LOGISTICS ACTIVITIES AND FACILITIES FOR MANGO

by

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ABSTRACT

This paper discusses logistics activities for mangoes, sweet fruit economically grown in tropical areas, and examines possibilities in which post-harvest logistics activities could be better tailor-made and improved, while being able to maintain cost-effective operations. The study was focused on Chachoengsao, a province where mangoes production is well known in Thailand. Logistics demands for mangoes largely influenced from three main reasons. First, mangoes have become a key export product for Chachoengsao, with main destinations are supermarkets in Japan. The second reason is that mangoes are easily bruised, affecting the taste and the appearance, thus reducing selling price. Third reason is that they are perishable products, with an average shelf life around two weeks and require certain handling and storage conditions. The study was classified into three phases. The first phase was to obtain data from primary sources such as agricultural trade data and export statistics. The second phase was to analyse the data, identify critical logistic activities for mangoes, as well as influencing factors. The study then explored possibilities of finding an optimum location for such activities within Chachoengsao area. The third phase verified the outcomes of these findings, through focus group discussions and key stakeholders interviews. The results show that key logistics activities and parameters specifically to post-harvest mango activities have been identified, including the potential benefits from implementing the logistic concept with mangoes post-harvest production. Furthermore, to achieve cost-effective post-harvest logistics operations, this study proposes an optimum location for undertaking key logistics activities. It further explores on cost-benefit aspects from setting up this centre for post-harvest logistics operations. Requiring an investment around 34.5 million baht, with 26.5% internal rate of return (IRR), and the benefit-cost ratio of 2.097. It is hoped that this centre could decrease the cost of logistics and increase the farmers’ capabilities in competing in the supply chain of mango production. Through logistic concept and logistic-based improvement, a better management, and lower operating cost, high quality mango could be achieved for end consumers.

KEYWORDS
Logistics, Centre, Mangoes, Thailand
INTRODUCTION

The need for logistics management seems to have risen quickly, following the recent global energy crisis and then the global financial crisis. Particular aspects like cost cutting, productivity and efficiency improvement and the likes are pushed to the forefront of operations focus. In many ways, logistics is one of important tools to enhance competitiveness, while ensuring a focus on serviceability. This paper focuses on how to apply logistics approach to mango production.

Mango (Anacardiaceae Mangifera) is a sweet fruit grown in many tropical countries, and becoming popular export to non-tropical countries. An average mango size is around 10-20 cm long, elongated shape, but with thin and soft skin, they can be easily bruised. When this occurs, texture and taste usually deteriorated on and around the bruised areas.

This paper examines the benefits of operational improvement that could be gained from applying logistics concept for the cost utilisation of mango production. The selected case study of mango, the tropical fruit, represents several challenges. First, exporting agricultural products have dominated in many Thailand's government reports, not least because Thailand predominantly retains a strong agricultural background, involving significant number of farmers. Secondly, wellbeing and quality of life of many farmers depend on the effectiveness of Thai agricultural supply chain. This is even more so, considering they are perishable and their prices correlate to freshness. Therefore, improvement efforts should focus on time-to-market.

Nevertheless, main problems of post-harvest mango production were that; (1.) mango unit price was considerably low, making any extensive quality-control process ineffective cost-wise, (2.) inconsistent handling and storage quickly led to bruises and rejects, (3.) lead-times for transporting from farms to collecting points, and (4.) relatively high cost and inefficient operations for many fragmented transportations for many individual collecting points.

From these assumptions, the researchers proposed that a centralised collection centre, which manage relating logistics activities, could help reduce the overall costs. Thus, the objectives of this research were to find optimal location and logistics-cost operations for mango production in Chachoengsao.

This paper examines how the overall cost and operations effectiveness of post-harvest mango production could be improved by applying logistics concept.

