การคัดเลือกทำเลที่ตั้งคลังเก็บดอกหญ้า จังหวัดเชียงราย โดยใช้หลักการตัดสินใจแบบหลายหลักเกณฑ์

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บทคัดย่อ

การคัดเลือกทำเลที่ตั้งที่เหมาะสมในการจัดตั้งคลังเก็บดอกหญ้าในจังหวัดเชียงราย เนื่องด้วยผู้ประกอบการค้าดอกหญ้ามีความจำเป็นที่ต้องการเพิ่มคลังเก็บดอกหญ้าให้มากขึ้น และเพิ่มความสามารถในการตอบสนองความต้องการของลูกค้าให้ได้มากขึ้นด้วย จึงมีความต้องการหาทำเลที่ตั้งใหม่ที่เหมาะสมในการจัดตั้งคลังเก็บดอกหญ้า ปัจจัยในการคัดเลือกทั้งหมด 7 ปัจจัย ได้แก่ ขนาดของพื้นที่ ราคาที่ดิน ต้นทุนแรงงาน สาธารณูปโภค รูปแบบในการขนส่งความสามารถในการเข้าถึงพื้นที่ ระยะห่างจากแหล่งวัตถุดิบ ซึ่งเป็นปัจจัยที่นำมาประกอบในการคัดเลือกทำเลที่ตั้ง จากการตัดตัวเลือกด้วย Conjunctive constrain method ทำให้เหลือพื้นที่ 4 แห่ง ได้แก่ อำเภอแม่จัน อำเภอแม่สาย อำเภอเชียงแสน และอำเภอเชียงของ จากนั้นทำการคัดเลือกทำเลที่ตั้งด้วยหลักการตัดสินใจแบบหลายหลักเกณฑ์ โดยเทคนิค AHP จากการศึกษาพบว่าพื้นที่อำเภอเชียงของมีทำเลที่ตั้งที่เหมาะสมที่สุดในการจัดตั้งคลังเก็บดอกหญ้า จังหวัดเชียงราย เนื่องจากมีความเหมาะสมภายใต้ปัจจัยทั้ง 7 ปัจจัย

คำสำคัญ: ทำเลที่ตั้ง,คลังเก็บดอกหญ้า,หลักการตัดสินใจแบบหลายหลักเกณฑ์,จังหวัดเชียงราย

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Multiple Criteria Decision Making (MCDM) for a Grass Warehouse Site Selection in Chiang Rai Province, Thailand

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Abstract

This paper presents a Multiple Criteria Decision Making (MCDM) process for the site selection of a grass warehouse in Chiang Rai Province, Thailand. The following seven criteria were used for site selection: size of property, property cost, labor costs, public utilities, mode of transportation, and ability to access the location, and distance from suppliers. In this paper, the conjunctive constraint method was used to reduce the alternatives from seven to four. The screened locations include Amphoe Mae Jan, Amphoe Mae Sai, Amphoe Chiang Saen, and Amphoe Chiang Khong. The decision regarding the site selection was made using the Analytic Hierarchy Process (AHP) technique. Based on this process, the criteria “distance from suppliers” and “property cost” were ideas identified as important to the site selection for the grass warehouse. As a result, we determined that Amphoe Chiang Khong was the most appropriate location for the warehousing of grass in Chiang Rai Province.

Keywords: Location, Storage of grass, multi-criteria decision making, Chiang Rai province

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1. Introduction

Regarding the necessity of storing inventory, entrepreneurs may not want to hold much inventory in stock because of economic liquidity and organizational cost concerns. However, in terms of pursuing efficient logistics management and the range and duration of transportation management, there must be a consideration of the space of time condition. If the distance is longer, transportation will also take longer, and it will lead to greater transportation costs. These considerations are reasons to hold an inventory and reduce costs. Having a warehouse is also important for storing inventory.

Brooms are important tools for cleaning houses; as a result, the life of broom may not be long, which means that the demand for them is continually high. Based on this persistent demand, the production and income related to brooms are also high. Broom manufacturing is a new business designed to earn more money for the villages of northern and northeastern Thailand. The supporting evidence shows that there are more broom producers today than ever before. Also, the production of brooms calls for many elements, especially grass, which is a broom's main component. The resources for grass in northern Thailand are Chiangrai, Phayao, Nan, and Chiangmai Provinces, and Laos. The main suppliers of grass are in Chiangrai and Laos; in fact, the Chiangrai Province produces the most grass, which makes a study of it interesting. The grass is collected during one specific season, from November through March. During this time, the grass is less expensive. Still, entrepreneurs must store the grass to meet the year-round demand. There is more demand in the market each year, and entrepreneurs are paying higher prices for grass because of the higher demand. With this in mind, entrepreneurs need to find, new appropriate locations to store grass in the Chiang Rai Province. When this can be done, entrepreneurs will be able to increase their storage capacity and reduce logistical costs.

