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The impact of transport infrastructure development on modal shift: case study of rubber goods in the southern Thailand

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Abstract

Thailand is a major agricultural production country in the Southeast Asia. The government has promoted developments of transport infrastructure to increase the value of agricultural goods and reduce the transportation costs. However, such developments are still in strategic plans of all products, not by product. This paper studies the impact of transport infrastructure development on a modal shift for rubber product transport in the southern Thailand. The multimodal transport model was developed to evaluate the impact. The results show that if all government projects, including the improvement and expansion of major roads to have at least four lanes along with the development of rail and water transports, are implemented; the transport time and cost could be reduced. However, there are a few modal shifts because the development of rail and water transports is insufficient to make the rail and water transports more convenient than the road transport. Therefore, more rail and water transport facilities, e.g. transfer points between truck and train (and port) as well as road network connecting the center of cargo transshipment and port, should be improved to enhance the capability of transport infrastructure in Thailand and interregional trade.

Keywords: Modal shift, Transport infrastructure, Rubber goods, Southern Thailand

1. Introduction

Transport infrastructure development is vital to the well-functioning of economic activities and a key to ensuring social well-being and cohesion of populations [1]. The Thai government has a strong focus on the development of transport infrastructures to support the logistics process in Thailand. This resulted that 87.5% of the cargos in Thailand was mainly transported by trucks on roads. Only 1.4% and 11.08% were transported by rail and ship, respectively, because the development of rail and water transports has been limited [2].

Thailand is a major export country of natural rubber in the Southeast Asia and also ranked as the world's largest producer and exporter of the natural rubber [3-4]. In 2014, the total amount of natural rubber exports was 3.41 million tons or US$ 6,021.54 million [5]. However, the rubber prices have fallen since 2011 because of global production surplus and the reduction of purchasing power from partner countries. As a result, the government has been attempting to limit the exports, reduce the amount of supply, and reduce the transport and logistics cost.

Recently, the government has promoted the Strategies to Improve Transportation Infrastructure in Thailand 2015-2022 [2]. The strategies include several transport infrastructure developments that aim to reduce the transport and logistics costs. However, such the developments are still in the strategic plans of all products, not by product. The objective of this paper is to evaluate the impact of transport infrastructure development, based on the above strategies, on a modal shift for freight transport. A case study of rubber products in the southern Thailand was focused in this paper. The paper consists of four main sections. The next section explains the development of the national transport model. The results of model application are presented in Section 3. Finally, Section 4 concludes the paper.

2. Development of national transport model

Several studies have been conducted on modeling freight transport, e.g. [6-8]. In Thailand, freight transport models were also developed based on the multimodal network assignment [9-10]. In this study, the national transport model for Thailand was further developed based on the study by Jaensirisak et al. [10]. In their study, the model was developed based on the four-stage model (see [10] for the details). The model includes lift-on and lift-off points between road and rail, and between road and water. However, there is no direct connection between rail and water transport in Thailand. In this paper, we separated all freight products into the rubber goods and other products. The passenger transport demand was also analyzed

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simultaneously in the network assignment. Thus, the developed model can evaluate the impact of transport infrastructures (road, rail, and water) on the freight transports (rubber goods and other products) and passenger transport simultaneously. The details of the model development can see in [11].

The data related to the volume and the transport costs of rubber products exported in the base year 2014 were collected and analyzed (see [11]). In total, the natural rubber exports by the southern Thailand amounted 2.855 million tons (75.7% of the country). 81.2% were transported by road, when 14.1% and 4.7% were transported by water and rail, respectively. The transport costs were found at 2.29, 0.509, and 1.065 Baht/ton-kilometers in that order.

The national transport model was calibrated using the Average Annual Daily Traffic (AADT) data observed on the network. The value of R2 between the observed and modelled flows was 0.9597, which is desirable.

3. Impacts of transport infrastructure development on modal shift

Based on the Strategies to Improve Transportation Infrastructure in Thailand 2015-2022 [2], this study sets up four scenarios to test the impact of transport infrastructure development and a reduced service cost on the modal shift for freight transport. The scenarios include:

- Scenario 1 – Road network improvement and expansion: the improvement included lane expansion of the current road network to have at least four lanes. Five motorway routes starting from Bangkok to five directions were also considered.
- Scenario 2 – Railway improvement: upgrading existing single rail track to double tracks which increase average freight speed from 30 kilometers/hour to 60 kilometers/hour.
- Scenario 3 – Water transport improvement: reduce 50% of the interchange time (between road and water transport) and 30% reduction of freight service cost. The improvement is mainly on the coastal ports in the Gulf of Thailand.
- Scenario 4 – Combination of the scenarios 1-3.

