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Analysis and Design of an Advanced Para Rubber Information System in Adherence to the Rubber Control Act 1999 for Rubber Supply Chain Management

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Abstract

To effectively oversee and manage Para rubber across the supply chain at the national level, the Government of Thailand issued the Rubber Control Act in 1999 and declare the Notification No. 13 in 2019 mandating collection of rubber plantation and trade information in order to regulate rubber industry and support nationwide strategic decision-making. However, challenges exist concerning data incompleteness and inconsistencies as well as information linkage since collected information is scattered among various government bodies overseeing rubber-related activities. The primary objective of this study is thereby to explore and adopt technologies for integrating scattered Para rubber information as well as to analyze and design a rubber information system to streamline data collection and data utilization in adherence to the provisions outlined in the Rubber Control Act of 1999 and Notification No. 13. The rubber information system analysis and design include analyzing rubber supply chain information, designing a system prototype, and developing a blueprint that facilitates operational procedures by systematically gathering data from transactions occurring at various stages of the rubber supply chain, encompassing farmers, trade dealers, manufacturers, and exporters. When the design and the prototype provided by this study

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are developed, key entities that manage Thailand's overall Para rubber can leverage the rubber information system and the integrated rubber information for strategic and well-informed decision-making.

Keywords: Rubber Information System, Rubber Supply Chain, Rubber Control Act 1999, Decision Support System, Para Rubber

Introduction

Natural rubber or Para rubber is one of the most important economic crops in Thailand with more than a million growers and nearly 3.5 million hectares of natural rubber planted (Pinitjitsamut, 2017). To ensure effective nationwide management of Para rubber, the government had passed the the Rubber Control Act of 1999 (Rubber Control Act, 1999) and Notification No. 13 (2019) from the Central Committee on Prices of Goods and Services, as issued by the Ministry of Commerce. The Rubber Control Act comprehensively regulates the upstream to downstream stages of Para rubber production, encompassing various economic activities such as planting, selling, purchasing, processing, licensing, and exporting. Legally, rubber farmers are required to register and report their natural rubber plantations. Traders within the rubber supply chain are also obligated to register for license, submit trading reports, detailing volume, type, price, and remaining inventory. Furthermore, traders must verify and record the license identification of all parties involved in transactions and record the quantity of rubber traded. The law also mandates the documentation of traded or exchanged volumes for accounting purposes.

However, part of this information is still recorded on documents with a time lag and limited traceability, and part of the information, even though on an information system, is scattered among relevant governmental offices such as the Rubber Division, Department of Agriculture (DOA) and the Rubber Authority of Thailand (RAOT), for specific purposes. In addition, not all rubber farmers and traders nationwide are registered. The current state of rubber management in the country is therefore hindered by constrained access to vital information and the haphazard distribution of data among relevant offices. This deficiency in accurate and dependable rubber information also raises uncertainties and obstructs data analysis essential for well-informed decision- making. Consequently, this hampers the ability to address the intricate and persistent issues within the Para rubber system, leading to missed opportunities and inabilities to effectively influence or guide the selling price of Para rubber in the international market.

This study therefore aims to comprehensively analyze and design a Rubber Information System in strict adherence to the provisions stipulated in the Rubber Control Act of 1999 and Notification No. 13 (2019) from the Central Committee on Prices of Goods and Services, as issued by the Ministry of Commerce. To accomplish it, we must meticulously identify and analyze the operational processes within the Para rubber supply chain, scrutinize the information life cycle, assess data integration technology, and design the Rubber Information System in accordance with the Rubber Control Act of 1999 and Notification No. 13. Once implemented, this comprehensive system could be utilized by key stakeholders, including the Natural Rubber Policy Committee (NRPC), Department of Agriculture (DOA), and the Rubber Authority of Thailand (RAOT), as a decision support system that augments the efficiency of Thailand's overall rubber management. These entities can leverage the system to oversee and manage the Para rubber system across the supply chain, ultimately enhancing the effectiveness and reliability of rubber

information for strategic and well-informed decision-making, similar to how the Fishing Info system (Department of Fisheries, 2014) can be utilized to support government for decision-making related to fisheries.

Objective

1. To explore and utilize technologies for integrating information among relevant organizations for seamless communication allowing systematic and efficient collaboration.
2. To analyze and design a rubber information system for Para rubber in accordance with the Rubber Control Act of 1999 and Notification No. 13 (2019) issued by the Ministry of Commerce.

Definition of Terms

Application programming interface (API) is a technology that provide a standardized way for applications to interact and share data, enhancing interoperability and efficiency in the digital ecosystem, thereby appropriate for integrating information among relevant organizations.

