Quality Improvement and Green Logistics Potential Assessment of the lump rubber in the Kut Chap District of Udonthani Province

[1]Tivarat Sriratee, [1]Rachaneekorn Dansirichaisawat, [1]Ariyapong Phuapant, [1]Mongkol Kittiyankajon & [1]*Narathip Pawaree

[1]Department of Industrial Management, Faculty of Technology, Udonthani Rajabhat University

*Corresponding Author: narathip.pawaree@gmail.com

Received	Reviewed	Revised	Accepted
09/04/2024	23/07/2024	26/07/2024	27/07/2024

Abstract

This research delves into the critical aspects of quality improvement and logistics system in the lump rubber industry, focusing on the Kut Chap District of Udonthani Province. The rubber sector plays a pivotal role in various automotive, construction, and manufacturing industries, underscoring the significance of efficient logistics and quality assurance practices. This study emphasizes the SWOT and SCOR model for continuous improvement in quality development and logistics to drive operational efficiency and competitiveness in the rubber sector. The implementation of ECRS principles led to enhanced efficiency and reduced waste in the manufacturing of lump rubber. This was achieved by streamlining work processes, resulting in a 33% reduction in the number of stages and increased overall quality. The truck, which has a diesel tank capacity of 10.5 liters, releases 27.05 $kgCO_2e$ of greenhouse gases per vehicle. This emission is measured to evaluate the capability and readiness of rubber plantations. Green logistics analysis shows potential for efficient logistics and supply chain management, requiring strategic measures like government initiatives and improved production technologies.

Keywords: Quality improvement; Green logistics; Lump rubber; Supply chain; SCOR model

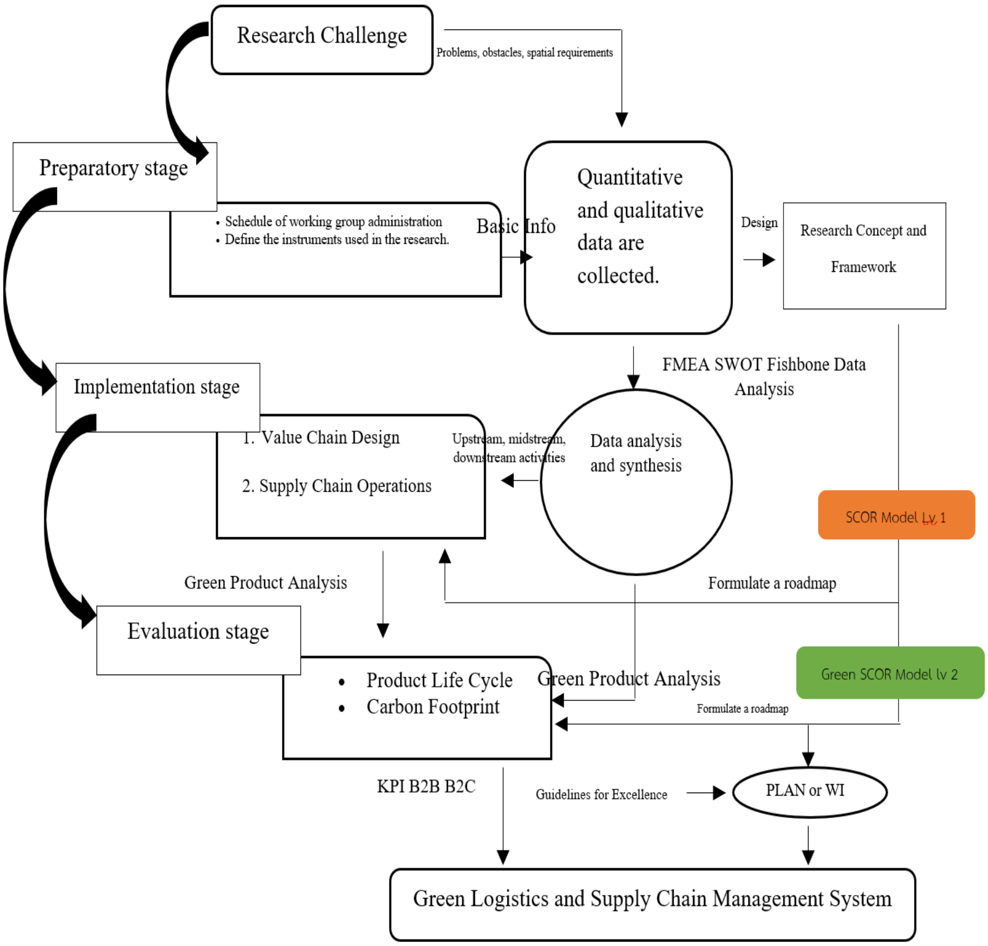
Introduction

The rubber sector, which is vital to the automotive, building, and manufacturing industries, depends on efficient logistics and quality assurance (Agarwal, S. et al, 2023). This entails efficient raw material transportation, prompt delivery, and cost containment. To satisfy the specific needs of end users, quality control procedures such as locating premium raw materials, streamlining the manufacturing process, and carrying out quality checks are crucial. Enhancing quality development and logistics can save expenses, increase productivity, and preserve customer satisfaction.