LITERATURE REVIEW

To specifically address logistics management, classification by Lambert et al. (1998) has been widely referred to, describing logistics as a process of planning, implementing, and controlling the efficient, effective flow, and storage of goods, services, and related information from point of origin to point of consumption for the purpose of conforming to customer requirements. The concept identifies key activities that focusing on utilization of time, cost, and operational effectiveness. Logistics activities relating to mango-production then are the followings; (1.) Gathering and collecting, (2.) Classification, (3.) Quality inspection, (4.) Packaging, (5.) Effective & Efficient Transportation, (6.) Materials Procurement, and (7.) Overall lead-times reduction

In terms of agricultural-related logistics study, Siriwongpaisarn et al. (2010) studied and surveyed logistics and supply chain system of Hua-It market, located in the southern part of Thailand. They developed supply chain models and strategies for adapting the market as a collection and distribution centre for agricultural products in the southern region of Thailand. They studied demand, supply, inbound and outbound physical flow, infrastructure, transportation routes, as well as logistics costs. The researchers derived supply chain models to measure the performance of the market, and potential as a collection and distribution centre. Proposed strategies included quality centre, cooperation, decreasing transportation cost, infrastructure, exporting values, information systems, administrative structure. Relating to finding an optimal location, the researchers also studied Hubs and Spokes model, determining appropriate number and location of collection and distribution centre, with minimal costs.

As introduced earlier, Mango (Anacardiaceae Mangifera) is a sweet tropical fruit, cultivated in many tropical countries including Thailand. Mango is arguably the most economically important with total farming area over 91,000 rais (approximately 146.5 square-kilometres). Famous for unique taste, freshness, and quality of the produce, Chachoengsao mango farmers exported fresh mangoes to many countries; mainly Japan, Singapore, Malaysia, and Vietnam. From Table 1 below, Thailand export on average over 15 million kilograms every year, from 2000 to 2005.
TABLE 1
THAILAND'S EXPORT STATISTICS OF MANGO

<table>
<thead>
<tr>
<th>Year</th>
<th>Pressurized Packaging Mangoes (Kilograms)</th>
<th>Fresh Mangoes (Kilograms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>6,687,196</td>
<td>8,754,625</td>
</tr>
<tr>
<td>2001</td>
<td>7,486,263</td>
<td>10,829,153</td>
</tr>
<tr>
<td>2002</td>
<td>7,393,236</td>
<td>8,735,824</td>
</tr>
<tr>
<td>2003</td>
<td>9,060,301</td>
<td>8,097,748</td>
</tr>
<tr>
<td>2004</td>
<td>10,904,903</td>
<td>4,692,433</td>
</tr>
<tr>
<td>2005</td>
<td>10,688,932</td>
<td>2,494,240</td>
</tr>
</tbody>
</table>

Source: Food Institute (2006)

Chachoengsao is on the right neighbouring side of Bangkok, and is also around 40 kilometres away, to Suvarnabhumi International Airport, main airport of Thailand. Chachoengsao also largely connected through national highways, had dual carriage rail tracks to Lam-Chabang Port, the largest port in Thailand. Chachoengsao local economies were driven by industrial estates and agricultural farming, even though the population was only around 650,000. In recent years, Chachoengsao mango farmers formed local cooperatives to utilize production volume and bargaining power. Because market price relies largely of freshness, this in turns requires an effective post-harvest operations.

Their main problems were that; (1.) mango unit price was considerably low, making it ineffective to go through quality-control process, (2.) inconsistent handling and storage quickly led to perished products, (3.) lead-times for transporting from farms to collecting points, and (4.) relatively high cost and inefficient operations for many fragmented transportation for any individual collecting point.

METHODOLOGY

The methodology of this research can be divided and described in three relating phases;

Information gathering and analysing phase

This work in phase involved obtaining data from primary sources such as agricultural trade data and statistics, and to analyse the data, identify influencing factors, critical logistic activities required, and also find an optimum location for a centre of such activities. The locality context of farmers was also taken into account. The researchers then studied and analysed secondary data, potential factions related to logistic system in Chachoengsao such as communication network data potential factors in geography, public utility system of agriculture data in the central market.

