A DESIGN OF TAPIOCA CHIP TRANSPORTATION MODEL IN THAILAND

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Abstract- Among the current economic situation regarding logistic activities in Thailand, one of the most crucial factors to be priory considered is transportation which needs to be managed effectively with the lowest possible cost for the best profitability. This research studies about transportation problem of tapioca chip product from production plant to harbor port. The problem of high transportation cost arises in the current transportation system of tapioca chip product because the lack of the correct assignment of river port to the plant. Therefore, the prototype of the optimization model for transportation of the tapioca chip is recommended in this paper. Microsoft Excel with Solver software is used as tools in solving the model. The total transportation cost reveals from the model is THB 1,374,078,500. It gives the reduction of 8.54% compare to the current practice.

Keywords- transportation model, allocation model, optimization, tapioca chips.

I. INTRODUCTION

Thailand is the biggest cultivator and the major exporter of cassava in Asia. The major importer of cassava in the world is China. China imports cassava and use it as an input to produce ethanol and various kinds of product. Thailand locates in the tropical area, therefore, several kinds of agricultural plants can be planted, including cassava. The cassava has been grown in many areas throughout the country. Cassava is considered as one of the economic crop that can be produced many types of semi-product such as tapioca pellets, cassava powder, tapioca chip, flour and starch, etc. This research had been considered for tapioca chip that high volume export more than 56 % of total cassava product.

According to the supply chain of exported tapioca chip product which is shown in Fig. 1, the collected cassava from the cassava filed will be delivered to tapioca production plant and then to the customer using multi-modal transportation. First, trucks will be used in order to deliver cassava from the harvesting field to the tapioca production plants which are mostly located in different regions of Thailand as shown as the circle dots in Fig. 2. After the production, the tapioca chip is delivery by truck to the river ports located along the Chao Phraya River or Bangpakong river as shown as the star marks in Fig. 2. The barges are then delivered tapioca chip to the Srirang Harbor port as shown as the square shape in Fig. 2. Lastly, the shipment will be made to international customer by sea transportation.

Currently, the logistics of the cassava from the field after harvesting to the destination river port are controlled by the middleman or traders. Prices will be agreed according to a contract but the transportation cost is paid by the farmer. From the observation and from the interviewing of the researcher, two major problems which cause higher transportation cost to the farmer are 1) the river ports which is assigned to the farmer are often far from the origin and 2) the assigned destination river ports are occupied and the emergency change has been made or the truck must wait at the port until it is available to be unloaded. The researchers, therefore, aim to introduce the prototype of the transportation model of the river ports to match with the tapioca production plant in order to minimize the total transportation cost.

II. LITERATURE REVIEW

When explode “allocation” wording that research in the exist literature usually find out objective of “location selection, port selection, hub & spoke
III. METHODOLOGY

3.1 Scope of the Study

In this prototype research, the scope of the study are as follows:

1) The origin of the products are from four tapioca production plants which are located in Nakhon Ratchasima, Kamphaeng Phet, Kanchanaburi and Chaiyaphum Provinces. Each plant has its own production capacity.

2) The destinations of the products are Srichang Harbor Port.

3) The river ports are Port of Nakhon Luang in Ayutthaya Province, Port of Bangsai in Ayutthaya Province, Bangkok Port in Bangkok, and Port of Bangpakong in Chacheang Sao Province. Each port has its own capacity and delivery time table.

4) Road transportation is made from plant to river port.

5) Waterway transportation using barges is made from river port to harbor port.

6) Transportation cost from plant to river depends on the distance between port and plant. Quantity of delivery is also a factor affecting cost. Table

7) Transportation cost from river port to harbor port is different from port to port and depend on quantity of delivery.

This research scope is to design the transportation model for tapioca chip from the production plant to harbor port in order to minimize the total transportation cost. Fig. 3 and Fig. 4 represent the network of the supply chain explained above.

