9-2022

Research on a suitable upstream traceability model for the natural rubber supply chain in Thailand, specifically for Rib-Smoke-Sheet (RSS)

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RESEARCH ON A SUITABLE UPSTREAM TRACEABILITY MODEL FOR THE NATURAL RUBBER SUPPLY CHAIN IN THAILAND, SPECIFICALLY FOR RIB-SMOKE-SHEET (RSS)

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2022

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Submitted to Lee Kong Chian School of Business in partial fulfilment of the requirements for the Degree of Doctor of Innovation

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I hereby declare that this Doctor of Innovation dissertation is my original work and it has been written by me in its entirety, I have duly acknowledged all the sources of information, which have been used in this dissertation. This dissertation has also not been submitted for any degree in any university previously.

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26th September 2022

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ABSTRACT

Traceability is the first step to gain visibility in the supply chain and can be used to meet different purposes. Similar to other agriculture crops, the natural rubber industry faces reputational damage due to deforestation, land grab, loss of biodiversity and non-compliance with environmental standards occurring in the upstream. The introduction of new social and environmental regulations accelerates the need for traceability. Reflecting on the importance of environmental and social considerations, this industry is looking at traceability to identify the historical trends leading to the present sustainability state and any ongoing sustainability risks in the upstream to enable downstream users to formulate responses and actions to mitigate these risks. However, traceability for natural rubber industry is still new and limited research had been conducted in this area. This research focuses on Thailand, world's largest natural rubber producing country, and their premium product, Rib-Smoke-Sheet (RSS), which is central to tire and car manufacturers. This study identifies the possible depth of traceability up to the closest point of origin in the complex upstream of Thailand Rib-Smoke-Sheet (RSS) and proposes two traceability models that can meet downstream users' requirements. This research also discusses how downstream users can implement these critical traceability initiatives successfully with supply chain actors; use traceability to formulate responses to sustainability risks; and finally, includes recommendations for future research directions.

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Acknowledgements

I would like to express my deepest thanks and heartfelt gratitude to my respected supervisor and Chair, Professor Pascale Crama, for mentoring me patiently and providing me with comprehensive guidance to fulfil each critical milestone leading to the completion of this thesis. She has been my main pillar of support, source of confidence and my guiding light when I needed it most. Thank you for never stopping to believe in me; I will always be indebted to you.

To my committee members, Associate Professor Helen Zhou Yang Fang and Associate Professor Jacob Ricks, thank you for assistance, guidance and helpful recommendations at each stage of this project.

To all my interviewees, who are owners and senior executives in their respective organizations, I would like to acknowledge my gratitude and appreciation for their precious time to share and to impart valuable industry insight for this research.

Lastly, I would also like to place on record, my sincere thanks and appreciations to all individuals, directly and indirectly who have willingly supported and unconditionally helped me and made it possible for me to accomplish my research towards the Degree in Doctor of Innovation.

Dedication

This research is dedicated to my parents “papa & mama” in heaven, who always believed that education broadens our horizons and will be a game changer for a person’s life, regardless of our background.

I wish you were still here.

1.0 INTRODUCTION

1.1 Sustainability

The concept of sustainability emerged as central in the Brundtland Report in 1987 (Brundtland, 1987). The report defined it as, “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs”. This concept is a building block for the United Nations’ 17 Sustainable Development Goals (SDGs) in 2015, acting as guiding principles for a transformative journey towards 2030. The goals include three main pillars: society, environment and economy. The United Nations calls on world citizens to come together, take actions to end poverty, protect the planet and achieve peace and prosperity for the human race. Consequently, countries and major economies have stepped up efforts and committed to new policies geared towards sustainability compliance. NGOs work to raise awareness of the SDG and exert pressure on large companies to adopt corporate policies that will meet the SDG global standards, and even exceed the regulatory compliance needed to adhere with local standards. Even without external pressures, sustainability can motivate businesses to promote the creation of shared value with all stakeholders, to keep alignment with best business practices, and to ensure all actors in the supply chain are moving ahead together. It is a form of investment for all companies to secure a better economic performance now and in the future.

Good corporate citizenship and sustainable practices not only impact future profitability, but also immediate performance. As civil society increasingly cares about sustainability, NGOs and activists attempt to uncover and highlight any unsustainable practices in large companies or their upstream

supply chain. These are the important issues and growing concerns in the natural rubber industry as well. (Refer to Table 1 in appendix). The resulting poor publicity can cause sizable reputational and monetary losses. One such example was triggered by Rainforest Alliance Network's campaign against Wilmar and its supplier PT Teupin Lada in their piece headlined "Fresh Evidence: Major Global Brands Refuse to Stop Sourcing Fire-Fueled Conflict Palm Oil, Despite Promises" (Rainforest Alliance, 2020). PT Teupin Lada was buying non-compliant palm product from PT Indo Alam who was exposed for slashing and burning forests in the Leuser Ecosystem in Indonesia. Wilmar and PT Teupin Lada investigated the alleged misconduct and ceased sourcing from the non-compliant indirect supplier to minimise reputation loss (Wilmar, n.d.). Simultaneously, we can also observe some signs that the Thai government is starting to take sustainability seriously and working towards reforestation. Illegal deforestation by rubber plantations has been successfully fought in courts which have handed down rulings to cut down on encroaching rubber trees, as seen in recent news in Nakhon Si Thammarat (Krissana, 2018) and Kaew Mountain National Forest Reserve (HatyaiFocus, n.d.).

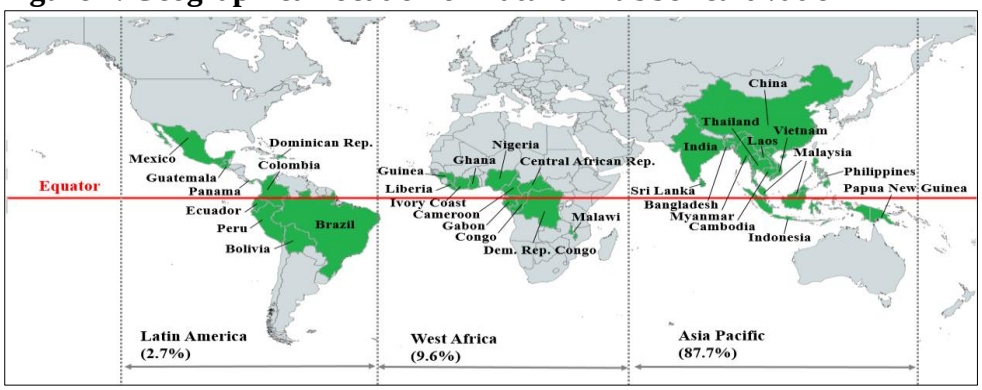
1.2 Natural Rubber

This work studies sustainability in the context of the natural rubber industry, the specificities of which are briefly introduced below. Natural rubber cultivation is concentrated within 10 degrees from the Equator, known for its tropical climate condition, and is thus often produced in less developed countries. Most natural rubber plantations are located in Asia Pacific (87.7%), followed by West Africa (9.6%) and Latin America (2.7%) **(see Figure 1).** In

2020, total world natural rubber production from these three main regions was 13.008 million tons. Based on International Rubber Study Group (IRSG) World Rubber Industry Outlook (WRIO) report released in July 2021, the three top producers of natural rubber were Thailand with a production of 4.506 million tons of natural rubber (34.6%), followed by Indonesia with 2.800 million tons (21.5%) and Vietnam with 1.248 million tons (9.6%) (IRSG WRIO, July 2021). In 2020, the world natural rubber consumption was 12.794 million tons in total. The consumption by regions were Asia Pacific (76.3%), EMEA (12.6%) and Americas (11.1%) (IRSG Rubber Statistical Bulletin, July-Sep 2021).

Natural rubber is a strategic raw material used in tires and many other products. The tire industry consumes approximately 70% of natural rubber produced, with Bridgestone, Michelin and Goodyear alone accounting for 25%. The remaining 30% goes into pharmaceutical goods and equipment, condoms, latex gloves (medical and non-medical), latex mattresses, pillows, sportswear, shoes, rubber hoses and belts, insulators, adhesives etc. Despite low prices during Covid19 in 2020, the total value of rubber produced was approximately US$18 billion, estimated using Singapore Commodity Exchange (SGX) average future prices.

Figure 1. Geographical location of Natural Rubber cultivation



Notes: Map is constructed using information from International Rubber Study Group (IRSG), Association of Natural Rubber Producing Countries (ANRPC) and desktop research.

Natural rubber is an agricultural product and therefore its upstream supply chain shares similar sustainability concerns to other agriculture crops. One recent publication concluded that seven agricultural commodities, including rubber, were accountable for 26% of global tree cover loss in between 2001 to 2015, with an estimated land size more than twice the size of Germany **(**Weisse & Goldman, 2021). The growing demand for natural rubber increases the need for more rubber cultivation land. Existing forested lands may be converted to plant rubber. In recent years, rubber planting has expanded from traditional to non-traditional areas. This raises questions around land ownership, land use change for rubber farming in the upstream, and environmental impact assessment, such as biodiversity loss, potential change in air and water quality as well as soil erosion.

Besides the environmental concerns listed above, the natural rubber industry also presents several societal issues. The volatility of commodity rubber prices impacts the income of smallholders and their ability to maintain their livelihood. During low rubber prices, income from rubber farming is insufficient for smallholders to sustain their daily life. This problem is compounded by the uneconomic size of farm owned by smallholders, lack of agroforestry skills, limited access to financial support and production technology, all of which prevent smallholders from improving their social situation. The increase in irregular and unpredictable weather patterns due to climate change further adds to their woes. Dry seasons may become longer and heavier rainfall in the monsoon season may lead to floods, bringing a temporary stop to rubber tapping. This reduces the smallholders' total income, making it difficult for them to keep up with sustainability best practices.

1.3 Research Questions

The purpose of this study is to identify a suitable upstream traceable model for Natural Rubber supply chain in Thailand, specifically for Rib-Smoke-Sheet (RSS). Tracing helps to identify the point of origin where raw materials come from. The study aims to answer the following questions:

i) Is traceability up to the closest point of origin possible in the complex upstream Thailand RSS?

ii) What are suitable traceability models for Thailand RSS supply chain?

iii) How can downstream firms use traceability to identify and reduce sustainability risk in the upstream Thailand RSS supply chain?

Natural rubber downstream users want traceable natural rubber to identify any sustainability risk in the upstream, partly due to push from NGOs, gradual introduction of new legislation and new import regulation into certain markets and countries. In the context of sustainable natural rubber, traceability encompasses Environment, Social and Governance (ESG). To ensure natural rubber sustainability, as first step, we need to know where the natural rubber comes from (where and who). To do that, we need to start tracing along the supply chain. As natural rubber is mainly a smallholders' crop, it is impossible to trace millions of smallholders' farms. This research tries to identify the current state of the industry and existing initiatives to support traceability up to the closest point of origin and their take up rates. We will research possible traceability models that are scalable with minimal hassle to supply chain actors while still being able to reduce the sustainability risk arising from the complex

upstream supply chain. We will also discuss how deep into the upstream each model can reach and what type of information can be gathered at each level.

Supply chain transparency provides granular information on daily activities that can help to identify areas for improvements. This activity can address potential upstream supply chain sustainability risks. Transparency also provides opportunities for supply chain actors to understand the availability and pricing of rubber sheet volume from each upstream supply point, especially during the high and low production seasons. This can help stakeholders to strategically plan their sourcing in advance to ensure stable supply by balancing supply from regions with different harvesting times. Firms can use this supply database and build up knowledge over time to plan their purchases, strengthen their own sourcing competitiveness, which supports better financial performance.

Finally, traceability can also lead to quality and process improvement for downstream users by knowing where the rubber sheets come from. It provides additional perspectives on the farming and rubber sheet production practices in different locations. Downstream actors can discover over time which areas produce higher quality rubber sheets with competitive prices. Typically, rubber sheets are hand-made and the production practices tend to differ from area to area. This will eventually lead to differences in the quality of the final product, the smoked rubber sheets. The upstream supply chain buyers can utilise this knowledge to plan their sourcing to achieve both quality excellence and process efficiency.

There are significant challenges ahead to answer these research questions. Statistically, 85% of world natural rubber production comes from

smallholder farmers. This translates into approximately 6 million farmers worldwide. These farms are located in remote areas and often without paved road access. Most of the time, small pick-up trucks and motorbikes are needed to access the farm. The large number of farms makes it very difficult to collect and monitor farm information and register it into a centralized system.

To further complicate matters, the supply chain in the natural rubber industry tends to be long and complicated. It varies greatly from one country to another. The very long rubber supply chain often starts with natural rubber smallholders tapping the trees, then passes through several layers of collectors and intermediaries before it reaches the processing factories. Long supply chains cause inefficiency, the brunt of which are borne by upstream farmers and smallholders. The many layers of collectors and intermediaries take their margins leaving only the balance to the upstream farmers.

This research to overcome above challenges, will limit the scope to the Thailand Rib-Smoke-Sheet (RSS) supply chain. Thailand is the world's largest natural rubber producer and world largest exporter of RSS. In 2020, Thailand produced 480.1 kilo tons of RSS (49.4%), followed by India 453.3 kilo tons (46.6%), and Sri Lanka with 38.7 kilo tons (4%) of global supply (IRSG Rubber Statistical Bulletin, July-Sep 2021). Thailand Rib-Smoke-Sheet (RSS), also known as rubber sheet in general, is a traditional and symbolic grade for the country, as it is the first rubber grade in the country and a source of the nation's pride. RSS is also a niche product with specific technical properties and unique quality. Driven by demand, rubber sheets continue to command a premium. With larger price premium commanded by rubber sheets, it is more economically viable to invest in traceability tools, technologies and

certifications. Today, sustainability comes with an implementation cost. Therefore, the higher value rubber sheet is a good choice of study to increase the motivation and level of buy-in from supply chain actors with a sustainability agenda. Given the current emphasis by downstream stakeholders on sustainability, even high quality RSS may lose its premium pricing if it is unable to demonstrate its environment sustainability impact. Besides, the existing infrastructure in Thailand is more developed than in other natural rubber producing countries, that helps to increase the success rate of information accessibility up to the closest point of origin. It is also better to focus on one specific supply chain, Rib-Smoke-Sheet (RSS), to have one clear standard reference (as opposed to many if all grades of rubber are considered) when conducting the interviews with actors along this supply chain.

2.0 LITERATURE REVIEW

2.1 Thailand Natural Rubber

Since 1961, the worldwide total planted acreage dedicated to rubber production has been increasing rapidly to meet the growing demand from downstream users. Thailand, the world's leading rubber producing country since 1995, has seen production increase year by year by 4% to 7% and accounts for more than one-third of global production (Somboonsuke, 2002; Viswanathan, 2008; Fox and Castella, 2013; Yamamoto, 2016; Ali et al., 2020). The commodity boom in the 2000s has further prompted a significant extension of all commodities crops, including rubber plantations, in Southeast Asian countries and adding of natural rubber cultivation areas into non-traditional producing areas.

In Thailand, rubber production was traditionally concentrated in the Southern region where currently 1,708,800 ha, or approximately 85% of the total area dedicated to rubber planting in Thailand is found (Krukanont & Prasertsan, 2004). Since 2002, planting has expanded to non-traditional areas in the North and Northeast region (Yamamoto, 2016). Over time, Northeast Thailand has become the second largest rubber production area in the country, with 348,000 ha of rubber plantations, followed by North Thailand with about 64,000 ha (Fox and Castella, 2013; Chambon et al, 2016).

By 2018, the land area for rubber cultivation expanded to 22,626,277 Rai (3.6 million Ha) and this translated to 15% of the agriculture land used for rubber cultivation (Thailand Office of Agricultural Economics, n.d.). In 2021, Thailand registered GDP of US$513 Billion, of which US$38 Billion (or 7.4%) came from agriculture, forestry and fishing sector (Statista, n.d.; The World Bank, n.d.). Natural rubber contributes to approximately 2% of Thailand GDP.

