The Comparisons of TOPSIS and AHP Method to Location Selected of Grass Flower Warehouse in Chiang Rai Province

Abstract
This is an instruction for a manuscript preparation for the IE Network Conference. Please follow this guideline strictly as it would appear in the proceeding without retouching. An abstract should contain a single paragraph and its length should not exceed 25 lines. It should include a concise statement of objectives and a summary of important results. The purpose of this paper is to select warehouse location of grass flowers in Chiang Rai province comparing of two techniques Multiple Criteria Decision Making (MCDM) between the two techniques for Order Preference by Similarity to Ideal Solution (TOPSIS) and The Analytic Hierarchy Process (AHP). For selected of grass flowers location warehouse in Chiang Rai Province. The entrepreneurs of grass flowers trading need to increase warehouse building to meet customer satisfaction. Thus, this paper is to surveyed 7 criteria of the entrepreneurs consist of size of property, property cost, labor cost, public utility, mode of transportation, ability to access of location and distance from supplier and investigated locating in 4 districts using conjunctive constrain method to screen the alternative consist of Mae Jan district, Mae Sai district, Chiang Saen district and Chiang Khong district were used to selection. The decisions making of location selection used by TOPSIS and AHP, the result of this comparison found that Tambon Pa Sang, Mae Chan district is appropriate located for building grass flowers warehouse in Chiang Rai province.

Keywords: Comparison Location selection, Decision making

1. Introduction
Regarding the necessity of the inventory, entrepreneurs may not want the much inventory in the stock because of the economic liquidity and the cost of the organization. But, in terms of inefficient logistic management and range and duration of transportation management, there will have the space of time condition. If the distance is longer, there will take longer time for transportation, as well as higher cost of transportation. That are causes to have the inventories to reduce the cost, and the warehouse is also important to store the inventories. Therefore, the location is very important to pay attention to the distance to the sources of production, the size of the area, land’s price, the cost of wage, along with the pattern of transportation. All of these are factors of the new chosen location to set the warehouse to save the logistic cost. That means if the location is not appropriate, there will be following problems such as the logistic cost may be higher because of farther distance from sources of production and market. Moreover, there will be insufficient quality labors, elements or materials, along with other necessary factors. Generally, the location has no dominant advantage than other areas. Only the best properties of the land towards the business will be paid attention for the least effect in the future. Generally, the efficient location for the business should be spent the cost of production and service as least as possible. Thus, many factors will be involved to choose the location of the business because the location is very important to
the business of the organization such as transportation planning, investment, and income, etc. (Sudathip Tuntinikulchai and Sakda Hongthong, 2004) [5]. Brooms are important to clean the house and the life of broom may not long, so the demand is also high continually. Form the demand, the production and income of brooms are also high. This is the new business to earn more money for the villages in Northern and Northeastern Thailand. The supporting evidences show that there are more brooms producers. Also, the producing of the broom will use many elements, especially grass which is the main elements of the brooms. The grass will be collected only in one season from November to March. During this period, the grass will be cheaper. The entrepreneur has to store the grass for further demand all year. There is more demand in the market each year and the entrepreneur has to buy the grass at a higher cost because of higher demand. From the mentioned problem, the entrepreneur needs to find the new appropriate location to store the grass in Chiang Rai Province to increase the capacity of the storage and reduce logistic cost.

2. LITERATURE, THEORY & METHODOLOGY

TOPSIS method are summarized in this section. The criteria to choose the location for the warehouse to gain the information for the study. The involving researches are started form Multi Criteria Decision Making. It is one of the popular criteria to choose to evaluate and analyze in various patterns such as (Kengpol, 2004) [2] who adapted the AHP technique to create the model of transportation problems and analyze the investment to choose the warehouse. He compared 2 locations in Bangkok under the transportation legal regulation. (Thiengburanathum, et al.,2006)’s research who adapted AHP technique to evaluate the transportation route from Khunming, China to Bangkok [6]. This criteria could indicate the significances of the importance of route in term of being the new route linked between Khunming, Yunnan Precinct and Bangkok, Thailand. Rather than AHP technique, there are many criteria from other researches which is the major decision. For example (Milan and Aura, 2002)’s research who adapted the 3 multi criteria decision making about the new center of air traffic of European Union, assigned to administrate the air traffic transportation business [3]. All of 3 criteria decision making are SAW (Simple Additive Weighting Method), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), and AHP (Analytic Hierarchy Process)

