The Location Selection of Land Logistics hubs in Lampang Province

Ms. Phatcharaphon Prommin[1] and Mr. Apichat Sopadang*[2]
[1]Department of Industrial Logistics Management, The Far Eastern University,
Mueng District, Chiang Mai Province, 50000
E-mail: phatchaberneken@gmail.com
[2]Excellence Center in Logistics and Supply Chain Management (E-LSCM),
Chiang Mai University, Mueng District, Chiang Mai Province, 50000
E-mail: sopadang@gmail.com*

Abstract

ASEAN Economic Community (AEC) and The Greater Mekong Sub-region (GMS) positively make Lampang Province becomes a possible logistics hub in Northern of Thailand. However, the selection of the logistics hub in Lampang Province still remained unidentifiably. This research aimed to specify the land for logistics hub location by applying the Multi Criteria Decision Making (MCDM), which was the applied engineering method for estimating land logistics hubs with Fuzzy environmental condition. In this processes, three alternative selected sectors such as Hang Chat District, Ko Kha District, and Ban Sadej District were generated from literatures. Also, sixteen factors were created from reviewing literatures. Then, AHP weighting was used to calculate the ratings of selected factors. Finally, the researchers applied the Fuzzy TOPSIS method to solve a location selecting problem. The results found that Ko Kha District provides a suitable area for Northern land logistics hubs.

Keywords: Land logistics hub; Lampang Province; Multi Criteria Decision Making; Fuzzy TOPSIS.

บทคัดย่อ

การรวมกลุ่มประชาชมเศรษฐกิจอาเซียน (ASEAN Economic Community, AEC) และโครงการความร่วมมือระหว่างอนุภาคลุ่มน้ำโขง (The Greater Mekong Sub-region: GMS) ส่งผลให้จังหวัดลำปางมีความเป็นไปได้ในการเป็นศูนย์กลางโลจิสติกส์ทางบกของภาคเหนือ อย่างไรก็ตามการคัดเลือกทำเลที่ตั้งศูนย์กลางโลจิสติกส์ทางบกของจังหวัดลำปางยังไม่มีความแน่ชัด การวิจัยนี้จึงมีวัตถุประสงค์เพื่อคัดเลือกทำเลที่ตั้งศูนย์กลางโลจิสติกส์ทางบกโดยใช้หลักการตัดสินใจแบบหลายหลักเกณฑ์ (Multi Criteria Decision Making ,MCDM) โดยใช้หลักการ Fuzzy ในการแก้ปัญหาของความคลุมเครือ โดยมีการศึกษาดังนี้ กำหนดทำเลที่ตั้งของทางเลือกจากการศึกษาข้อมูลประกอบด้วย 3 ทำเลคือ อำเภอห้างฉัตร อำเภอเกาะคา และตำบลบ้านเสด็จ นอกจากนี้มีการกำหนดหลักเกณฑ์ในการคัดเลือก ซึ่งได้จากการทบทวนวรรณกรรม ประกอบด้วย 16 หลักเกณฑ์ จากนั้นทำการกำหนดน้ำหนักของหลักเกณฑ์โดยวิธี AHP weighting และทำการคัดเลือกทำเลที่ตั้งที่เหมาะสมโดยใช้วิธีการ Fuzzy TOPSIS ผลการศึกษาพบว่าอำเภอเกาะคาเป็นทางเลือกที่เหมาะสมสำหรับการตั้งศูนย์กลางโลจิสติกส์ทางบกของภาคเหนือ

1. Introduction

ASEAN Economic Community (AEC) is the cooperation which focuses on expanding commercial agreements between the countries of South East Asia. AEC allows memberships to gain the benefits such as international trades, international taxations, and multiculturalism. From this association, it directly contributes Thailand to be the central of logistics activities. Moreover, Thailand is the member of the Greater Mekong Sub-region (GMS),which is the center of Southeast Asia region to promote agricultural markets, financial markets, foreign investments, employment expansions, living standard improvements, and the transaction of technological knowledge.