Thailand engages in rubber production. The quantity is 3.16 million metric tons. It was sent out of the country for sale or use in another country. For domestic use, a significant amount of 2.73 million metric tons (86% of the entire output) is produced. The production of 399,415 tons, accounting for 12% of the overall output, has the potential to generate over 400,000 million baht annually. Nevertheless, most rubber exports consist of primary processed raw materials that have minimal additional worth, such as smoked rubber sheets. The application of lump rubber and latex has a direct impact on the country's economic generation.

Enhancing the efficiency of this development will yield substantial benefits for both the nation and rubber cultivators. Hence, rubber is a crucial cash crop that plays a vital role in generating employment and fostering prospects for enhanced growth. Businesses need to concentrate on developing high-quality lump rubber (Puttipipatkajorn, A. & Puttipipatkajorn, A., 2021) locating premium raw materials, streamlining manufacturing procedures, and putting strict quality control systems in place to satisfy the varied needs of end customers. Encouraging innovation and implementing sustainable practices can enhance brand perception and correspond with consumer preferences (Jansson, J., 2011) that are environmentally concerned. This all-encompassing strategy may result in steady expansion, higher earnings, and a competitive advantage in the world rubber industry.

This research was carried out to develop green logistics and supply chain management in rubber production (Hu, H. et al, 2021), meanwhile and improve the quality of lump rubber. The potential assessment of supply chain in Kut chap district, Udonthani Province: Identifying Challenges and Barriers in Logistics These are recognizing and exploring strategies for enhancing supply chain management and logistics. The structure of this article consists of 1) Introduction 2) Literature review 3) Research methodology, 4) Results and Discussion 5) Conclusions and suggestions. The schematic of framework is shown in Figure 1.



2. Literature review

Logistics management is crucial for organizations to gain a competitive advantage by focusing on operating costs and lowering them to increase market competitiveness (Herden, T., 2020). Key activities supporting logistics processes, such as customer service and transportation, are the root cause of these costs. Total cost reduction is a critical issue for efficient logistics process management. According to an analysis of the existing research literature. Logistics and supply chain analysis of the rubber industry include In Thailand, Wasusri, T. & Chaichomphoo, A. (2008) the study due to ineffective regulations governing mass transportation, Thailand, a major exporter of natural rubber to China, must improve its logistics infrastructure or risk losing its competitive edge in the low-priced agricultural products sector. Kritchanchai, D. & Chanpuypetch, W. (2009) the Thailand National Strategic Plan aims to improve business logistics, develop trade channels, improve inter-trade logistics services, and build capacity, but policy execution is yet to occur. Meanwhile, Panoram, P. (2022) the study explores the challenges and expenses in the rubber logistics system used by ASEAN rubber producers in Buriram, recommending that entrepreneurs expand their workforce and seek government support. Chanchaichujit, J. et al. (2017) the study investigates the effects of restructuring transportation and distribution on Thailand's rubber industry supply chain, concluding that this approach is more efficient in mitigating greenhouse gas emissions. Pongsayaporn, P. (2020) Thailand is investigating a multimodal transportation system to decrease logistics expenses and enhance commerce. This investigation is mainly centered around variables such as container yard capacity, accessibility, documentation, adequacy of service providers, and truck operating hours. On abroad, Rukmayadi, D. (2016) The study devised an environmentally conscious logistical framework for rubber agro-industrial activities. This framework employed ISM, Green VSM, and Fuzzy Green QFD methods to minimize the environmental effects, enhance the quality of packaging, and improve institutional performance. Iqbal, S. et al. (2006) the study identifies logistic analysis income level, revenue source, and land availability as crucial determinants affecting Sri Lankan smallholder farmers engaged in rubber-tea intercropping. The most probable aspects contributing to significant monthly earnings and agricultural activities are highlighted. de Souza, C. D. R. & Márcio de Almeida, D. A. (2013) the research assesses the long-term sustainability of collecting and repurposing used tires by introducing an analytical model that examines cost recovery, commercial profitability, and decreased user expenses. Chaising, S. & Haasis, H. D. (2021) the research indicates that cloud computing can optimize business operations by enhancing logistics and procurement services, specifically focusing on the shoe and rubber sectors.

3. Research methodology

3.1 The study will focus on the methodology related to rubber farming management and logistics in Kut chap District, Province of Udonthani, to determine the conditions for the research. It will employ inquiry and interview techniques to gather information from industry stakeholders about rubber production, including the cultivator's role in the process.

Kut Chap district spans a total area of 785 square kilometers, which is equivalent to 490,625 rai. The study group conducted a survey of the Khon Yung Subdistrict in the Kut Chap District of Udon Thani Province. The survey covered a total area of 78,702 rai, as indicated in Table 1.

Table 1. The varieties of areas.

Plantation	Area (rai)
1. Village	1,861
2. Public	987
3. Farmland	55,256
4. Fruit	428
5. Rubber	6,978
6. Fishing	78
7. Forest	12,489
8. Other	21,165

The rubber varieties selected for cultivation include RRIT 251, which was selected from rubber seedlings grown on private plots in Songkhla province. These types exhibit medium growth, are highly branching and bushy, and have huge, spherical, gradually deciduous leaves. The stem size exhibits a consistent and homogeneous distribution across the entire plot. The initial bark and the regenerated bark exhibit a moderate thickness and moderate wind resistance. Powdery mildew, convex leaf spot, and moderate pink mold.