A prototype is a preliminary version of a design or a system created for the purpose of evaluating concepts or functionalities. It serves as a representation that allows stakeholders to visualize and assess key aspects of the final system before it is fully developed so that stakeholders can make informed decisions.

Expected Benefits

This study brings multiple benefits to key entities that manage Thailand's overall Para rubber. First, the prototype of a Para rubber information system resulted from this study should provide experimental model which can guide system development and reduce risks associated with system deployment. The study also employs a technology that helps integrate Para rubber information among relevant organizations resulting in seamless and efficient collaboration. With the prototype and the integrated data, an information system can be developed allowing Para rubber organizations such as the Natural Rubber Policy Committee (NRPC), Department of Agriculture (DOA), and the Rubber Authority of Thailand (RAOT) to efficiently oversee and manage the Para rubber system across the supply chain, ultimately enhancing the effectiveness and reliability of rubber information for strategic decision-making.

Research Methodology

In this study, our primary objective is to leverage a technology to integrate and interconnects data and to scrutinize an operation-based data structure system, aligning it with information and software engineering principles, for the purpose of designing and developing an information system and databases. To ensure a comprehensive analysis, qualitative research will be employed to gather insights, opinions, and recommendations from experts, stakeholders, and other relevant individuals. The methodology encompasses the following sequential steps:

1. Document Research: This step involves an extensive review of various sources, including documents, academic articles, research reports, statistics, as well as legal and regulatory materials related to Para rubber.

2. Data Survey and Analysis: The importance of different types of rubber data will be assessed in accordance with the stipulations outlined in the Rubber Control Act of 1999 and Notification No. 13 (2019).

3. Supply Chain Information Analysis: This step involves a meticulous examination of analytical data and fundamental information about Para rubber, focusing on parameters outlined in the Rubber Control Act of 1999 and Notification No. 13 (2019). This includes aspects such as planting area, productivity, export volume, domestic consumption, tire prices, and the rubber processing industry.

4. Technology Survey and Analysis: This step involves survey of various technologies that can help integrate information and system development.

5. Drafting a Blueprint for the Rubber Information System: The design of functions and technology for the rubber information system will be undertaken by delving into theories and principles of information systems, data integration, artificial intelligence, big data, system development, and data integration and prototyping.

6. In-Depth Interviews: Conversations will be conducted with various stakeholders, including experts, policy-making officers, rubber farmers, cooperatives, and other individuals actively engaged in the rubber industry.

7. Presenting Study Results and Conducting Public Hearings: The findings of the study will be presented, and public hearings will be conducted to ensure transparency and solicit input from a broader audience.

This comprehensive approach seeks to not only analyze the technical aspects of the information system but also to incorporate valuable perspectives and insights from key stakeholders, fostering a holistic and well-informed development process.

Results and Discussion

This section provides results and discussion following seven sequential steps of the methodology described in the previous section.

Document Research

At the document research step, documents and reports relating to this study are reviewed such as the Rubber Control Act of 1999 and Notification No. 13 (2019), documents and reports such as case study reports on a fishery information system.

The study of the Rubber Control Act of 1999 and Notification No. 13 (2019) finds that the Act regulates the upstream to downstream stages of Para rubber production, including economic activities such as planting, licensing, selling, purchasing, processing, and exporting while the Notification mandates rubber traders with high trade volumes to provide accounting reports. Under the Rubber Control Act of 1999, rubber farmers must register their lands and report their natural rubber plantations. Rubber traders within the rubber supply chain must apply for license, report their trades including volume, type, price, and remaining inventory to the competent authority (DOA) by the 10th day of the subsequent month. In addition, traders are required to verify and record the license identification of all parties involved in transactions. The Act also details penalties if rubber farmers or traders do not follow the Act. Under the Notification No. 13 (2019), rubber business operators with a monthly trading volume of five thousand

kilograms or more are required to report their trading activities and must compile three types of monthly documentation, namely rubber purchasing logs, rubber selling logs, and rubber inventory records, specifying rubber type, sale and purchase volume, consumption or processed volume, remaining stock, and storage location. These documents are required to be submitted to officials by the 10th day of the subsequent month. They must also maintain daily inventory accounting records, updating them within three days of the transactions, and submit them to the competent authority, the Ministry of Commerce (MOC).

