



Green Supply Chain Management of Sustainable Rubber Industry

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Abstract

This study aims to analyze the supply chain of the natural rubber and rubberwood industry in Thailand across three levels: upstream, midstream, and downstream, and to propose guidelines for transitioning toward Green Supply Chain Management (GSCM).

The results indicate that the upstream stage generates greenhouse gas emissions of up to 6.4 tCO₂e from cultivation and approximately 35.90 kgCO₂e from chemical use. In the midstream stage, high energy consumption results in emissions of about 80.92 tCO₂e, with fuel and water usage averaging 0.033 and 0.028 gha/ton, respectively. In the downstream stage, emissions from electricity use and transportation are approximately 51.82 and 1.08 kgCO₂e, respectively. The GSCM approach can significantly reduce these impacts, for example, organic fertilizers can reduce emissions by 30–50%, biological inputs by 5–20%, and clean energy can reduce carbon emissions by approximately 0.9 kg CO₂/kWh.

Furthermore, integrating circular economy concepts, developing value-added products such as biofuels and recycled products, and promoting the role of consumers as “carbon stewards” contribute to the long-term sustainability of the rubber industry. The adoption of standards such as FSC and EUDR also enhances competitiveness in global markets, despite challenges related to costs and business adaptation.

Keywords : Rubber; Supply Chain; Green Supply Chain; Rubber Products; Green Products

Introduction

Natural rubber (*Hevea brasiliensis* Muell. Arg.) is an important economic crop for Thailand, particularly as the country is one of the world's leading producers and exporters of natural rubber. According to data from 2024, Thailand exported more than 2.4 million tons of natural rubber, generating over 500 billion baht in revenue, covering both raw rubber and rubber-based products [1]. China was the largest export destination, with a volume of 1,859,259 tons, valued at more than 22.7 billion baht [2]. However, the expansion of rubber plantation areas over the past two decades—especially into new regions such as northern Thailand—has had

environmental impacts, including land-use changes, deforestation, and a decline in biodiversity [3].

In the context of environmental change and global market pressures, Thailand has established development directions through its 20-Year National Strategy and the 13th National Economic and Social Development Plan. These emphasize environmentally friendly economic growth, the promotion of high-value agricultural industries, and efficient resource utilization. There have also been efforts to promote sustainable production and processing of natural rubber through the use of clean technologies, carbon emission reduction, and environmentally friendly products [4]. In this context, Green Supply Chain Management

(GSCM) plays a crucial role in reducing environmental impacts and enhancing the competitiveness of the natural rubber industry. This concept encompasses the entire supply chain—from raw material selection, production processes, and transportation to waste management—with the aim of integrating sustainability principles into every stage [5].

Most existing studies tend to focus on only certain segments of the supply chain, such as rubber plantations or processing factories, and lack a comprehensive system-level analysis that connects upstream, midstream, and downstream activities within a GSCM framework. Furthermore, there are limitations in studies of new rubber-growing areas such as northern Thailand, which have different ecological contexts, economic structures, and land-use patterns compared to traditional growing regions. In addition, there is a lack of analysis on structural supporting factors, such as environmental standards, green market mechanisms, and linkages to regional greenhouse gas reduction targets.

For northern Thailand, which is a newly established rubber-growing region and still in the early stages of supply chain development, studying green supply chain management models can help identify key potentials and supporting factors. This would lead to systematic approaches for developing rubber plantation management and rubber product industries in alignment with international

standards and current environmental change contexts.

Methodology

1. Data Collection on the rubber and rubberwood supply chains. Researchers gathered data on the rubber and rubberwood supply chains from related literature and previous research with a focus on analyzing existing supply chain diagrams to serve as a basis for further study including Kanthicha Khotsaenlee, Prayoon Tosanguan, Chutikarn Suklim and Asae-san Kasemarn. The analyzed supply chains were presented into various supply chain diagram formats, allowing systematic analysis and comparison with the green supply chain concepts.