3.2 The systematically display relation diagram and value stream mapping as shown in Figure 2 and 3, that contribute value to the lump rubber production company, the data were utilized to establish a logistics and rubber supply chain, examine important operations, and support supporting activities in case studies.

Logistics and supply chain activities

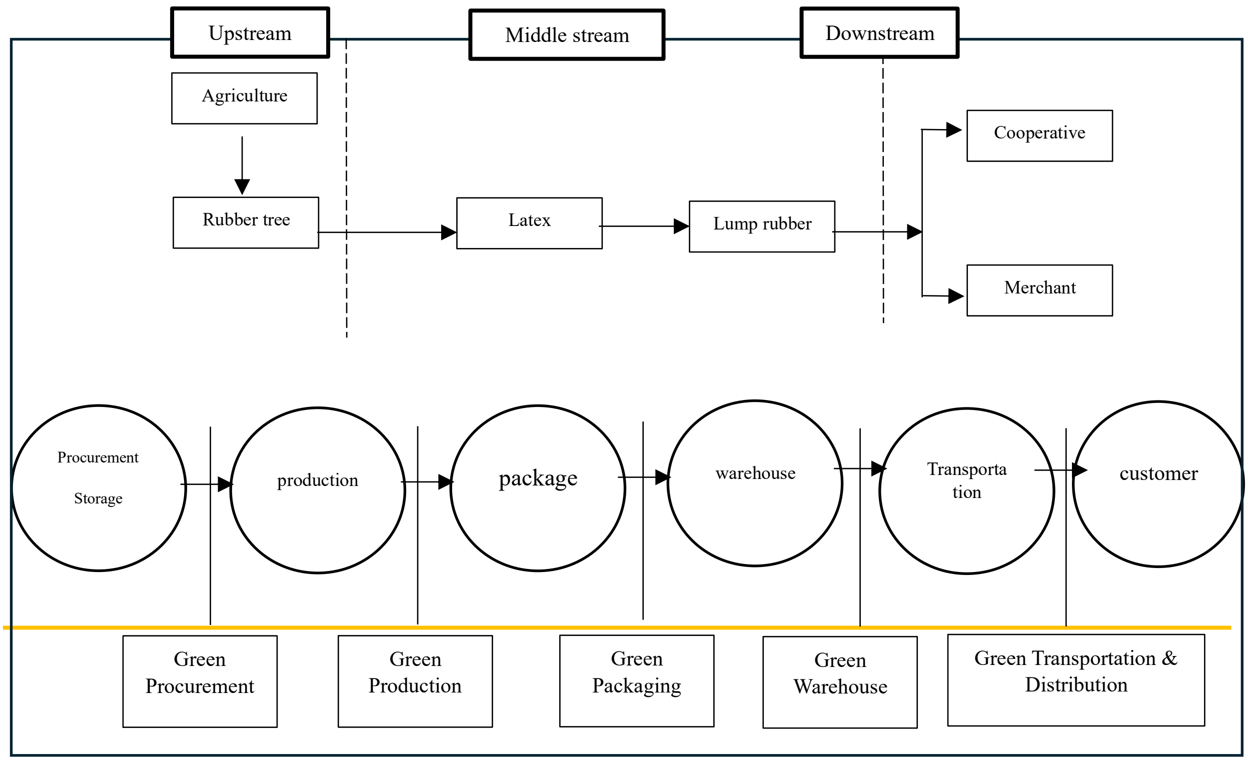


Figure 2. The green logistics and supply chain management relationship.

Supporting Activities	Company Infrastructure				
	Human Resources Management				
	Technology development				
	provision				
Main Activities	Inbound logistics	Implementation	Outbound logistics	Contributing factors	profit
	-quality control -communication with rubber auctioneers - Add channels for electronic auctions	- There are established quality inspection standards. - Increase methods of communication - The establishment of a collective agricultural community aims to enhance competitiveness.	- Utilize vehicles that are appropriate for the quantity of rubber - Logistics for cargo transportation is organized in advance. -Reduced fuel costs - Implement a very effective transportation management system.	- There exists a support organization.	

Figure 3. Logistics and Value Chain represents the main and supporting activities in the supply chain.

3.3 The analysis of the SWOT (Benzaghta, M. A et al., 2021) and SCOR model (Chehbi-Gamoura, S. et al. 2020 & Chopra, A. et al. 2022 & Ricardianto, P. et al. 2022) in this research illustrates the approach. These explain the operations and management of the supply chain, as follows:

1) SCOR employs the five processes of plan, procure, manufacture, deliver, and return to manage rubber at the Level 1 level. This examines the present state of business competition. Defining performance metrics is required. The rubber processing industry is external to the client company. Targets for operations consist of the proportion of shipments that satisfy client specifications and a proportional quantity. The order was duly and completely delivered. From receipt to delivery, processing a consumer order requires time.