Given that 85% to 90% of the rubber plantations in the country are owned and run by smallholders with a plantation size of less than 8 ha (Chantuma et al, 2011; Yamamoto, 2016), the Thailand Ministry of Agriculture and Cooperatives estimates that there are approximately 1.5 million rubber smallholders in the upstream. When the actors in the downstream supply chain – intermediaries and processors – are included, Kongmanee et al (2020) find that approximately 10% of the Thai population is involved in the rubber industry.

Thailand is not the only natural rubber producing country in Asia and we will briefly contrast Thailand with its neighbour Malaysia. Both are natural rubber producing countries. Summary results made below, **Table 1**. Since

Thailand has very strong upstream raw rubber exports and downstream tires exports, this supports our focus on the Thai RSS supply chain.

Table 1: Thailand vs. Malaysia Natural Rubber Industry

Items	Thailand Natural Rubber Industry	Malaysia Natural Rubber Industry
Rubber Raw Material	Major natural rubber exporter	Major natural rubber importer
	Abundance of raw materials in the country	Reliance on import of raw materials
Rubber Speciality	Rib-Smoked-Sheet (RSS) •Sizable amount •Tire grade	Ekoprena, Pureprena •Small volumes •Non tire grade
Rubber products	Mainly Tires	Mainly latex goods
Rubber export earning	Upstream earning is higher than downstream	Downstream earning is higher than upstream
Downstream export	Tires exports constitutes two third of rubber product revenue	Tires constitutes small amount of rubber export
	Vehicle tires exports are dominated by large multinationals: Bridgestone, Michelin, Goodyear	Vehicle tires exports are not dominant
Government coordination	More coordination in upstream	Ongoing coordination in the upstream
	Weak linkage with downstream	More coordination in mid-downstream
Expansion of rubber cultivation	Expansion of rubber production to Northeast Thailand	No expansion of rubber cultivation in the country
Technology Innovation	Follower	Leader

Source: Doner & Abonyi, 2013; Doner, 2016; Ricks & Doner, 2021; Author's own research

2.2 Environmental Sustainability

This expansion of agricultural activity has resulted in land clearing, which affects global environment and threatens biodiversity loss (Dirzo et al, 2003). Indeed, the rapid development of rubber plantation areas in the past two decades has been found to alter the ecosystem, and replace secondary forest (Zhe Li & Jefferson, 2011). Studies made across Southeast Asia found most of the rubber plantation expansion were by smallholders, taking up 61% into protected areas and 70% in biodiversity areas (Ahrends et al, 2015). To combat these issues, sustainable agriculture attempts to increase the efficiency of yield production to reduce consumption of land, water and fertilizer to alleviate the environmental impact (Tilman et al, 2011).

There exist positive and negative environmental practices. Individual farmers pick whether to use positive or negative environmental practices. When farmers adopt good agriculture practices such as agroforestry and mixed crop practices, it has the potential to reduce negative environmental impacts (Frentrenie & Levang, 2009). When farmers use negative environment practices, it can lead to deforestation, chemical pollution, and climate change (Fox et al, 2014). To know whether natural rubber supply is contributing to sustainable practices, we need to know the point of origin or the supply traceability. Traceability used as a verification method to guarantee environmentally sustainable production practices at point of origin (Loveless et al, 2010; Myae and Goddard, 2012) and provide evidence to support sustainability claim of a product is in fact true (Lombe et al, 2015).

2.3 Traceability for Risk Mitigation

Traceability is not new and its benefits, challenges and implementation have been studied extensively in different industries. Traceability originated from the food and medical industries with significant emphasis on safety and quality standard to gain consumer confidence. The EU's General Food Law Regulation (2002) mentioned, "Article 18 of the regulation makes traceability compulsory for all food and feed businesses at all stages of production, processing and distribution. Traceability allows food business operators and authorities to withdraw or recall products – and trace the source – in cases of possible risk" (European Parliament, 2017).

Traceability has been gaining traction in non-food industry as well, such as in the timber, leather shoe and fashion industries with the aim of promoting sustainable sourcing and practices within the upstream supply chain that covers both ethical and environment aspects (Björk et al, 2011; Marconi et al, 2017; Mejías et al, 2019).

The motivation behind traceability trend is to mitigate reputational and commercial risks, in addition to meeting regulatory requirements and product differentiation (Henson & Reardon, 2005; Bailey et al, 2016). Traceability claims are also used as an agriculture marketing approach (Echols, 1998). Traceability provides protection against potential monetary loss resulting from false claims made on products and strengthens brand image (Wang et al, 2017). There is a growing perception among consumers to associate origin source of product with sustainability. Traceability gives consumers the necessary knowledge to make informed choices, by providing relevant information about the origin or source of product that meets with market consensus and industrial

interest in sustainably sourced products (Beekman, 2008; Epstein et al, 2008). Supply chain visibility increases responsiveness to fast changing business environments in both the upstream and downstream (William et al, 2013). Traceability provides visibility to buyers on the upstream situation and helps to identify sustainability risks through periodical monitoring, where responses can be formulated to mitigate identified risks (Hau and Sonali, 2017).

2.4 Traceability Models

The purpose of this section is to identify what are the traceability models found in the market. The type of industries using these models is analysed further, on what type of specific needs are met, and to identify the advantages and disadvantages of these models, and finally to identify which industry is not yet using these models.

The first model, Identity Preserved or Track-and-Trace was first developed to distinguish Genetic Modified and non-Genetic Modified products and was further expanded to trace sustainably produced products. This model allows end products to be traced back to the point of origin. The supply needs to come from one single, identifiable supply base and has to be fully segregated throughout the supply chain (Bullock & Desquilbet, 2002; Mol & Oosterveer, 2015; Rival et al, 2016; Cartier et al, 2018). Identity preserved model makes up the majority share of traceability models in the palm oil, fish, tea and meat supply chains (Mol & Oosterveer, 2015; Rival et al, 2016). Identity preserved helps to capture specific sensory (texture and flavour) profile in cocoa and chocolate industry, to harness specific nutritional values, specific traits of oil and protein profiles from the origin source of ingredients in food industry. This

allows structured and standardized production to achieve a consistent end product (Bennet, 2008; Perez et al, 2021), and can help to capture a premium consumer market willing to pay for the particular characteristics of the product (Lin, 2002; Smyth and Philips, 2002). Identity preserved product is very costly (Cartier et al, 2018), it requires precision and there is a quantity limitation from specific source (Goldsmith, 2004).

The second model, Bulk Commodity or Segregation requires strict separation of certified sustainable and non-certified sustainable products. This model guarantees physical products come from a certified-sustainable supply source (Mol & Oosterveer, 2015; Rival et al, 2016; Gassler & Spiller, 2018; Cartier et al, 2018). However, the products need not come from a single point of origin. The Segregation model is widely used in agricultural commodities supply chains such as palm oil, soy, sugar, cotton, tea, cocoa, and coffee; non-agricultural supply chains such as timber, biofuels, gems; as well as fish and meat supply chains (Mol & Oosterveer, 2015; Rival et al, 2016). Segregation is used to prevent comingling of products from different sources. Segregation increases the available quantities from sustainable product source categories. It can fetch higher prices when compared to comingled products. At the same time segregation can motivate consumers to choose more sustainable products (Smyth & Philips, 2002; Bertini et al, 2012; Gassler & Spiller, 2018). Specifically in the food industry, the segregation system is used to prevent potentially unsafe food from other similar production sources from entering the supply chain (Smyth & Philips, 2002). Monitoring system needs to be put in place for the entire supply chain and constant monitoring is necessary to make sure products are fully segregated. This increases the production complexity and

transaction cost. Segregation requires separate storage locations within the processing facilities. This can be a challenge for small size processing facilities (Isaac, 2005).

The third model, Mass Balance is used as a product differentiation strategy without the need to strictly separate storage or separate verification for certified sustainable and non-certified sustainable products in the production, with partial product claims. Mass balance allows blending of certified-sustainable and non-certified sustainable products at any stage in the supply chain. Hence, mass balance is more efficient, reduces the transaction cost, quickly increases the demand and supply of sustainable products, and accelerates the buy in from the mainstream market (Mol & Oosterveer, 2015; Rival et al, 2016; Gassler & Spiller, 2018; Cartier et al, 2018). Mass balance model can be found in the palm oil, soy, sugar, cotton, timber, biofuels, tea, cocoa, coffee and gems supply chains (Mol & Oosterveer, 2015; Rival et al, 2016; Cartier et al, 2018). It is necessary for the reconciliation between the quantities of certified materials bought and sold to be verified by a certification agency (Mol & Oosterveer, 2015).

The fourth model, Book and Claim introduces a certificate trading scheme without any physical intervention on the supply chain. The certificates do not claim products are made from sustainable raw materials, but these allow manufacturers to demonstrate their commitment to support sustainable materials. Manufacturers can purchase certificates and make a sustainability claim (Rival et al, 2016; Gassler & Spiller, 2018; Cartier et al, 2018). This model is found in the palm oil, soy, and sugar supply chains (Mol & Oosterveer, 2015; Rival et al, 2016). The main advantages of this model is that there is no

monitoring and no segregation in the supply chain, no separate storage space is needed and it is very simple. It is also independent from the geography where the actual products come from. The drawback of this model is that there must be a central registry of the certificates set up in advance before trading can take place. This model is not able to guarantee sustainable production of actual products. Trading certificates may also become a business for participants not directly involved in the supply chain (Mol & Oosterveer, 2015).

Research was conducted on different types of traceability models, "identity preserved, segregation, mass balance and book and claim", used in key agriculture commodities and summary results are presented below, **Table 2.**

Table 2: Traceability Models in Agricultural Commodities Industries

Traceability Models	Palm Oil	Sugar	Cocoa	Coffee	Tea	Cotton	Rubber
	(*,**,***)	(*)	(*)	(*)	(*)	(*)	-
Identity Preserves	Yes	Yes	Yes	Yes	Yes	Yes	No
Segregations	Yes	Yes	Yes	Yes	Yes	Yes	No
Mass Balance	Yes	Yes	Yes	Yes	Yes	Yes	No
Book and Claim	Yes	Yes	No	No	No	No	No

Source: Mol & Oosterveer, 2015(*); Rival et al, 2016(**); Gassler & Spiller, 2018(***);

As of now, no literature was found on the potentiality of adopting any of these four models in the natural rubber supply chain, because in accordance to a review of the natural rubber industry and sustainability movement by Millard (2019), "Natural rubber is a laggard compared to other agriculture commodities products on sustainable movement. This subject just emerged in recent years for natural rubber industry. The industry is in the nascent stage of learning about sustainability, drawing knowledge from other agriculture commodities industries and related publications in public domain remains limited. Producing

countries' governments claimed that natural rubber cultivation is sustainable". Rubber companies are less exposed to media spotlight because rubber is a smallholder crop compared to other agriculture commodities such as beef, soy, palm oil and wood products that are mostly produced on large plantations (WWF and RSBP, 2017). Civil society can easily identify large forested lands cleared for planting compared to expansion of small sized farmlands owned by natural rubber smallholders. Prior to 2016, there was no strong requirement to purchase sustainably sourced, deforestation free, and differentiated natural rubber from downstream users. Also limited numbers of voluntary sustainable certification were sighted for rubber (Millard, 2019). Only in June 2016, Michelin was the first natural rubber buyer and tire maker to publicly commit to a "zero deforestation" sourcing policy (Michelin, 2016). Then in 2017, General Motors was the first automaker publicly announced to source sustainable natural rubber for its tires, working towards "zero-deforestation" (General Motors, 2017). In 2021, Pirelli launched world's first FSC-certified tyre, equipped onto the BMW X5 Plug-In Hybrid car model (FSC, 2021). With a gradual increase of interest in differentiated natural rubber products in the market, an opportunity is presented for further research to find out which traceability models are suitable for the natural rubber industry to mitigate sustainability risks such as deforestation and environmental degradation.

3.0 RESEARCH METHODOLOGY

To reach the defined goals of this research, the study employs primary and secondary data. To gather the primary data, we took a qualitative research model. We conducted the data collection exercise in two (2) steps: the survey approach and the semi-structured interview.

We designed the survey mainly in Multiple Choice Questionnaires (MCQ) with several open-ended questions to capture key information within 60 minutes. The survey questionnaires targeted three (3) group of respondents, representing upstream and downstream supply chain actors, with specialization in the Thailand Rib-Smoke-Sheet (RSS) supply chain. The MCQs provide the initial visibility about the string of upstream actors, their activities and any existing tracking or tracing initiatives. Second, we adopted a semi-structured interview approach, asking broad and open-ended questions intended to give respondents the flexibility to lead interviews, to share their knowledge and experiences on the supply chain freely, as well as bring in new and creative ideas as the conversation develops. The survey questionnaires complemented the semi-structured interviews to mitigate any possible biases.

Semi-structured interviews draw on Theories-in-use (TIU) approach to address research questions or issues that are broad and deep, and for which we do not readily have good answers. Research participants are selected for their knowledgeability about the questions or issues, and their willingness to share their knowledge and experiences with the researchers. Importantly, the researcher should have a very strong interest in the research questions or issues and should have good general knowledge related to them to enable the

researchers to listen carefully to participants, ask probing questions and challenge participants when appropriate (Zeithaml et al. 2020).

The potential respondents were identified through personal contacts, referrals from prominent industry associations and company websites. We made sure the potential respondents consisted of numerous knowledgeable, highly important and influential individuals in their respective fields to serve as an assurance of the credibility of information. Due diligence checks were made in advance by direct contact with the general enquiry email address of the organization and head of the company. This was to identify potential candidates with relevant background, their initial interest to participate, to clarify in advance if any local internal review board (IRB) approval needed and any form of document submission was needed from the researcher before the on-boarding process. After obtaining the necessary approvals from the Singapore Management University (SMU)'s internal review board (IRB), official invitation letters were sent to the potential respondents. These respondents reserved the right to accept or decline the official invitation to take part in both the survey and the interview. For those interview sessions that did not complete in one sitting, it had to be continued on another day, with the consent of the respondents.

The scope and coverage of the survey questionnaires and interviews are summarized below, **Table 3.**

Table 3: Survey and Interview Questionnaires (The Scope and Coverage)

Items	RAOT	RSS Producers	Supply Chain Experts
1. Survey Questionnaires (Mainly MCQ)	√	√	√
	Qualtric Survey		
Purpose and Scope of Coverage	1. Mapping Upstream Supply Chain		
	2. Tracing Physical Rubber Sheets		
	3. Tracing Documentation Flow		
	4. Traceability Models (4 Models)		
2. Semi-Structured Interview Questionnaires	√	√	√
	TEAMS Interview		
Purpose and Scope of Coverage	1.Tracing Thailand Upstream Rubber Sheets (USS/RSS) Supply Chain		
	2.Traceability Models for Upstream Rubber Sheets (USS/RSS) Supply Chain		
	3.Sustainability Initiatives and How Downstream Firms Uses Traceability		

Three (3) groups of respondents were identified to take part in this study.

Group1: Rubber Research Authority of Thailand (RAOT)

This is a state enterprise, representing the actors in the upstream Thailand Rib-Smoke-Sheet (RSS) supply chain. Rubber Authority of Thailand (RAOT) provided one suitable candidate with relevant experience to answer questions. This expert contributes to better visibility of the structure in the upstream from his years of direct involvement and collaboration with upstream actors. His involvement in industry activities has included, disseminating information on government initiatives & policies to all upstream actors, data collection for generating government statistics & reporting, research & development, promoting good management practices to upstream actors to keep up with standards and expectation from international communities, and provide education & financial support to the upstream farmers, among others.