2. Comparative Analysis of Conventional Supply Chain and Green Supply Chain. At this stage, the researcher conducts a comparative analysis between the conventional supply chain structure and the concept of the Green Supply Chain (Green Supply Chain Management: GSCM). The analysis considers various dimensions, such as efficient resource utilization, waste reduction, minimization of environmental impacts, and value addition in the production process. The results of this analysis will be used to propose guidelines for developing and improving the supply chain system of the natural rubber industry to be more sustainable and environmentally friendly.

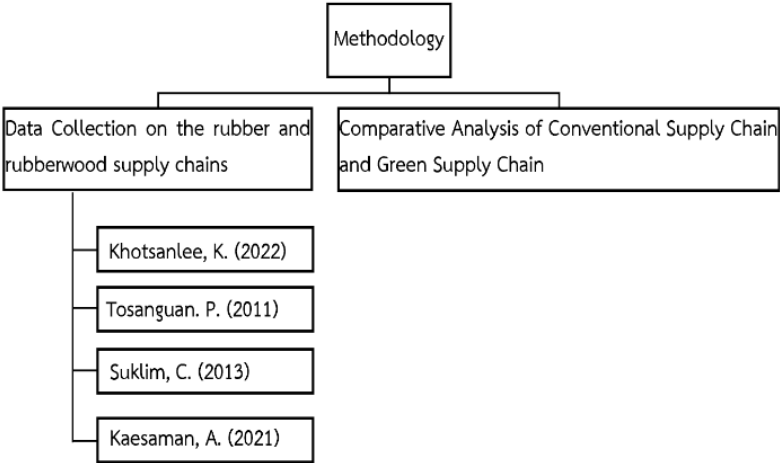


Figure 1 Methodology Map

The data collected will be analyzed to illustrate the supply chain structure of natural rubber and rubberwood production, which is divided into

- **Upstream** cultivation and maintenance, fertilizers, chemicals, and water use
- **Midstream** energy consumption, transportation, and water usage
- **Downstream** energy consumption and fuel usage

Results and Discussions

1. Rubber and Rubberwood Supply Chain

Based on the compilation of supply chain data for natural rubber and rubberwood products from various sources, along with comparative analysis (as illustrated in **Figure 1**), it was found that the supply chain of the natural rubber industry consists of three main groups: upstream, midstream, and downstream, as follows

1) Upstream Rubber farmers and primary buyers (e.g., raw latex, rubber lumps, logs, and twigs) were identified as the first stage. This sector was considered critical for ensuring quality control before products were transferred to the midstream stage. In Northern Thailand, farmers were observed to be in the early stages of industry development, although expansion was ongoing [6].

2) Midstream: Primary processing facilities (e.g., smokehouses, sawmills) and rubberwood product manufacturers were included in this stage. It was found to play a vital role in adding value to products from the upstream stage. For example, logs and twigs that were processed in FSC-COC (Forest Stewardship Council - Chain of Custody) certified sawmills into products are suitable for export [7].

3) Downstream: This stage comprised distributors and consumers at both national and international levels. Products certified by FSC were found to have increased value in international markets where sustainability is emphasized.

The comparative analysis between the conventional supply chain and the green supply chain found that the green supply chain approach played a role in reducing environmental impacts, such as the use of certified wood, waste management from production processes, and the promotion of alternative energy use. All these measures helped reduce greenhouse gas emissions and enhanced the product's image in the eyes of consumers.

In addition, environmentally friendly supply chain management aligned with the 20-Year National Strategy and the 13th National Economic and Social Development Plan, which emphasized sustainable production and consumption [8].