2) The rubber cooperative group has transformed SCOR Level 2 into a suitable procedure. It provides a comprehensive overview of the operational procedure in the planning portion—acquisition of primary resources, production, and distribution—encompassing intra-organizational and inter-organizational operations. Display the SCOR model at Level 1 and Level 2. The rubber production process originates with rubber growers. The resulting output yields high-quality raw rubber. Agriculture will transport the rubber to the cooperative and, after that, to the factory, following a descending order of quality from level 1 to level 4.

3.4 A research summary is a report that presents data gathered via surveys and data collecting. It involves using tools to fulfill research goals and assess performance based on indicators and activities in the production process.

4. Results and discussion

4.1 SWOT and SCOR model

A diagram illustrating the supply chain for rubber bales in the Kut Chap district was created after examining the diagrams. As demonstrated in Table 2, it will enable the development of environmental and potential analyses to evaluate the rubber plantations' strengths, weakness, opportunities, and threat.

Table 2. Analysis of SWOT and potential.

Internal factors / External factors	Strengths (S) S1 100% market support. S2 harvests all year round. S3 rubber quality	Softening Point(W) W1 The cost of production is high. W2 Latex content W3 weather
Opportunities (O) O1 The market is very demanding. O2 Mixed cropping O3 processes many products.	S1+O1 economy crops S2+O2 earnings increase S3+O3 Demand Increases	W2+O2 Competitors W3+O2 is infected with diseases from different plants. W2+O3 shortage of raw materials
Threat (T) T1 cost price increase T2 tire prices are volatile. T3 Floods or other natural disasters	S2+T1 cost increase S1+T2 Volatile Economy S3+T3 does not yield	W1+T1 cost increase W2+T2 sells at a low price. W3+T3 is not productive

Regarding measurement, the researcher established the supply chain, as depicted in Figure 1. The researcher analyzed the rubber cube production process using the SCOR model theory. This analysis aimed to measure the work process of the lump rubber production process and demonstrate the possibility of measuring and enhancing the operation. The findings of this analysis are presented in Figure 4.

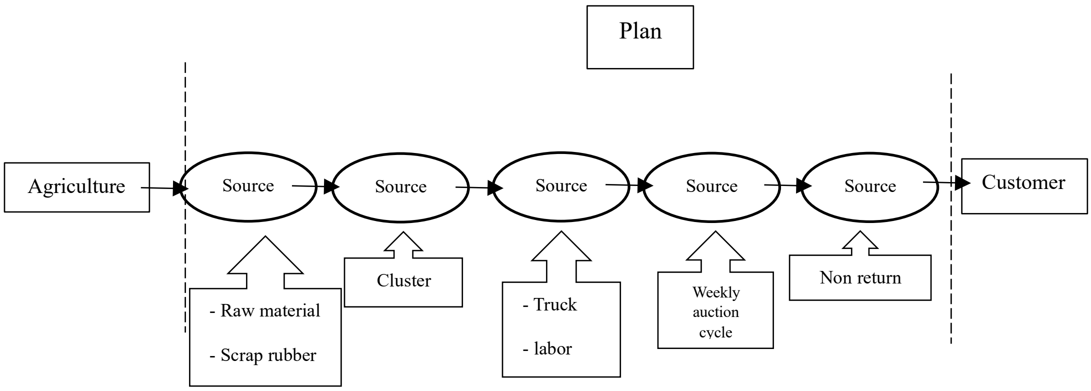


Figure 4. Analysis of capability within the production of lump rubber (Scor model 1).

Once the suitable work process and relevant factors have been identified, they will be converted into an appropriate working process, as shown in Figure 2. The researcher has designed a process separation to allow for the application of measurement factors, which will enhance the efficiency of lump rubber production, as shown in Table 3.

Table 3. Analysis of the separation of lump rubber production (Scor model 2)

Criterion	Quality Level 1	2nd level quality	3rd level quality	4th level quality
1. cleanliness	Coagulates into a container-like clump. No bark. leaf	Coagulates into a container-like clump. No bark. leaf	It clumps together like a vessel with bark. slight foliage	It clumps together like a vessel with bark. leaf Not too much.
2. Humidity	Not more than 30 %	Not more than 35%	Not more than 40 %	Not more than 45 %
3. Rubber texture and color	White to burnt brown	White to burnt brown	White to burnt brown	White to burnt brown
4. Average weight per cube	80 – 800 (g)	Not more than 1500 (g)	Not more than 1500 (g)	Not more than 1500 (g)
5. Size	semicircle Mouth width 6.8 inches Height 5 inches	semicircle Mouth width 6.8 inches Height 5 inches	semicircle Mouth width 6.8 inches Height 5 inches	semicircle Mouth width 6.8 inches Height 5 inches

A cause and effect diagram, often known as a fishbone chart, illustrates the reasons behind a particular outcome (Vaziri, H., 2023). Potential issues were identified through team brainstorming to explore their root causes. Figure 5. demonstrates the significance of excessive quantity of latex problems in producing lump rubber.

4.2 Implementation

Examining the work process data for rubber lump production revealed the need for improvement to enhance efficiency (Pawaree, N. et al. 2022). Establishing criteria for enhancing processes Lump rubber producers have systematically implemented ECRS concepts to minimize losses and fulfill the most suitable criteria (Kelendar, H. & Mohammed, M. A. (2020) & Pertiwi, A. F. O. & Astuti, R. D. (2020), as shown in Table 4.