RAOT can provide an up-close perspective on the upstream actors, help to identify complexity of the upstream supply-chain, provide a clearer picture on how information is being disseminated both ways from far end of upstream to downstream and vice-versa. RAOT's information on the workings of the upstream will no doubt provide a good start-up and solid foundation to this research, by presenting the type of information is currently available and collected, as well as the challenges and opportunities for improvements.

Group2: Rib-Smoke-Sheets (RSS) Producers

Typically family-owned private companies, RSS producers are midstream actors in the natural rubber supply chain. This group is one of the important actors in the supply chain. They can support by providing relevant information including about intermediaries' operations from their years of "on-the-ground" interactions with the upstream supply chain actors. Their information would be helpful in the mapping process of upstream supply chains and complement the information received from RAOT.

For this research, in the preliminary screening process, we found four suitable candidates selected from the Thailand Rubber Associations' members list, industry referrals and personal contacts. The interviewees were management level employees in prominent rubber factories, two of which have operations in South Thailand – the traditional rubber-growing area – and two in Northeast Thailand – a fast expanding non-traditional rubber-growing area. The interviewees give us two different perspectives on the ground situation in both locations. They would be able to provide their perspective of the limitations of

the RSS supply chain, on how to overcome and make progresses in upstream traceability to support sustainability risk mapping. Their RSS rubber factories source their raw materials from both government and private firms, and are in a good position to provide a wider view of the upstream supply chain.

Group3: Rubber Sheets Supply Chain Experts

The rubber sheets supply chain experts were recruited from industry referral and personal contact. All of them have a minimum 35years of working experience in the natural rubber industry. They are currently holding senior positions within their respective organizations such as advisor to the board, CEO and director; and have experienced overseeing the entire natural rubber supply chain ranging from plantation management, factory production, marketing, packaging, logistics and quality assurance. All the selected interviewees are at least degree holders. They have knowledge of both rubber sheets and block rubber supply chains in more than two rubber producing countries, as well as in-depth knowledge of the different supply chain actors. They have experienced working for tire makers, rubber producers and international rubber dealing houses, with significant influence in the rubber industries and within the organizations of their employ. They are also actively involved in sustainable natural rubber initiatives within the industry, and are aware of the recent traceability requests from downstream users especially tire-makers. The purpose of interviewing this group of experts is to tap into their vast experience and deep understanding of the natural rubber supply chain. Their knowledge will complement, and their contributions will serve to confirm the other data collected in this research.

Finally, I have both conducted Qualtrics online survey questionnaires and TEAMS interviewed in depth with all three groups of respondents. Group 1, 2 and 3 respondents combine make up a total of 225 years of industry experience in the natural rubber supply chain from upstream to downstream. Interviews took approximately 60 minutes and notes were taken down by hand using pen and paper. The manually written notes were immediately typed up in Microsoft Word after each interview sessions. The data gathered was carefully analyzed using the inductive approach to identify common themes and similarities leading to emergent theories. Future research areas and opportunities were also identified in the process. The anonymized list of the respondents for this paper is displayed in **Table 4**.

The study also uses secondary data related to macro information on the Thai natural rubber industries and related statistics from desktop research, company websites, association websites, government websites, industry reports, statistical reports, journal articles, proceedings and other related documents by searching comprehensively in both electronic and non-electronic databases.

Table 4: Profile of Anonymized list of Experts interviewed

Respondents	Designation	Organization	Remarks
Respondent 1	Foreign Relations Office, Foreign Affairs Sub-Division, Office of the Governor	State Enterprise managing natural rubber supply chain	Specialist for rubber cooperatives and socio-economic of rubber smallholders with 10 years of service with the state enterprise.
Respondent 2	Managing Director	Major natural rubber producer and exporter	Strong knowledge in both purchasing and manufacturing activities for all rubber grades: latex, RSS and STR include experience in downstream rubber glove sector with over 25 years of presence within the industry.
Respondent 3	General Manager	Major natural rubber producer and exporter	Strong comprehension on natural rubber upstream supply chain network, supply chain actors and business practices. He has 10 years of hands-on experienced in managing rubber sheets factory located at non-traditional areas in Thailand.
Respondent 4	Managing Director	Major natural rubber producers and exporters	Third generation entrepreneur with experience in managing rubber plantations, rubber sheets and block rubber processing factories located at non-traditional areas in Thailand. She has over 15 years of experience within the industry.
Respondent 5	Executive Director	Major natural rubber producer and exporters	Strong understanding of rubber sheets and block rubber supply chain network in Thailand with experience in rubber sheets and block rubber operation. Current executive committee member of the Thai Rubber Association. He has over 15 years of relevant industry experience.

Respondents	Designation	Organization	Remarks
Respondent 6	Chief Executive Officer	Producer with presence in emerging countries in Asia	Specialist for natural rubber supply chain in both mature and emerging producing countries in Asia with over 35 years of experience within the rubber industry.
Respondent 7	Director	Producer with regional headquarter in Singapore managing processing assets in Asia and Africa	Rubber industry "guru" with broad knowledge of stakeholders in natural rubber supply chain and a well-respected strategic influencer for sustainability initiates within the industry platform with over 40 years of experience.
Respondent 8	Managing Director	Consulting firm in Singapore	Strategic advisor, writer and speaker on topics related to natural rubber heritage, supply chain and sustainability. He has over 40 years of experience covering full spectrum of upstream plantation and downstream industry.
Respondent 9	Executive Director	Major downstream user	Seasoned industry professional in both commercial and technical aspects of RSS and TSR supply chain with over 35 years of practical field experience in Asia and Africa. Sustainability champion within the current organization.

4.0 RESULTS AND ANALYSIS

The objective of traceability is to enable ESG initiatives. Of particular concern in the ESG objectives, downstream users need traceability to meet new regulations, to be able to respond swiftly to NGOs claims, and to gain visibility of the activities in the upstream to formulate responses to mitigate potential risks that occur at the upstream supply chain. Respondents explained, *"Traceability itself cannot reduce risk, but can be means to identify risky areas and practices and buyers to encourage mitigation."* (Respondent 7), *"There [is a] chance traceability can help sustainability but cannot guarantee. Something we know, we can work on it further. Traceability is a tool for sustainability."* (Respondent 2) and *"It is possible to use traceability to identify the supply chain to reduce sustainability risk."* (Respondent 6).

Traceability also complements the effort to restore deforested areas and identify farms with and without official land rights. To elaborate further, when the price of rubber sheets hit the high of US$6/Kg in 2011, there was a massive expansion of rubber cultivation in Thailand. Respondent 5 says, "*[…] 10years ago when rubber price [was] US$6/Kg, deforestation already [happened]."* Smallholders expanded the rubber farms first and then tried to register their farms years later. While the government did not always approve all land registration applications, rubber sheets from unregistered farm continue to be sold in the market. Respondent 6 mentions, *"If the [registered] land can [only] produce 1MT but [the farmer] can sell 2MT, something [is] strange."*

Traceability requirement is new for natural rubber industry. As of now, the supply chain actors still do not have the same view on the objective of traceability and expected results from traceability. They also do not have

sufficient information and knowledge to undertake traceability activities by themselves. Hence, no significant implementation and achievements exist on the ground. Multiple respondents confirmed this: *"At this time [there is] no traceability and so [we are] unable to implement and ensure sustainable practices."* (Respondent 8) and *"Sustainability is still a fairly new concept."* (Respondent 6).

To achieve the ESG objectives, there is a need to understand the entire supply chain starting from the upstream cultivation site all the way to downstream users to increase sustainability and have a meaningful traceability. First, we will provide an overview of the Thailand Rib-Smoke-Sheet (RSS) supply chain to understand the sourcing structure. We will identify the main supply chain actors and their unique characteristics. This will lead us to the challenges and opportunities of traceability at different levels of the supply chain. We also present a review of the successes and failures of past traceability initiatives.

After understanding the present state of the Thailand RSS supply chain and its traceability challenges, we will discuss the benefits and drawbacks of four traceability models found in the literature and how downstream users could use traceability to formulate responses to mitigate upstream risks. The study will conclude with recommendations for future research.

4.1 Thailand RSS Supply Chain

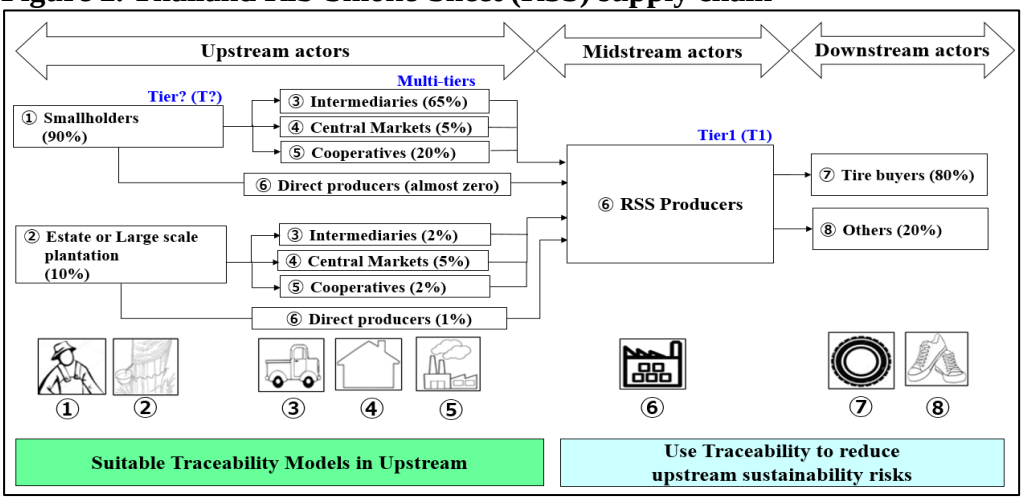
4.1.1 Mapping the Supply Chain Actors

Throughout this write up, we will use the common term rubber sheets, which consists of both Un-Smoke-Sheet (USS) and Rib-Smoke-Sheet (RSS).

Where necessary for clarity, we will use the specific term Un-Smoke-Sheet (USS) or Rib-Smoke-Sheet (RSS) to enhance understanding of the RSS supply chain. Individual smallholders typically produce and sell USS whereas farmer cooperatives typically produce and sell RSS. Central markets and intermediaries collect and sell both USS and RSS, which makes up 20% and 80% of their volume, respectively. To a large extent, the RSS comes from cooperatives and the USS directly from farmers. When discussing central markets, we will focus on RSS from cooperatives. Intermediaries' transact about 80% in USS. The USS comes from farmers. For intermediaries, we focus on USS from farmers. RSS producers collect USS and RSS from all sources: cooperatives, the central market, and intermediaries. After transforming any USS into RSS by washing, smoking, grading and removing foreign material, they pack and sell RSS to the downstream users. The downstream users purchase RSS in bale form, consisting of about 100 RSS, or 111.11kg.

The information gathered from the Qualtrics surveys and semi-structured interviews was used to construct a map of the Thailand Rib-Smoke-Sheet (RSS) supply chain **(see Figure 2)**.

Figure 2. Thailand Rib-Smoke-Sheet (RSS) supply chain



This figure shows the process flow of Thailand RSS starting from upstream smallholder farmers to the downstream users. The upstream RSS supply chain is very complex and challenging to monitor. The overwhelming majority of RSS – or 90% - is cultivated and harvested by smallholder farmers, while only 10% is grown on estates or large-scale plantations. This translates into more than one million smallholder farmers transacting their rubber sheets through diverse sets of channels, featuring multiple layers of supply chain actors, before the rubber reaches the RSS producers who pack the RSS in bale form for sale to downstream users.

Consequently, intermediaries (collectors, middlemen) hold the lion's share of the rubber sheets supply chain, adding up to approximately 67%. There are typically multiple layers of intermediaries, as smaller, local intermediaries bring their rubber sheets to progressively larger intermediaries. Intermediaries can also transact with the other types of intermediaries: cooperatives and central markets, which account for 20% and 10%, respectively. Negligible volumes are transacted directly by smallholder farmers to RSS factories.

In the downstream rubber sheets supply chain, 80% of rubber sheets are used by the automotive industry in niche product categories such as air-plane tires, agricultural tires, mining tires, truck and bus tires etc.; and the remaining 20% goes to branded winter and comfort shoes categories, specialities hoses, inner tubes etc.

4.1.2 Traceability Challenges

The rubber sheets supply chain lacks visibility into the upstream supply chain, where deforestation, land rights, loss of biodiversity and human rights

issues occur. The Qualtric survey and my interviews have identified the problem areas within the RSS supply chain that make it challenging to trace up to the farm level. These problem areas are driven by the unique characteristics of each upstream rubber sheet actor. We will discuss each actor and the specific challenge they represent for traceability in turn, starting from the upstream.

a) Farmer

The majority of rubber is cultivated by smallholder farmers. There are approximately 1.5 million smallholders. It is common for smallholders to plant rubber trees behind their home back in the village and a typical smallholders' farm size ranges from 10 to 50 Rai (1.6Ha to 8.0Ha). Smallholder farmers can only produce very small amount of unsmoked rubber sheets (USS) daily. For illustration, Respondent 5 said, *"[Farmers] have about 15 Rais. One Rai gets about 1-2kg per day depending on season. One sheet is about 1.2kg. So, […] about 12-25 sheets per day."* As the USS moves down the chain, it will be grouped with other USS that can come from different farms spread over vast geographical areas within the country. This is unavoidable, because the supply chain intermediaries need to accumulate a sufficient volume of USS to sell to RSS factories. As rubber sheets are a commodity, they are impossible to distinguish after mixing in the absence of marking or coding. This makes determining the point of origin (POO), i.e., which farm produced each rubber sheet, extremely difficult.

From farmers' perspectives, there are several reasons why they do not adopt indication (marking or coding) on unsmoked rubber sheets (USS). From the Qualtric survey, very few respondents thought that hassle was the main reason for farmers not marking their sheets. Please refer below to **Table 5.**

Table 5. Reasons for farmers not marking unsmoked sheets (USS) by Qualtrics respondents

No	Reasons for not marking unsmoked sheets (USS)	Count
1.	Not mandatory and no sales to central market	3
2.	No incentive	2
3.	Only hassle or inconveniences	1

Marking is not a mandatory requirement to sell rubber sheets to buyers and not legislated by a related government body. For sales to central markets, smallholders are encouraged to put markings on USS, but there is no written requirement for marking on USS. The central markets do not enforce marking on USS to smallholders. In the absence of a proper system to record and manage the marking, smallholders do not think marking is important as they can sell their USS even without marking. Farmers do not voluntarily put the marking on USS if they do not see any incentive that motivates them for the additional work, time and effort required to mark their production. Smallholders do not want hassle for themselves. Some smallholders keep several rollers and not all rollers are engraved with markings. They use these rollers interchangeably. For those who do put markings on USS, they are free to use their own designed mark. The markings are not always unique and duplication may happen. Interestingly, nobody raised any issue on the different type of markings found on rubber sheets. It is also unclear how receivers of rubber sheets may record and may use the marking to identify the smallholders. Please refer to **Table 6** below.

Table 6. Smallholders' perceptions on traceability challenges (USS)

No	Traceability Challenges (USS)
1.	Not obligatory
2.	Inconvenient and costly yet no incentive available
3.	Coding is not always unique

b) Intermediaries (collectors, middlemen)

The Qualtric survey and interview respondents mentioned there are a few thousand of intermediaries (collectors, middlemen) in Thailand. Approximately 67% of rubber sheets are transacted through this channel, and majority is unsmoked rubber sheets (USS). Intermediaries are frequently also farmers who are better off financially, and move into rubber sheet trading by becoming intermediaries for smaller farmers in their surrounding areas. Intermediaries will accumulate larger volumes and find buyers by themselves.