Development phase

This phase studied the locality context of mango operations, potential analysis of logistic in Chachoengsao, through 30 interviews with stakeholders. In order to identify optimal location for the mango collection and logistics center, the “center of gravity” approach was employed. The optimal location was obtained from the center of gravity model and quantitative comparison. This is achieved by multiplying the sum of mango production in each Amphur (sub-province areas), with the distance to each location. Potential analysis of logistic in Chachoengsao, was subsequently validated through the 30 stakeholder interviews. After analysing all the information from the stakeholders. The optimal location to employ centre of gravity model and quantitative comparison, with the sum of mango production in each Amphur, multiplied by distance to each location and qualitative comparison with evaluations of location by five logistics experts, the plant and facility design of mango distribution centre and logistic in Chachoengsao, with systematic layout planning of Muther concept (Muther, 1974). Qualitative comparison was undertaken by evaluations of location by five experts, the plant and facility design of mango distribution centre and logistic in Chachoengsao province, with systematic layout planning of Muther concept (Muther, 1974). A focus group was held with 11 experts and stakeholders.

This phase also involved the interviews of key stakeholders about relevant logistic management activities, location, the operating criteria of distribution centre, activities in the distribution centre, suggestions of management in
the distribution centre, preparation for personnel, budget. The population and sample in this research were the representatives from the government sector; such as the governor of Chachoenfsao, the mayor of Provincial Administration Organization, Provincial Agriculture Organization. Provincial Transportation, Provincial Town Plan, Provincial Commerce and Provincial Industry. The representatives of the private sectors were Chachoenfsao Industrial Council, Chachoenfsao Chamber of Commerce, trade-men and retailers. The representatives of the agricultural sector were mango farmers that keen on improving their agricultural practices. As this phrase was the qualitative research. The sample consisted of specifically sampled 30 people (Vongvanich and Viratchai, 2546 : 111). The researchers also took into account the locality context of mango farmers, middlemen, retailers in Chachoenfsao and survey of the needs of distribution centre and logistic activities for mango in Chachoenfsao. Population and sample were farmers, middlemen, retailers. The researchers defined the sample size by using the table of Krejcie and Morgan. The sample consisted of 367 population by cluster- or area-sampling, divided into 11 districts : Muang, Bang- Khla, Bang-nam-preao, Bang-pa-kong, Ban-phoe, Pha-nom-sa-ra-kham, Sa-nam-chai-khel, Plang-yao, Rat-cha-sart, Thu-ta-kiab, Khlong-khuen, with 34 people in each district.

Result verification and evaluation phase

The third phase sought to verify the outcomes of the findings. This was done by using focus groups and interviews of key stakeholders by interviewing 40 stakeholders, and undertaking a financial feasibility study. Development phase by the focus group from 11 experts and stakeholders. Evaluation phase by 40 stakeholders and finally feasibility study phase by economic analysis. The design of facility was also reviewed by the stakeholders.

ANALYSES AND RESULTS

Location

The analysis of optimal location for mango distribution centre and logistics in Chachoenfsao was divided into 2 steps. The first step is to find out the optimal location by the Centre of Gravity Method and the second step is to compare the location. Each step was concluded as follows:

First, the Centre of Gravity Method was applied to be the model to determine the coordinates of (x, y). The Centre of Gravity Method was chosen to be a basis of calculation, aiming to determine approximate coordinate of x-y axis (latitude-longitude). This was calculated by the weight of mango produced in 11 districts of Chachoenfsao province. Graphic Information System (GIS) was used as the point of reference. MapMagic™ Program was then used to define the position to get the optimal location of mango distribution centre and Logistic in Chachoenfsao province. The weight of mango quantity of 11 districts in Chachoenfsao was used for calculation. According to the result of calculation, the coordinate of x was 101.293, and the coordinate of y was 13.694. It is the location of Tambon Nong-nae, Phanomsarakham District., which is about 800 metres from the highway. 304.8 Kilometres from Bang-Khla intersection. It is considerably close to the main highway, and thus is convenient to transport the mangoes to Suvarnabhumti International Airport.