Table 4. Rubber tapping process.

No.	Procedure	Methods	ECRS Description	After Improvement
1	Sharpen a rubber tapping knife.	-	-	-
2	Measure the height of the rubber tree from the ground 150 cm.	-	-	-
3	Use cardboard at a 60-degree angle. Use a nail to scratch it.	C and R	Combine steps 3 and 5 and rearrange them.	Hammer (tongue) latex vice
4	Make slits in front of the tire along the markings that have been determined.	E and C	Eliminate this step combined with step 7.	Cut the rubber according to the position made.
5	Take the cup wire and tie it to the rubber tree.	E, C, and R	Eliminate this step, combine it with step 3, and rearrange the procedure.	Wait for the latex to stop flowing.
6	Hammer the trough (tongue) latex backing.	E and R	Eliminate this step and rearrange it.	Acid added
7	Rubber tapping	C and R	Combine steps 4 and 7 and rearrange them.	Repeat steps 4,5 and 6.
8	Acid drops	-	-	Repeat steps 4,5 and 6.
9	Use a bent iron to hook the rubber out of the cup and set it aside outside.	-	-	Keep the tires in the sack full.
10	Keep the tires in the tank full.	-	-	-
11	Pour rubber out of the pile aggregation tank.	E and C	Eliminate this step combined with step 12.	-

12	Keep the sack full.	C and R	Combine step 11 and rearrange the steps.	-

By enhancing the rubber tapping process through the application of waste reduction measures. ECRS determined that the decrease in process waste from 12 steps to 8 steps. Relocation and Patience The most minimal step occurs during the transition phase. Consequently, the operational procedure has been streamlined to minimize loss time, allowing the agricultural sector sufficient downtime for tire tapping in the subsequent cycle.

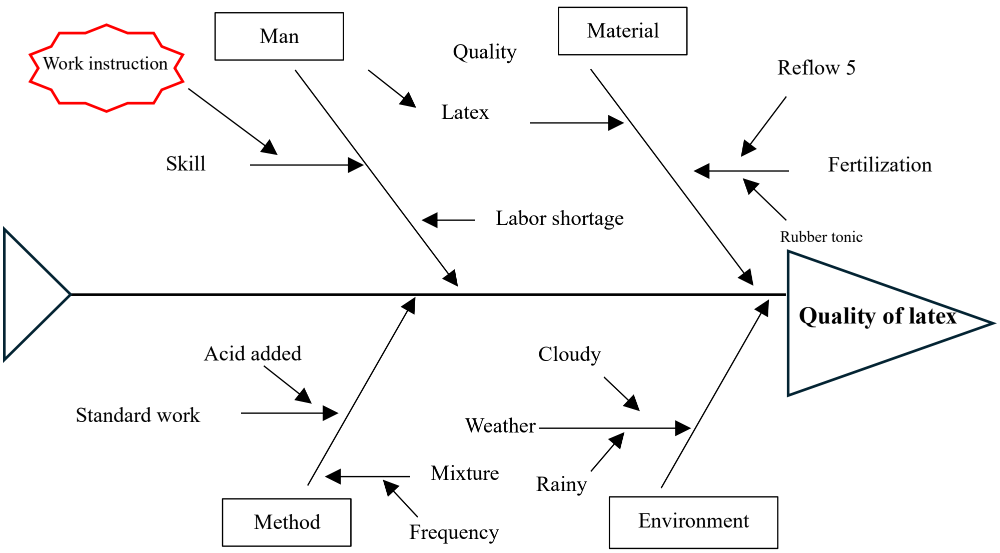


Figure 5. A cause and effect diagram of lump rubber.

4.3 Evaluation of sustainable procedures in green logistics and supply chain management

The examination focuses on the principles of logistics management across the supply chain and product life cycle evaluation through an assessment of sustainable logistics and supply chain management practices (Dzwigol, H. et al. 2021). The threshold is provided in increasing order, from 1 to 5.

1. Competency: Consider the level of competence and readiness of enterprises to manage logistics activities to reduce environmental impact.

2. Importance: Consider the severity of the environmental impact of the logistics activity.

The evaluation of the ecological logistics and supply chain management is depicted in Table 5.