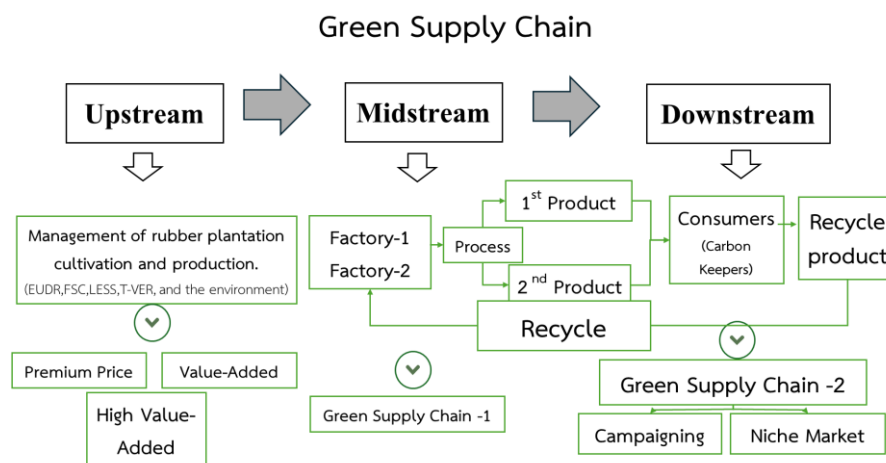


Figure 2 Rubber and Rubberwood Supply Chain

1.1 Upstream Information

Natural Rubber Cultivation

Successful rubber cultivation requires proper land preparation, planting materials, and appropriate planting methods. Determining the planting direction is important to reduce damage to rubber trees and to facilitate tapping and latex collection. Planting rows should be arranged perpendicular to the direction of water flow to minimize soil erosion and surface runoff. The rows should be at least 1.5 meters away from plantation boundaries, and each tree should have a planting area of no less than 20 square meters to prevent nutrient competition and promote proper growth. Common planting spacing in traditional rubber-growing areas includes 2.5×8 meters or 3×7 meters, while in new planting areas spacing such as 2.5×7 meters, 3×6 meters, or 3×7 meters may be used depending on soil fertility and site conditions [9].

Rubber can be cultivated using several methods, including budded stumps, budding in the field, and planting of polybag seedlings. Each method has different advantages, with polybag seedlings generally offering the highest success rate due to uniform growth and earlier tapping readiness. After planting, proper maintenance is required, such as fertilization to replace nutrients lost during latex production. Both chemical and organic fertilizers should be applied to enhance growth efficiency. Weed control is also necessary to reduce competition for nutrients and prevent the accumulation of pests and diseases [9].

Tapping is a crucial step in harvesting latex. Rubber trees are ready for tapping at around 7 years of age or when the trunk circumference reaches at least 50 cm at a height of about 150 cm above ground, with at least 70% of trees meeting the criteria. Proper tapping techniques must consider the depth and angle of the cut, as well as tapping frequency, to maintain tree health and ensure sustainable yield. Typically, half-spiral tapping is performed every other day, and tapping should not exceed 160 days per year to avoid long-term impacts on tree growth [9].

1.2 Midstream Information

The primary rubber processing industry involves transforming fresh latex into raw materials for downstream rubber product

manufacturing. Primary rubber products can be classified into five main types: ribbed smoked sheets (RSS), block rubber, crepe rubber, air-dried sheets, and concentrated latex. These are used as raw materials for finished products such as automobile tires, motorcycle tires, bicycle tires, rubber gloves, condoms, elastic bands, and industrial rubber hoses. The tire industry, in particular, relies heavily on raw rubber sheets, smoked sheets, and block rubber [9].

Raw rubber sheets are a key primary product that can be further processed into air-dried sheets or ribbed smoked sheets. Their price depends on quality, which requires cleanliness of latex, uniform thickness during rolling, and appropriate proportions of water and formic acid. Smallholder farmers often produce raw sheets themselves, while larger plantations may sell latex to processing factories. The production process includes filtering latex to remove impurities, adding formic acid to coagulate the latex, kneading and rolling it into sheets of about 3–4 mm thickness, and washing with clean water to remove residual impurities and acid. The sheets are then air-dried in the shade or dried in a kiln to prevent mold and extend shelf life [9].

Raw sheets can be further processed into ribbed smoked sheets, a widely used product in the rubber industry. The process involves cleaning, drying, and smoking at temperatures of approximately 50–60°C for 4–12 days. Afterward, impurities are removed, and the sheets are compressed into bales for easier transport and sale. Ribbed smoked sheets are an important midstream product due to their versatility as a raw material [9].

