a foundational reference for formulating well-suited strategies tailored to the circumstances of the cocoa supply chain, facilitating the effective execution of sustainability principles. The SWOT analysis is built with the categorize an aspect in internal and external within stakeholder in cocoa supply chain based on sustainable potential.

3.2.1 Strengths

The potential for future expansion of cocoa, one of East Java's key export crops, is evident due to the growing demand for chocolate products. This presents a promising trajectory for the ongoing enhancement of the cocoa sector. This heightened demand offers an opportunity for additional community income [17]. The effectiveness of establishing a sustainable cocoa supply chain in Blitar Regency is exemplified through the creation of the Chocolate Village, which contributes to increased earnings for local residents. Efforts to enhance sustainability in the cocoa supply chain, starting from the upstream stages, are gaining momentum. This is evident in the development of superior cocoa varieties at the Jember Research and Development Center, aimed at bolstering productivity using advanced seeds [18]. The production of cocoa fruits yields various by-products, including fruit husks that hold potential as a biomass source for future biorefinery ventures, thereby adding value to the equation.

Table 2. SWOT analysis of Sustainable Cocoa Supply Chain in East Java

Strengths	Weaknesses
High Demand Income Generation Export Potential Availability of Employment Community Livelihoods Social Cohesion Resources of Biomass Research and Innovation (Puslitkoka) in cocoa variety	Price Volatility Income Inequality Limited Access to Finance Land use change Prone to contamination Seeds are not superior to deforestation Chemical Use Less waste processing Limited waste utilization Limited Technology Adoption Post-Harvest Losses Quality control not available Low product quality
Opportunities	Threats
GAP Value Addition in cocoa beans Utilization of Cocoa by products Supply Chain Integration Education and Training Technology Dissemination Processing Efficiency Farmers Cooperatives Government Support	Climate Change Diseases and Pests High Competition Labor Shortages Community Displacement Soil Degradation Technical Barriers Inadequate Infrastructure Regulatory Changes Market Access Barriers

Source : Owner Data (2023)

3.2.2 Weakness

The community-driven plantation model exhibits deficiencies in its execution, particularly in the realm of cultivation control, which is not effectively managed. This deficiency can lead to diminished levels of productivity, compromised quality, and potentially decreased selling prices [19]. The selling price of cocoa on the farmer level tends to remain depressed due to a combination of collector-driven price fluctuations and the inclination of farmers to sell unfermented fruits and beans. In East Java, farmers' awareness of the fermentation process remains low as they perceive it to be time-consuming, intricate, and economically unrewarding [20]. The market value of both unfermented and fermented dried cocoa beans stands at a mere IDR 1,000 per kilogram, prompting farmers to opt for fruit or non-fermented dried beans as their preferred selling format.

Beyond pricing challenges, the implications of the community-based plantation approach extend to the quality of resources. The individuals or farmers engaged in cocoa cultivation activities often belong to an aging demographic with limited educational attainment. Consequently, the inclination to revise practices for improved outcomes is lacking [21]. This can be attributed to the reluctance of the younger generation to pursue agricultural endeavors. The presence of underqualified human resources can result in the squandering of inherent potential, characterized by weight loss, compromised quality, cocoa bean contamination, tree susceptibility to diseases, and even difficulties in the adoption of emerging technologies.

3.2.3 Opportunities

Enhancements can be made to the strengths of the cocoa supply chain while simultaneously mitigating its weaknesses through the recognition and effective utilization of existing opportunities. The potential for supply chain advancement encompasses both the upstream and downstream segments[22]. In the upstream, prospects lie in leveraging superior cocoa varieties to amplify productivity, along with the implementation of Good Agricultural Practices (GAP) and certifications throughout the supply chain. Possessing certifications can augment consumer trust and uphold quality standards within the supply chain. Progressing to the downstream aspect of the supply chain, there is room for the development of cocoa by-products to heighten the value of the cocoa supply chain [23]. The transformation of cocoa by-products into biomass or other derivative goods presents a noteworthy avenue for development [24].

The establishment of comprehensive supply chain institutions can be initiated, particularly in light of the surge in governmental initiatives geared toward bolstering the sustainability of agricultural commodity supply chains. The integration of institutions, such as agricultural departments, plantations, educational entities, and research organizations, can be orchestrated to collaborate and attain enhancements within the supply chain, thereby generating mutual benefits across all parties involved.