There may be more than one appropriate location so the multi criteria decision making will be the assistance to choose the best location of the warehouse as indicated below. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) TOPSIS, developed by Hwang and Yoon in 1981, is a simple ranking method in conception and application. The standard TOPSIS method attempts to choose alternatives that simultaneously have the shortest distance from the positive ideal solution and the farthest distance from the negative-ideal solution. The positive ideal solution maximizes the benefit criteria and minimizes the cost criteria, whereas the negative ideal solution maximizes the cost criteria and minimizes the benefit criteria. TOPSIS makes full use of attribute information, provides a cardinal ranking of alternatives, and does not require attribute preferences to be independent (Chen and Hwang, 1992; Yoon & Hwang, 1995) [1]. To apply this technique, attribute values must be numeric, monotonically increasing or decreasing, and have commensurable units.

TOPSIS method to the location selection warehouse of grass in Chiang Rai province. TOPSIS is a multiple criteria decision making methodology (MCDM) which determines solution alternatives from a finite set in the basis of maximizing the distance from the negative ideal point and minimizing the distance from the positive ideal
point. (Olson, 2004) TOPSIS is interesting with its need for decision maker’s limited number of subjective input. Only subjective input is in the criteria weighting phase [7]. The model algorithm steps of TOPSIS (Olson, 2004) and its practice in the case study is as follows:

Step 1: Construct normalized decision matrix

\[ \frac{X_{ij}}{ \sum_{j=1}^{n} X_{ij} } \], \ i = 1, 2, 3, ..., m, j = 1, 2, 3, ..., n

Where \( X_{ij} \) and \( R_{ij} \) are original and normalized sore of decision matrix, respectively.

Step 2: Construct the weights normalized decision matrix

\[ W_{ij} = \frac{V_{ij} \times R_{ij}}{ \sum_{j=1}^{n} W_{ij} } \], \ i = 1, 2, 3, ..., m, j = 1, 2, 3, ..., n

Where \( W_{ij} \) is the weight for \( j \) and \( \sum_{j=1}^{n} W_{ij} \)

Step 3: Determine the positive ideal and negative ideal solutions

\[ V^+ = \left\{ v^+_1, ..., v^+_n \right\} = \left\{ \left( \max_{i \in I} v_{ij} \right), \left( \min_{i \in I} v_{ij} \right) \right\} \]

\[ V^- = \left\{ v^-_1, ..., v^-_n \right\} = \left\{ \left( \max_{i \in I} v_{ij} \right), \left( \min_{i \in I} v_{ij} \right) \right\} \]

Step 4: Calculate the separation measures for each alternative. The separation form positive ideal alternative is:

\[ S^+_i = \sqrt{ \sum_{j=1}^{n} \left( v_{Aj} - v^+_j \right)^2 } \], \ j = 1, 2, 3, ..., n, \]

Similarly, the separation form negative ideal alternative is:

\[ S^-_i = \sqrt{ \sum_{j=1}^{n} \left( v_{Aj} - v^-_j \right)^2 } \], \ j = 1, 2, 3, ..., n,

Step 5: Calculate the relative closeness to the ideal solution \( V^+ \)

\[ C_i = \frac{ S^-_i }{ S^+ + S^-_i } \], \ i = 1, 2, 3, ..., m

Where \( C^* = 0 \leq C_i^* \leq 1 \) When \( V_i = V^- \) And \( C_i^* = 1 \) When \( V_i = V^+ \)

Select the Alternative with \( C_i^* \) closest to 1

Analytic Hierarchy Process (AHP)

The elements of AHP are as follows.

- Criteria
- Comparison of criteria
- Table of priority or preference level

Elements in decision process can be divided into 4 parts.

1. The problem or goal is the beginning of the decision that affects the determination and evaluation of the alternatives.
3. Sub Criteria is secondary criteria used to enhance effective decision making process.
4. Alternative. The consideration of alternatives is the most important step in the decision process. It also affects the ability to diagnose alternatives.