In addition, the “Fishing Info (E-PIPO)” information system (Department of Fisheries, 2014) is also studied. The Fishing Info is an information system developed by Department of Fisheries aiming to integrate fishing-related information from various sources to enable government officials to control and inspect fishing boats as well as to quickly detect and stop illegal fishing activities. The fishing-related information needed for the information system includes fishing boats information, fishing license information, fishery labour information, and fishing boat location tracking information. The information is integrated from various government agencies such as Department of Fisheries, Marine Department, Royal Thai Navy, Thai Marine Police Division, and Department of Labour Protection and Welfare.

Data Survey and Analysis

The results from the document research step demonstrate that the development of the information system for Para rubber in accordance with the Rubber Control Act of 1999 and Notification No. 13 (2019) requires following data: rubber farmers, rubber plantations, rubber traders and dealers, planting activities, rubber trading licenses, and trade accounting.

During the data survey and analysis, we found that the required data is collected only partially and is scattered among relevant governmental offices such as the Rubber Authority of Thailand (RAOT), the Rubber Division, Department of Agriculture (DOA), and the Department of Internal Trade, Ministry of Commerce. For example, the RAOT collects rubber farmer information where rubber farmers, both as individuals or corporations, are encouraged (but not required) to register with the RAOT to receive funding and welfare benefits. The Rubber Division collects rubber trading license information where rubber traders are required to register for trading licenses including trading rubber domestically, importing and exporting rubber internationally. The Department of Internal Trade, Ministry of Commerce collects rubber trade accounting reports from rubber business operators with a monthly trading volume of five thousand kilograms or more under the Notification No. 13 (2019).

In addition, some of the information is still collected manually. Only the rubber trading licenses are collected and processed via an information system. The Rubber Division, Department of Agriculture (DOA) provides an information system for rubber traders to conveniently register for trading licenses (Rubber Division, 2020). The RAOT only has an information system to check and verify that a rubber farmer has been registered, but the rubber farmers must fill out the registration applications using paper forms and submit the forms on site at the RAOT main office or local branches (Rubber Authority of Thailand, 2015). Rubber business operators must submit trading reports via postal mail, fax, or email to the Department of Internal Trade, Ministry of Commerce as detailed in the Notification No. 13.

There are other existing information systems from the RAOT and the Rubber Division, but they are not directly related to the Rubber Control Act of 1999 and Notification No. 13 (2019) such as the Replanting Fund System, Central Market System, the Export Fee Collection System (e-CESS), and the National Single Window (NSW) for importing and exporting information.

Supply Chain Information Analysis

Evidently from the results of previous steps, the regulation and the requirements from the Rubber Control Act and the Notification No. 13 provide the foundation of national Para rubber strategy management for the government. Figure 1 shows activities need to be recorded as required by the Act such as various type of licensing and illustrates DOA officers' tasks to review information and record comments.

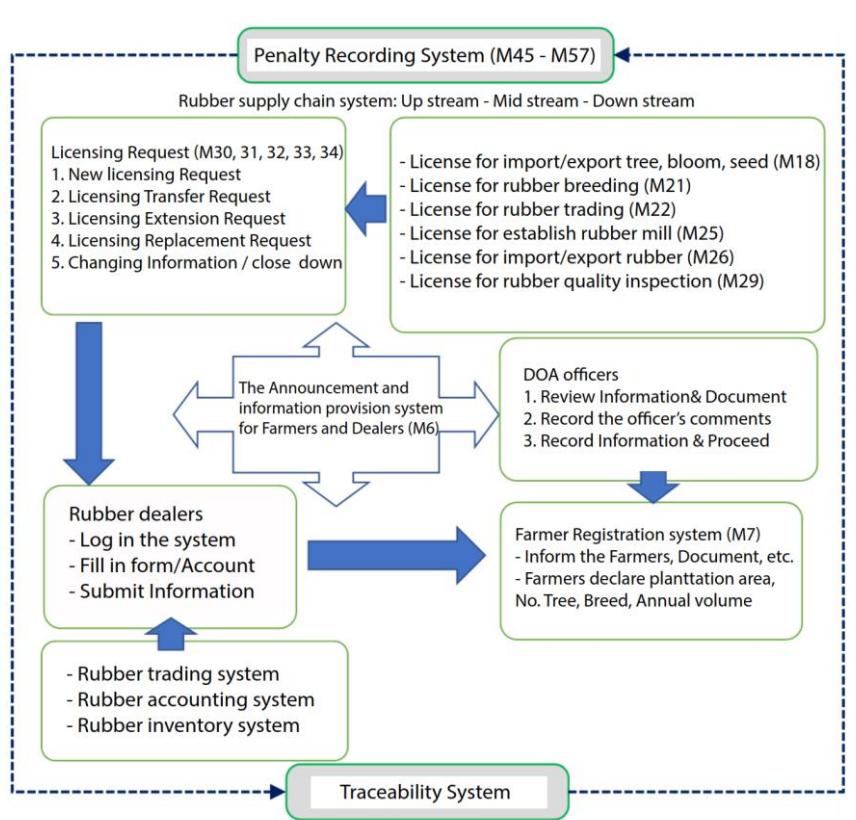


Figure 1 Diagram of Rubber Information in Compliance with the Rubber Control Act 1999 and Notification No.13