Because Thailand is the center of Southeast Asia region, this confirms that the selection of the suitable location for the logistics hubs should be investigated. In 2014, obvious data shows that Thailand can gain commercial benefits from ASEAN countries and China, which are 146.5 billion baht [1] and 57.2 billion baht [2], respectively. In the other hands, when we look specifically on the geographical map of Thailand (figure 1), it shows northern boundary closes to Myanmar, Lao republics and South China (Yunnan province), eastern boundary borders with Vietnam and Cambodia, southern borderline joints nearby Malaysia and western frontier closes to a whole the borderline of Myanmar. In addition, Thailand is able to offer logistical systems, including traffic networks (roads, trains); shipping (Gulf of Thailand and Andaman Sea); air transportations. Consequently, what is the priority area which should be prepared?

Figure 1The alternative locations of Lampang province

Based on the availability of flat areas that located in the central part of northern Thailand, Lampang province was selected as one of the best alternatives province for land logistics hub in Thailand [3]. Moreover, the province also has a multimodal transportation that included road, railway and the air transportations. In order to investigation more in the location selections, three possible areas including Hang Chat District, Ko Kha District, and Ban Sadej District are targeted by using literatures and field surveys (as shown in figure1). Then, the Multiple Criteria Decision Making (MCDM) is applied to find the best location of land logistics hub.

2. Multiple Criteria Decision Making

2.1 Fuzzy TOPSIS

TOPSIS (the technique for ordering similarity preferences to an ideal solution) method is presented in Hwang and Yoon [4] who stated that it is the multiple criteria method to identify solutions from a finite set of alternatives. In a term of the alternative basic principle, it has the shortest distance between the positive ideal solution and the negative ideal solution.

Fuzzy TOPSIS is broadly applied in many engineering researches ,for example, Ilraj M., et.al. [5] who indicated that the proposed design MCDM of Fuzzy TOPSIS used to solve a selected problem,

Maysam A. et al. [6] who extended the Fuzzy TOPSIS method for the selection of warehouse locations. Chen T. C. [7] who approached the fuzzy to select the location of the distribution center. Deng Y.and T. C. Chu [8-9] who applied Fuzzy TOPSIS in order to select the plant location underneath linguistic environments. Irfan E. and Nilsen K. [10] who compared between Fuzzy AHP and Fuzzy TOPSIS method for facility location selection. Golam K. and M. Ahsan A. H. [11] who gave a comparative analysis of TOPSIS and Fuzzy TOPSIS for the evaluation travel websites' service quality.

In this paper, applied Fuzzy method can be described as follows: [8], [11-14]

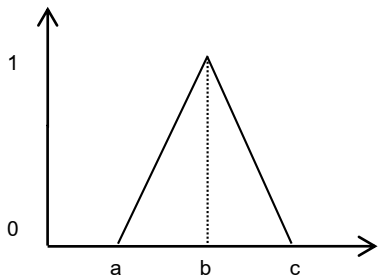

Figure 2 The membership function

Definition 1 A Fuzzy set, we let X be a universe of discourse, where $\tilde{a}$ is a fuzzy subset of X and x is for all of X ($x \in X$). There is interval number in set X is that $\mu_{\tilde{a}}(x) \in [0,1]$ which is assigned to represent the member of x in $\tilde{a}$, and called the member of $\tilde{a}$ [12].

$$\mu_{\tilde{a}}(x) = \begin{cases} 0, & x < a \\ \dfrac{x-a}{b-a}, & a \le x \le b \\ \dfrac{c-x}{c-b}, & b \le x \le c \\ 0, & x > c \end{cases} \quad (1)$$

Definition 2 Fuzzy numbers are a subset of the universe of discourse X that is both of convex and normal (in figure 1). It shows a fuzzy number $\tilde{a}$ in the universe of discourse X that relates to this fundamental Fuzzy definition. [14]