The mathematical model represents the transportation model of the above network is shown in equation (1) – (7). The decision variables in the model are Qij and Qjk. Qij is the amount of tapioca chip transported from plant i to river port j, while Qjk is the amount of tapioca chip transport from river port j to harbor port k. Cij and Cjk are the transportation cost per ton-km from plant i to river ports j and from river port j to harbor port k, consecutively. Parameter U is the amount of total tapioca chip in this case study. Ui is the amount of tapioca chip at plant i and Pj is the capacity of each river port j.

Minimize total Cost (TC) Z ;

\[ Z = \sum_{i=1}^{I} \sum_{j=1}^{J} C_{ij}Q_{ij} + \sum_{j=1}^{J} \sum_{k=1}^{K} C_{jk}Q_{jk} \] (1)

Subject to

\[ \sum_{j=1}^{J} Q_{ij} = U_i \forall i \] (2)

\[ \sum_{i=1}^{I} Q_{ij} \leq U_i \forall j \forall i \] (3)

\[ \sum_{i=1}^{I} P_j \cdot Q_{ij} \leq U_i \forall j \forall i \] (4)

\[ \sum_{j=1}^{J} Q_{ij} = Q_{ik} \forall j \forall k \] (5)

\[ Q_{ij} \geq 0 \] (6)

\[ Q_{jk} \geq 0 \] (7)

Equation (1) shows the objective function to minimize the total transportation cost which includes cost from plant to river port and from river port to harbor port. Equation (2) and (3) ensure that the shipment of each plant will be made while the capacity of each river port constraint is shown in equation (4). Equation (6) shows the conservation equation of the network where the input of the transshipment node which are the river ports equal to the output. Last two equations which are (6) and (7) are non-negativity variable constraints.
Table 1 shows the transportation cost from each origin to the river ports, while Table 2 transportation cost from each river port to the harbor port. Table 3 shows the capacity of each river port. Table 4 shows the capacity of each tapioca chip production plant.

Table 1: Transportation cost from plant to river port (THB/km-tonnage)

<table>
<thead>
<tr>
<th>Plant</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>P4</th>
</tr>
</thead>
<tbody>
<tr>
<td>U1</td>
<td>1,223.04</td>
<td>1,397.76</td>
<td>1,603.68</td>
<td>1,622.4</td>
</tr>
<tr>
<td>U2</td>
<td>3,173.22</td>
<td>3,090.26</td>
<td>4,573.17</td>
<td>3,816.16</td>
</tr>
<tr>
<td>U3</td>
<td>936</td>
<td>792.48</td>
<td>1,335.36</td>
<td>867.36</td>
</tr>
<tr>
<td>U4</td>
<td>1,697.28</td>
<td>1,890.72</td>
<td>2464.8</td>
<td>2,152.8</td>
</tr>
</tbody>
</table>

CONCLUSIONS

This research is a prototype model of transport tapioca chip from production plant to the harbor port. The current practice depends on the mandated of the middleman, while the transportation is on the farmer or the plant side. This model seeks to recommend the model of how to assign ports to the plant in order to minimize the transportation cost. The result reveals that total cost from this case study is THB 1,374,078,500. It gives the reduction of 8.54% compare to the previous practice. However, data used in this model is a collected and static data from a point of time period. The next research, the model should be expanded to handle the dynamic data from the various time period. The model also should be expanded to cover all area of the origin and destination in Thailand.

REFERENCES


IV. RESULT

This research uses solver software which is installed in Microsoft Office Excel to solve this problem. The answer to the problem is shown in Table 5. Product from plant Nakornratchasima has to be distributed to port Nakornluang-Ayutthaya, Bangprakong-Chacheongsa and Bangkok Port, Bangkok while product from plant Kumpangpet has to be distributed to port Bangsai-Ayutthaya only. Product from plant Kanjanaburi has to be distributed to Bangkok Port-Bangkok and while product from plant chaiyaphumi to Nakornluang-Ayutthaya only. Consist primarily total cost from plant to river port is THB 977,018,000.00 with secondary total cost THB 279,600,000.00. The total amount of transportation cost is THB 1,256,618,000.00.