Additionally, block rubber, or Standard Thai Rubber (STR), is a key product in Thailand's rubber industry, especially STR 20, which has the highest export volume. The production process begins with raw materials such as cup lumps, rubber scraps, and raw sheets. These are cleaned, sorted, and chopped into small pieces, then dried using hot air at temperatures of about 100–120°C. The dried material is compressed into standard-sized blocks using hydraulic presses, making it suitable for storage and transportation. The final products are packaged and labeled according to international quality standards before export or distribution to rubber product manufacturers [10].

1.3 Downstream Information

Rubber Processing and Latex Industry

The downstream rubber processing industry transforms primary rubber products into finished goods for various markets. Primary rubber products—ribbed smoked sheets, block rubber, crepe rubber, air-dried sheets, and concentrated latex—serve as raw materials for manufacturing products such as automobile tires, motorcycle tires, bicycle tires, rubber gloves, condoms, elastic bands, and industrial rubber hoses. The tire industry is particularly dependent on raw sheets, smoked sheets, and block rubber [9].

Rubber products can be made from natural rubber, synthetic rubber, or blends of both. Natural rubber is used in both dry forms (e.g., sheets and blocks) and concentrated latex. Synthetic rubber is produced through polymerization of chemical precursors and is commonly used in industrialized countries due to its customizable properties, such as oil resistance, high-temperature resistance, and air retention [11].

Rubberwood Industry

The rubberwood industry is another important sector that utilizes rubber trees after they reach the end of their latex-producing life. It covers plantation management, logging of old trees, and processing into various products with economic, social, and environmental benefits. Rubberwood is widely used to produce furniture, toys, picture frames, particle board, medium-density fiberboard (MDF), and parquet flooring due to its favorable properties and low production cost [10].

Generally, rubberwood with a diameter greater than 6 inches is suitable for furniture and high-quality wood products, while smaller wood is used for MDF or particle board production. Currently, about 60% of Thailand's furniture industry relies on rubberwood as a raw material, with major export markets including Japan, the United States, and the United Kingdom [9].

Logistics System and Rubber Supply Chain

The logistics system for rubber in northern and northeastern Thailand is similar, as both are new rubber-growing regions. Farmers' products—such as raw sheets, cup

lumps, and rubber scraps—are typically sold through small local traders who collect products and pass them on to larger traders. These larger traders aggregate significant volumes and sell them to central rubber markets, particularly in Rayong Province. Prices received by farmers are usually 1–2 baht per kilogram lower than those at central markets [9].

Transportation of rubber products from northern Thailand to central markets or processing factories in the eastern region is primarily conducted by truck, passing through key provinces such as Chiang Rai, Phayao, Lampang, and Tak before reaching Rayong. Additionally, rubber is exported to China via border trade checkpoints. This logistics system plays a vital role in linking farmers' production with industrial sectors and international markets [11].

2. Comparative Analysis of Conventional Supply Chain and Green Supply Chain

From the comparative analysis between the conventional supply chain and the green supply chain, it was found that the green supply chain for rubber and rubberwood is distinguished from the conventional model by the integration of environmental standards such as FSC, T-VER, and CFP at all stages of production. This integration reduced environmental impacts and increased long-term sustainability, whereas the conventional supply chain focused on production volume and efficiency while often neglecting environmental considerations. The green supply chain also promoted local economies through the utilization of local resources and job creation, and it encouraged responsible consumption by consumers, particularly in their role as carbon keepers. Despite the constraints of higher costs and greater system complexity, the green supply chain enhanced competitiveness in the global market and served as a key mechanism for advancing Thailand's rubber industry toward sustainability in line with Net Zero targets. The details are as follows

2.1 Rubber and Rubberwood Conventional Supply Chain

Based on the supply chain structure of the FSC™ (Forest Stewardship Council) (as shown in **Figure 3**), it was found that the entire chain from upstream to downstream added both economic and environmental value, as follows:

1) Upstream: FSC-FM/COC-certified (Forest Management/Chain of Custody) farmers harvested rubber trees when latex production ceases (typically at 25–30 years of age) and separate them into logs and twigs for sale to FSC-COC-certified sawmills [12].

