

Designing the Multimodal Network in an Agriculture Supply Chain in Thailand

Witchayut Timaboot, Logistics Program,
University of the Thai Chamber of Commerce, Thailand
Nanthi Suthikarnnarunai, Logistics Engineering Department,
University of the Thai Chamber of Commerce, Thailand

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Abstract

In terms of economic situation towards logistics implementation, it is found that one of the most important factors to consider about is transportation costs which need to be handled in many ways in order to get the best effectiveness and the lowest costs for the best profitability. For land transportation, rail transportation costs cheaper when compared with road (truck) transportation because rail transportation can load a lot of goods in one time and can avoid traffic troubles. This research is made to study a simulation of decision making on means of logistic transportation for tapioca which comes from 20 different originals that considered as having the largest productivity and delivered to train stations for further multimodal transportation. The so-called train stations are decided by the government as double-track railways for reasons of further benefits in the future. Each station has next destination at Leamchabang Station (final destination) and the goods will be transferred to another Ship marine Port. This demonstration of decision making is designed using mathematic simulation by setting target of transport quantity of each transport destination. Moreover, terms and conditions of transport quantity, quantity of goods from the origin to destination, different types of transport vehicles, transport capacity and quantity of vehicles, by using Microsoft Excel Solver programme for calculating the lowest cost. As a result after the simulation of decision making, the transportation cost can be 183 Million baht reduced compared with the previous mean in which the products will be transported by truck starting from farms to river port and shipped to seaport. Also the decision of model able apply with other agriculture products.

Keywords: Distribution Network, Agriculture Supply Chain, Rail transportation, Linear programming model

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1. Introduction

Thailand is a country that grows and exports tapioca the most in Asia. Thailand also exports tapioca to overseas, and the biggest buyer is China. China imports tapioca for processing it to consumption ethanol including processing into many other kinds of product. Largely, Thailand has areas for growing agricultural products and this is a main reason that Thailand can grow tapioca in each region all around the country. Nowadays, when the product is ready for harvesting, agriculturists will gather tapiocas which are ready to be delivered and load them on a truck, and transferred to the destination. After that, the tapioca will be on road transportation, and then shipped by barge. It can be seen that, transportation costs mainly take place at road (truck) transportation with the highest cost. Nevertheless, the transportation of tapioca can be managed in several means and on many routes of transportation. Thus, this research studies transportation routes which can support transport activities in accordance of requirements of each distribution center properly. By this, the transportation by train, which newly supported by the government recently, was added to be one of the ways of railway transportation. Double-track railway was also built for further benefits in the future. Therefore, its advantages was realized in terms of reducing cost, that it may help reduce the cost more effectively than the previous mean of transportation; by truck. Furthermore, the distribution center of tapioca which has trains passing by was considered as a starting point and transferring to inland destination, passing to the nearest seaport and ending at Port of Ko Sichang. A new way of transportation was simulated to be replaced the previous one in which the products will be delivered to estuary, then to Port of Ko Sichang by barge which takes longer time.

2. Objectives

- 2.1 To reduce the costs of agricultural product transportation (case study of tapioca)
- 2.2 To build decision-making model for allocation of the distribution centers where the train passed.

3. Literature Review

The previous researches have focused on how to select and manage goods storage by providing many means of transportation, creating mathematic simulation to help making decision on product delivery by using trouble-shooting programs such as AMPO, CPLEX, etc. for considering controlled factors and adjusting figured as required.

For this research, the basic programs installed in Microsoft Office Excel, a menu in Add Ins called "Solver" were picked up as the important tools as they are simple, easy to understand and suitable for analyzing small-size data quickly.

4. Research Methodology

4.1 Studied about the quantity of tapioca productivity delivered to each distribution center. After studying and choosing the origin of logistics for tapioca products, it was found that Thailand can grow and produce plenty amount of products, and harvesting areas expanded in each region; North Eastern, Northern, Eastern and

Western parts of the country while Central and Southern parts rarely grow tapioca as their topography is not so applicable.

Nonetheless, if taking all data and information of each area into account for simulating a transportation model, the large amount of information may be needed to analyze while basically all data cannot be evaluated. Thus, only top 20 areas that have largest productivity in the country was selected. A table below shows productivity of each area.

