OPTIMIZATION TRANSPORTATION MODEL WHICH IS SUITABLE OF AGRICULTURAL PRODUCTS IN THAILAND CASE STUDY OF HYGIENIC AGRICULTURAL PRODUCTS

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Abstract- Thailand is one of the most important agricultural countries in the world. It grows rice, rubber trees, cassavas, sugarcanes, seasonal fruits and vegetables. Most agricultural products in Thailand are transported to Talaad Thai, a large fruit and vegetable wholesale market. This research studied about hygiene agricultural product focusing on lemongrass as it has the largest amount of cultivation. Lemongrass is produced mainly in northern, central and eastern parts of Thailand which are far from the destination, and therefore, transportation costs are quite high; the costs are THB 583,308.75 per year. This research has designed proposed a new transportation pattern by adjusting types of transportation truck and adding goods consolidation points using four step model and applying Center of Gravity technique in order to lower transportation costs for farmers. The results of study show that transporting by 6-wheel truck with milk run technique would provide the lowest transportation costs. The cost becomes THB 196,324.17 per year. Moreover, adding consolidation points in Sukhothai and Phrae provinces by having pickup trucks carried the products from agricultural resources to consolidation location, then shipped by 6-wheel trucks to the destination, Talaad Thai, would make cost become THB 617,283.58 per year and 474,642.57 per year respectively.

Keywords- Transportation Cost, Four Step Model, Center of Gravity, Consolidate, Milk Run

I. INTRODUCTION

a) Research Background
Thailand is one of the most important agricultural production resources in the world. There are plenty kinds of products exported to many countries around the world. Nowadays, majority of consumers choose to consume hygiene and nontoxic products so Thai agriculturists are persuaded into producing hygiene agricultural products.

The Department of Agriculture, Ministry of Agriculture and Cooperatives is also promoting cultivating of vegetables by introducing hygiene cultivation to the Thai agriculturists so that they can produce standard products that are safe for themselves and consumers, moreover, the product price will have greater value. Recently, more than 60% of the domestically produced goods have the same destination- Talaad Thai, the largest agricultural product market in Thailand. Most of the agricultural products will be transported here first before being distributed to domestic markets or exported to other countries.

Vegetables are also transported to Talaad Thai, especially the top 5 hygiene agricultural products: lemongrass, celery, morning glory, Melientha Suavis and basil, which to be transported to either domestic markets or overseas, would almost be dropped at this market. This research focuses only on lemongrass as it has the biggest amount of cultivating in the country.

After being harvested, lemongrass will last longer than other products. A problem regarding transportation of this product which can be seen from this research is that a distance of transportation from farms to the Talaad Thai is far away and they use pickup trucks for transportation so it brings high costs of transportation. This research proposes a concept of selecting location for consolidation. The concept is that, after receiving the products at consolidation location, the products will be transferred to a bigger truck and brought to Talaad Thai or using milk-run technique to get the products from farms and transport them to Talaad Thai in order to reduce the total transportation costs and prevent the product from spoiling.
b) The Research’s Objectives
The research is aimed to seek for the transportation which is suitable with transportation of lemongrass, a kind of popular hygiene agricultural product. This transportation way will make the total transportation cost the lowest and will not spoil the products.

c) Statement of Problem
The distance from the biggest lemongrass resources in Thailand which located in northern, central and eastern parts of Thailand; A. Muang and A. Maewang in Cheingmai Province, A.Muang in Lampang Province, A. Lomsak in Phetchabun Province, A. Saiyok in Kanchanaburi Province, A. Nongsue and A. Klongluang in Pathum Thani Province, to Talaad Thai (located in A. Klongluang, Pathum Thani), a major market of the country is far, and they use pickup trucks for transportation, thus the transportation costs are generally high.

According to the current problem and the questions made during researching, the researcher are interested in researching the actual costs of transportation responsible by the agriculturists.