The quantitative comparison was the sum of mango production in each district of year 2002-2004, multiplied by the distance to each location. The qualitative comparison was evaluation of locations by five experts. The principal factors were technical factors, the factors of land, communication network system, public utility system, raw materials factors, economic factors, social factors, the factors of market and other factors. In comparison of locations, it was showed that the highest value was 0.279, which was the location of Tambon Sa-med-nua centre and Logistics in Chachoenfsao province.
### TABLE 2
**CHACHOENGSAO DISTRICTS AND THEIR COORDINATES**

<table>
<thead>
<tr>
<th>District</th>
<th>Area (Rai)</th>
<th>Quantity (Ton/Year)</th>
<th>Coordinates</th>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Muang (Central)</td>
<td>6,504.50</td>
<td>5,223.11</td>
<td>101.06756</td>
<td>13.68955</td>
<td></td>
</tr>
<tr>
<td>2. Ban-Pho</td>
<td>1,754.00</td>
<td>1,408.46</td>
<td>101.07356</td>
<td>13.60162</td>
<td></td>
</tr>
<tr>
<td>3. Bang-Pa-Kong</td>
<td>781.50</td>
<td>627.54</td>
<td>100.99156</td>
<td>13.54493</td>
<td></td>
</tr>
<tr>
<td>4. Bang-Nam-Priew</td>
<td>4,799.50</td>
<td>3,854.00</td>
<td>101.05090</td>
<td>13.84984</td>
<td></td>
</tr>
<tr>
<td>5. Bang-Khla</td>
<td>17,394.50</td>
<td>13,967.78</td>
<td>101.20628</td>
<td>13.73081</td>
<td></td>
</tr>
<tr>
<td>6. Panom-Sarakam</td>
<td>22,489.00</td>
<td>18,058.67</td>
<td>101.34376</td>
<td>13.74684</td>
<td></td>
</tr>
<tr>
<td>7. Sanam-Chaiket</td>
<td>2,212.50</td>
<td>9,806.64</td>
<td>101.43644</td>
<td>13.66084</td>
<td></td>
</tr>
<tr>
<td>8. Plang-Yao</td>
<td>8,090.00</td>
<td>6,496.27</td>
<td>101.28182</td>
<td>13.58666</td>
<td></td>
</tr>
<tr>
<td>10. Tha-Ta-Kieb</td>
<td>9,332.75</td>
<td>7,494.20</td>
<td>101.70225</td>
<td>13.38708</td>
<td></td>
</tr>
<tr>
<td>11. Khlong-Kueun</td>
<td>13,066.00</td>
<td>10,492.00</td>
<td>101.16067</td>
<td>13.79358</td>
<td></td>
</tr>
</tbody>
</table>

In order to find an optimal location for Centre of Logistic Activities (CLA), the centre of gravity model was employed, combined with the MapMagic™ software to interpret coordinates.

From the calculations, the results showed that the desirable coordinate was 101.2934019 (latitude) and 13.6947474 (longitude). This coordinate pinpointed the location in Tambon Nong-nae, Amphur Panom-Sarakam. Theoretically, this location is only around 800 meters from the 304 national highway, which is the main road linking Bangkok and eastern provinces.

Another approach in this research was to apply the quantitative and qualitative comparison of optimal location for mango distribute centre and logistic in Chachoengsao. In order to determine the optimal location, the top three locations were compared: (1.) Tambon Khao-jon-sorn, (2.) Tambon Sa-med-nua, and (3.) Tambon Nong-nae. The quantitative comparison was the sum of mango production in each district in average production between 2002-2004, multiplied by the distance to each location. The qualitative comparison was the result of evaluation by five experts, using the Delphi technique.