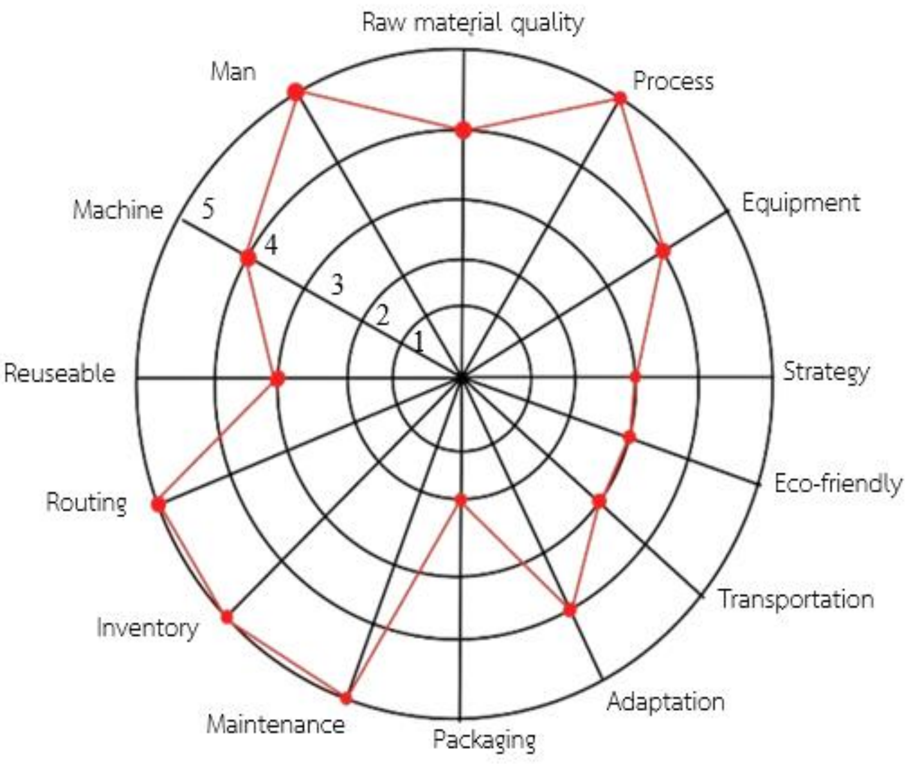


Figure 6. Radar chart showing the status of the case study.

Table 5 Green Logistics Management assessment.

Order	Activities / Actions	Competency	Importance
1.	Environmentally friendly procurement		
	1.1 Raw material quality	4	5
	1.2 Farmer-friendly production process	5	5
	1.3 Natural equipment materials (whetstone)	4	5
2.	Environmentally friendly production		
	2.1 Cost reduction	3	5
	2.2 Use of environmentally friendly chemicals	3	5
	2.3 Handling efficiency during the production process	3	4
3.	Environmentally friendly packaging		
	3.1 Reduce the number of packages.	4	4
	3.2 Replacing compostable packaging	2	5
4.	Environmentally friendly transportation and distribution		
	4.1 Vehicle Maintenance	5	5
	4.2 Sorting goods for convenience and speed of transportation	5	5
	4.3 Shipping Route Management	5	5
5.	Reverse Material and Cargo Handling Process		
	5.1 Packaging Reuse	3	3
	5.2 Use of scrap materials as fuel	4	5
	5.3 Choose equipment suitable for the age of the rubber tree.	5	4

After gathering data to evaluate logistics and supply chain management, we use the performance evaluation results to create radar charts. This can demonstrate an organization's potential and readiness to improve its operations, as shown in Figure 6. It is implementing sustainable logistics practices to minimize the environmental footprint. This enables the establishment to evaluate its preparedness for addressing and enhancing the issues that arise from each activity.

Furthermore, the data acquired from the evaluation is utilized, alongside radar charts, to display the capabilities and preparedness of organizations in addressing difficulties. Let us generate a matrix chart that combines the importance and competency evaluation findings on a single display (Figure 7). The metrics chart displays the relationship and spread of different logistics operations with the significance or degree of environmental impact caused by logistical activities, as well as their preparedness and capability to tackle challenges that have already diminished their environmental impact. Hence, it addresses the matter of pressing environmental consequences that require immediate implementation.

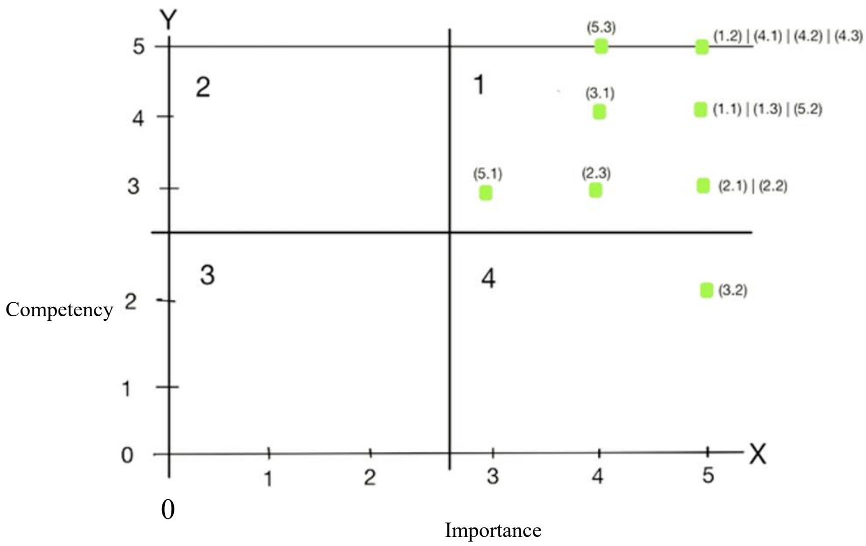


Figure 7. Data matrix of Competency and Importance.

The analysis of the radar chart suggests that businesses replace their use of degradable packaging. The organization currently needs to improve its ability and preparedness to perform enhancements. Thus, it refers to a collection of tasks that must be undertaken with preparedness and competence to implement immediate enhancements since they can impact both the environment and the workplace significantly.