These intermediaries stay within the same neighbourhood as the smallholders, mainly in the same district. One reason for their prominence is their important role in providing financial support to smallholders over the years. Farmers can receive advance payments from dealers to pay for school fees for their children especially when the new school terms open, as illustrated in the following quote by Respondent 2: *"Some months, smallholders do not have lots of finance. Sometimes, dealers [are] supporting them on the financing like short team loan[s]. Dealers [are] like ATM machine[s] for advance money."* To return the goodwill of the intermediaries for helping them financially, smallholders bring their unsmoked rubber sheets (USS) to these intermediaries. Thus, strong relationships with high levels of trust build up between smallholders and intermediaries over the years.

Intermediaries know their immediate sellers because they keep transaction records. These transaction records include dates of transaction, rubber sheets, price, volumes, sellers (name, address) and buyers (name, address). While intermediaries are thus theoretically capable of supporting

traceability initiatives, they may be hesitant to cooperate because of concerns about disintermediation, as mentioned by multiple respondents:

"Intermediaries are unwilling to disclose supply chain due to fear that they will be eliminated from the chain once processor knows their sources of supply" (Respondent 8).

"So far, attempts to get the long chain dealers to do traceability has not been very successful because they perceive this as a trade secret on who and where they source their supply from" (Respondent 9).

In addition to that, there are unregistered intermediaries in the supply chain who transact in their own name, rather than as a registered company with the aim to evade taxes. This is a second reason intermediaries can be reluctant to support traceability requests from downstream users, as traceability could come with regulatory and financial penalties if accessible and utilized by the government to identify tax evasion. Respondent 4 says: *"Dealers received revenue and need to pay tax. But, dealers do not want to pay tax. Hence, they use [their] personal bank account. If tax department does not collect enough revenue, they will go and identify who are the dealers who did not pay tax. If buying factories disclose the dealers' information, then that dealers will not want to sell to this factory again."*

The intermediaries' also suffer from very similar concerns to the smallholders that affect the traceability by stopping them from segregating unsmoked rubber sheets (USS) with marking and unsmoked rubber sheets (USS) without marking. Intermediaries do not voluntarily segregate the USS if they do not see any incentive that motivates them for the additional workload, time, effort and warehouse spaces needed. Besides that, in reality, same farmer

may bring both USS with marking and without marking to dealers. This makes segregating the USS less meaningful. For farmers who put marking on USS, dealers can find different type of markings (in either Roman alphabet or Thai script, numbers or a mixture of random alphabet and numbers). There are also possibilities of finding the same marking on rubber sheets produced by different farmers. Even if the dealers do segregate the rubber sheets with marking, in the absence of standard marking requirements and a publicly accessible centralized markings registry, they cannot extract any useful information related to the markings on rubber sheets. Furthermore, this is not a mandatory requirement for buyers. There is no controlling body and not legislated by a related government body. Currently, only central markets keep the database of marking on rubber sheets for their approved smallholders (sellers), but this database is not open to public.

Please refer to **Table 7** below, which summarizes the key points on intermediaries' perspective for not segregating the rubber sheets with marking and without marking.

Table 7. Intermediaries' perceptions on traceability challenges (USS/RSS)

No	Traceability challenges (USS/RSS)
1.	Disintermediation concerns
2.	Tax evasion
3.	Inconvenient for a few reasons so incentive needed
4.	No standard marking requirement
5.	Not mandatory

d) Cooperatives

The Qualtic survey and interview respondents mentioned there are a few hundred cooperatives in Thailand. The percentage of smoked rubber sheets (RSS) produced by cooperatives is about 20%. Smallholders inside the village come together voluntarily and form cooperatives, a jointly owned enterprise. In

the cooperatives, smallholders bring their fresh field latex to a single joint facility and process it into smoked rubber sheets. Selling RSS can fetch better prices and increase the income for smallholder farmers. Cooperatives also give smallholder farmers collective bargaining power and better chance to access the market. For illustration, this is an extract of what mentioned by Respondent 2: *"Selling through central market or cooperatives can get better price[s]. Central market auction price is the highest. Cooperatives also refers to central market price."*

The cooperatives business model does help in providing traceability up to the point of origin (POO) at the farm level. However, it is not easy to expand and replicate. The size of cooperatives depends on the size of the village. It requires a lot of effort and coordination amongst the smallholders, local community and government agency. For illustration, this is an extract of the challenges mentioned by Respondent 8: *"Cooperative[s] could be one way to gain traceability but development of cooperatives is time consuming and require[s] government agency involvement as well as District and village leadership."*

Scalability is another challenge. Smallholders who are cooperative shareholders do not have sufficient operating cash flow, knowledge and management skills to run and to sustain the cooperative as a business. Cooperatives are producing RSS, which is a commodity, influenced by the volatile price movement. They do not have sufficient knowledge to manage the purchase and sales price, and do not have price hedging capability. They also do not have a professional marketing team in place. Their access to buyers remains limited. Due to limited management capabilities in these areas, most

cooperatives cannot sustain profitable levels and some eventually discontinue operation. For illustration, respondent 2 said: *"[Cooperatives have] no management skill. So, [they] cannot operate well. [They] keep changing management and some closed due to losses."*

c) Central Markets

The Qualtric survey and interview respondents mentioned there are seven central markets in Thailand. The only central markets transacting in rubber sheets are located in South Thailand, which is the biggest natural rubber producing region in Thailand. (For more information, please refer to Appendix – Figure 1). These three central markets are located in Songkhla, Surat Thani and Nakhon Si Thammarat province. The central markets are platforms organized by the government for smallholders, intermediaries, cooperatives and RSS factories to buy and sell via an auction system. The motivation is to help the smallholders to get the highest selling price. The government wants to keep a good relationship with the smallholders to get their support in every election. Respondent 5 says, *"Government takes care [of] all farmers in Thailand. If farmers cannot survive [the] government [is] also in big trouble."* Central markets transact approximately 10% of the rubber sheets in the market, of which 80% are smoked rubber sheets (RSS) and 20% are unsmoked rubber sheets (USS). There exists an official marking requirement for quality purpose.

Central markets collect the USS from the farmers and some from the intermediaries. There is a required marking but it is not enforced. Smallholders located near to these central markets will sell their USS here. However, smallholders who are located far from central market tend to sell their USS to the nearest buyers in their areas. For illustration, this is an extract of what

mentioned by Respondent 5: *"I think convenience is key. […] accessibility is another [reason]."*

Central markets collect RSS from cooperatives and marking is strictly enforced. When quality claims happen, central markets can trace the sheets back to the seller. Central markets can then contact the management of the cooperatives to rework or arrange replacement of cargoes.

Based on this discussion, the challenge to traceability at central markets only arise from USS, where marking is typically not enforced to ensure greater access to farmers.

e) Rib-Smoke-Sheet (RSS) factories

The Qualtric survey and interview respondents mentioned there are approximately forty RSS factories in Thailand, which purchase negligible volumes of rubber sheets directly from smallholders. There are several reasons. First, farmers' sale quantities per transaction is too small. It is very difficult for RSS factories to handle several thousands of farmers directly. Second, farmers need to collect cash after each sales. RSS factories cannot have large amounts of cash at the premises in anticipation of farmers coming to sell their produce due to security concerns. Although mobile payment is one way to solve this issue, it is not widely used by the farming community yet. For RSS factories, they prefer to transact with big rubber sheets sellers who can sell substantial volumes per transaction and accept payment by cheque. Although direct transaction with farmers can help RSS factories to gain access to the point of origin (POO) information at the farm level, it is not workable due to abovementioned operational limitations.

RSS factories buy USS and smoke it into RSS or buy RSS directly. RSS factories can buy RSS from cooperatives and central markets as well. If RSS factories buy USS, they will transform the USS into RSS by washing, smoking, grading and removing foreign material. They then pack the RSS into the 111.11kg bale form as per the industry standard for sell to the automotive industry.

RSS factories that practise traceability can improve their quality control process. Dry rubber content of rubber sheets determines the value and price of the rubber sheets. This is estimated by judging the dryness and degree of cleanliness of the raw materials through visual inspection at point of receiving. Hence, the point of origin (POO) information from, the farm level is important. RSS factories can identify areas with consistently high quality rubber sheets and to increase sourcing from these areas. In addition to that, they can avoid buying from areas and suppliers who supply poor quality rubber sheets. This can improve their sourcing competitiveness over time.

Rubber trees go through cycles of high and low output throughout the year, commonly known as seasonal production pattern. Typically, there will be a low season where the trees shed leaves, commonly known as “wintering” season, followed by a period of peak production season. By practising traceability, RSS factories can gain useful information on the seasonal patterns in each region. In addition, the impact of changes in weather patterns on the quality and output quantity of rubber can be measured by comparing with historical average climatic temperatures and precipitation. This helps the RSS factories to increase the predictability of raw materials available, as well as the

quality throughout the year, accounting for any occurrence of abnormal or extreme weather condition. Please refer to **Table 8** below.

Table 8. Benefits to adopt traceability by RSS producers

No	Benefits to adopt traceability
1.	Identify sources with consistent high quality
2.	Identify changes in raw materials quality by locations
3.	Increase predictability of raw materials availability with change in weather pattern

There are several drawbacks in adopting traceability from the RSS producer to the point of origin (POO) at the farm level. Implementation of traceability will incur cost and increase workload, time and effort. The RSS factories will need to start checking the marking on every rubber sheet manually and start keeping records on the POO. Given the volumes involved, this will become daunting routine work, labour intensive and very time consuming. Due to detailed information needed, it is very tough to manage the records. This will lead to inefficiency and overall cost increase. At the moment, there is no guarantee of incentives from tire makers to RSS factories to trace up to POO. Even if RSS factories do receive incentives, there is also no guarantee that RSS factories will pass on the incentive to their upstream suppliers, especially the smallholders where the traceability needs to start from. Respondent 4 said: *"Everyone needs to get incentives from this activities"*. Please refer to **Table 9** below.

Table 9. Drawbacks to adopt traceability by RSS producers

No	Reasons for not adopting traceability
1.	Inconvenience for a few reasons so incentive needed
2.	Lack of incentive
3,	No traceability models and system in the rubber industry

f) Automotive industry

The automotive industry is the main user of RSS. It takes up 80% of the market shares. RSS is used in niche products categories such as airplane tires, agriculture tires, mining tires, truck and bus tires etc. RSS has good elastomeric properties. The plasticity and plasticity retention index value for rubber sheets are higher than block rubber making it useful in high performance areas because of its good tensile strength and high durability.

Currently the automotive industry is experiencing a push to adopt traceability. The main purpose is to meet regulatory requirement, to meet sustainability expectations in the areas of ESG and to respond swiftly to NGOs claims. Traceability helps in mapping high-risk areas in the upstream, which can lead to actions that improve the sustainability aspects there. Traceability will trigger concerted efforts and actions to secure stable supply from ESG compliant sources. This will become a marketing and branding tool for automotive industry. Please refer to **Table 10** below.

Table 10. Benefits to adopt traceability by automotive industry

No	Benefits to adopt traceability
1.	Meet regulatory requirement
2.	Mapping of high risk areas in upstream
3.	Marketing and branding purpose

The automotive industry also will experience drawbacks in adopting traceability. Automotive industry will experience increases in workload, time and effort required to coordinate with their immediate RSS suppliers on how to collaborate this activity. Due to the many layers inside the supply chain, managing the paper records is very challenging. Traceability is new and there are very few traceable sources available for now. For the short term, due to imperfect traceability, this will increase the competition to secure the same ESG

compliance sources. However, in the longer term, this situation should improve as more traceable sources become available in the market. Although there are opportunities to cultivate premium buyers, there is no guarantee of premiums and incentives for sustainable end products. Furthermore, the natural rubber industry is still at the nascent stage in adopting traceability. There is no standard requirement for traceability, with no traceable models and systems in the natural rubber industry and no strong support from all stakeholders in the supply chain, thus making it very challenging for everyone. Please refer to **Table 11** below.

Table 11. Drawbacks to adopt traceability by automotive industry

No	Reasons for not adopting traceability
1.	More resources needed to manage new work areas
2.	Imperfect traceability will increase competition
3.	No traceability model and system in the rubber industry

4.1.3 Past Traceability Initiatives

Before we proceed to look at how to improve traceability in the RSS supply chain, it is important to review past traceability attempts. Interviewees mentioned three cases in the past where identification (marking or coding) was required on rubber sheets.

The first initiative was when the Thailand government implemented the price support scheme for rubber sheets. The government introduced this price subsidy during a period of low rubber prices. The latest round of price subsidy was made in the last quarter of 2019 to early 2021. Smallholders are required to register themselves with the Rubber Authority of Thailand (RAOT), present a legal land title and put an identification on the rubber sheets to receive the subsidy. This was a non-legally binding requirement to get the subsidy. Once the subsidy period ended, most smallholders discontinued putting identification on rubber sheets.

Second, after the end of the price subsidy downstream users made an attempt to continue using the marking. Tire makers did approach their immediate RSS suppliers to explore the possibilities for them to work with their upstream actors to continue putting identification (marking or coding) on rubber sheets and to expand the coverage. This is an extract from Respondent 1: *"Many tire makers are interested in traceability. This is more benefi[cial] to private sector."* RSS factories did try to cooperate and request their upstream suppliers to supply rubber sheets with identification (marking or coding) but the acceptance level remains low and the attempt failed. RSS factories can only request and their upstream suppliers are not obliged to mark their sheets. This is an extract of what was mentioned by Respondent 2: *"We, [the] private company is not policy or lawmakers. We cannot instruct [the] middleman to do coding on rubber sheets."*

A handful of RSS factories tried to approach the dealers and try to encourage their farmers to mark their (farmers) sheets with their (farmers) existing code or with a code provided by the RSS factory. However, there were mixed responses. Some farmers were not prepared to change their existing daily operation due to the additional work. They were unwilling to do so without clear incentives to motivate them. Those farmers who agreed to cooperate were mostly long-term suppliers with good relationships built up over the years.

The reason for the low success rate was due to lack of trust. Smallholders tended to trust the government and are likely to heed official requests, the same is not true for producers (RSS factories) as smallholders have the impression that producers are tough negotiators. Respondent 5 says, *"Most farmers thought producers always want to take advantage of them. If [RSS producer] goes to*

farmer directly at 60Baht/kg, [they] will not trust us. Smallholders will trust RAOT more than us."

The third initiatives are mainly practised in some estates and large-scale plantations. They use identification on the rubber sheet as a method to identify which tappers made the rubber sheets to calculate each tappers' share of the revenue. Today, this method is still in use in estates and large-scale plantations that produce rubber sheets.

Finally, even during the period when the price subsidy was active, not all smallholders would comply. Some smallholders who did not require government's support preferred not to register with the authorities. They are amongst those who manage to make enough to sustain their livelihood. Respondent 2 says, *"Farmers also have different levels. Some are very poor, some medium level and some very rich also."* Alternatively, some may not have qualified for the subsidy if they were selling rubber sheets from unidentified sources planted on forest areas, as mentioned by multiple respondents: *"Those that does not have land title [are not eligible for subsidy]. Some does not have land title due to [planting on] illegal lands and forests."* (Respondent 5), and *"Some farmers may have plantations inside the forest areas"* (Respondent 3).

Due to mismatches in interests and expectations between the upstream and downstream actors, identification (marking and coding) on rubber sheets is not widely implemented. At this moment, there is no official statistic on identification in the market. Based on the interview conducted, conservatively, the current usage of identification is around 20% in the market.

4.1.4. Summary

The mapping of Thailand's Rib-Smoke-Sheet (RSS) supply chain provides an overview of the present state of the sourcing structure. RSS originates from approximately 1.5 million smallholders making it very challenging to trace. This situation is further aggravated with the involvement of multi-tier intermediaries in the supply chain, who are reluctant to disclose their supply source to the next buyer, as they are worried about disintermediation.

Nevertheless, the existing infrastructure of cooperatives does demonstrate the possibility for rubber sheets traceability up to the point of origin (POO), i.e., the farm level. However, there are limitations in this operation. It is very tough to scale unless there are solutions to overcome these challenges.