2) Midstream: FSC-COC-certified sawmills process logs and twigs into sawn timber and other value-added products, including sawn wood (for furniture and construction materials), rubberwood furniture (for export), wooden pallets, wood pellets for biomass energy, and woodchips and sawdust that can be further processed or used for renewable energy production.

3) Downstream: These rubberwood products are exported to international markets, particularly to countries that prioritize environmental standards, such as the European Union, Japan, and South Korea, which place high value on FSC-COC-certified products.

The application of FSC™ standards at every stage of the supply chain not only ensures transparency in sourcing from sustainable origins but also strengthens the international image of Thai products and increases access to premium markets. These findings are consistent with the “Green Supply Chain Management” concept, which emphasized environmental integration throughout the production and distribution processes. This approach reduced the environmental impacts of wood waste by reusing woodchips and sawdust for biomass energy and decreased the need for harvesting from natural forests, thereby benefiting overall the ecosystems [13].

2.2 Rubber and Rubberwood Green Supply Chain

The study of the rubber and rubberwood supply chain incorporating the green supply chain concept (as shown in **Figure 4**) revealed that environmental standards such as FSC, EUDR, and T-VER were integrated into all stages. The upstream stage was managed under FSC-FM/COC standards for sustainable rubber plantation operations, enabling the transfer of raw materials to FSC-COC-certified sawmills for processing into furniture or rubberwood products intended for export [14–15]. In the midstream stage, the circular economy concept was applied, whereby production waste was utilized as raw material for other processes, such as the production of wood pellets, in order to reduce waste and increase resource efficiency. In the downstream stage, consumer participation in post-consumer product management was promoted through activities such as recycling and product return programs, along with the provision of carbon footprint information to raise awareness of their role as a “carbon sequester.” This approach aligns with the concept of ‘Green Marketing with Engagement’ and contributes to progress toward the Net-Zero Emission goal [16]. Furthermore, the implementation of the green supply chain was found to create added value through premium pricing, brand image, and sustainable production efficiency, serving as a key strategy for enhancing the competitiveness of Thailand’s rubber industry in environmentally conscious global markets.

Sustainable Value Supply Chain of Rubber wood according to FSCTM Standard

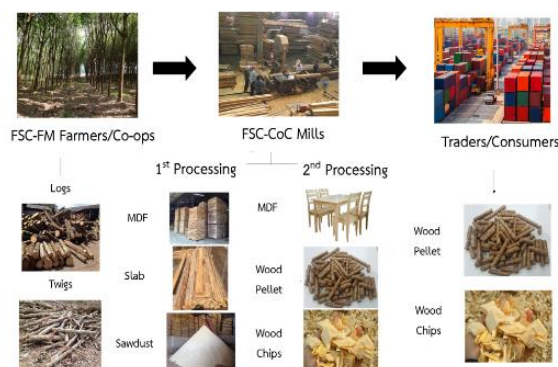


Figure 3 FSC certified Rubber and Rubberwood Supply Chain

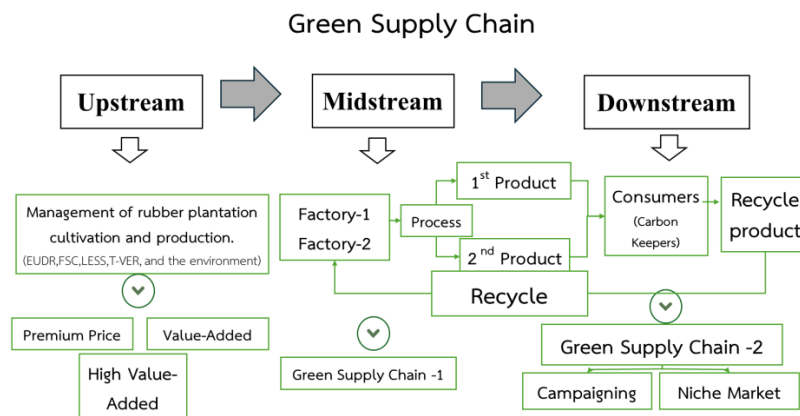


Figure 4 Rubber and Rubberwood Green Supply Chain

2.2.1 Classification of Green Supply Chain Mechanisms and Land Use in Different Rubber Plantation Models

The analysis (as shown in **Figure 5**) indicated that different types of rubber plantations are managed in ways that have varying effects on the green supply chain and land use, as follows