Triangular fuzzy numbers are used as a triangular fuzzy number ($\tilde{a}$), which can be defined by a triplet $(\tilde{a}_1, \tilde{a}_2, \tilde{a}_3)$. Its conceptual schematic format mathematical form is shown by Eq. (1)

Definition 3 The concept of the linguistic variable benefits for dealing with complicated situations which is difficult to define. This leads to reasonably describe as a conventional quantitative expression. Linguistic variables are represented in words, phrases or artificial languages, which each value can be modeled into a fuzzy set. In this study, the ratings of qualitative criteria are regarded as linguistic variables; these linguistic variables might be expressed in positive triangular fuzzy numbers as showed in Table 1.

Table 1 linguistic variable for the ratings

Very poor (VP)	(0,0,3)
Poor (P)	(0,3,5)
Fair (F)	(3,5,8)
Good (G)	(5,7,10)
Very good (VG)	(7,9,10)

Definition 4 A standard operation using fuzzy numbers is used in this study. This obtains a simple fuzzy TOPSIS method. This canonical representation of operation on triangular fuzzy numbers is applied. This approach is based on the graded mean integration representation method.

Table 2 Graded mean integration representation for the ratings

Very poor (VP)	0.5000
Poor (P)	3.000
Fair (F)	5.1667
Good (G)	7.1667
Very good (VG)	8.8333

Definition 5 Given a triangular fuzzy number $\tilde{A} = (a_1, a_2, a_3)$, the graded mean integration representation of triangular fuzzy number A is defined as:

$$P(\tilde{A}) = \frac{1}{6}(a_1 + 4a_2 + a_3) \quad (2)$$

By applying Eq. (2), the graded mean integration representation decisive ratings are shown in Table 2.

Fuzzy TOPSIS method is employed by following steps for the proposed model as [4]:

Step: 1 calculating the Fuzzy decision matrix for the alternative and the criteria, The matrix $\tilde{D}$ is described by

$$D = \begin{array}{c} \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{array} \begin{array}{c} \begin{array}{cccc} C_1 & C_2 & \text{----} & C_n \end{array} \\ \begin{bmatrix} r_{11} & r_{12} & \text{----} & r_{1n} \\ r_{21} & r_{22} & \text{----} & r_{2n} \\ \vdots & \vdots & \text{----} & \vdots \\ r_{m1} & r_{m2} & \text{----} & r_{mn} \end{bmatrix} \end{array} \quad (3)$$

Step: 2 Normalizing the Fuzzy decision matrix $\tilde{R}$ is defined by

$$R_{ij} = \frac{\sum_{t=1}^{K} r'_{ijt}}{K} \quad (4)$$

Step: 3 To construct weighted normalized, fuzzy decision matrix is progressed, the weighted normalized value $\tilde{v}$ is estimated as;

$$V|V_{ij}| = |w_i * r_{ij}|, \text{ i = 1, 2, 3,..., m ,}$$
$$\text{j = 1, 2, 3,..., n} \quad (5)$$

Step: 4 To identify the set of positive ideal (V^+) and negative ideal (V^-) solutions, the fuzzy positive ideal solution and the fuzzy negative ideal solution are calculated as follows:

$$V^+ = \{v_1^+, ..., v_n^+\} = \{(\max v_{ij} i \in I), (\min v_{ij} i \in I)\} \quad (6)$$

$$V^- = \{v_1^-, ..., v_n^-\} = \{(\max v_{ij} i \in I), (\min v_{ij} i \in I)\} \quad (7)$$

Step: 5 The correspondent degree of each alternative form V^+ and V^-, the distance (S^*, S^-) of each weight alternative can be currently calculated by Eq.(8) and Eq.(9).