The developed model was applied to test the above four scenarios. When the transport infrastructures were developed; transport cost and time of transport routes and modes between origins and destinations would be changed. As a result, the freight volume would be changed to the highest utility routes or modes. For each scenario, transport cost, time and service charge of transport routes and modes are changed differently. The model was used to evaluate the effects by estimating the freight volume (in Tons) for each mode, as shown in Table 1 and Figure 1. For the base case (do-nothing) in 2014, it can see obviously that the road transport dominates almost all freight transports in Thailand. For the future year, the results can be summarized that:

Table 1 Modal shares in terms of Tons under different scenarios

Transport modes	Year 2014		Year 2030									
	Base case		Base case		Scenario 1		Scenario 2		Scenario 3		Scenario 4	
	Rubber	Others	Rubber	Others	Rubber	Others	Rubber	Others	Rubber	Others	Rubber	Others
Road	80.82%	82.14%	83.06%	87.31%	89.21%	92.27%	78.82%	90.41%	84.72%	83.18%	82.05%	82.36%
Rail	4.60%	2.24%	4.86%	2.35%	0.60%	1.09%	6.96%	3.01%	0.55%	1.06%	4.13%	2.03%
Water	14.58%	15.62%	12.07%	10.34%	10.19%	6.64%	14.22%	6.58%	14.73%	15.76%	13.82%	15.61%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

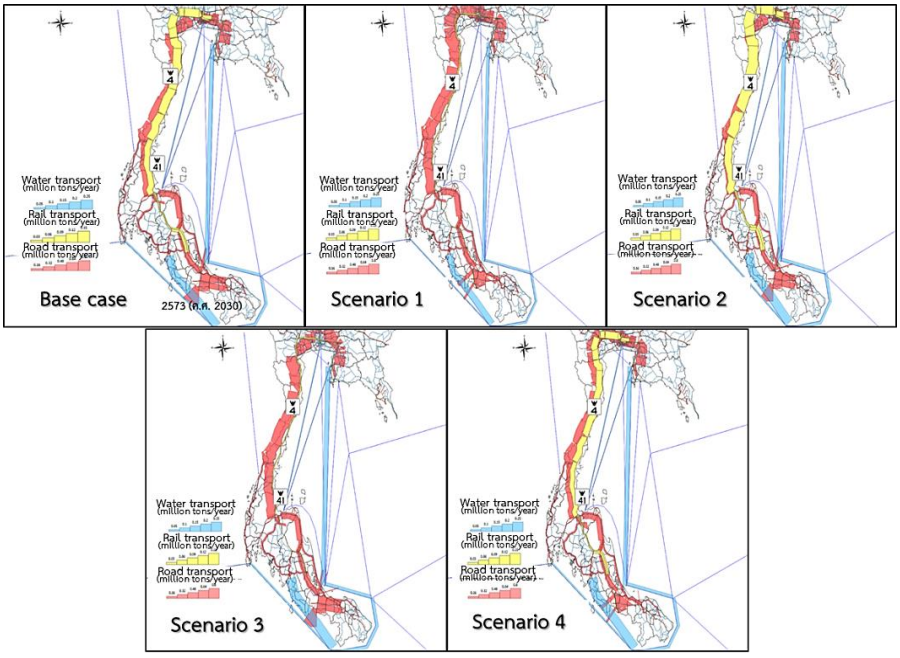

Figure 1 Freight flows on the network under different scenarios in the year 2030

- For the base case, the modal shares of the three transport modes are hardly changed.
- The improvement of the road service level (Scenario 1) will increase the modal share of road transport. This increase is not significantly high because the motorway expansion is only 100-200 kilometers radius around Bangkok.
- Improvement of rail networks (Scenario 2) could encourage a slight modal shift to the rail transport, i.e. from 4.86% (base case) to 6.96%.
- Water transport improvement (Scenario 3) could increase the modal share of water transport to 14.73%, compared to the base case 12.07%.
- Combination all projects (Scenarios 4) could reduce the transport time by road significantly (modal share 82.05%). In contrast, the transport time by rail and water transports would increase, see [11] for the details of transport time reduction. This results in the modal shares of rail and water transports are at 4.13% and 13.82%, respectively (which are slightly changed from the based case).

The results show that the modal shares for rubber product transport by rail and water could be increased if the transport infrastructures are developed. However, the modal share of road transport is still rather high. This is because the rubber goods produced in the upper area of southern Thailand are mainly shipped to the Lam Chabang port, while those in the lower area are primarily transported to Malaysia by road and rail transports. In addition, the rail and waterway networks cover only some parts of the study area. The double track rail network will be only about 900 kilometers when the coastal shipping is mainly on the east side of the study area. On the other hand, the network of major roads in the southern Thailand will be more than 10,000 kilometers, which provide more convenient door-to-door service for rubber product shipment compared to the rail and water transports.

Furthermore, the results show that the combination of all projects (road, rail and water transport improvement) can achieve modal shift less than the improvement of rail transport alone. This is because road network improvement and expansion competes with the rail service. Thus, to achieve higher modal shift road network (particularly motorway) must be well plan to integrate with rail network (rather than compete each other) and other policies (e.g. pricing policy) should be designed to push further. This integration is likely to achieve synergy (overall benefits are greater than the sum of individual policy).

4. Conclusions

The national freight transport model was developed and used to evaluate the impacts of transport infrastructure development on the modal shares of rubber product transport in the southern Thailand. Different scenarios based on the Thai government's development projects and the reduced service cost (not included in the plan) were tested. The results showed that the integration of road, rail, and water transport development could achieve a few modal shifts from road transport to the two alternatives. The modal share of road transport is still high because the rail and waterway networks cover only some parts of the study area. To achieve higher modal shifts, the rail network should be significantly expanded. Freight rail speed needs to be increased. Connecting hub of multi-modal interchange (between road and rail, and between road and coastal ports) is the key issue of modal shift. Pricing policy for road transport also needs to be set up properly to encourage the modal shift and to reflect externality costs.

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