3.2.4 Threats

Unaddressed shortcomings may lead to potential external hazards that could undermine the sustainability of the supply chain. The cocoa supply chain faces a threat from the external factor of severe climate change, which could lead to diminished productivity [25]. Inadequate management of the supply chain not only jeopardizes quality but also diminishes both the quantity and the quality of the surrounding environment.

3.3. Sustainable approach with risk identification

The weaknesses and threats identified through the SWOT analysis resulted in a reduction in the caliber and volume of cocoa goods. This decline in cocoa quality and quantity is attributed to inadequate adherence to cocoa standards in the supply chain processes. Consequently, in this phase, the potential hazards facing upstream supply chain participants—those farmers engaged in the primary production phase, responsible for generating items for distribution to subsequent supply chains—will be scrutinized. Several supply chain vulnerabilities pertain to these farmer participants. Table 3 shows the risk identification in Smallholder farmers to apply the sustainable supply chain in East Java.

Table 3. Risk identification in smallholder farmers in cocoa supply chain in East Java.

Dimension	Risk Potential
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Economic	Capital prediction error
	Disruption of farming financing
	Uncertainty of farmers' income
	High loan interest rates
	The selling price of farmers is not profitable
	Changes in the rupiah exchange rate
	Uncertainty of payment terms
	Production of dry cocoa beans does not meet demand
	Return of cocoa beans because they do not meet the quality
	Delivery of cocoa beans is not on time
Social	The cocoa cultivation changed to alternative crops is on the rise.
	Farmers with expertise in subpar cocoa farming techniques.
	Farmers with expertise in inadequate cocoa fruit handling and processing methods.
Environment	Accumulation of cocoa pod skin
	Accumulation of cocoa pod liquid waste
Technical	The clone type is not superior
	Fertilization is not according to the dosage
	Plants are attacked by pests and diseases
	Pesticide use close to harvest time
	Cocoa fruit yields are low
	Moldy seeds
	Seed quality is not uniform
	Unstandardized processing of wet cocoa beans
	Water content > 7.5%
	Physical contamination (soil or gravel) > 0.5%
	Damaged seeds
	Moldy seeds
	Limited curing box capacity
Institutional	Limited production facilities
	A demand for increased quality benchmarks has been put forth by the government.
	Furthermore, obligatory quality assurance certifications such as UTZ, fair trade, and organic have been introduced.
	Efficient communication and coordination among farmers within a single institution are yet to be fully optimized.

3.4. Supply chain mitigation strategy for sustainable implementation in cocoa supply chain

Drawing from the outcomes of the SWOT analysis and the identification of risks within the cocoa supply chain, the pivotal focus for fostering a sustainable cocoa supply chain in East Java centers around cocoa smallholder farmers. These farmers, who play an essential role as the initial guardians of cocoa quality in East Java, need to be harnessed as a pivotal element in advancing sustainability. A central point of concern lies within the production process, particularly the stages of fermentation and drying, which demand standardized processing to ensure adherence to quality standards. A range of strategies for risk mitigation can be applied across the cocoa supply chain:

- Economic Dimension: Enabling access to capital loans, offering subsidies, and extending assistance during operational processes [26].
- Social Aspect: Instilling motivation and providing support for implementing Good Agricultural Practices (GAP) and National Standards of Indonesia (SNI) for the product [27].
- Environmental Focus: Expanding the outreach and utilization of cocoa by-products [28]. Provision of post-harvest support facilities and infrastructure assistance.
- Technical Domain: Providing training, extending guidance, and overseeing cultivation

and post-harvest activities [29].

- Institutional Element: Bolstering governmental, educational, and research institutions through an integrated approach as part of a comprehensive program, ensuring harmonious and sustainable operations [30].

4 Conclusion

The pursuit of sustainability within the cocoa supply chain stands as a shared objective among all stakeholders involved. This drive stems from the realization that integrating sustainability into the supply chain not only ensures an uninterrupted flow of resources, information, and capital but also upholds other essential aspects, thereby aligning conditions for equitable profit within the supply chain. To effectuate supply chain sustainability, an in-depth exploration of potentials and vulnerabilities is imperative, laying the foundation for the subsequent phase of sustainability implementation in the supply chain. Drawing from the outcomes of a comprehensive analysis utilizing a five-dimensional framework for supply chain sustainability, it becomes evident that smallholder farmers, who constitute supply chain actors, are a pivotal juncture necessitating development and enhancement. This serves as the initial stepping stone for refining supply chain operations, especially in augmenting post-harvest quality and quantity. Proposals for further research encompass a meticulous SWOT analysis and exhaustive risk identification specific to each supply chain actor. Such an approach ensures a more precise mitigation strategy that can be devised.

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