As the above has demonstrated, the warehouse location is very important. Entrepreneurs must pay attention to the distance from it to the sources of production, the size of the area, land prices, the cost of wages, and transportation patterns. All of these are factors affecting the choice for the new location and will help to save logistics costs. If the location is not appropriate, problems will result, such as higher logistics costs because of a greater distance from the sources of production to the market. Moreover, there will be insufficient quality labor, elements, or materials, along with other necessary factors. Generally speaking, one location has no dominant advantage over other areas. Only the good properties of the land that will benefit the business should be considered. To choose an efficient location for the business, entrepreneurs need to consider the cost of production and services, keeping them as low as possible. Many factors will be involved in choosing the location for the business, including transportation planning, investment, income, and so on. [1]

2. Study area and methodology

This study is an adaptation of the MCDM process used to choose the location for a grass warehouse in Chiang Rai Province. Chiang Rai is the appropriate strategic province in which to set the warehouse. There are many resources available each year, and it is home to an important economic route for exporting products to nearby countries. If the warehouse is set in Chiang Rai Province, it will be convenient to transport the grass to other provinces in Northern Thailand throughout the year, and it will be possible to store the materials imported from nearby countries. This will lend a logistical efficiency to the location. There may be more than one

appropriate location for the warehouse, so the MCDM approach will be used to choose the best one, as indicated below.

2.1 Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is one of the MCDM methods originally developed by Prof. Thomas L. Saaty. In short, it is a method used to derive ratio scales from paired comparisons. AHP allows for some small inconsistencies in judgments, because humans are not always consistent. The ratio scales are derived from the principal Eigen vectors, and the consistency index is derived from the principal Eigen value.

The elements of AHP are as follows:

- Criteria
- Comparison of criteria
- Table of priorities or preference levels

The elements in a decision-making process can be divided into four parts:

1. Identifying the problem or goal is the beginning of the decision-making process and affects the determination and evaluation of alternatives.

2. Major criteria is a set of criteria for decision making problem.

3. Sub-criteria are secondary criteria used to enhance the effective decision-making process.

4. Alternatives. The consideration of alternatives is the most important step in the decision-making process. It also affects the ability to diagnose alternatives.

Prioritizing criteria

Priorities are established among the elements of the hierarchy by making a series of judgments based on pairwise comparisons of them, as shown in Table 1.

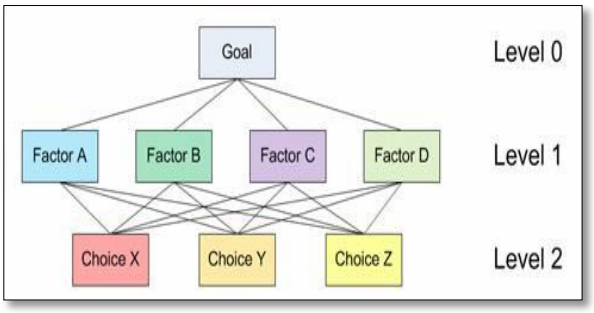

Figure 1. A Simple AHP hierarchy

Table 1. *Preference level and numerical value of AHP hierarchy*

Numerical Value	Preference Level
9	Very Strong
8	Strong to very strong
7	Strong
6	Marginally strong to strong
5	Marginally strong
4	Moderate to marginally strong
3	Moderate
2	Equal to moderate
1	Equal

AHP calls for the following steps:

The methodology of the AHP technique can be explained in the following steps:

Step 1: Divide the problem into a hierarchy of goals, criteria, sub-criteria, and alternatives.

Step 2: Enter input data into the Pairwise Comparison Matrix to determine the weights for comparing various criteria.