Fig.4. Transferring lemongrass at Talaad Thai

d) Literature review
Thailand is one of the most important agricultural countries in the world. It grows rice, rubber trees, cassavas, sugarcanes, seasonal fruits and vegetables. Most agricultural products in Thailand are transported to Talaad Thai. The distance from the biggest lemongrass resources in Thailand which located in northern, central and eastern parts of Thailand a major market of the country is far, and they use pickup trucks for transportation. The FMS is a framework model with four step model (McNally: 2007)
1) Trip generation, in which the number of trips originating from source zone
2) Trip distribution, in which the origin and destination “trip ends”
3) Mode split, in which trip origin-destination (O-D) flows are “split” between feasible modes
4) Trip assignment, in which auto and transit O-D trips are “assigned” to explicit paths through the road and transit networks

However a large fruit and vegetable wholesale market. In terms of transportation of agricultural products which become spoiled easily, transportation time, weather, a safe transferring, etc. should be considered in order that the products will still be fresh when arriving at their destination (Riccardo :2013). Also to draw a Center of Gravity has constraints in decision making which are latitude and longitude, distance of transportation from the starting point to the destination, and frequency of transportation considered from GIS (FU Juana:2011). It is can be simply said that, if there are more consolidation locations, costs of transportation will be reduced, but it is necessary to consider about time of product storage as well. In other words, the more time of

Fig.5. The four step model
product storage, the more time of consolidation, and it will bring more expensive costs of transportation in total (Phichet:2015)

II. RESEARCH METHODOLOGY

2.1. Data Collection

1) Secondary data
This research has gathered information and data from researches relating to distribution of agricultural products or products that are easy to become spoiled. Databases come from the Science Direct, the Emerald, and the Google map. To get information about cultivating resources or areas, the amount of production and distance from cultivating resources to Talaad Thai, I have studied from databases inside the country; from the Department of Agriculture, Talaad Thai, Taladsimummuang, for instance.

2) Primary data
The researcher has interviewed 8 agriculturists who transport lemongrass to Talaad Thai about method, time consuming of loading and unloading the product, costs of transportation and how the products look like when transported from cultivation resources A. Muang and A. Maewang, Cheingmai Province, A. Muang, Lampang Province, A. Lomsak, Phetchabun Province, A. Saiyok, Kanchan Buri Province, A. Nongsua and A. Klongluang, Pathum Thani Province.

2.2 Four step model

1) Trip generation, in which the number of trips originating from source zone The researcher select source of lemongrass at 4 location is A. Muang Cheingmai Province, A. Muang, Lampang Province, A. Lomsak, Phetchabun Province and A. Saiyok, Kanchan Buri Province because 4 location is important lemongrass sources of Thailand and lemongrass transport by pickup truck to Talaad Thai.

2) Trip distribution, in which the origin and destination “trip ends” Trip distribution from lemongrass source to Talaad Thai by pickup truck.

\[
\begin{array}{|c|c|c|c|}
\hline
\text{Origin} & \text{Type of transport} & \text{Frequency/year} & \text{Percentage} \\
\hline
\text{Chiang Mai} & \text{pickup} & 221 & 32.94 \\
\text{Lampang} & \text{pickup} & 112 & 16.69 \\
\text{Phetchabun} & \text{pickup} & 148 & 22.06 \\
\text{Kanchanaburi} & \text{pickup} & 190 & 28.32 \\
\hline
\text{Total} & & 671 & 100 \\
\hline
\end{array}
\]

3) Mode split, in which trip origin-destination (O-D) flows are “split” between feasible modes

4) Trip assignment, in which auto and transit O-D trips are “assigned” to explicit paths through the road and transit networks
Trip assignment from origin to destination by selection road for transport focus on shortage times by Google map.
Route 1 A. Muang Cheingmai Province to Talaad Thai

\[
\begin{array}{|c|c|c|c|c|c|}
\hline
\text{Origin} & \text{Quantity (ton)} & \text{Origin to Talaad Thai (KM)} & \text{pickup} & \text{6 wheel} & \text{10 wheel} \\
\hline
\text{Chiang Mai} & 230.94 & 631 & 25 & 37 & 37 \\
\text{Lampang} & 117.85 & 561 & 112 & 19 & 19 \\
\text{Phetchabun} & 147.84 & 351 & 148 & 23 & 23 \\
\text{Kanchanaburi} & 190.00 & 251 & 190 & 32 & 32 \\
\hline
\text{Total} & 676.64 & & 671 & 100 & 100 \\
\hline
\end{array}
\]
Route 2 A. Muang, Lampang Province to Talaad Thai