The result optimal location of mango distribution centre and Logistic in Chachoengsao province was Tambon Sa-med-nua, Blang-Kla district. Logistic activities component were as follow; harvest activity, transportation mangoes to distribution centre, mangoes collecting from farmer, size classification, weighing and inspection, packaging, keeping, warehouse, government inspection, material handling, reverse logistic, communication and transportation transfers. Plant and facility design; the total area was 3,600 m². This area was divided into transportation port, mangoes collecting, size discrimination and inspection, weighing, packaging, cold storage, delivery area, equipment and tools, packaging room, vapour-treatment area, government inspection area, warehouse area, office, and security-perimeter area.

**Facility Layout Design**

For maximising the operational effectiveness, it is important to take into consideration the logistics activities discussed in the section above. These are; (1.) harvest activity, (2.) transportation of mango to distribution centre, (3.) collecting mangoes from cotters, (4.) size discrimination, (5.) weighing and inspection, (6.) sterilizing mangoes with vapour, (7.) packaging, (8.) keeping, (9.) warehouse, (10.) inspection by government prior to export, (11.) handling, (12.) reverse logistic, (13.) communication, and (14.) transfer of transportation.

Designing the Centre of Logistic Activities also considered the layout and facility design of the distribution centre, the concept of Systematic Layout Planning (SLP) by Richard (1974). Firstly, data of product quantity and the nature of stored products were defined, then activities in the distribution centre and logistics were also defined. The activity flows were analysed to find out the relationship between each activity, in order to define the Relationship Chart and the Relationship Diagram. Subsequently, the calculation was undertaken to determine the size of required space and the existing space for creating the Space Relationship Diagram.
Further dialogues with the stakeholders during the interviews and the focus group helped fine-tune the design for practicality. The total area for the facility was determined at 3,600 square metres. The area was categorised into key areas; security area, working office, quality inspection area, warehouse area equipment and maintenance area, packaging room, packing area, delivery area, collecting area, size-classification area, weighing area, conveyor-belt for loading area, machine for size-classification. Weighing and inspection room, sterilizing by vapour area. Cold storage room 1, cold storage room 2, and parking area for the waiting container.

Finance

Once the design of prospective collection and distribution centre was completed, the financial feasibility was next undertaken to determine the feasibility of establishing mango distribution centre and Logistics in Chachoengsao. This was to assess whether design parameters were feasible. The result of financial analysis showed that the project required a minimum of 32,394,320 Baht, or 32.3 million Baht for investment, and the payback period was 3 years 8 month, and 13 days. The present value at discount rate of 8% was 35,373,854 Baht, while the internal rate of return were 26.5%, and benefit/cost ratio was 2.097. This showed that the facility was financially feasible for investment.

Verification

Once the results were obtained through series of quantitative and qualitative analyses above, the researchers then sought to verify and validate those results via several means. The focus group was implemented to propose the direction and suggestion, location of the centre of logistic activities, activities in the centre, the administrative management, suggestions in the level of the governmental policy by experts and stakeholders. The researchers defined the sample of 11 people and employed the specific sampling, consisting of experts, modern farmers, retailers, middlemen, representatives of the government sector, consisting of the governor of Chachoengsao, the representatives from the Provincial Agriculture Office, Federal of Chachoengsao Industries, and Chachoengsao Chamber of Commerce.

The model of mango distribution centre and logistics activities was then proposed to 39 stakeholders for evaluation. The researchers employed semi-structured interviews, combined with 5-point Likert-scale questions employed in some topics, in order to quantify judgement and determine appropriateness of approach. According the opinions of these stakeholders, the result of model evaluation was at a good level, the average point was 4.19 and the standard deviation of 0.12.