Conventional Rubber Plantations:

These are generally focused on yield quantity, with potential limitations in environmental management. Land use may not adequately consider biodiversity and community forests, and the potential for implementing LESS and T-VER mechanisms is often limited.

FSC-Certified Rubber Plantations:

Certification under FSC standards indicated that plantation management is conducted with environmental and social responsibility. Greater emphasis is placed on the conservation of community forests and biodiversity.

2.2.2 Linkages to Land Use, Community Forests, Biodiversity, and the Circular Local Economy

The management of rubber plantations certified under FSC and T-VER standards promotes sustainable land use, conservation of community forests, and the preservation of biodiversity, alongside the development of a circular community economy. Certified rubber plantation management is positively associated with efficient resource utilization,

local employment generation, and increased community economic value, compared to conventional rubber plantations, which may face limitations in these aspects.

Furthermore, the concept of the circular economy enables more efficient use of resources, waste reduction, and the development of value-added products. At the same time, rubber production systems also function as carbon sinks, creating opportunities for both farmers and consumers to participate as carbon stewards through mechanisms such as carbon credits.

Therefore, integrating these concepts and standards represents an important approach to enhancing the natural rubber industry in alignment with sustainable development and future greenhouse gas emission reduction goals.

2.2.3 Value Creation in Primary Processing and Environmental Impact Assessment

The analysis of the production process from natural rubber latex to primary products (latex and block rubber) indicates that the adoption of environmentally friendly technologies and production processes can significantly reduce environmental impacts. These practices also enable products to be evaluated and certified under schemes such as CFP (Carbon Footprint of Product), Eco Label, and LESS (Low Emission Support Scheme). Such certifications contribute to value creation by enhancing product sustainability and increasing market credibility.

Table 1 Comparison between the conventional supply chain and the green supply chain

	Supply Chain	Green Supply Chain
Upstream	<i>Hevea brasiliensis</i> cultivation Is reported to generate greenhouse gas emissions of up to 6.4 tCO ₂ e	The “Kaset Sanjorn” platform suggests that replacing chemical fertilizers with organic or bio-compost fertilizers can reduce nitrous oxide (N ₂ O) emissions by 30–50%.
	Use of chemicals (e.g., ammonium) results in emissions of approximately 35.90 kgCO ₂ e.	The United Nations Environment Program states that using biological alternatives (e.g., microbial pest control) can reduce greenhouse gas emissions by 5–20%, or about 0.1–0.5 tCO ₂ e per rai per year.
Midstream	Energy consumption results in emissions of 80.92 tCO ₂ e.	The Thailand Environment Institute notes that coal-based electricity emits approximately 0.9 kg CO ₂ per kWh, suggesting that reducing coal-based energy use can significantly lower emissions.
	Fuel consumption is about 0.033 gha per ton.	According to Bangkok Bank (2024), switching to electric vehicles for transportation can reduce energy and maintenance costs by 69.87%.
	Water usage is about 0.028 gha per ton.	The United Nations Environment Program indicates that using sensors and irrigation planning can reduce water usage by 20–40% and decrease greenhouse gas emissions by 0.2–0.7 tCO ₂ e per rai per year.
Downstream	Electricity consumption results in emissions of 51.82 kgCO ₂ e.	The Thailand Environment Institute reports that reducing coal-based electricity use can lower emissions by approximately 0.9 kg CO ₂ per kWh.
	Transportation fuel use generates about 1.08 kgCO ₂ e.	According to Bangkok Bank (2024), adopting electric vehicles can reduce energy and maintenance costs by 69.87%