Table 1: showing productivity of tapioca in each area

Area	Productivity (ton)	Remark
Khon Buri	765,111	Nakhon Ratchasima Province
Seangsang	750,340	Nakhon Ratchasima Province
Nongboonmak	742,599	Nakhon Ratchasima Province
Khanuworalukburi	694,671	Kanphaeng Phet Province
Mueng Kamphaeng Phet	632,736	Kanphaeng Phet Province

(Source: Centre of Agricultural Information, Office of Agricultural Economics 2015)

According to Table 1: Tapioca productivity in the top 5 different areas in 1 year's time, it can be seen that only 2 provinces; Nakhon Ratchasima and Kamphaeng Phet have the outstanding amount of product. However, as these 2 provinces are in the different regions, so we need to consider their transportation route to destination separately. And this research considers information and data from the top 20 areas.

4.2 Studying the recent transportation routes in order to apply with the new transportation routes.

Currently, transportation of tapioca is performed mainly by truck in which its crucial limitations are delivery quantity per one time, traffic jam, high petrol cost, etc. Therefore, the benefits from the multimodal transport are realized by considering adding railway transport into the entire of carriage. One of the government projects is to develop double-track railway more effectively, so this idea is taken into account for simulating a model of setting destination as the same location as double-track train station completed in the near future. In addition, building 12 routes of double-track railway is decided as accelerated project in order to be the distribution center for the above 20 areas.

4.3 Simulation of decision making under conditions of quantity, cost and transportation route.

Regarding the simulation of decision making, this research designs mathematical equation based on relations of environmental factors and conditions using linear programming as follows;

The lowest total cost Min Z ;

$$\sum_{o=1}^O \sum_{d=1}^D \sum_{w=1}^W C_{odw} Q_{odw} \quad (1)$$

“o” is the origin source of tapioca in each area while “d” is a destination of distribution center in each station, “w” is each mean of transportation, “C” is cost in THB per ton calculated from the distance multiplied by cost per unit (baht-ton/km.), and “Q” is quantity of carriage (unit is ton).

$$\sum_{w=1}^W \sum_{d=1}^D Q_{odw} = Q_o \quad ; \quad \forall_o \quad (2)$$

Total amount of tapioca from each origin “o” to destination “d” by each mean of transportation; 4-wheel, 6-wheel and 10-wheel trucks; must not be over the total quantity from the starting point. “w” is a pattern of transportation from the starting point of each area and the cost will be varied by different amount of product each time. “Q” is gross amount of tapioca from the starting point.

$$\sum_{o=1}^O \sum_{d=1}^D Q_{odw} \leq Q_d \quad ; \quad \forall_d \quad (3)$$

For the total amount of tapioca in each origin “o” to destination “d”, all means to transportation need to deliver the goods in the amount not over the limit (Q_d) at the destination “d”

$$\sum_{o=1}^O \sum_{d=1}^D Q_{odw} \leq Q_w \quad ; \quad \forall_w \quad (4)$$

The total number of rounds of carrier in each area “o” to purchasing spot “d” should not have amount of product exceeded the transport capacity (Q_w). Conditions of transport capacity are as follows;

Table 2: showing transport capacity in one round (unit is ton) as well as costs of each type of trucks

Type of trucks	Amount of transport/round (ton)	Cost per unit (baht-ton/km)
4 wheels	2	6.44
6 wheels	12	5.08
10 wheels	30	6.63

According to table 2, it can be applied for setting the number of transport rounds in each origin “o” to destination “d” but not over the amount of the number of transport round in each area “d”. Moreover, it shows cost per unit in each mean of transportation (Ref: petrol price at 29.94-33.33 baht/liter)

As a result of decision making on tapioca transportation, it was found out that, there is a program selecting transportation from farm to train stations of double-track railway properly before transferring to a port. The program selected to use all provided resources under conditions of quantity, capacity of delivery- purchasing, product weight that can be loaded on the truck, the number of truck's rounds and the lowest cost. It selects transportation by 6-wheel truck which has low cost at THB 8,207,726,132.13 altogether. The cost reduces 183 Million baht comparing with the previous mean of transportation. Moreover, it created a new mean of transportation model which considers about limitations of each mean of transportation, and therefore it selected a double-track train station as a distribution center in order to get the advantage of transportation as much as possible.

As a result, we can get benefits from management of transportation routes from each area (region) to each destination which has the lowest cost. Utilizing double-track train as a product gathering center (tapioca's distribution center) is a way to transfer the product via railway. With the method, the transportation cost will be lower than other road transportation. Furthermore, we can manage and select the best mean of transportation suitable with transportation cost, ability including limitation each kind of transportation for the best effectiveness.

5. Suggestion

This route model is designed to help making decision of transportation routes which do not have too many conditions or factors as the program can respond to only 200 items. As a result, decision making might not be so accurate. The number of truck's rounds was also only an assumed number, but if the actual numbers could be figured out, it will help analyze more correctly.

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Contact email: wtchayut_til.com; nanthi_sut@utcc.ac.th;