Step 3: Estimate the weights through the 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 the consistency ratio (CR) is greater than 0.1, it means this is incorrect data. If the CR is less than 0.1, it means it is correct data. The CR can be calculated as:

$$CR = \frac{CI}{RI} \quad (1)$$

Where CR = consistency ratio

CI = consistency index

RI = random index

So, the consistency index (CI) can be obtained as:

$$CI = \frac{\lambda - n}{n-1} \quad (2)$$

Where n = number of criteria,

λ = maximal Eigen values

The Random Index (RI) is shown in Table 2

Table 2. *Values of Random Index (RI)*

N	1	2	3	4	5	6	7
RI	0	0	0.58	0.90	1.12	1.24	1.32

3. Related Research

In this study, the researcher examined previous studies about the best criteria for choosing the location for a warehouse. This data provided information for the present study. The involved studies all used MCDM. This is one of the most popular methods for choosing how to evaluate and analyze various patterns, as noted by [3] who adapted the AHP technique to create a model of transportation problems and analyze the investment needed to choose a warehouse. He compared two locations in Bangkok according to legal regulations related to transportation. [4] adapted the AHP technique to evaluate the transportation routes from Khunming, China to Bangkok. These criteria could indicate the significance or the importance of routes in terms of the new route linking Khunming, in the Yunnan Province, and Bangkok, Thailand.

In addition to the AHP technique, there are many criteria decision techniques suggested by other researchers for decision making. For example, [5] used three multi criteria decision making techniques to solve the problem of air traffic transportation business. Similar researches are found in many studies that use the MCDM technique. For example, [6] uses the ordinal analysis technique to choose tertiary logistics services. [7] was mentioned in the literature review for its capacity evaluation and logistical capacity development index, and for using four MCDM, such as TOPSIS, ELECTRE, PROMETHEE, and AHP, to choose the destination province for a logistics center for product transportation from the North-South and East-West economic corridors related to the route of the Asian Development Bank (ADB). Further [8] studied the criteria used to choose an area for a warehouse by comparing the criteria associated with MCDM. The criteria they used were AHP, TOPSIS, ELECTRE, and Grey.

In the first procedure, the results from each theory were compared. After that, the locations were chosen using criteria from AHP, TOPSIS, ELECTRE, and Grey. The best result was chosen. [9] focused on the location for a goods warehouse and the criteria of cost, labor, fundamental structure, and marketing. The weight of each criterion was set by the researchers. When the data were analyzed using the Fuzzy ANP technique, the location was finally chosen. MCDM is used in many studies that call for choosing a location. For example, [10] used the fuzzy technique to choose an appropriate location.

Based on our literature review, we can say that MCDC can be adapted to a variety of purposes. This is why the researcher wants to use the approach to choose the location for the grass warehouse in Chiang Rai Province. The AHP technique has advantages when important elements of the decision are difficult to quantify or compare, or where communication among team members is impeded by their different specializations, terminologies, or perspectives.

4. Results and discussion

After studying the related research to select the multi-criteria most appropriate for

choosing the best place for the warehouse, the results made it clear that the criteria are dependent upon how appropriate they are to the research objectives. With this in mind, the appropriate criteria were synthesized based on data gleaned from the entrepreneurs' interviews. Moreover, the proper criteria were set by considering the possible choices for siting the grass warehouse in Chiang Rai. Based on the interviews the decision maker of the warehouse site selection and the evaluation of the location's surroundings, seven criteria were used to choose the location, as they covered all of the concerns listed below.

1. Size of property (X1)
2. Property cost (X2)
3. Labor costs (X3)
4. Public utilities (X4)
5. Mode of transportation (X5)
6. Ability to access the location (X6)
7. Distance from suppliers (X7)

The basic criteria for choosing the location of the grass warehouse in Chiang Rai Province was set forth by the conjunctive constraint method. The filtering factors are as follows.

1. It must be less than 50 kilometers away from the material source because the entrepreneur does not want to be too far from the resources.
2. It must be located on main transport routes.
3. It has a main road linking the area.

Based on the initial screening with the above-constrained conditions, the choices were narrowed to four districts, including:

1. Amphoe Mae Chan (A1)
2. Amphoe Mae Sai (A2)
3. Amphoe Chiang Saen (A3)
4. Amphoe Chiang Khong (A4)

The AHP hierarchy can be seen in Figure 2.

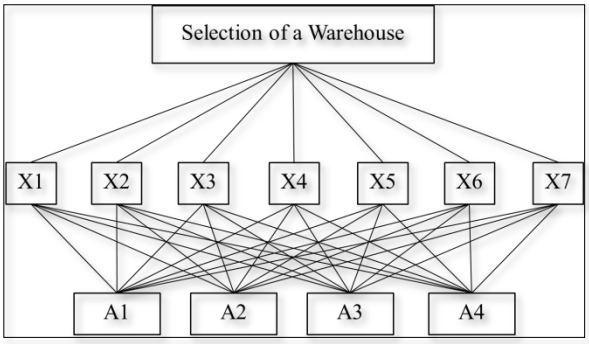

Figure 2. A simple AHP hierarchy, with the goal of selecting the location for a grass warehouse in Chiang Rai Province

As mentioned above, AHP criteria are used to estimate the importance of each attribute. The criteria to create matrices of pairwise comparisons are set by the entrepreneur's chosen elements for emphasis. The weight given by the top manager, as shown in Table 3, has a consistency of 0.08, 0.1 lower than the criterion for the highest possible index, showing the stability of the decision maker. Further, each of the matrices' pairwise comparisons of Attributes X1 to X7 is shown in Table 4.