In this study, we will identify traceability models that are scalable to a larger proportion of the supply chain, in the context of the Thailand RSS supply chain.

4.2 Traceability Models

In this section, we will discuss the Qualtrics survey results and semi-structured interview results for the four traceability models. We will review both the benefits and drawbacks of each model.

4.2.1 Identity Preserved (Model 1)

Identity preserved means the supply needs to come from an identifiable supply base. This model requires marking on rubber sheets. Respondent 3 says, *"If every piece of rubber sheets have marking, it can solve the traceability*

issues." This model could be at different point of origin (POO). We will discuss two different POOs: farm level or district level. In the current context of Thailand Rib-Smoke-Sheet (RSS) supply chain, tire makers who purchase the finished product must be able to trace back to the POO, to map the ESG risk. In the following paragraphs, we will discuss the advantages and drawbacks for this model.

4.2.1.1 Farm Level: Benefits and Drawbacks

This model is good for rubber sheets that come directly from one big supply base. It is suitable for big plantations because they can produce commercially viable volumes with marking and tire makers can trace this identity preserved rubber to the point of origin (POO), the farm level. Hence, tire makers can conduct specific ESG data collections here to identify any ESG risks. Data collected will become evidence that the POO, the farms, adopt sustainable activities, in compliance with all applicable laws and potentially contribute towards reforestation. When ESG risks are uncovered, tire makers can formulate responses to mitigate the risks.

This model is potentially helpful in the behavioural analysis of tappers in relation to the price movement as well. For example, during the low price period, tappers may stop tapping and look for another job that can give them better income to sustain their livelihood. Besides that, this model also helps users to keep a consistent supply base and can monitor the evolution of supply through the seasons. The RSS factories can structure their production schedules to produce and market traceable smoked rubber sheets (RSS). This helps to

capture potential premium the tire makers may be willing to pay to get access to the point of origin (POO) at the farm level.

There are several disadvantages to this model at the farm level. There are just too many smallholders with small farms throughout the country. It is impossible to trace up to complete depth to reach every farmer along the supply chain. The traceability cost will get higher as the tracing goes deeper into the upstream. Besides that, as each farm is small, the rubber sheets volume per harvest is too small to make up a production lot or a typical lot size for one container of rubber sheets of 20MT for export market. Respondents 9 mentioned, *"When 15kg of rubber sheets from [specific] farmer reach factory, can your production line produce 15kg of rubber?"* Respondent 4 says, *"We need to have enough supply from [Source A] to [have a continuous] production."* Even when tracing up to the farm level becomes possible, it is not effective and not impactful to carry out sustainability initiatives at one specific farm in exchange for the huge resources invested.

In conclusion, while identity preserved at the farm level provides the greatest possible granularity of information about the point of origin (POO), it is also very expensive and difficult to do.

4.2.1.2 District Level: Benefits and Drawbacks

In the absence of a sufficient number of large plantations to support identity preserved at the farm level in practice, another option could be to reduce the reach of traceability into the supply chain by defining the district level as the point of origin (POO). The supply chain actors also need to cooperate and

do their part in segregating the various batches of identity preserved marked sheets and other unmarked sheets along the supply chain to make it happen.

There are many advantages of introducing identity preserved as point of origin (POO), the district level. Here, the single identifier is the district level. The supply base is widened from farm to district level, allowing a sufficient amount of rubber sheets to be sourced and grouped together to support continuous production. Traceability costs will be lower, tracing will be less difficult and data collection will be simpler. This model does address the concern of disintermediation. ESG mapping will now extend to a wider area, district level, with opportunities for zooming into smaller units like village and farms when needed. Hence, this POO at district level is more efficient and resource friendly.

Likewise, there are several drawbacks. In a targeted district, there may be insufficient cooperatives or cooperatives that are too small to be viable for this purpose. For small cooperatives, there will be similar traceability costs pressures, similar to the point of origin (POO) at farm level, albeit at a lower cost. The quantities depend on marking preserved at the district level. This requires big numbers of facilities producing marked sheets at the district level. The initial investment cost will be high and it takes time to setup.

In conclusion, the point of origin (POO) at district level can be an alternative from going deeper into the supply chain such as village and farm level.

4.2.2. Bulk Commodities or Segregation (Model 2)

Bulk commodities or segregation means to ensure inputs come from traceable sources. This model allows mixture of all traceable sources. This model requires strict separation of marked and unmarked rubber sheets. Marked rubber sheets are traceable to point of origin (POO), i.e., to the farm. Unmarked rubber sheets are not traceable. Model 2 shows relaxation of the requirement compared to the earlier model as the rubber sheets need not come from a single identifiable supply base, not from one specific supply base. Respondent 5 says, *"[This model] is much easier for all parties involve."* In the following paragraphs, we will discuss the advantages and drawbacks for this model.

Model 2 increases the available quantities from traceable source categories. Production can be continuous with more access to the traceable sources. The production cost will become lower due to economies of scale. It can command a higher price compared to commonly available mixture of marked and unmarked sheets. The current marketing approach can change from selling rubber sheets as a commodity to selling traceable rubber sheets with marking and non-traceable rubber sheets without marking. Central market in particular, can advertise and conduct auction based on traceable and non-traceable source. They can publish price of traceable rubber sheets to motivate smallholders to participate. Once smallholders see the benefit for putting the marking, they will be interested to put marking on rubber sheets. Hence, the supply of traceable sources will increase over time. This model is also attractive for tire maker. Respondent 9 says, *"My tire is 100% [comes] from traceable and sustainable source[s]. Branding is very strong."*

The interview respondents expect additional costs to arise if they need to use this model. Respondent 2 says, *"There will be cost involved for segregating the raw materials."* This model requires placement of more workers at the receiving point to separate marked and unmarked rubber sheets. Respondent 5 says, *"The challenge is to get them segregated."* It is not easy to get the cooperation from intermediaries. For RSS factories, it is important for them to accumulate enough traceable volumes to start the production and to keep production running continuously. Respondent 9 says, *"If 1% or 2% traceable rubber, then not able to have full production run."* In addition to that, RSS factories also need to keep separate production lines and extend the warehouse for more space to segregate the rubber sheets. Besides that, the integrity of supply chain segregation must be monitored, recorded and maintained. Respondent 3 says, *"We need to implement some system to track and to record."*

Similar to identity preserved, this model requires cooperation from the supply chain actors to do their part in segregating the marked and unmarked rubber sheets along the supply chain to make it happens. They need to keep record of marked rubber sheets by point of origin (POO), i.e., the farm level or district. Respondent 3 says, *"Dealers can provide district information where they picked up the rubber sheets."* When they deliver the traceable rubber sheets with marking to the next supply chain actors, the sellers need to provide the list of origin of rubber sheets with marking and respective quantities. Respondent 3 also mentions, *"We need cooperation from our suppliers to provide the traceability details to us."*

4.2.3 Mass Balance (Model 3)

The third model, mass balance allows mixing of marked rubber sheets (traceable) and unmarked rubber sheets (non-traceable) at any stage in the supply chain. The requirement for this model is to have certification of claims by third party. Respondent 8 says, *"The most practical model of the four assuming that [all supply chain actors who are handling the mix] can get certified."* In the following paragraphs, we will discuss the advantages and drawbacks of this model.

Mass balance is more efficient because the traceable rubber sheets volumes from model 1 and model 2 can combine with non-traceable rubber sheets volumes at RSS factories. Prior to processing, RSS factories need to record the known percentage of traceable rubber sheets. No segregation needed thereafter during the processing. Hence, it reduces the factory operational cost. This model increases the volumes for continuous production. Respondent 4 says, *"The advantages of this model allows for more raw materials to work with."* It can quickly increases the demand and supply for traceable RSS, and accelerates the buy in from mainstream market.

The drawback of this model is that RSS factories need to keep record of the traceable and non-traceable sources in the product mix. This product mix information needs to be passed down to the next buyer. The subsequent buyers in the supply chain also need to keep record of the product mix at each stage along the supply chain. This model only allows partial product claim. Respondent 5 says, *"The end buyer may not get all information. It might not be good enough for car manufacturer."* It does not convey strong message to external stakeholders and it is not favourable for branding. Multiple respondents

mentions, *"My tire is 20% comes from traceable and sustainable sources, 80% comes from non-traceable sources."* (Respondent 9) and *"Dealers can only say have 20% to 30% traceable. What happens if buyers need more details?"* (Respondent 5).

For this model to work smoothly, the industry bodies need to set targets with mass balance model at some realistic percentage of traceable rubber sheets. This target level can increase gradually over time in tandem with the maturity of the implementation of traceability within the rubber industry. Respondent 7 says, *"In rubber industry, nobody practise this yet."* Tire makers must have an agreement with car manufacturers that the mass balance method is acceptable. Respondent 4 says, *"This method needs to be recognised and accepted."*

4.2.4 Book and Claim (Model 4)

The fourth model, book and claim introduces a certificate-trading scheme with minimal intervention to supply chain to achieve sustainability. For this model to work, the main requirement is to have infrastructure supporting certificate trading scheme in place. Respondent 3 says, *"[We] need to have system to buy and sell certificates."* The issuing body will generate the certificates and will monitor the production of the certified sources. However, it does not have a direct physical link with traceability.

In contrast to the first three models, this model does not require segregation of rubber sheets, nor the monitoring and recording of traceable and non-traceable materials. There is no additional warehouse space required. This model allows supply chain actors to purchase certificates and make sustainability claim. This model requires NGOs and third parties certification

bodies to come in to certify the cultivation site and the supply chain as a pre-requisite to issue certificates. Multiple respondents says, *"NGOs are promoting certification but cost is high"* (Respondent 6) and *"[We] need to wait for any certifier such as FSC, PEFC etc. to offer such coupons"* (Respondent 7).

The potential drawback from this model is certificate trading may become independent business separate from actual needs. The players, who trade in the certificate market, may or may not come from natural rubber industry. More demand for certificates will drive up the premium. However, this premium has no direct relationship with the traceability and the point of origin (POO) from the farm level. The actual upstream actors do not benefit directly from this premium. It is also not realistic to compare traceable or non-traceable rubber sheets by looking at certificates. It is more helpful to show traceability with record on paper. Respondent 2 says, *"It is more practical to do by objectives [rather than] showing paper of the certificate and paying unnecessary money. Why don't you pay more for farmers?"* Some interviewees expressed concern that intermediaries may make agreement with the farm directly to support certification process, in exchange for the right to sell the physical rubber sheets and to sell the certificates through the trading platform. This indirectly encourages some supply chain actors to come in and take away business from smallholders resulting in a more risky and vulnerable supply chain. Respondent 2 says, *"[This model] makes the whole sustainability environment not trusting each other."*

Currently, certification is not a requirement in natural rubber industry. This model is the least helpful out of all models from the perspective of traceability.

4.3 Traceability Usefulness

In this section, we will discuss the usefulness of traceability. The results from the Qualtrics survey are used to rank the usefulness of traceability as perceived by the respondents. Please refer below to **Table 12,** where the data helps us to understand the relative ranking importance of the many different reasons for usefulness that are covered. The respondents did not think the market premium was that important, but they all agreed the risk mapping was important.

Table 12. Ranking on Traceability Usefulness by Qualtrics Respondents

No	Reasons for adopting traceability	Count
1.	Mapping of high risk areas in the upstream	8
2.	Meet sustainability expectation in the areas of ESG	6
3.	Improve sustainability activities in the upstream	6
4.	Identify evolution of raw materials sources & qualities	6
5.	Identify changes in raw materials availability by season	6
6.	Identify changes in raw materials quality by season	6
7.	Increase access to premium buyer	5
8.	Meet regulatory requirement	4
9.	Marketing and branding purpose	4
10.	Downstream product quality improvement	4

In the following sub-section, we will discuss how the downstream automotive industry uses traceability. The industry is using traceability to increase visibility of the upstream Thailand RSS supply chain, to map high risk areas, to identify and to reduce sustainability risk in the upstream, mitigate RSS supply shortage, identify good quality sources, for branding purposes, formulating responses to external stakeholders etc.

4.3.1. Economic

Downstream users are concerned about the liability and responsibility imposed on them for violations of human rights and environmental standards within their supply chain. In line with the sustainable development goals (SDGs), many governments of importing countries and NGOs are pushing for materials that are traceable and sustainable. EU and America specifically are moving much faster than other countries in the sustainability agenda.

New regulations hold companies responsible for every step in their supply chain from raw materials to the finished product. Some most recent highlights include the EU parliament's proposal to include rubber into EU's Anti Deforestation Law (EU Parliament, 2021) and the new German supply chain act (Holger Hansen, 2021) imposing fines on companies and holding them responsible if their contractors abroad are found to breach human rights or environmental rules. In America as well, Biden's Executive Order includes combating global deforestation (The White House, 2022).

Due to the regulatory change, the downstream users need to find ways to increase their visibility on their own supply chain. This requirement is cascaded up to their upstream supply chain actors. Currently, the RSS factories are not much motivated because they have not seen clear benefit for them. Respondent 3 mentions, *"If Thailand same as some other countries like EU and US can reduce tax for traceability product for exporters, then there will be motivation."* However, currently there is inadequate urgency and absence of government regulation in the exporting countries, which slows down the traceability initiatives. Indeed, countries whose economics rely heavily on agriculture may not fully agree with stricter sustainability requirements if this affects their

economic development. From the interactions with interviewees, there were indeed some comments of not relishing traceability and the reasons were regrettably understandable. Respondent 8 says, *"Generally the richer countries are advocating green at the expense of the poorer agriculture-based emerging countries."* However, the wrongful destruction to the environment in the past should be lessons for all to preserve what is left for our future generations.

4.3.2 Environment

The downstream users also want to support the restoration of deforested areas by tracing the history of deforestation. Besides checking historical trends, users can check alerts that can help users to act for the prevention of future occurrences of deforestation. The geographical coordinates of the farm such as longitude and latitude, along with the map of the farm can form the basis for checking. They can use satellite imagery (Landsat), NGOs and other sustainability service providers such as Global Forest Watch (GFW) to map the changes to forest cover at the targeted rubber farms location for specific period.

In addition to that, downstream users also want to make sure existing supply is not coming from areas overlapping with biodiversity rich areas such as elephant conservation areas, national parks and protected areas. Respondent 2 mentions, *"We also try to get [the] rough location of middleman and key in to Thailand Royal Forestry Department website to find out [whether the rubber sheets] come from risk areas or non-risk areas. We also want to see whether any supply comes from protected areas."* Downstream users also subscribe to advanced risk-scoping tool and databases available in the market to generate the heat map of potential risks at area of interest. There are available open sources

in the market that support similar types of risk mapping initiatives, such as Integrated Biodiversity Assessment Tool (IBAT), etc.

Downstream users can use traceability to identify and make sure smallholders use proper land preparation methods. For example, slash and burn land clearing is detrimental to the surrounding air quality; whereas and also the chemicals, including pesticides and fertilizers, could be harmful to water sources in the area.

4.3.3 Governance

Governance is part of risk management. Land governance looks into how users access and use the land. In the context of Thailand, for the natural rubber supply chain, legal farm ownership is important and relevant to make sure the farmland belongs to the rightful owner. There were cases where actual location of farmland is different from the registered document. Traceability can help to verify this.

The downstream users want to ensure legal farms' ownership. This can be proven through official land deed or land registration document. However, there are questions surrounding rubber farms without official land title and the accuracy of the polygon drawing on the map indicated in the official documentation versus the actual location of farm. There are discrepancies between actual location and record on paper. "*We have been talking a lot on zoning for plantation but this has not been carried out properly. There are cases [of] family own[ed] land rights for 20 years but the document shows different location. There may be mismatched."* (Respondent 5). With traceability, verification is possible.

4.3.4 Human Rights

Nowadays, the younger generation are more educated in rubber growing areas. They tend to look for better opportunities in the cities rather than taking up rubber tapping as a profession. Rubber tapping is not an attractive job. This has created a shortage of rubber tappers in the industry. Hence, farm owners need to hire foreign tappers to fill this role.