$$S_i^* = \sqrt{\sum_j^m (v_{Aj} - v_j^*)^2} \quad \text{,j = 1, 2, 3,..., n} \quad (8)$$

$$S_i^- = \sqrt{\sum_j^m (v_{Aj} - v_j^-)^2} \quad \text{,j = 1, 2, 3,..., n,} \quad (9)$$

Step 6 Calculating the closeness coefficient (CC_i). This step resolves the similarities to an ideal solution by

$$CC_i = \frac{S_i^-}{(S_i^* + S_i^-)} \quad \text{,i = 1, 2, 3,..., m} \quad (10)$$

Step 7 Rank the alternative by choosing an alternative with maximum CC_i or rank alternatives according to CC_i in ascending order.

3. Research Methodology

In this section, The Fuzzy TOPSIS method can be used to select the location of land logistics hub as follows:

3.1 Choosing area and fundamental factors.

To choose a suitable area, there are three alternative sectors such as Hang Chat District (A1), Ko Kha District (A2) and Ban Sadej District (A3) that would be selected in this study. According to Prommin and Sopadang (2015) [16] who stated that there were five factors which related to this

study, including size of area, land cost appraisal, quantity of traffic, the number of population in each area and traffic security. To extend the selection process, sixteen criteria were used to select the land logistics hub included : land cost appraisal (X1), land restructuring (X2), cost of public utility (X3), sizes of areas (X4), quantity of transportation modes (X5), quantity of main roads (X6), distances from rail stations (X7), distances from airports (X8), traffic volumes (X9), traffic channels (X10), water and power supply preparedness (X11), Internet systems (X12), the numbers of population in each area (X13), people's referendums (X14), distances from local areas (X15), and distances form cultural areas (X16).

3.2 Fuzzy TOPSIS

The Fuzzy TOPSIS was applied for eliminating ambiguous data and used to find the suitable area for building logistics hub in Lampang province. In this case, the rankings of alternatives were designed by decision makers who were a government officer, an official civil expert, and a private entrepreneur.

4. Result and Discussion

4.1 Alternative and criteria

Before calculating the answer, it has to complete in both of alternative sector selecting and criteria selecting. The result shows that there are three alternative areas (A1, A2 and A3) and sixteen important factors (X1-X16), which are provided in table 3.

Three decision makers give the linguistic variable by evaluating the ratings of three alternatives and sixteen criteria in Table 3. The decision makers' weights are showed in Table 4.

4.2 Fuzzy TOPSIS

In this section, this study applied Fuzzy TOPSIS method for selecting land logistics hubs. The decision makers evaluate the rating of alternatives each condition by using the linguistic variable in Table 1.

To calculate the weight of each criteria by AHP weighting method, the result shows in Table 4. The sizes of areas are the most important weight. On the other hand, distances from airports is the lowest weight in this study.

Table 3 Ranking of alternative by decision makers

Criteria	Candidates	Decision makers		
		D1	D2	D3
X1	A1	G	G	F
	A2	VG	VG	G
	A3	F	P	F
X2	A1	G	VG	G
	A2	G	G	G
	A3	G	G	F
X3	A1	F	G	P
	A2	G	G	F
	A3	G	VG	G
X4	A1	VG	G	G
	A2	G	VG	G
	A3	P	G	F
X5	A1	G	G	G
	A2	G	VG	P
	A3	VG	VG	G
X6	A1	G	G	F
	A2	G	VG	G
	A3	G	G	P
X7	A1	VG	VG	G
	A2	G	G	G
	A3	G	G	F

Criteria	Candidates	Decision makers		
		D1	D2	D3
X8	A1	F	VG	G
	A2	G	G	F
	A3	F	G	F
X9	A1	G	F	G
	A2	G	VG	F
	A3	F	G	F
X10	A1	VG	VG	G
	A2	VG	G	G
	A3	VG	VG	F
X11	A1	G	G	F
	A2	F	G	G
	A3	G	F	F
X12	A1	G	G	G
	A2	F	G	G
	A3	G	VG	F
X13	A1	F	F	G
	A2	G	G	F
	A3	F	F	P
X14	A1	F	F	G
	A2	G	VG	F
	A3	G	VG	G
X15	A1	P	G	G
	A2	G	G	G
	A3	P	VG	G
X16	A1	G	G	P
	A2	G	G	G
	A3	P	G	F