The above findings lead to the need for integrating information among relevant organizations and a centralized rubber information system to efficiently manage the Para rubber system across the supply chain for strategic decision-making. This study focuses on exploring appropriate technologies for integrating information and design a prototype of a centralized rubber information system. Additionally, this research introduces a penalty record system (Sections 45-57), a rubber traceability system, and a farmer registration system (Section 7) to augment the oversight and efficiency of the Para rubber system.

Technology Survey and Analysis

The technology survey and analysis explore various technologies for integrating information and technologies and processes for developing an information system. Technologies for integrating information includes

databases and data services using Application programming interface (API). Databases are essential technologies for storing and collection data. Application programming interface (API) allows data integration among various sources and databases. An API provides a standardized protocol for communicating and sharing data. The typical usage is to implement APIs for databases that need to be shared. When any applications need to retrieve data from particular databases, instead of accessing the databases directly, the applications can access data via APIs. To utilize APIs effectively and efficiently, the APIs must be carefully designed and implemented.

Technologies and processes for developing an information system includes software engineering tools and practices and must underwent a structured process involving five key phases:

1. System Requirements Analysis: The initial step focuses on thoroughly analyzing the requirements of the system.
2. System Design: This phase includes the design of crucial elements such as APIs, user interfaces, system architecture, and databases.
3. System Development: Following the design phase, the actual development of the system takes place. The system is written carefully using programming languages and frameworks.
4. System Testing: Rigorous testing is conducted to ensure the functionality, reliability, and security of the system.
5. System Deployment: The final step involves putting the system into operation.

Drafting a Blueprint for the Rubber Information System

At the Drafting a Blueprint for the Rubber Information System step, we follow the above structured process up to the design phase and produce the design of the prototype of the rubber information system as shown in Figure 2. The core rubber information system comprises of four main components as follows.

- (1) The rubber farmer and plantation registration system (M.7) component for rubber farmers to register and report their natural rubber farms and plantations.
- (2) The e-licensing system to manage rubber trader license registration and related licensing processes including activities such as establishment of rubber factories; import-export procedures; and arrangements for analysis and testing of rubber services.
- (3) The rubber supply chain and traceability system for traders to record daily transaction activities of rubber dealers such as buying, selling, exchanging rubber; import-export of rubber trees, florets, and seeds; propagation of rubber trees for trade. These records can be compiled into rubber purchasing logs, rubber selling logs, and rubber inventory records as required by the Act. Since the license information can be integrated via APIs, the licenses of involved traders can be verified by the system. This component helps provide rubber traceability.

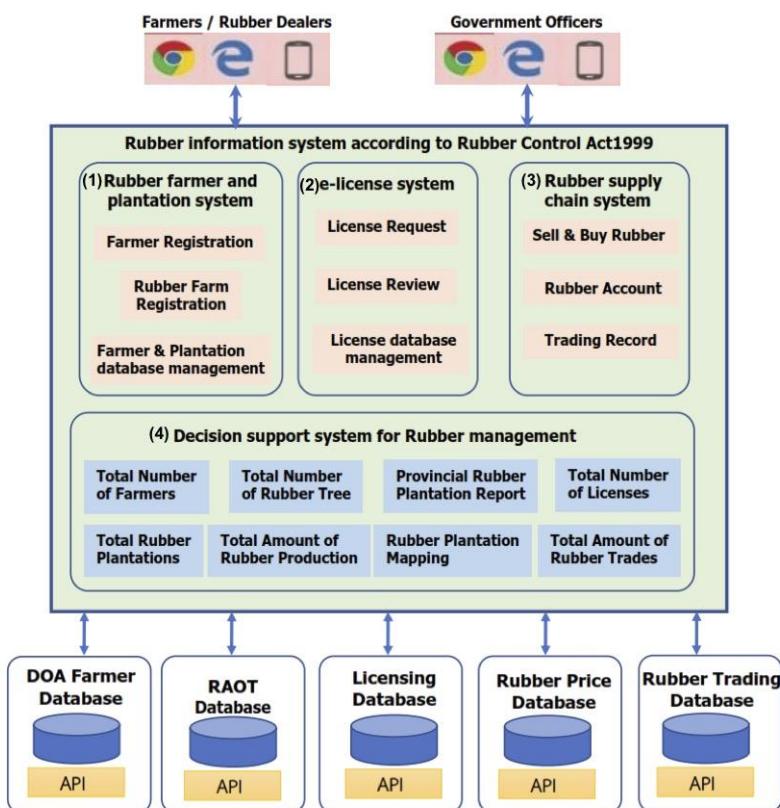


Figure 2. Rubber Information Systems Architecture under the Rubber Control Act 1999 and the Notification No.13