There are concerns about illegal foreign labour from neighbouring countries, such as Myanmar and Cambodia, working in the farms as tappers. These illegal workers may be underaged and may not receive accommodation supported with acceptable living conditions that includes access to clean water, food and a religious place for prayers. They may work longer hours and receive less wages compared to the local tappers. Respondent 2 says, *"[…] foreign workers also has a lot of problem because most of the foreign workers [may not receive adequate support and compensation]. They are illegal workers. They cannot enjoy same benefits as local people."* Due to their education level and language barriers, this may prevent them from expressing their situation well and reduce their chances of getting necessary support.

A central issue surrounding the relationship between the farmer and the tapper – both for foreign and local tappers – is the lack of a written contract. As a result, it is difficult to identify whether tappers receive their wages in accordance to the minimum wage level. At present, the tappers' shared revenue ratio between the farm owner and tapper are on a negotiated basis. Furthermore, there is no loyalty from tappers as they move between farms to earn a living. Respondent 1 says: *"In reality, smallholders hire tapper[s] to harvest [latex]. They do not sign contract with tappers. [There are ethical concerns on this].*

Sometimes tapper[s] work for them, and sometimes tapper[s] work for other farm[s]. This is complicated."

Not all farms are well managed and the working conditions of tappers may require consideration for improvements. The farm owners do not always provide safety equipment, while the working conditions of the tappers may be harsh and potentially unsafe. Respondent 2 says: *"Tapping rubber starts as early as 2am to 3am. [The] tapper needs to walk very long distance[s]. [There are] many mosquitoes, wild animals [such as] snake. It is very tough job."* With a sounds traceability infrastructure in-place, there could be opportunities to identify these deficiencies and implement corrective measures for improvement.

4.3.5 Secure Supply

There are concerns on the discontinuation of Thailand rubber sheets supply because the production process is labour intensive and not attractive for younger generation. Multiple respondents mentioned, *"Now many farmers change from making USS and RSS to sell[ing] latex because it uses less labour."* (Respondent 3), *"[To produce] USS and RSS is a tough and tedious work, which not many people wants to do especially the young."* (Respondent 6). This is similar to the situation once experienced by their neighbour, Malaysia. Malaysia ultimately discontinued the production of rubber sheets and lost its dominant position as the world's largest natural rubber exporter in the 1980s.

Traceability is advantageous in helping downstream users to identify specific patterns to refine their sourcing strategy. They can optimise their own operations to achieve better outcomes. Through traceability and periodical

monitoring of supply sources, downstream users can identify how changes in weather patterns influence the rubber sheets supply. They can adjust their inventory holdings in accordance to high and low production seasons, such as increasing the percentage of inventory holdings ahead of the low production season. They can shift their sourcing from low production regions to high production regions by shifting sources from South to Northeast areas at specific times of the year and following the changes in regional weather patterns.

In addition, the quality of rubber sheets also changes according to the weather patterns. Traceability also helps to identify locations that produce good quality rubber sheets with specific characteristics within the sourcing areas. Respondent 3 says, "*In Northeast areas, rubber trees [are] quite young. Weather is dry and [with] not much rain. Rubber sheet is clear but [the] elasticity is not as good as South Thailand."*

The unique soil conditions and the type of rubber tree clones planted in specific areas will affect the chemical properties of the rubber sheet. This will influence the performance of the rubber sheets. Downstream users do source from targeted locations to harness specific characteristic of rubber sheets for specific applications in their products offerings. The consistent quality of rubber sheets fed into the production process will be more cost-effective, promote standardization and achieve consistent end-product quality.

4.3.6 Reputation

End-buyers are highly conscious about the products they purchase and desire to purchase a sustainable product. They expect the products' supply chain to contribute positively towards the environment and society at the cultivation

site. Traceability plays a significant role to provide industry customers with the relevant details. This helps to strengthen trust and confidence.

Downstream users are trying to seize the market opportunity as the industry pushes for green practices. They want to build a reputation as the leading Environment, Social and Governance (ESG) company. Multiple respondents mentioned, *"Automakers who buy tires from tire manufacturers have indicated that they want a sustainable supply chain."* (Respondent 8), and same respondent mentioned in another occasion "*Tire makers' reputation will gain the most [for those] who want to do traceability and sustainability."* and *"Opportunity for automotive company [to adopt traceability] for branding for supplying green tire."* (Respondent 9).

Firms that are able to respond positively to their immediate customers who want sustainable supply chains that meet new regulations and can respond to NGOs' claims, can then showcase their activities in their annual sustainable report to both internal and external stakeholders. This will contribute positively to their ESG ratings. For public listed companies, this will have positive effects on their share price.

4.3.7 Formulating Responses

Traceability can be useful to formulate responses. If we have traceability, it will be possible to respond better to NGOs comments, grievances raised, human rights issues, etc. These are the important issues and growing concerns in the industry. To mitigate and fix these problems, we need traceability. Downstream users are unable to formulate responses without knowing where the rubber sheets they are using comes from. Downstream users

can take immediate actions and conduct investigations to identify the root causes once they gain visibility into their supply chain through getting traceability information.

Once the downstream users recognise any violation of the environment and human rights at a specific location, they tend to avoid sourcing from that area to avoid negative publicity. However, currently the tire makers only know the country of origin of the rubber sheets, but not the point of origin (POO) at the farm level. This means they can only formulate responses at the country level and are not able to formulate specific responses more focused on the problem area. Respondent 9 says, *"We are avoiding [Country X] because NGOs identify some risk here."* When actions are formulated and implemented at the country level, all the supply sources, both good and bad received the same treatment. This is unfair for those who did not break the rule. If traceability can be up to the POO of the farm level, responses to mitigate the risk can be localized and made pertinent to the identified risks.

Traceability is thus a pre-requisite for a targeted grievance mechanism. Traceability allows tire makers to know where the rubber sheets are coming from. Companies with a grievance mechanism framework will be able to recognise any misconduct at the point of origin (POO) once grievances are raised at either the farm, district or province level. This will trigger an internal investigation on that affected source, to clarify the grievances raised by the situation and to take further action. During the investigation process, the affected source will be temporary suspended until the grievance is resolved and no further risks are sighted, after which business will continue as usual. In the event there are no amicable solutions or the risks continue, these companies, in

consultation with all stakeholders may take following actions: issue a warning letter, reduce business volumes, impose penalties such as fines, and stop buying from the non-compliant supply chain. Without traceability, even with grievance mechanisms in-place, the above actions are not possible.

5.0 CONCLUSIONS AND RECOMMENDATIONS

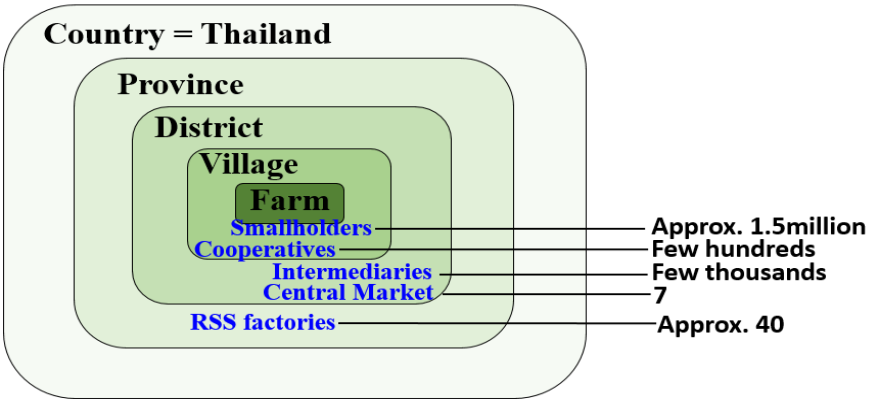
Based on the information presented before, we provide recommendations on how to improve traceability in the supply chain. First, we will discuss our recommendation for the appropriate point of origin (POO) in section 5.1. We will then introduce two proposals in section 5.2. Identity Preserved (Model 1) in subsection 5.2.1 on the proposal to scale this model to a larger proportion of the supply chain in the context of the Thailand RSS supply chain. We will also discuss Bulk Commodities or Segregation (Model 2) in subsection 5.2.2 which can be an alternative to Identity Preserved (Model 1) if the earlier model does not work well. We will make a comparison between Model 1 and Model 2 in subsection 5.2.3. This is followed by a brief discussion of alternative traceability initiatives emerging in the industry in section 5.3. We also offer some suggestions on critical success initiatives to help bring together all the relevant supply chain actors in section 5.4. Finally, we conclude with a discussion on the limitation and future research direction in section 5.5.

5.1 Point of Origin (POO) Recommendation

There are different types of point of origin (POO) and the selection of POO will be driven by the benefits and drawbacks, as well as the geographical specifics of the country. In terms of administrative levels within Thailand, there

are 76 provinces, 1 special administrative region and 878 districts. (Thailand Administrative Division, n.d.). (Please see Figure 2 in the appendix). Within the districts are villages and farms. For illustration, please see **Figure 3** below.

Figure 3. Traceability Concept in Thailand RSS Supply Chain



Notes: This is a simplified ground up drawing to illustrate the concept.

The main driver in selecting the appropriate point of origin (POO) stems from the large number of small farms and villages. This makes traceability and mapping of ESG risks extremely difficult, which encompasses farms and villages. Hence, we propose to choose the district level as the most appropriate POO. This model with POO at district level helps to avoid most of the drawbacks associated with the farm level, such as high costs, additional workload, more resources, complicated data collection and limited supply volumes due to the small area covered. This model also captures existing benefits, which include amongst others ESG risk mapping and formulating responses. The ESG risk mapping is required for sourcing locations to identify any continuous violation of environmental and human rights issues there. District level information is sufficient because the ESG practices in an area are a good indication of the adoption of similar practices at farm level. This

approach also applies to grievances raised. When firms launch investigations into the grievances filed, it is helpful to know the district information to formulate a localised action, rather than at the country level which indirectly punishes all the supply chain actors across that country. In the event that, more details are needed for investigation, firms may potentially trace further from district to village and to the farm if necessary. For these reasons and others (discussed in earlier subsection 4.2.1.2), we propose to define the POO to be at the district level.

We can identify districts with high risk and low risk to simplify the implementation for the ESG risk mapping at the district level. If many districts with high risk fall under the same province, the province can be identified as a high risk zone. Similarly, when more low risk districts fall under the same province, the province can be identified as a low risk zone. In addition to that, those provinces with high biodiversity rich areas and with large forest reserves or protected land can also be classified as high risk zones.

In conclusion, tire makers will not want to go up to the farm level because this is the most expensive method. Hence, they need to find the most downstream level that will still capture the required ESG benefits. We do not need to go deeper into the supply chain if it is already possible to capture most of the benefits at the district level. We can stop at this point of origin (POO) at the district level.

5.2 Traceability Models Recommendation

In this sub-section, we are developing a recommendation and implementation proposal for an Identity Preserved (Model 1) with point of

origin (POO) at the district level. This requires the whole market to adopt traceable rubber sheets (marked) and the targeted stakeholders for this Model 1 will be the tire makers. The tire makers can engage with the District and village leaders to work on this Model 1. With the strong signal shown by tire makers, Model 1 will happen. However, if Identity Preserved (Model 1) is difficult to implement, cannot be implemented fully or does not work in some location upstream, we propose to implement the Bulk Commodities or Segregation (Model 2) instead. The targeted stakeholders for Model 2 will be the RSS factories and intermediaries.

5.2.1 Identity Preserved (Model 1)

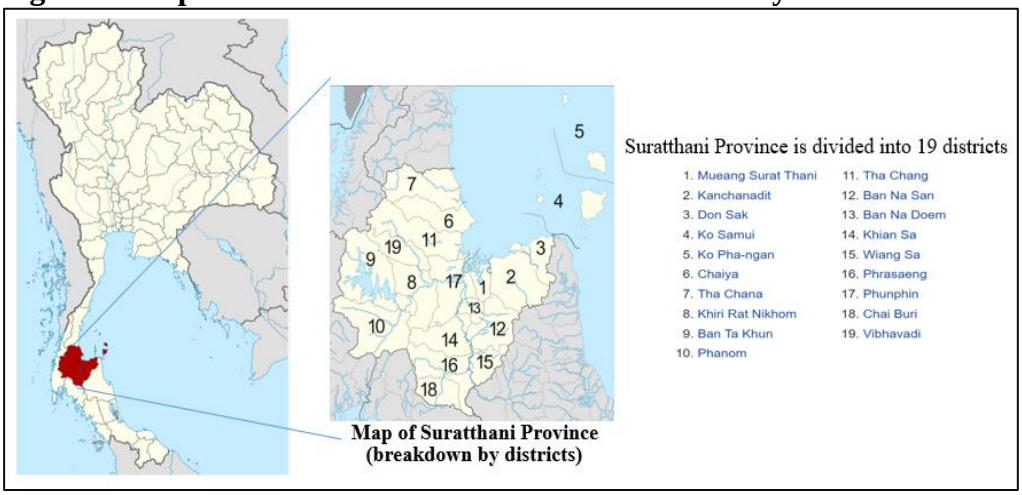
The starting point for Identity Preserved (Model 1) requires identification (marking and coding) on rubber sheets. There are two ways to increase the take up rates for marking on rubber sheets in the complex upstream Thailand RSS supply chain.

• Government policy. The requirement for marking on unsmoked sheet (USS) can be legislated by putting it into the Rubber Act. Respondent 2 says, *"We need government who has power to enforce the traceability. In Thailand, they can put this on [the] Rubber act [and] local authority can follow up smoothly."* To ensure the effective implementation of marking on rubber sheets, the Government needs to communicate the objective of this change to supply chain actors in official public meetings. It is important to emphasize the positive outcome from this policy change. Government and supply chain actors need to discuss and to have consensus on the approach to monitor. The discussion also needs to address enforcement capacities of the appointed

organization. This can quickly increase the supply of marked rubber sheets in the market. Tire makers can lobby the government if they really want this approach. However, lobbying activity is not happening because the tire industry has no intention to lobby the government for more regulations.

• Expansion of cooperatives: Another approach requires more small cooperatives to be setup at the village level to be the collection points for latex, as well as large cooperatives at the district level. The small cooperatives will bring the latex collected to the larger cooperatives within their district. In Thailand, there are 76 provinces and each province is divided into up to 20 districts of various sizes. Each district is further divided into hundreds or even a thousand villages of different sizes. Please refer to **Figure 4** below**.**

Figure 4. Map of Suratthani Province with breakdown by Districts



To ensure the success of the cooperatives, several additional measures are needed to overcome existing challenges. Government agencies and private institutions can provide financial support to strengthen cooperatives' cash flow, equip the management team with commodity trading knowledge and downstream buyers' management skills. When more cooperatives come into operations, the supply of traceable marked RSS in the market will also increase. This would happen because more farmers will bring their latex to cooperatives

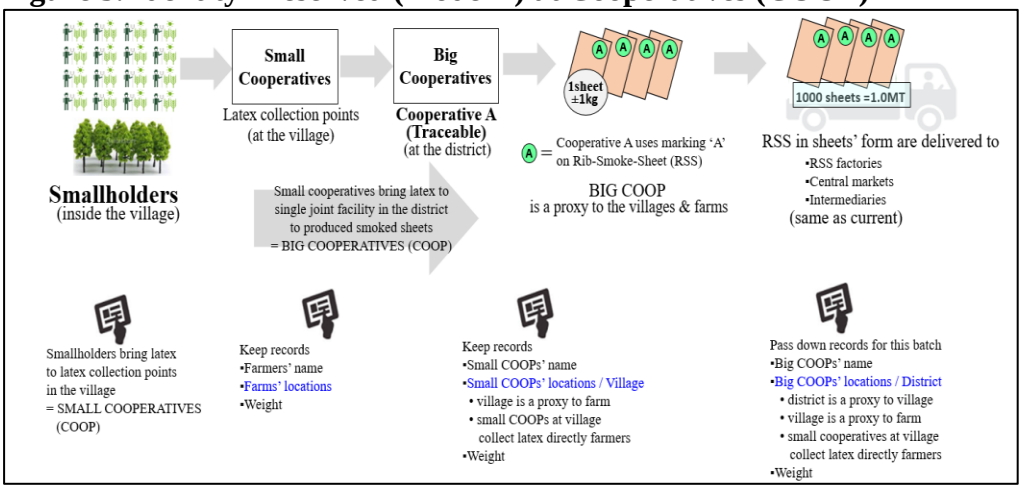
because cooperatives have stronger bargaining power and can sell the rubber at the highest auction price in the central market.