Fig. 9. Trip assignment route 2

Route 3 A. Lomsak, Phetchabun Province to Talaad Thai

Fig. 10. Trip assignment route 3

Route 4 A. Saiyok, Kanchan Buri Province to Talaad Thai

Fig. 11. Trip assignment route 4
2.3 Crate transportation model

The research studied about the transportation which has far distances from the 4 resources in the country; lemongrass farm in A. Muang, Chiangmai Province, A. Muang, Lampang Province, A. Lomsak, Petchabun Province, and A. Muang, Kanchana Buri Province, in order to analyse a breakdown of the old transportation. Then, the research investigated the most economy costs of transportation in terms of changing to the bigger consolidation trucks by considering the ways that will take the shortest time and increasing the consolidate points with the technique of Center of Gravity. I have drawn a transportation method as follows;

![Fig.12.Model 1: direct transportation by pickup truck from the production resource to Talaad Thai](image1)

![Fig.13.Model 2: transportation by 6-wheel truck collecting the products from various production resources to Talaad Thai](image2)

![Fig.14.Model 3: transportation by pickup truck from production resources to consolidate points, then, transfer to 6-wheel truck and transport to Talaad Thai](image3)

2.4 Location selection use to center of gravity technique.

After four step model, the researcher will be data including of quantity of lemongrass, frequency, transportation route and geographic position of origin and destination and calculated to determine the most appropriate collection point and transport to Talaad Thai.

2.5 Analysis transportation model

Costs of transportation and transferring, time of transportation and transferring of each method of transportation mentioned above were compared so that the most suitable transportation model would be selected.

2.6 Result Summary

As a result of considering each different method of transportation, the method that is considered to be the most suitable, has a cost of handling which is in an acceptable level, and the products are not damaged due to this transportation. Thus, this would be one of transportation choices for agriculturists who transport their products to consider.

III. RESULTS AND DISCUSSION

After studying about consolidate points using the technique of Center of Gravity, it was found out that the consolidate point is located in Sukhothai Province accordingly GPS in the Google Map.

Furthermore, according to a study of the actual transportation, it was found out that a transportation route from Kanchana Buri Province is further because it takes a roundabout way. Therefore, I have designed a new transportation method by taking the amount of transportation from Kanchana Buri Province out, in order to find a new consolidate point. The new consolidate point is located in Phrae Province.

### Table 3: Searching consolidate points from the 4 starting points to the destination

<table>
<thead>
<tr>
<th>NODE1</th>
<th>Destination (KM)</th>
<th>frequency</th>
<th>Location each Node 1</th>
<th>X</th>
<th>Y</th>
<th>X coord</th>
<th>Y coord</th>
<th>Location (Thai Market)</th>
<th>X</th>
<th>Y</th>
<th>X coord</th>
<th>Y coord</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiang Mai</td>
<td>653</td>
<td>111</td>
<td>18.790506</td>
<td>98.993122</td>
<td>2085.746166</td>
<td>10988.23632</td>
<td>14.110221</td>
<td>100.560345</td>
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</tr>
<tr>
<td>Lampang</td>
<td>561</td>
<td>56</td>
<td>18.28869</td>
<td>99.491573</td>
<td>1024.16664</td>
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<tr>
<td>Phetchabun</td>
<td>355</td>
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<td>16.779072</td>
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<td>1241.651328</td>
<td>7491.93131</td>
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<td></td>
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<tr>
<td>Kanchanaburi</td>
<td>235</td>
<td>95</td>
<td>14.433824</td>
<td>98.865908</td>
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<td>9392.26126</td>
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<td></td>
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<td></td>
<td>Sukhothai</td>
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</tbody>
</table>

### Table 4: searching consolidate points from the 3 starting points to the destination

<table>
<thead>
<tr>
<th>NODE1</th>
<th>Destination (KM)</th>
<th>frequency</th>
<th>Location each Node 1</th>
<th>X</th>
<th>Y</th>
<th>X coord</th>
<th>Y coord</th>
<th>Location (Thai Market)</th>
<th>X</th>
<th>Y</th>
<th>X coord</th>
<th>Y coord</th>
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<td>5571.528368</td>
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<td>7491.93131</td>
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</table>
The researchers have come up with a new transportation route in which the goods will be transported from the production resources using pickup trucks, then, they will be consolidated at Phrae Province, and from Phrae Province, the goods will be transported to Talaad Thai by 6-wheel trucks while the products from Kanchan Buri Province will be transported directly to Talaad Thai.