Table 4 Weight of criteria

Criteria	Weight
X1	0.055
X2	0.022
X3	0.124
X4	0.148
X5	0.048
X6	0.111
X7	0.022
X8	0.011
X9	0.025
X10	0.013
X11	0.041
X12	0.094
X13	0.034
X14	0.034
X15	0.122
X16	0.069

Following the data of Table 1, the linguistic variables in table 5 are converted into triangular fuzzy numbers for fuzzy decision matrix. The rating of criteria can be calculated and resulted as follows:

Table 5 Decision Matrix

	A1	A2	A3
X1	0.354	0.493	0.246
X2	0.171	0.151	0.138
X3	0.627	0.792	0.985
X4	1.172	1.033	1.033
X5	0.336	0.427	0.427
X6	0.710	0.883	0.630
X7	0.194	0.153	0.124
X8	0.083	0.073	0.066
X9	0.159	0.183	0.144
X10	0.114	0.102	0.106
X11	0.264	0.264	0.239
X12	0.484	0.599	0.687
X13	0.198	0.219	0.152
X14	0.247	0.268	0.215
X15	0.694	0.875	0.810
X16	0.389	0.480	0.347

To normalize decision matrix can be resulted as follows:

Table 6 Normalization Decision Matrix

	A1	A2	A3
X1	0.119	0.165	0.083
X2	0.039	0.034	0.031
X3	0.318	0.402	0.500
X4	0.362	0.319	0.319
X5	0.283	0.359	0.359
X6	0.139	0.397	0.283
X7	0.044	0.034	0.028
X8	0.013	0.011	0.010
X9	0.328	0.376	0.296
X10	0.354	0.316	0.330
X11	0.344	0.344	0.311
X12	0.274	0.338	0.338
X13	0.049	0.054	0.038
X14	0.338	0.367	0.295
X15	0.294	0.363	0.343
X16	0.320	0.395	0.285

To determine the positive ideal solution ($V+$) and negative ideal solution (V^-), this is described into Eq. (6) and Eq. (7). Then, the result is showed in Table 7.

Table 7 Positive ideal solution (V^+) and negative ideal solution (V^-)

Criteria	V^+	V^-
X1	0.083	0.165
X2	0.031	0.039
X3	0.318	0.500
X4	0.362	0.319
X5	0.359	0.283
X6	0.397	0.283
X7	0.028	0.044
X8	0.010	0.013
X9	0.376	0.296
X10	0.354	0.316
X11	0.344	0.311
X12	0.388	0.274
X13	0.038	0.054
X14	0.367	0.295
X15	0.363	0.294
X16	0.395	0.285

The distances of each alternative are the positive ideal solutions and the negative ideal solutions (S^*, S^-). After that, CC_i calculating is proven, ordering rank of CC_i is managed to find the best area that shows in Table 8 and compared the result of Fuzzy TOPSIS with the result of TOPSIS.

Table 8The results of Fuzzy TOPSIS

	S^*	S^-	C	Rank
A1	0.201	0.212	0.514	2
A2	0.141	0.249	0.638	1
A3	0.271	0.170	0.385	3

Table 8 represents information about the result of Fuzzy TOPSIS method. According to the data, A2 is the best rank from three different details with the highest score from solution of closeness coefficient (CC_i), which is 0.638. The result; Ko

Kha District (A2) is a suitable place for building logistics hub in Lampang province.

5. Conclusion

In the beginning, Lampang province is the central of economic corridor zone 1 in Thailand. The three possible areas, which are Hang Chat District, Ko Kha District and Ban Sadej District, are determined. After that, only sixteen unclear principles are selected for analyzing.