The priority setting of criteria

Priorities among the elements of the hierarchy are established by making a series of judgments based on pairwise comparisons of the element as shown in table 2.1

![Figure 2.1: A Simple AHP hierarchy](image-url)
Table 2.1: Preference level and numerical value of AHP hierarchy

<table>
<thead>
<tr>
<th>Numerical Value</th>
<th>Preference Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Very Strong</td>
</tr>
<tr>
<td>8</td>
<td>Strong to very strong</td>
</tr>
<tr>
<td>7</td>
<td>Strong</td>
</tr>
<tr>
<td>6</td>
<td>Marginally strong to strong</td>
</tr>
<tr>
<td>5</td>
<td>Marginally strong</td>
</tr>
<tr>
<td>4</td>
<td>Moderate to marginally strong</td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
</tr>
<tr>
<td>2</td>
<td>Equal to moderate</td>
</tr>
<tr>
<td>1</td>
<td>Equal</td>
</tr>
</tbody>
</table>

AHP has the following steps:

Step 1 Divide problem into a hierarchy of goal, criteria, sub-criteria and alternatives.

Step 2 Enter input data into Pairwise Comparison Matrix to determine the weights for comparison of various criteria. Given that A1, A2, A3, ...An are decision criteria. Analysis is conducted in the form of matrix n x n

\[
\begin{bmatrix}
  A_1 & A_2 & A_3 \\
  1 & A_2/A_1 & A_3/A_1 \\
  A_2/A_1 & 1 & A_3/A_2 \\
  A_3/A_1 & A_3/A_2 & 1
\end{bmatrix}
\]

Step 3 Estimate the weights through Geometric Mean

Step 4 Set the weights with respect to the criteria or sub-criteria and ratings with respect to the alternatives.

Step 5 Estimate consistency. If consistency ratio (CR) is greater than 0.1, it means incorrect data. If consistency ratio (CR) is less than 0.1, it means correct data. Consistency ratio (CR) can be calculated by:

\[
CR = \frac{CI}{RI}
\]

Where CR = consistency ratio
CI = consistency index
RI = random index

So, consistency index (CI) can be obtained through

\[
CI = \frac{\lambda - n}{n - 1}
\]

Where n = number of criteria

And Random Index (RI) shown in table 2.2

Table 2.2: Values of Random Index (RI)

<table>
<thead>
<tr>
<th>N</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>RI</td>
<td>0.58</td>
<td>0.90</td>
<td>1.12</td>
<td>1.24</td>
<td>1.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.41</td>
<td>1.65</td>
<td>1.49</td>
<td>1.51</td>
<td>1.48</td>
<td>1.56</td>
<td>1.57</td>
</tr>
</tbody>
</table>

3. Results

The results stated that the criteria are depended on the appropriate to the research’s objectives. So, TOPSIS method the appropriate criteria were synthesized from the involving researches’ reviews. Moreover, the proper criteria were set by considering from the possible choices to choose the warehouse of grass in Chiang Rai Province. From the reviews of involving literatures and the evaluation of the location’s surroundings, there are 7 criteria were set to choose the location covered all concerns as below. Size of property (X1), Property cost (X2), Labor cost (X3), Public utility (X4), Mode of transportation (X5), Ability to access of Location (X6) and, Distance from supplier (X7)

The basic of criteria for the location of warehouse of grass in Chiang Rai Province is Conjunctive constrain method. The filtering factors are as below.

1. It must less than 50 kilometers far from material source.
2. It must be located on main transport routes.
3. It has main road linking the area.

From the initial screening by the above constrained conditions, the choices were cut into 5 districts, including:

1. Tambon Krung Mae Chan Chiang Khong District (A1)
2. Tambon Sri Don Chai Chiang Khong District (A2)
3. Tambon Ban Saew Chiang Saen District (A3)
4. Tambon Mae Chan Mae Chan District (A4)
5. Tambon Pa Sang Mae Chan District (A5)

When the TOPSIS adjust the weight to a standard, it will calculate the weight factor by multiplying the available information to make a smooth adjustment to the weighting normalize and identifying positive ways. And negative by calculating $v_j^+$ and $v_j^-$ of the numerical consideration the weight for this study using the Ratio Weighting, which is the weight of the value Geometric Mean of each factor. In order to apply for the $S^+ S^-$ and $C^*$