According to the table, transportation by pickup truck has the total costs of transportation at THB 583,308.75 per year, costs of transferring products is THB 4,191.5 per year, and it takes 8.32 hours/round from Chiangmai, the longest distance.

Table 6: transportation by 6-wheel truck

<table>
<thead>
<tr>
<th>Origin</th>
<th>Quantity (Tons)</th>
<th>Distance (KM) to Talaad Thai</th>
<th>Transport/Route</th>
<th>Total Transport/Route</th>
<th>Transport/Route</th>
<th>Handling/Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiang Mai</td>
<td>220.95</td>
<td>1,191.2</td>
<td></td>
<td>1,381.4</td>
<td>12.04</td>
<td>70.72</td>
</tr>
<tr>
<td>Lampang</td>
<td>111.85</td>
<td>1,234.3</td>
<td></td>
<td>1,381.4</td>
<td>12.04</td>
<td>70.72</td>
</tr>
<tr>
<td>Phetchabun</td>
<td>147.84</td>
<td>1,149.4</td>
<td></td>
<td>1,127.7</td>
<td>10.68</td>
<td>70.72</td>
</tr>
<tr>
<td>Kanchanaburi</td>
<td>190.00</td>
<td>1,217.5</td>
<td></td>
<td>1,381.4</td>
<td>12.04</td>
<td>70.72</td>
</tr>
<tr>
<td>Total</td>
<td>670.64</td>
<td>1,217.5</td>
<td></td>
<td>1,381.4</td>
<td>12.04</td>
<td>70.72</td>
</tr>
</tbody>
</table>

According to the table, transportation by 6-wheel truck has the total costs of transportation at THB 196,324.17 per year. transporting products is THB 25,149 per year, and it takes 11.88 hours/round from Chiangmai, the longest distance.

Table 7: transportation by pickup truck to the consolidation point in Sukhothai Province, and by 6-wheel truck from Sukhothai to Talaad Thai

<table>
<thead>
<tr>
<th>Origin</th>
<th>Quantity (Tons)</th>
<th>Distance (KM) to Talaad Thai</th>
<th>Transport/Route</th>
<th>Total Transport/Route</th>
<th>Transport/Route</th>
<th>Handling/Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiang Mai</td>
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<td>70.72</td>
</tr>
<tr>
<td>Total</td>
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<td>1,191.2</td>
<td></td>
<td>1,381.4</td>
<td>12.04</td>
<td>70.72</td>
</tr>
</tbody>
</table>

According to the table, the total costs of transportation is THB 617,283.58 per year, costs of transferring products is THB 12,587 per year, and it takes 11.94 hours/round from Chiangmai, the longest distance.

Table 8: transportation by pickup truck to the consolidation point in Phrae Province and by 6-wheel truck from Phrae Province to Talaad Thai

<table>
<thead>
<tr>
<th>Origin</th>
<th>Quantity (Tons)</th>
<th>Distance (KM) to Talaad Thai</th>
<th>Transport/Route</th>
<th>Total Transport/Route</th>
<th>Transport/Route</th>
<th>Handling/Route</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chiang Mai</td>
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<td>Total</td>
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<td>1,381.4</td>
<td>12.04</td>
<td>70.72</td>
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According to the table, the total costs of transportation is THB 474,642.57 per year, costs of transferring products is THB 12,587 per year, and it takes 12.04 hours/round from Chiangmai, the longest distance.

As a result from this research, it can be seen that, the transportation by 6-wheel truck with Milk Run service which will collect and consolidate the products from various production resources, then ship to Talaad Thai, provides the lowest transportation costs.
CONCLUSIONS

In conclusion, there are some terms and conditions which have not been studied yet; such as whether or not the longer time of transportation will affect to the products’ price, whether or not big amount of transportation will destroy the product, time of storage the products at the consolidate point, etc. in which these factors may influent to selecting the most suitable way of transportation.

REFERENCES