4.4 Guidelines for Logistics and Supply Chain Management

Lump rubber is manufactured through the chemical treatment of latex with formic acid to create a binding agent. Tobacco is processed into thin sheets, started, and then wrapped before being distributed. Tobacco is used as a component by rubber fumigation makers. Production planning encompasses the strategic arrangement and scheduling of activities, whereas warehouse management ensures the effective processing and storage of commodities.

A component of the B2B assessment is the evaluation of carbon emissions related to the transportation of lump rubber. This is because numerous companies utilize smoked rubber as a basic material, which consists of the following:

1) Determination of greenhouse gas emissions from rubber transportation

Weight of oil = fuel consumption x specific gravity

= 10.5 liters x 0.8504 kg/liters

= 8.93 kg

2) Greenhouse gas emissions from diesel production:

= Diesel fuel weight x Coefficient of greenhouse gas emissions

= 8.93 kg x 0.3215 kgCO_2e/kg

= 2.87 kg CO_2e

3) The amount of greenhouse gas emissions from the combustion of diesel fuel:

= Diesel quantity x combustion coefficient from diesel fuel

= 10.5 liters x 2.7080 kg CO_2e/liter

= 24.18 kg CO_2e

therefore, the quantity of greenhouse gas emissions caused by transportation:

= 2.87 kg CO_2e + 24.18 kg CO_2e

= 27.05 kg CO_2e

The carbon footprint calculation revealed that rubber trucks with a diesel reload capacity of 10.5 liters and a single shipment emission of 27.05 kg CO_2e constitute Scope 1 Direct Emissions (DEs). Rubber trees can sequester a minimum of 1.72 metric tons of carbon dioxide per rai (or more to compensate for each round of transportation).

Based on an analysis of supply chain management and logistics in the fumigation lump rubber industry. Operators must adhere to the prescribed protocols regarding the evaluation outcomes of environmentally sustainable supply chain management and logistics. As indicated in Table 6.

Table 6. The guidelines for Rubber manufacturing.

Topic	Guidelines
1. Aspects of raw material acquisition	• Determine the quality of latex purchased to control the quality of the resulting product. • Encourage the involvement of environmentally conscious fresh rubber suppliers to support environmentally sustainable procurement practices.
2. Manufacturing and packaging	The development of a wastewater treatment system aims to reduce water consumption in the production process and circulate waste back for use in subsequent stages.
3. Transportation and Distribution	Arrange transportation vehicles and transportation routes appropriately. By delivering customers on the same route at the same time to save energy and reduce the amount of transportation.
4. Reverse Material and Product Management	Reuse leftover materials or process them in other process.

5. Conclusions and suggestions.

Enhancing the quality of lump rubber by implementing process improvement and establishing work instructions. Through the analysis and identification of solutions for the production process of lump rubber, the main reason for the quality problems in lump rubber production has been identified as inappropriate working procedures. Using ECRS principles, work processes are optimized, reducing time, increasing production efficiency, and decreasing process waste. The number of stages has been reduced from 12 to 8, resulting in a decrease of 33%.

Furthermore, green logistics analysis is employed to assess the capacity and efficiency of lump rubber production for its application on the radar chart. Matrix data theory the evaluation of the logistics system in Kut Chap District, Udonthani Province, was discovered. This entity's logistics and supply chain management potential ranges from moderate to very good, as indicated by its average score. The study revealed that the establishment had replaced its degradable packaging—inadequate capability and preparedness to carry out a task. Hence, to enhance entrepreneurial prospects, it is imperative to undertake strategic initiatives, such as fostering government-led development, implementing supply chain-focused entrepreneurial development strategies, adopting competitive development strategies, and advancing production technology.

A carbon footprint estimate is used to evaluate the capacity and preparedness of rubber plantations to minimize their environmental impact. The investigation revealed that the truck was carrying lump rubber. The diesel tank has a capacity of 10.5 liters. The emissions of greenhouse gases per vehicle amounted to 27.05 $kgCO_2e$.

Based on the findings of the paper. there is suggestion of future work: The rubber industry should explore the integration of advanced technologies like machine learning and big data analytics in quality control processes, implement circular economy practices for sustainable operations, enhance supply chain management, evaluate eco-innovation adoption, and explore cloud computing solutions for logistics and procurement services. These strategies can lead to increased sustainability, efficiency, and competitiveness in the global market. By focusing on these areas, the rubber industry can achieve greater sustainability, efficiency, and competitiveness.

6. Acknowledgments

The author of this paper is grateful to Udonthani Rajabhat University for support the research.

References

Agarwal, S., Tyagi, M., & Garg, R. K. (2023). Conception of circular economy obstacles in context of supply chain: a case of rubber industry. *International Journal of Productivity and Performance Management*, *72*(4), 1111-1153. https://doi.org/10.1108/IJPPM-12-2020-0686.

Benzaghta, M. A., Elwalda, A., Mousa, M. M., Erkan, I., & Rahman, M. (2021). SWOT analysis applications: An integrative literature review. *Journal of Global Business Insights*, *6*(1), 54-72.