Farmers living in the same village can form cooperatives. The size and number of cooperative members varies. Interview respondents mentioned small cooperative could have members ranging from 20-50. The usual distance and travelling time for the member farmers to the cooperative location is around 15 minutes, within a 10 km radius. The farmers tend to join the cooperative that is close to them because it saves time and is convenient. The cooperatives at village areas are small and usually can collect around 5-10 MT of latex monthly. Currently not all villages have cooperatives. There is no official statistic on what is the average numbers of farmers in the village, because the condition of villages varies. However, it is common for every household to plant rubber trees. Respondent 4 says, *"Like Nabon [district], most household[s] own a bit of plantation."*

There are very few big cooperatives around. The number of farmers in big cooperatives start from few hundreds to few thousands, depending on the size of the village. The location respondents mentioned the coverage areas of big cooperatives varies greatly from above a 20 km radius to 200 km radius, with travelling time within the area ranging from 0.5-2.0 hours. Big cooperatives can produce in between 200-500 MT per month.

In this segment, guided by **Figure 5,** we will discuss how the setting up of more small and big cooperatives can increase the Identity Preserved RSS and contribute towards better traceability.

Figure 5. Identity Preserved (Model 1) at Cooperatives (COOP)



Notes: This is a simplified ground up drawing to illustrate the model.

As a start, small cooperatives in the village collect the latex only from farmers who are registered members. These small cooperatives will have all the necessary information of their members such as name, size and farm location, which is the farm level information. When small cooperatives bring the latex to the big cooperatives' facilities, their names (small cooperatives, sellers) and the weight of latex delivered are recorded as part of the transaction record for making payment. This same information is useful for traceability and can meet the objective of identifying sources at the farm level.

The big cooperatives then can process the latex into RSS and will have their unique mark on their sheets. For example, a big cooperative 'A' will have their designated marking 'A' on their RSS sheets. These big cooperatives will bring their final RSS product with markings to the next collection points: the central markets and intermediaries within the same province. They could pass down the information such as the village and farm locations for this batch of marked RSS to the RSS factories (in case of direct sales) or the collection points of the central market and intermediaries. In the event that the big cooperatives are reluctant to provide the source details, the buyers would need to record down

the location of this big cooperative which is at the district level, as a proxy for the villages and farms in its surrounding areas. In this case, the POO is at the district level, within the confines of Identity Preserved (Model 1).

The RSS factories, on accumulating sufficient volume for continuous production run, will pack the marked RSS into bales ready for export. This model requires that the collection points; central market and intermediaries, all pass down both the information of the farms' locations and list of cooperatives (big and small) when they deliver the rubber sheets to the RSS factories.

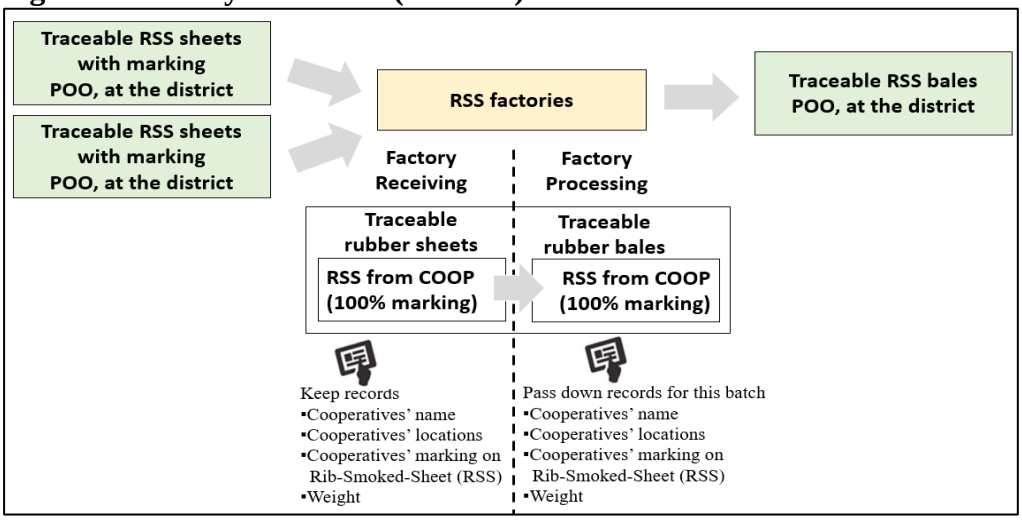
It is important to note that the big cooperatives are located inside the district. Villages and farms are a subset of district. The next buyers, who are the intermediaries, central markets and RSS factories, will group the big cooperatives' RSS by district, and will position the big cooperatives as the point of origin (POO) at district (cooperative) level.

In the above situation, there is a perfect traceability and all the RSS delivered are clearly traceable under identity preserved up to the point of origin (POO) at the district level, using the big cooperatives' markings on RSS. The RSS factories can collect and group them together into commercially viable volumes, packed into bale form for export. Similar to the collection points, RSS factories could be required to keep records on farms' locations, the cooperatives' names and district information where the traceable (marked) RSS comes from. This same information will have to be passed down to tire makers to facilitate traceability initiatives. The knowledge of the district level POO can be complemented with the batch information passed down from upstream sellers at every stage along the supply chain, to enable further tracing up to the farm level when the need arises. Please see **Figure 6**.

With many more small cooperatives set up at the village level and big cooperatives setup at the district level, the supply of Identity Preserved, marked RSS will increase in the market, because more farmers will bring their latex to these latex collection facilities setup under the small cooperatives in the villages.

It is important to note that although the RSS sheets would carry the marking of the cooperatives, it is the RSS would not be carrying the marking of the farms. We can pass on the farm information but cannot identify whether a particular RSS sheet comes from a specific farm because cooperatives draw from a group of farms. Each batch could draw from different groups of farms and could provide a different composition.

Figure 6. Identity Preserved (Model 1) at RSS Factories



Notes: This is a simplified ground up drawing to illustrate the model.

This proposal for an Identity Preserved (Model 1) enables traceability to the point of origin (POO) at district level where big cooperatives are located. With the available information of where the big cooperatives get their supply of latex, further tracing is possible to small cooperatives at the village level that serve as the latex collection points for surrounding member farms.

5.2.2 Bulk Commodities or Segregation (Model 2)

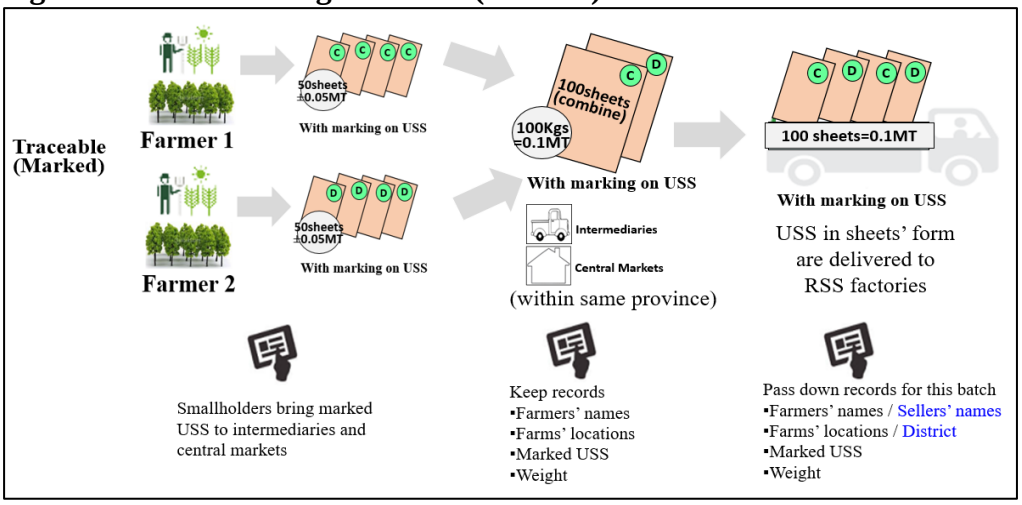
Model 2 aims to achieve traceability to the district level, based on the current operations of the farmers and existing cooperatives, in which marked and unmarked rubber sheets coexist. This model does not increase the share of sheets going to cooperatives, nor does it influence how many farmers voluntarily mark their USS. This model relies on the cooperation of the intermediaries to segregate the rubber sheets, both marked and unmarked, to maintain traceability, without the requirement for marking of all sheets.

As marked sheets can always be traced based on their marking, our discussion will focus on USS. Note that to facilitate downstream operations, the supply chain actors would be required to segregate marked from unmarked sheets. The majority of rubber sheets come in the form of unmarked USS and travel through many intermediaries, which makes them untraceable unless intermediaries who hold USS by more than one district strictly segregate the USS by district, and this segregation continues throughout the supply chain.

For a better understanding, please see both **Figure 7** where farmers bring in the traceable (marked) USS to intermediaries, and **Figure 8** where farmers bring the non-traceable (unmarked) USS to intermediaries. In both cases, record keeping is necessary to ensure traceability. Intermediaries, on receiving the USS, need to record down farmers' names, farms' locations, marking and weight of USS delivered. This information has to be passed down from one upstream actor to the next. However, intermediaries are always concerned about disintermediation once they disclose all information especially the names of their sources. To allay their concerns, the intermediaries need only disclose the district-level information and correspondent weight for each batch of USS sent

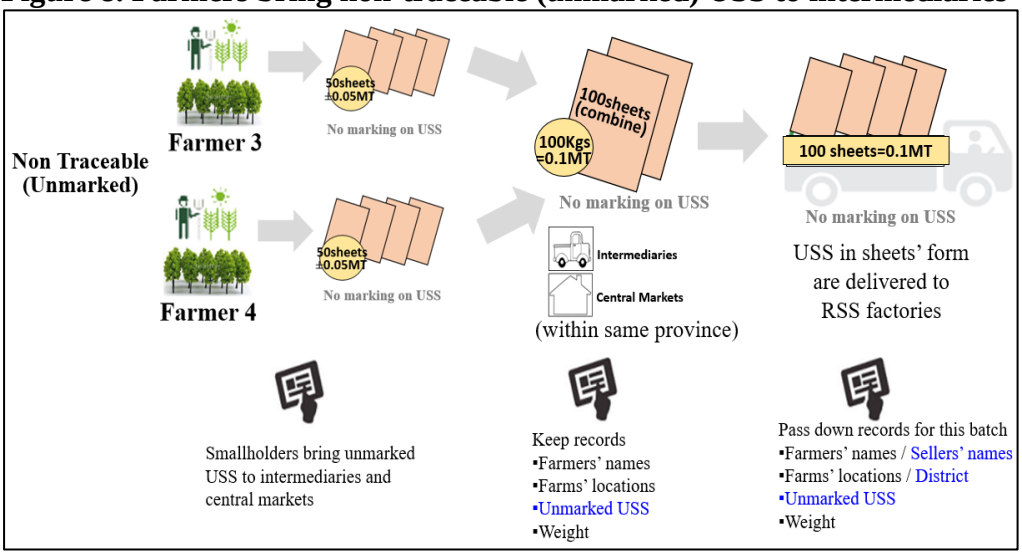
to the RSS factories. In that case, it still remains possible to trace to the district level.

Figure 7. Farmers bring traceable (marked) USS to intermediaries



Notes: This is a simplified ground up drawing to illustrate the situation
(The actual USS volumes for delivery to RSS factories will be higher than the volumes shown in above diagram.)

Figure 8. Farmers bring non-traceable (unmarked) USS to intermediaries

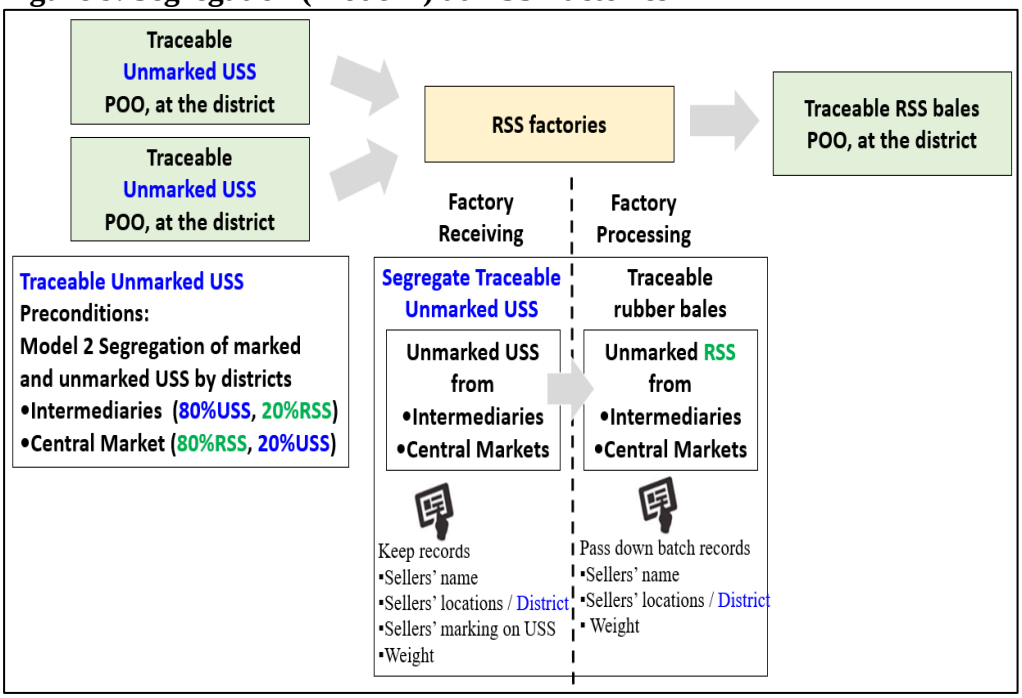


Notes: This is a simplified ground up drawing to illustrate the situation
(The actual USS volumes for delivery to RSS factories will be higher than the volumes shown in above diagram.)

The rubber sheets delivered to the RSS factory tend to have marked and unmarked sheets segregated by districts. The RSS factory can either mark the unmarked sheets to indicate their district and process all sheets as marked sheets to facilitate continuous production while maintaining traceability to the district;

or accumulate sufficient volumes of unmarked sheets from a single district to form single-district rubber bales. These batches of sheets can therefore be traceable up to the district level. Similar to the other collection facilities at the intermediaries and central markets, RSS factory also could keep records on sellers' names and locations. The most important record keeping would be the list of districts of the marked and unmarked rubber sheets received and segregated in the factories. This same information would be passed on to tire makers to facilitate traceability initiatives. Please see **Figure 9**.

Figure 9. Segregation (Model 2) at RSS Factories



Notes: This is a simplified ground up drawing to illustrate the model.

In the final analysis for Bulk Commodities or Segregation (Model 2), we can conclude that traceability is still possible up to the point of origin (POO) at district level, even in an imperfect traceability situation in the long supply chain with many layers of intermediaries. By adopting Model 2, we can increase the supply of traceable volume immediately, while waiting for the volumes that would be generated through Identity Preserved (Model 1).