Table 3. *Pairwise comparisons matrix of the analysis criteria*

	X1	X2	X3	X4	X5	X6	X7	Weight
X1	1	1/3	4	6	4	4	1/4	0.16
X2	3	1	6	5	6	5	1/3	0.25
X3	1/4	1/6	1	1/2	2	3	1/6	0.06
X4	1/6	1/5	2	1	2	3	1/7	0.06
X5	1/4	1/6	1/2	1/2	1	1/2	1/6	0.04
X6	1/4	1/5	1/3	1/3	2	1	1/6	0.04
X7	4	3	6	7	6	6	1	0.39
Consistency = 0.08								

Table 4. *Pairwise comparisons Matrix of Attributes X1 to X7*

for X1	A1	A2	A3	A4
A1	1	4	5	3
A2	1/4	1	3	3
A3	1/5	1/3	1	1/2
A4	1/3	1/3	2	1
Consistency = 0.08				

for X2	A1	A2	A3	A4
A1	1	5	3	3
A2	1/5	1	1/4	1/4
A3	1/3	4	1	1/2
A4	1/3	4	2	1
Consistency = 0.06				

for X3	A1	A2	A3	A4
A1	1	3	4	5
A2	1/3	1	4	4
A3	1/4	1/4	1	1
A4	1/5	1/4	1	1
Consistency = 0.05				

for X4	A1	A2	A3	A4
A1	1	1/2	1/3	1/3
A2	2	1	2	2
A3	3	1/2	1	1
A4	3	1/2	1	1
Consistency = 0.06				

for X5	A1	A2	A3	A4
A1	1	1	1/3	1/3
A2	1	1	1/3	1/3
A3	3	3	1	1
A4	3	3	1	1
Consistency = 0				

for X6	A1	A2	A3	A4
A1	1	5	4	2
A2	1/5	1	1/5	1/5
A3	1/4	5	1	1
A4	1/2	5	1	1
Consistency = 0.07				

for X7	A1	A2	A3	A4
A1	1	1/3	1/6	1/7
A2	3	1	1/5	1/6
A3	6	5	1	1
A4	7	6	1	1
Consistency = 0.04				

After making the pairwise comparisons, the weight of each alternative will be obtained by the entrepreneur, and adjustments can be made to sum 1, as shown in Table 5. Finally, the scores are added by multiplying data in table 5 by the weight of each criterion, as shown in Table 6

Table 5. *The weights of all alternatives*

	X1	X2	X3	X4	X5	X6	X7
A1	0.54	0.50	0.53	0.12	0.13	0.49	0.05
A2	0.24	0.07	0.29	0.38	0.13	0.06	0.10
A3	0.09	0.18	0.09	0.25	0.37	0.21	0.41
A4	0.13	0.25	0.09	0.25	0.37	0.24	0.44
Sum	1.00	1.00	1.00	1.00	1.00	1.00	1.00

Table 6. *Total sum of the alternatives' scores*

Alternative	Score
A1	0.2947
A2	0.1427
A3	0.2629
A4	0.2997

Based on the AHP criteria for choosing the location of the grass warehouse in Chiang Rai Province via the seven criteria, the results show that the Chiang Khong and Mae Chan Districts are the best places for the warehouse. The Chiang Khong District has an advantage, in that it is close to the resources. Mae Chan is appealing, however, due to the larger size of the property and its lower property cost. Both the Chiang Khong and Mae Chan Districts have different advantages that can appeal to an entrepreneur selecting a grass

warehouse location. The runner-up districts are Chiang Saen and Mae Sai.

5. Suggestions and Conclusion

By involving previous research in the location selection for a grass warehouse in the Chiang Rai Province, the MCDM approach has called for using the AHP procedure, which consists of seven criteria: the size of the area, the land's price, the cost of wages, public utilities, transportation, the ability to reach the area, and the area's distance from the raw materials. Based on our analysis, it was clear that the most appropriate location for the grass warehouse in Chiang Rai Province is the Chiang Khong District. In future studies, the researcher would like to use other criteria, such as TOPSIS, SAW, and WPA, to compare results to those gained via AHP. It would also be useful to analyze data using the Fuzzy theory.

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