Chaising, S., & Haasis, H. D. (2021). Cloud computing for logistics and procurement services for SMEs and raw material suppliers. *International Journal of Logistics Systems and Management*, *38*(4), 459-474. https://doi.org/10.1504/IJLSM.2021.114767.

Chanchaichujit, J., Saavedra-Rosas, J., & Kaur, A. (2017). Analysing the impact of restructuring transportation, production and distribution on costs and environment–a case from the Thai Rubber industry. *International Journal of Logistics Research and Applications*, 20(3), 237-253.

Chehbi-Gamoura, S., Derrouiche, R., Damand, D., & Barth, M. (2020). Insights from big Data Analytics in supply chain management: an all-inclusive literature review using the SCOR model. *Production Planning & Control*, 31(5), 355-382. https://doi.org/10.1080/09537287.2019.1639839.

Chopra, A., Golwala, D., & Chopra, A. R. (2022). SCOR (Supply Chain Operations Reference) model in textile industry. *Journal of Southwest Jiaotong University*, *57*(1). https://doi.org/10.35741/issn.0258-2724.57.1.33.

De Souza, C. D. R., & Márcio de Almeida, D. A. (2013). Value chain analysis applied to the scrap tire reverse logistics chain: an applied study of co-processing in the cement industry. *Resources, Conservation and Recycling*, 78, 15-25. https://doi.org/10.1016/j.resconrec.2013.06.007.

Dzwigol, H., Trushkina, N., & Kwilinski, A. (2021). The organizational and economic mechanism of implementing the concept of green logistics. *Virtual Economics*, 4(2), 41-75.

Herden, T. T. (2020). Explaining the competitive advantage generated from Analytics with the knowledge-based view: the example of Logistics and Supply Chain Management. *Business Research*, 13(1), 163-214.

Hu, H., Liu, J., Zhu, Q., & Chen, Q. (2021). An integrated supply chain management system for end-of-life tires in China and its promotion barriers: a stakeholder perspective. *Resources, conservation and recycling*, 164, 105214.

Iqbal, S. M. M., Ireland, C. R., & Rodrigo, V. H. L. (2006). A logistic analysis of the factors determining the decision of smallholder farmers to intercrop: a case study involving rubber–tea intercropping in Sri Lanka. *Agricultural Systems*, 87(3), 296-312. https://doi.org/10.1016/j.agsy.2005.02.002.

Jansson, J. (2011). Consumer eco-innovation adoption: assessing attitudinal factors and perceived product characteristics. *Business Strategy and the environment*, 20(3), 192-210.

Kelendar, H., & Mohammed, M. A. (2020). Lean and the ECRS principle: developing a framework to minimise waste in healthcare sectors. *International Journal of Public Health and Clinical Sciences*, 7(3), 98-110.

Kritchanchai, D., & Chanpuypetch, W. (2009). A framework for decision support systems in logistics: A case study for Thailand rubber exports. *International Journal of Logistics and SCM systems*, 3(1), 24-31.

Panoram, P. (2022). THE OPTIMIZATION OF LOGISTICS MANAGEMENT OF THE RUBBER WITHIN BURIRAM OF THAILAND FOR ASEAN. *International Journal of Economics and Finance Studies*, 14(03), 280-292.

Pawaree, N., Phukapak, S., Puapant, A. & Phukapak, C. (2023). The Spray Dryer Optimization Factor for Yanang Process in small enterprises. *Journal of Science and Technology, Rajabhat Maha Sarakham University,* 6(1), 88-103.

Pertiwi, A. F. O., & Astuti, R. D. (2020). Increased line efficiency by improved work methods with the ECRS concept in a washing machine production: a case study. *Jurnal Sistem dan Manajemen Industri*, 4(1), 13-29. https://doi.org/10.30656/jsmi.v4i1.2184.

Pongsayaporn, P., Chinda, T., & Ammarapala, V. (2020). Key factors influencing multimodal transportation of natural block rubber in Thailand. In *MATEC Web of Conference,* 312, 02008. EDP Sciences. https://doi.org/10.1051/matecconf/202031202008.

Puttipipatkajorn, A., & Puttipipatkajorn, A. (2021). Spectroscopic measurement approaches in evaluation of dry rubber content of cup lump rubber using machine learning techniques. *International Journal of Agricultural and Biological Engineering*, 14(3), 207-213.

Ricardianto, P., Barata, F., Mardiyani, S., Setiawan, E., Subagyo, H., Saribanon, E., & Endri, E. (2022). Supply chain management evaluation in the oil and industry natural gas using SCOR model. *Uncertain Supply Chain Management*, 10(3), 797-806. http://dx.doi.org/10.5267/j.uscm.2022.4.001.

Rukmayadi, D., Marimin, M., Haris, U., & Yani, M. (2016). Rubber agro-industry green logistic conceptual model. *International Journal of Supply Chain Management*, 5(3), 192-204.

Vaziri, H. (2023). Investigating the causes of student failure in the 10th physics lesson and the cause and effect diagram of the laboratory with the SWOT matrix.

Wasusri, T., & Chaichomphoo, A. (2008). A study of logistics system for exporting natural rubber from Thailand to China. In *13th International Symposium on Logistics (ISL 2008) Integrating the Global Supply Chain*, 6, 277.