Table 3.1 Result of weighting normalize and identifying positive ways. And negative

<table>
<thead>
<tr>
<th>Criteria</th>
<th>A1</th>
<th>A2</th>
<th>A3</th>
<th>A4</th>
<th>A5</th>
<th>$v_j^+$</th>
<th>$v_j^-$</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>0.0787</td>
<td>0.0525</td>
<td>0.0899</td>
<td>0.0630</td>
<td>0.1049</td>
<td>0.1049</td>
<td>0.0525</td>
</tr>
<tr>
<td>X2</td>
<td>0.0804</td>
<td>0.0764</td>
<td>0.0402</td>
<td>0.0402</td>
<td>0.0563</td>
<td>0.0804</td>
<td>0.0402</td>
</tr>
<tr>
<td>X3</td>
<td>0.0316</td>
<td>0.0316</td>
<td>0.0190</td>
<td>0.0253</td>
<td>0.0316</td>
<td>0.0316</td>
<td>0.0190</td>
</tr>
<tr>
<td>X4</td>
<td>0.0365</td>
<td>0.0365</td>
<td>0.0122</td>
<td>0.0243</td>
<td>0.0243</td>
<td>0.0365</td>
<td>0.0122</td>
</tr>
<tr>
<td>X5</td>
<td>0.0145</td>
<td>0.0435</td>
<td>0.0145</td>
<td>0.0290</td>
<td>0.0290</td>
<td>0.0435</td>
<td>0.0145</td>
</tr>
<tr>
<td>X6</td>
<td>0.0199</td>
<td>0.0199</td>
<td>0.0133</td>
<td>0.0199</td>
<td>0.0199</td>
<td>0.0199</td>
<td>0.0133</td>
</tr>
<tr>
<td>X7</td>
<td>0.0169</td>
<td>0.0169</td>
<td>0.0169</td>
<td>0.0084</td>
<td>0.0084</td>
<td>0.0169</td>
<td>0.0084</td>
</tr>
</tbody>
</table>

Table 3.2 Results of TOPSIS show that $S^+ S^-$ and $C^*$ and rank of results

<table>
<thead>
<tr>
<th>Alternative</th>
<th>$S^*$</th>
<th>Rank</th>
<th>$S^-$</th>
<th>Rank</th>
<th>$C^*$</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>0.0580</td>
<td>2</td>
<td>0.0657</td>
<td>3</td>
<td>0.5312</td>
<td>2</td>
</tr>
<tr>
<td>A2</td>
<td>0.0649</td>
<td>3</td>
<td>0.0695</td>
<td>2</td>
<td>0.5174</td>
<td>3</td>
</tr>
<tr>
<td>A3</td>
<td>0.0939</td>
<td>5</td>
<td>0.0390</td>
<td>5</td>
<td>0.2936</td>
<td>5</td>
</tr>
<tr>
<td>A4</td>
<td>0.0715</td>
<td>4</td>
<td>0.0590</td>
<td>4</td>
<td>0.4519</td>
<td>4</td>
</tr>
<tr>
<td>A5</td>
<td>0.0356</td>
<td>1</td>
<td>0.0886</td>
<td>1</td>
<td>0.7134</td>
<td>1</td>
</tr>
</tbody>
</table>

After study the related researches to select the multi-criteria to choose the best place for the warehouse, the results stated that the criteria are depended on the appropriate to the research’s objectives. So, Analytic Hierarchy Process (AHP) method the appropriate criteria were synthesized from the involving researches’ reviews. Moreover, the proper criteria were set by considering from the possible choices to choose the warehouse of grass in Chiang Rai Province. From the reviews of involving literatures and the evaluation of the location’s surroundings, there are 7 criteria were set to choose the location covered all concerns as below.