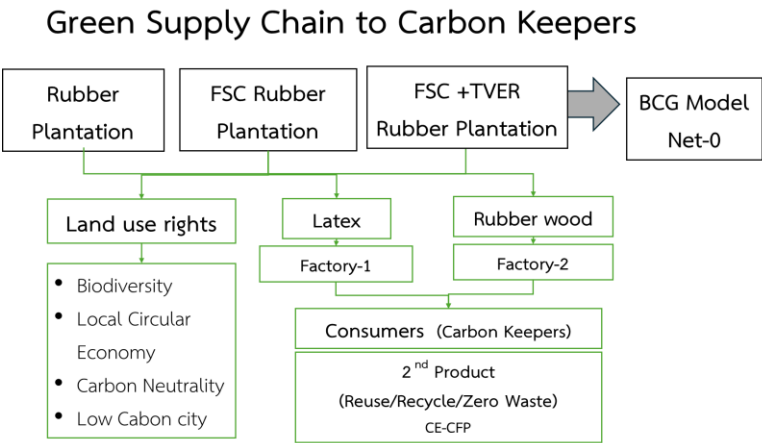


Figure 5 Land Use in Rubber and Rubberwood Green Supply chain

2.2.4 Advancement to Secondary Products and the Role of Consumers as Carbon Stewards

The development of primary products into secondary products, such as biofuels and recycled products (CE-CFP: Circular Economy–Carbon Footprint of Product), promotes circular economy principles and

reduces waste generation. Utilizing production residues or by-products for biofuel production or recycling represents an important approach to improving resource efficiency, minimizing industrial waste, and adding value to leftover materials within the rubber industry system.

At the same time, communicating and raising consumer awareness about the role of

rubber products in carbon sequestration, along with promoting environmentally friendly consumption, can enhance consumer participation in the green supply chain. Consumers can thus play a role as “carbon stewards” by supporting sustainable products and contributing to a more environmentally responsible supply chain.

2.2.5 Barriers and Practical Challenges

The implementation of EUDR and FSC measures in supply chain management requires significant business adaptation, while also creating new opportunities for organizations. On the opportunity side, these measures enhance product credibility, particularly in European markets where environmental concerns are taken seriously. Products that can demonstrate they are not associated with deforestation [17] or that have verifiable and compliant sourcing are more likely to gain market access. They can also command higher value, as many consumers are willing to pay a premium for environmentally friendly products. In addition, compliance with these standards improves traceability systems, enabling organizations to clearly identify the origin of raw materials. This reduces legal risks and increases transparency in management, while also strengthening the organization’s image as a responsible and forward-looking business aligned with global trends.

However, several challenges arise in implementing these measures. One of the main issues is increased costs, including FSC certification fees, investments in traceability systems, and adjustments to production processes to comply with EUDR requirements. These costs can be particularly burdensome for small and medium-sized enterprises. Furthermore, EUDR imposes strict requirements, such as detailed identification of raw material sources, including geographic coordinates, making data collection and verification more complex. Supplier-related issues also present significant challenges [18], as organizations may need to change suppliers or invest in supplier development if partners are unable to meet the required standards. This process requires additional time and resources. Moreover, the level of understanding among

organizational personnel is critical; insufficient knowledge of these measures may lead to inefficiencies and difficulties in implementation.

Conclusions

The analysis of the supply chain for natural rubber and rubberwood products shows that it can be classified into three main stages: upstream, midstream, and downstream. Each stage involves different activities related to resource use and greenhouse gas emissions.

At the upstream level, rubber cultivation and plantation maintenance—through the use of chemical fertilizers, water, and agrochemicals—contribute significantly to greenhouse gas emissions. For example, emissions from the cultivation of *Hevea brasiliensis* can reach up to 6.4 tCO₂e, while the use of ammonium-based chemicals can generate approximately 35.90 kgCO₂e. However, the Green Supply Chain approach can mitigate these impacts by promoting the use of organic or bio-compost fertilizers, which can reduce nitrous oxide emissions by 30–50%. In addition, the use of biological products, such as microbial pest control agents, can reduce greenhouse gas emissions by 5–20%, or approximately 0.1–0.5 tCO₂e per rai per year.