To sum, the results are as follows:

1) Marketing analysis

Most of mangoes produced in Chachoengsao have been sold in the county and the trend of exporting to overseas has been increasing as the agreement between farmers and exporters had been done since 2001. The mainly exported mango is Nam Dok Mai. The largest exporting market is Japan, Europe and united states of America respectively. Secondly qualified mangoes have been exported to Malaysia, Indonesia and Singapore, The market requires a lot of products; however, the productivity is insufficient for serving these markets.

2) Technical analysis

The technical analysis was the identification and determination of optimal location for mango distribution centre in Chachoengsao. From the analysis, the optimal location was in the area of Tambon Sa-med-nua, Bang-khla District. Regarding to the facility design for mango distribution centre and Logistics in Chachoengsao, the total area is 4,800 square meters, and the area for distribution centre is 3,600 square meters.

3) Administration analysis

From the focus group discussion, the mango distribution centre and logistics was considered most appropriate to be managed in the form of company limited. The organization structure of this centre was divided into two parts; support and operations. The operation will be divided into two main departments; Quality Department and Transportation Department. According to human resource consideration, the required manpower then would be a total of 17 persons, 1 Manager, 2 Assistant Managers, 2 persons for supporting Division, Department and 8 persons from Transportation Department.
4) Financial analysis

Planning for financial data in various matters is to estimate the income and the business expense in order to analysis an estimate of profit/ lost, cash flow for the whole project. The remuneration from business would be calculated, in order to determine its feasibility for investment. The sensitivity had also been analysed.

Regarding the financial analysis, it showed that the project required around 32.4 million baht for investment, the payback period was 3 years 8 months 13 days. The present value at discount rate of 8% was around 35 million baht, while the internal rate of return was 26.5%. Therefore, it can be concluded that it was financially possible to invest in the implementation of this centre. In addition, the financial sensitivity will be analysed by the simulation model by considering the change occurring in the advance cash flow (while other variables are stable) and how it impacts the change of NPV and IRR.

In this study, it was supposed to have the change in sales amount, discount rate of 5% and 10%, then the Calculated value of NPV and IRR in each case of the project were compared. And calculated the changing rate of sales amount that caused NPV to be zero, according to the analysis of sensitivity. It showed that the rate of remuneration in this project was higher than 8% and NPV was plus And when the NPV was zero, the changing rate of sales amount decreased 44.10%. In conclusion, the benefit cost ratio was 2.097. Therefore, it is appropriate to establish the distribution centre in Chachoengsao, to help farmers and business entities to find prosperity.

The initial findings were then validated by the key stakeholders in the form of focus groups, as well as a series of in-depth interviews. The results showed that by having key logistic activities identified for mango industry, and by strengthening those activities, the mango operators could systematically increase the effectiveness of their activities.

CONCLUSION

This research identified key logistic activities for mango industry, and proposed several improvement plans, including an identification of optimal location for those logistic activities. The paper examines the benefits from implementing the logistic concept with mango products. Through logistic concept and logistic-based improvement, a better management, and lower operating cost, high quality mango could be achieved for end consumers.

In conclusion, it was found that, establishing a collection and distribution centre for post-harvest mango operations would enhance overall effectiveness. This centre would require an initial investment around 32.4 million Baht, the payback period was 3 years 8 months and 13 days. The present value at discount rate of 8% was around 35 million baht, while the internal rate of return was 26.5%. The initial findings were validated by key stakeholders in the form of focus groups, as well as a series of in-depth interviews. The results showed that by having key logistic activities identified for mango industry, and by strengthening those activities, the mango operators could systematically increase the effectiveness of their activities.

The research and development of distribution centre and logistic model for mango in Chachoengsao province is to help decrease the cost of logistics and increase the farmers’ capabilities in competing in the supply chain of mango production. While many have argued for an ability to respond to rapid growth and changes in business environment, this paper supports the logistics concept by highlighting the benefits gained from such practice. It is also hoped that implication from logistic concept could be extensively studied and thus employed to other types of products.

REFERENCES