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2. Property cost (X2),
3. Labor cost (X3),
4. Public utility (X4),
5. Mode of transportation (X5),
6. Ability to access of Location (X6) and
7. Distance from supplier (X7)

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3. Tambon Ban Saew Chiang Saen District (A3)
4. Tambon Mae Chan Mae Chan District (A4)
5. Tambon Pa Sang Mae Chan District (A5)

The AHP hierarchy can be shown in the figure 3.1:

Figure 3.1 A simple AHP hierarchy, with goal to select the Location Selection of Warehouse of Grass in Chiang Rai Province

From the mention above, AHP criteria is to estimate the importance of each attribute. And the criteria to create matrixes pairwise comparisons to set the weight, as shown in table 3.3 with consistency at 0.08, 0.1 lower than the criterion is the highest possible index, showing the stability of the committee. And, each of matrixes pairwise comparisons of the attribute X1 to X7 was shown in table 3.4.

Table 3.4 Pairwise comparisons Matrix of attributes X1 to X7

<table>
<thead>
<tr>
<th>X1</th>
<th>X2</th>
<th>X3</th>
<th>X4</th>
<th>X5</th>
<th>X6</th>
<th>X7</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>1/5</td>
<td></td>
<td>0.16</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>5</td>
<td>1/3</td>
<td>0.27</td>
</tr>
<tr>
<td>1/4</td>
<td>1/6</td>
<td>1</td>
<td>1/2</td>
<td>2</td>
<td>3</td>
<td>1/5</td>
<td>0.06</td>
</tr>
<tr>
<td>1/6</td>
<td>1/5</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>1/7</td>
<td>0.07</td>
</tr>
<tr>
<td>1/4</td>
<td>1/6</td>
<td>1/2</td>
<td>1/2</td>
<td>1</td>
<td>½</td>
<td>1/4</td>
<td>0.04</td>
</tr>
<tr>
<td>1/4</td>
<td>1/5</td>
<td>1/3</td>
<td>1/3</td>
<td>2</td>
<td>1</td>
<td>1/4</td>
<td>0.04</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>1</td>
<td>0.37</td>
</tr>
</tbody>
</table>

Inconsistency = 0.08

After making pairwise comparisons, the weight of the alternatives will be obtained and then make adjustments to the sum 1 as shown in Table 5. Finally summing the scores by multiplying the weight of each criterion by the weight of each criterion as shown in Table 3.5.

Table 3.5 Total sum of alternatives scores

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>0.2960</td>
</tr>
<tr>
<td>A2</td>
<td>0.1403</td>
</tr>
<tr>
<td>A3</td>
<td>0.2608</td>
</tr>
<tr>
<td>A4</td>
<td>0.3028</td>
</tr>
<tr>
<td>A5</td>
<td>0.2624</td>
</tr>
</tbody>
</table>

From AHP criteria to choose the location of the warehouse of grass in Chiang Rai Province through the 7 criteria, the results stated that Chiang Khong district is the interesting place to be...
the location of the warehouse. The runner-up
district is Mae Chan, Chiang Saen, and Mae Sai,
respectively.

When analyzing data for selection in various
ways. With different ideas To find the most
appropriate alternative from the various methods.
There are 2 methods of decision making: TOPSIS
And how to AHP The results of the order of choice
in various ways. It can be concluded that Option
A7 (Tambon Pa Sang, Mae Chan District) is the
most appropriate choice. To build a warehouse of
glass since it is the first place selected from the
two methods ranked second to the A1 (Tambon
Pa Sang, Mae Chan District) A2 (Tambon Sri
Srichon, Chiang Khong District) A6. (Tambon Mae
Chan, Mae Chan District) and A3 (Tambon Ban
Saew, Chiang Saen District), respectively.

4. Conclusion

This paper provides a structured overview of the
location selection of warehouse of glass in Chiang Rai province using multiple criteria decision
making (MCDM) which is two techniques for order
preference by similarity to ideal solution (TOPSIS)
procedure and AHP procedure, consisting of 7
criteria; the size of area, the land’s price, the cost
of wage, public utility, transportation, the ability to
reach the area, and the distance from the raw
materials. From TOPSIS method analysis, the
results stated that the appropriate location to be
the warehouse of glass in Chiang Rai Province is
Tambon Pa Sang, Mae Chan district which the
location is appropriate to the needs of entrepreneurs. It is also land prices are not too
high, transport facilities adjacent to major
transportation routes R3A, easily accessible
entrance is quite wide and it is not far from the
source material. From AHP method analysis, the
results stated that the appropriate location to be
the warehouse of glass in Chiang Rai Province is
Chiang Khong District.

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