Fuzzy TOPSIS is applied for estimating the best possible choice. This ranks alternatives measuring their relative distances to the positive ideal solution and the negative ideal solutions. Then, they provide a meaningful performance measurement for each alternative [9]. The results of this research found that Ko Kha District (A2) is a greatly suitable area for northern land logistics hubs in this study. Meanwhile, Hang Chat District (A1) is the second choice and Ban Sadej District (A3) is the third choice, respectively. In conclusion, this research can be concluded that the Fuzzy TOPSIS is the acceptable technique in this study to resolve selected location problem.

For the further study, more factors related to construction and implementation phases should be added into the study. In addition, the reliability of calculation can be improved if more experts are involved in the weighting system for each criteria during the selection process

Acknowledgement

The researchers would like to sincerely thank to Chiang Mai University, Excellence Center in Logistics and Supply Chain Management (E-LSCM) for supporting and funding the research.

References

[1] Thai Commerce, 2014, “Import and export products’ value and the comparison between Thailand and Asia countries’ balance of trade (value: million baht) [online]. 2014 [July 10], Available at: http://www2.ops3.moc.go.th/

[2] Thai Commerce, 2014, “Import and export products’ value and the comparison between Thailand and China’s balance of trade (value: million baht) [online]. 2014 [July 10], Available at: http://www2.ops3.moc.go.th/.

[3] Excellence Center in Logistics and Supply Chain Management. GMS and AEC’s logistics administration development project. Industrial Engineering Program, Faculty of engineering, Chiang Mai University. 2013.

[4] Hwang, L.C., Yoon K. Multi Attribute Decision-Making: A Methods and Applications, Lecture Series in Economics and Mathematical Systems. Springer-Verlag, Berlin, Germany, 1981.

[5] Iraj M., et.al. Designing a model of fuzzy TOPSIS in multiple criteria decision making. Applied Mathematics and Computation. 2008; 206: 607–617

[6] Maysam A. et al. Application of fuzzy TOPSIS method for the selection of Warehouse Location: A Case Study. Interdisciplinary Journal of Contenporary Research in Business 2012; 3.

[7] Chen T. C. A fuzzy approach to select the location of the distribution center. Fuzzy set and system. 2001; 118: 65-73.

[8] Deng Y. Plant location selection based on fuzzy TOPSIS. Int J AdvManufTechnol. 2006; 28: 839–844.

[9] T. C. Chu. Selecting Plant Location via a Fuzzy TOPSIS Approach. International Journal Manufacturing Technology. 2002; 20: 859-864

[10] Irfan E. and Nilsen K. Comparison of fuzzy AHP and fuzzy TOPSIS methods for facility location selection. International Journal Manufacturing Technology. 2008; 39: 783-795.

[11] Golam K. and M. Ahsan A. H.

COMPARATIVE ANALYSIS OF TOPSIS AND FUZZY TOPSIS FOR THE EVALUATION OF TRAVEL WEBSITE SERVICE QUALITY. International Journal for Quality research. 2012; 6.

[12] L. A. ZADEH. Fuzzy Sets. INFORMATION AND CONTROL. 1965; 8: 338—353.

[13] H.J. Zimmermanm. Fuzzy set theory. John Wiley & Sons, Inc. 2010; 2.

[14] B. Sodhi and P. T.V. A Simpllified Description of Fuzzy TOPSIS. IIT Hanpur. 2012.

[15] Jahanshahloo, G. R., Lotfi, F. H., and Izadikhah, M. Extension of the TOPSIS method for decision-making problems with fuzzy data. Applied Mathematics and computation. 2006; 181(2): 1544-1551.

[16] Prommin P. and Sopadang A. The Selection of Land Logistics hubs in Lampang Province using fuzzy TOPSIS. IE NETWORK Conference: 2015.

.