At the midstream level, processing activities such as drying and thermal energy use are highly energy-intensive, generating emissions of approximately 80.92 tCO₂e. Fuel consumption in transportation and production processes averages about 0.033 gha per ton, while water usage is around 0.028 gha per ton. The Green Supply Chain approach emphasizes the adoption of clean and renewable energy sources, such as reducing reliance on coal-based electricity, which emits approximately 0.9 kgCO₂e per kWh. It also promotes the transition to electric vehicles for transportation, which can reduce energy and maintenance costs by up to 69.87%, as well as the use of sensor technologies and efficient water management planning, which can reduce water consumption by 20–40% and lower greenhouse gas emissions by approximately 0.2–0.7 tCO₂e per rai per year.

At the downstream level, electricity and fuel consumption in transportation and

distribution remain key sources of greenhouse gas emissions, with emissions from electricity use at approximately 51.82 kgCO₂e and from transportation at around 1.08 kgCO₂e. Nevertheless, the Green Supply Chain approach can reduce these impacts through the use of clean energy, improved logistics efficiency, and the promotion of electric vehicles.

Furthermore, the integration of circular economy concepts, including the development of primary products into secondary products such as biofuels and recycled materials, as well as the involvement of consumers as “carbon stewards” through the selection of environmentally friendly products, represents an important mechanism for reducing greenhouse gas emissions and promoting the long-term sustainability of the natural rubber supply chain.

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References

- [1] Office of Agricultural Economics. 2024. Natural Rubber Situation Report 2024. Ministry of Agriculture and Cooperatives.
- [2] Customs Department. 2024. Thailand Natural Rubber Export Situation in 2024. Retrieved from https://www.customs.go.th/data_files/1464e9704d42e956952d42e6255202fc.pdf
- [3] Ziegler, A. D., Fox, J. M. and Xu, J. 2009. The rubber juggernaut. *Science*, 324(5930): 1024-1025. <https://doi.org/10.1126/science.1173833>
- [4] Office of the National Economic and Social Development Council. 2023. The 13th National Economic and Social Development Plan (2023–2027). <http://www.nesdc.go.th>
- [5] Sarkis, D.R. 2012. A boundaries and flows perspective of green supply chain management. *Supply Chain Management: (Massachusetts)*17(2): 202-216.
- [6] Kotrsaenlee, M.T. 2022. Supply Chain Development of the Natural Rubber Industry in Northern Thailand.
- [7] Kaesaman, D.R. 2021. Promotion of FSC-COC Standards in the Rubberwood Industry. *Journal of Rubber Industry*, 13(2): 25-33.
- [8] Office of the National Economic and Social Development Council. 2022. The 13th National Economic and Social Development Plan (2023–2027).
- [9] Tosanguan, D.R.2013.Supply Chain of the Rubber and Rubber Products Industry in Northern Thailand. 3(1): 1-25.
- [10] European Forest Institute. 2024. Thailand's Natural Rubber Producers Are Preparing for New Market Requirements. European Forest Institute.
- [11] Office of Industrial Economics. 2024. Report on the Industrial Economics Status. Bangkok: Office of Industrial Economics.
- [12] Suklim, M.T. 2013. Potential of Rubberwood Utilization in Southern Thailand.
- [13] FSC Thailand. 2023. Overview of FSC Certified Rubberwood Supply Chain in Thailand. Retrieved from <https://th.fsc.org/>
- [14] Forest Stewardship Council. 2021. Benefits of FSC Certification for Forest Value Chains. FSC International.
- [15] BCG Economy Institute. 2022. Thailand BCG Model for Sustainable Development.
- [16] Thai Carbon Balance. 2023. Guidelines for Reducing Carbon Footprint in Rubberwood Products. Thailand Greenhouse Gas Management Organization (TGO).
- [17] Forest Stewardship Council. 2022. FSC Principles and Criteria for Forest Stewardship.
- [18] European Commission. 2023. EU Deforestation Regulation (EUDR).