(4) The decision support system providing various dashboards and statistics to assist government officials and executives to oversee the Para rubber system across the supply chain for strategic decision-making.

The bottom of Figure 2 shows APIs for each database to be integrated with the core system enabling cross-operations such license verification and rubber traceability.

In-Depth Interviews and Presenting Study Results and Conducting Public Hearings

During the step 6, In-Depth Interviews, and the step 7, Presenting Study Results and Conducting Public Hearings, we have interviewed prominent leaders in rubber industry and government officials as well as presented study results and conducting public hearings. The interviewees include the Chairman of the Federation of Rubber Planters Association of Thailand, the Deputy Governor of the Rubber Authority of Thailand, the ex-Deputy Director of the Rubber Research Institute, and an official from Rubber Division, Department of Agriculture (DOA) (Pinitjitsamut, 2020).

The feedback from the interviews and the hearings concludes that while the utilization of rubber information is integral, challenges still persist for agencies operating under the Act, particularly concerning data inconsistencies and information linkage among various government bodies overseeing rubber-related activities. Notably, the completeness of rubber plantation and farmer registration data faces hurdles, as private large plantation estates may be hesitant to register outside government initiatives. Given the critical role of data analytics, regular analysis becomes essential for long-term planning and policy development.

To address these challenges, the development of mobile applications for farmer registration, rubber trade, and other information systems is recommended to enhance transparency and provide real-time data. Establishing confidentiality levels for rubber information is also crucial, and the creation of a data analytics center is proposed to disseminate information on the rubber situation to the public. This center, supported by academic experts, would engage in activities related to the rubber economy, the rubber product market, and supply-demand forecasting trends. Moreover, it would address the limitations faced by farmers' institutions and individual farmers in accessing the rubber information system.

Ultimately, this study recommends that the government institute policies should aim at developing a rubber information system in accordance with the Rubber Control Act of 1999. Furthermore, incentives for farmers and entrepreneurs should be provided to encourage their participation, thereby mitigating transaction costs and fostering increased trade opportunities.

Further Discussion and Policy Implications

Nevertheless, the comprehensive rubber information system development recommended by this study requires budget allocation and additional policies to assure the success of the development and the achievement of high participation in using the rubber information system. Therefore, a strategic allocation of budget by the government to the Department of Agriculture (DOA) is recommended for the expeditious development of a rubber information system in order to align seamlessly with the operational requirements of the Rubber Control Act of 1999. Policies regarding the establishment of a central database that integrates and interconnects various related systems need to be enacted. Incentive mechanisms for active participation in the rubber information system should be introduced for both farmers and rubber dealers. Furthermore, endeavors should be undertaken to encourage farmers and entrepreneurs to align their operations with the information system.

Moreover, educational initiatives should be organized to disseminate knowledge and provide training to farmers and entrepreneurs, fostering a better understanding of the information system's benefits. Collaborative efforts with financial institutions, as outlined in Section 4 of The Rubber Authority of Thailand Legal (2015), could lead to the development of credit benefits, further incentivizing participation. In addition, mobile applications tailored to trading activities are also recommended to mitigate trading transaction costs and create more trading opportunities, thereby contributing to the overall efficiency and competitiveness of Thailand's Para rubber sector.

Conclusion

This research study accomplishes the objective of analyzing and designing a rubber information system in accordance with the Rubber Control Act of 1999 and Notification No. 13. The purpose of the rubber information system is for the government to leverage rubber information processed by the system to effectively oversee and manage Para rubber across the supply chain. Since existing rubber information is scattered among government bodies overseeing rubber-related activities, this study also explores and adopts technologies for integrating information using Application Programming Interface (API). We draft a Blueprint for the Rubber Information System following the information system analysis and design and incorporate information integration technologies in link information from various sources. Additionally, the interviews of prominent leaders in rubber industry and

government officials as well as the public hearings provide feedback, challenges, valuable foresights with further recommendations on budget allocation, supporting policies, and educational initiatives.

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