5.2.3 Comparison between Model 1 and Model 2

We are proposing for the two alternative models to coexist because there are concerns that Model 1 will not work immediately as initial investment, coordination amongst farmers and district leadership are required, and it takes longer to setup. Model 2, however, is simpler to implement and will yield almost immediate benefits. Therefore, starting on Model 1 and Model 2 simultaneously will allow us to capture (partial) benefits from Model 2, while Model 1 is still in its implementation phase. If Model 1 becomes successful, it will eliminate the need for Model 2 and also greatly reduce the role of intermediaries in the Thailand supply chain.

For a better comparison, we summarize the two models, Identity Preserved (Model 1) and Bulk Commodities or Segregations (Model 2), in **Table 13** below. The summary defines the necessary conditions, as well as the various advantages and disadvantages of the two models.

Table 13. Identity Preserved vs. Bulk Commodities or Segregation

Recommendation	**Identity Preserved (Model 1)**	**Bulk Commodities or, Segregation (Model 2)**
Final Outcome	• Traceable at district level with details on Cooperative	• Traceable to district but relying on trust with intermediaries
Jurisdiction	• District	• District
Pre-condition	• Ability to expand and set up cooperatives at the village and district level • Majority of farmers belong to cooperative	• Every intermediaries with more than one district need to sort and segregate unmarked USS by district
Grouping	• Marked sheets by cooperative at the district level. • At collection points: intermediaries, central markets and RSS factories, to group cooperatives RSS by district	• Marked and unmarked USS segregated by district • Marked USS can trace up to the farm level if needed • Unmarked USS can trace only up to district level • Marked RSS can trace up to the district (cooperatives)
Advantage	• Farms level information of the cooperatives' members are known • Individual marked sheets information at district level is known • Unique marking at the cooperative level • Fairly close to the downstream	• Individual marked sheets information at farm level is known • Individual unmarked sheets information at district level is known • District level information is used as proxy to village and to farm level • No cost at the farmer • Implementation fairly easy

Table 13: Identity Preserved vs. Bulk Commodities or Segregation (cont.)

Recommendation	Identity Preserved (Model 1)	Bulk Commodities or, Segregation (Model 2)
Disadvantage	• Initial investment needed • Setting up cooperatives takes time • There will be changes in farmers' operation because farmers need to become the members of the cooperatives	• Farm level information is not 100% accessible. • Number of marked USS will not increase • Unmarked USS continue • Rely on the intermediaries to be honest about where they collect their marked USS from and those unmarked USS need to be aggregated and labelled at the district level • Intermediaries are only willing to disclose the information up to district level. • Intermediaries and RSS factories need to have high level of trust for dealers to disclose further information on farmers and farms
Transaction record for payment	• Farmers' name, location of farm, weight of latex sold	• Sellers' name and address, weight of rubber sheets sold
Information to pass down to next buyer	• Cooperatives' and districts' name, with corresponding volumes	• Sellers' and districts' name, with corresponding volumes

In conclusion, Identity Preserved (Model 1) can be expanded in Thailand's RSS supply chain through the setting up of more small cooperatives in each villages and big cooperatives at the district level. At the RSS factories or at the collection points (central markets & intermediaries), marked rubber sheets are grouped together by district, and Identity Preserved at POO is achieved. On the other hand, Bulk Commodities or Segregation (Model 2) could be implemented alongside the Identity Preserved (Model 1). This segregation model is able to counter the difficulties associated with additional layers of intermediaries in the supply chain. The unmarked USS can be sorted out and segregated by district and processed as marked sheets at district level. This can increase the traceable volumes from unmarked sheets up to district level.

5.3 Other Traceability Initiatives

Finally, we will briefly discuss the recent development of an alternative traceability initiative within the industry. In Indonesia, it is proposed to adopt a blockchain system for traceability. Blockchain is new in the rubber industry. The industry perceives blockchain as highly advanced and not so suitable for the rubber supply chain. For this system to work, farmers need to have a smartphone and the knowledge to use the application that connects to this blockchain system. This is challenging because not all farmers own a smartphone and not all farmers are digitally savvy. In reality data collection from the farm is not easy. Farmers will not voluntarily enter the data into the application on the smartphone. Hence, to make it work, rubber factories could need to organise their own team of field inspectors to visit the farm one by one, to collect and input their data into the smartphone system. Hence, the deployment on the ground is not effective and requires huge resources.

From this research, we have identified marking as possible on RSS. We can exploit this concept and apply to cup lump although it is not common. Cup lump is used to produce block rubber. Theoretically, it will be more resource intensive to introduce markings on cup lump as smallholders and plantation owners would need to invest in the new cups with marking. This is not traditionally done but it is possible with some cost. To ensure this works, it requires support from the farming community.

If we compare the two options, using marking on cup lump will be more cost effective compared to using blockchain. The initial investment for putting marking on cup lump is smaller than compared to investing in a smartphone. For marking on cup lump to work and to scale, we would also require collection

centre facilities and cooperatives set up, with close proximity to farmers at district level. Farmers could bring their marked cup lump to this centre, with similar approach as in Thailand.

5.4 Critical Success Initiatives with Supply Chain Actors

For the proposed Identity Preserved (Model 1) and the alternative Bulk Commodities or Segregation (Model 2), several critical success initiatives must be implemented alongside the traceability process. We need the incentive to flow through the supply chain starting from the tire makers to their tier-1 suppliers and from their tier-1 supplier to their next tier along. The incentive needs to be given by tire makers to those they have business relationships with. Tire makers need to incentivise their own tier-1 suppliers for them to cooperate and to participate in the model process. The incentives can be monetary or motivational approaches, such as providing public recognition in the form of special awards, increasing business volumes over time, preferential treatment for future business, technology transfer opportunities and priority lanes for new factory approvals.

The downstream users, the tire makers, can consider increasing their direct business engagement and collaboration with their immediate suppliers. They can award special trading status such as Preferred or Partner supplier for more business volume that has traceability as a pre-condition. Additional clauses to the supply contracts could assist in achieving traceability and ESG objectives. Respondent 9 says, *"Downstream buyers like tire makers need to set pre-condition in the contracts."*

With the official contracts in place between downstream users, the tire makers and their immediate RSS suppliers, they can request their suppliers to provide self-declaration that their supply chain activities are complying with good environment and human rights practices. Tire makers can request their RSS factories to conduct periodical self-assessment on their upstream supply chain. They can also choose to conduct on-site verification to confirm the actual situation, based on a risk-mapping and sampling approach.

The tire makers together with their preferred RSS suppliers, could collaborate further with their upstream supply chain actors. Once the tire makers are able to identify the point of origin (POO) at the district level where they source the rubber sheets from, tire makers can co-work with their RSS suppliers on a series of programs, which bring benefits to the smallholders. In the Bulk Commodities or Segregation (Model 2), the traceability process will proceed smoothly when there are sufficient levels of trust and good business relationships between the RSS factories and the intermediaries. It is an assurance of no disintermediation, if intermediaries were to disclose the district level where the traceable (marked and unmarked) USS comes from. Without this strong level of trust, this Model 2 will not work well with the recommendations made here.

Tire makes that work hand-in-hand with their preferred RSS suppliers can deepen their engagement levels with the farming community on location, to provide valuable, in-kind support in terms of trainings, capacity building outreach programs, donating high quality clones, etc. Ideally, the duration of the program should be long enough (e.g. 3 years) to have an impact on the ground. During this periods, data collection, monitoring, and impact

assessments can be made. This can fulfil ESG compliance requirements, industry needs for stable supply and contribute to development in the smallholders' communities.

5.5 Limitations and Future Research Direction

Similar to other qualitative research, there are several limitations. First, the researcher is the primary data collector and analyser. Hence, there may be limitations arising from the bias of the researcher. Second, the traceability models proposed in this thesis have not been implemented on the ground.

Due to time constraints, my research focuses on Rib-Smoke-Sheet (RSS) supply chain. For future research, the study can be extended to latex and block rubber to examine any similarity and differences in the traceability approaches due to the different physical form of the products. The research can also expand to other natural rubber producing countries, to find out if there exist country-specific supply chain difficulties, which affect traceability.

It is important to note that traceability requires a level of institutional capacity in both monitoring and enforcement, that is currently lacking in Thailand's rubber supply chain. It is interesting to look into institutional development in either the government or business (or both), for incentives to exist for actors on the supply chain. We can also take into consideration if the supply chain actors may resist or not comply with traceability requirements despite the incentives offered.

In addition to that, it will be interesting to look into digitalizing the traceability information in the natural rubber supply chain. This can start with analysing type of digital tools in market, which is suitable to capture the

traceability information flow. Thereafter, we can analyse the role of digitalization in accelerating the adoption of traceability. Finally, it will be interesting to analyse the performance of companies in the rubber industries over the next few years as most of them are beginning to study and adopt various traceability initiatives. We can review what are the critical success factors for these companies that do well and what are the reasons for companies that do not.

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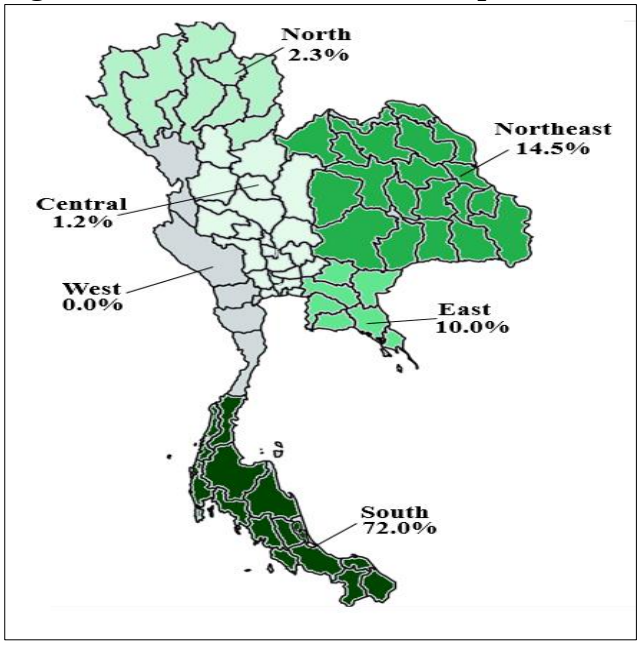
APPENDIX

Table 1. Publications related to Natural Rubber Sustainability Concerns

Year	Concerns	Articles
2013	Land Grabs	**Rubber Barons** In Rubber Barons, Global Witness documents the devastating impact of Vietnam's rush for rubber on local communities in Laos and Cambodia.https://www.globalwitness.org/en/campaigns/land-deals/rubberbarons/
2015	Land Rights	**Guns, Cronies and Crops** Myanmar's business, political and military cronies conspired to grab farmers' land, leaving communities struggling to survive.https://www.globalwitness.org/en/campaigns/land-deals/guns-cronies-and-crops/
2016	Deforestation	**Don't Let your Tires Destroy the World's Forests** All industry stakeholders should come together to join the good cause in realising responsible rubber production – not deforestation. https://time.com/4391096/rubber-deforestation/
2018	Deforestation, Land Grabs, Human Rights etc.	**EU Consumption of Rubber and Deforestation** This article highlighted key concerns on natural rubber upstream supply chain and calling EU as a key consumer, to play an influential role to change the situation by making sustainable choices. https://www.fern.org/publications-insight/eu-consumption-of-rubber-and-deforestation-31/
2018	Deforestation, Human Rights, Biodiversity etc.	**BADYEAR Driving Deforestation** This article accused Goodyear tires for endangering species, and human right abuses by continuously sourcing natural rubber from problematic suppliers. https://www.mightyearth.org/wp content/uploads/2018/04/2018_April_25_Goodyear_Investigation_FINAL.pdf

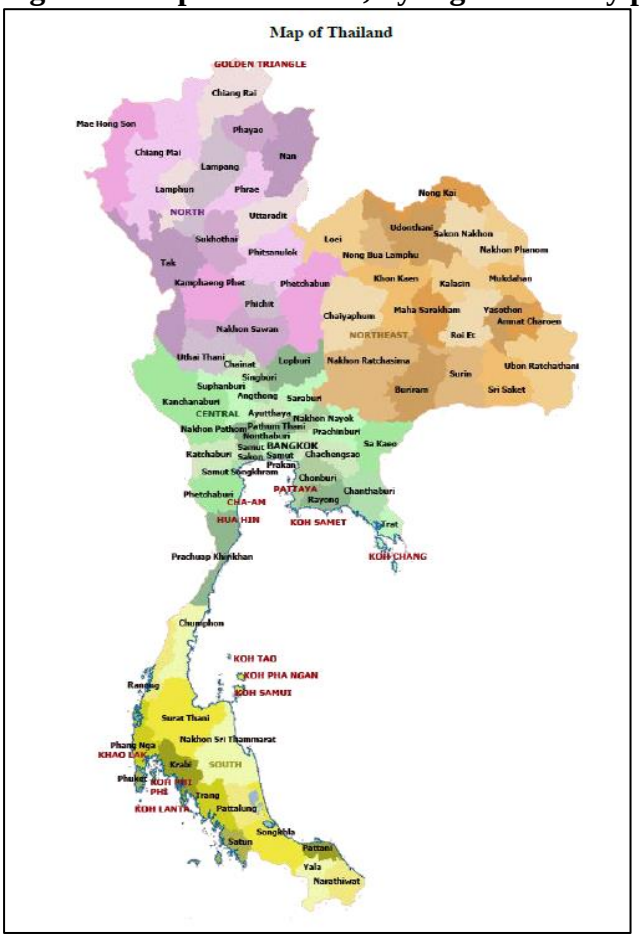
2019	Land Grabs, Human Rights, Biodiversity loss, etc.	**Alleged human rights abuses at Cameroon rubber plantation pile pressure on Sudcam** The article unveiled the forest clearing activities by rubber company has affected local communities, environment and biodiversity here. https://www.earthsight.org.uk/news/idm/human-rights-abuses-cameroon-rubber-plantation-pressure-sudcam
2019	Deforestation Land Grabs Habitat loss, etc.	**Infographic: The Hidden Cost of Rubber** This article summarized the sustainability concerns in upstream rubber supply chain and called for actions to switch to sustainable rubber. https://www.mightyearth.org/2019/07/03/infographic-the-hidden-cost-of-rubber-2/
2020	Deforestation, Land Grabs, Biodiversity loss, etc.	**Complicit: An Investigation into Deforestation at Michelin's Royal Lestari Utama Project in Sumatra, Indonesia.** This report claimed tire company is covering up industrial-scale deforestation in a rubber joint-venture project in Sumatera Indonesia.https://www.mightyearth.org/2020/10/08/complicit-an-investigation-into-deforestation-at-michelins-royal-lestari-utama-project-in-sumatra-indonesia/
2020	Labor Rights, Environmental issues, etc.	**Report: Bridgestone Connected to Ongoing Labor and Environmental Concerns on its Liberia Rubber Plantation** Mighty Earth documented down findings on social and environment concerns in Bridgestone's Liberian Rubber Plantation and a plan for remediation. https://www.mightyearth.org/firestone
2020	Deforestation, Land Rights, etc.	**European Consumers Demand Sustainable Natural Rubber: Survey** The survey respondents showed concern over the risks posed by unsustainable methods of natural rubber production. https://www.mightyearth.org/2020/10/14/european-consumers-demand-sustainable-natural-rubber-survey/
2021	Deforestation, Land Rights, etc.	**The Unfashionable Truth About Unsustainable Latex Rubber** This article listed down several sustainability concerns surround the rubber producing countries in Southeast Asia and Africa https://www.mightyearth.org/2021/01/26/the-unfashionable-truth-about-unsustainable-latex-rubber/

Figure 1. Thailand natural rubber production areas



Notes: Map is constructed using data from Rubber Research Centre Thailand. South Thailand is the traditional natural rubber growing area. North-Northeast Thailand is the non-traditional rubber growing area.

Figure 2. Map of Thailand, by regions and by provinces



Source: Thailand Administrative Division