Evaluation of logistics centre location based on weighted entropy

Yiru Shen*

School of Business Administration, Zhejiang Gongshang University, 310000 Hangzhou, China

Abstract. It is crucial to locate logistics centres for realising optimization of the the entire logistics process. A kind of effective and practical location evaluation method is in an urgent need. This study analyses principles of logistics centre location, constructs a relative evaluation index system and forms evaluation based on weighted entropy which is derived from the information entropy. A true example is lodged in this study is to indicate how this method eliminates subjective influence of traditional evaluation and increases evaluation precision, which introduces a new solution to site selection of logistics centres.

1 Introduction

In order to explore correlationship between indices of logistics centre location, qualitative and quantitative methods are used such as Grey relation[1], Fuzzy evaluation[2], Data envelopment analysis[3] et al. by defining weights of all indices, summing up to weighted averages and working out final evaluation results. Weights herein are usually defined by Delphi approach or Analytic hierarchy process. Delphi approach is weighting empirically on specialists' direct judgement and uses averages as the evaluators' collective ideas, which is fairly subjective. AHP is a multi-target and multi-standard decision making method with quantitative and qualitative analysis by setting up judgment matrixes and then obtaining weights of the indices, while consistency checking of which cannot be met easily because it is difficult for the specialists to classify correctly the importance grades[4]. This paper, therefore, puts forward an evaluation model of weighted entropy for more logical in analysis of index importance and more reliable in assessment of logistics centre location.

2 An evaluation model based on weighted entropy

Entropy is a concept from heat mechanics for surveying indefinite system. As a credible way for defining weights, entropy is widely used in selection, evaluation, multi-target decision making in fields of engineering, sicial economics or management after being introduced by the U. S. mathematician C. E. Shannon. Entropy is a measurement of the disordered system, the less value of which shows the more variety of the index with bigger weight, otherwise, the bigger value of which indicates the less variety of the index with

* Corresponding author: 1956950505@qq.com

smaller weight[5]. Deriving weights of all indices from entropy and cumulating them can obtain more objective results and improve precision of evaluaion. We can define weights by entropy as follows:

If there are m objects and n indices, the evaluation sequence is

$$O = (o_{ij})_{m\times n}\ , (i = 1,2,\cdots,m\ ;\ n = 1,2,\cdots,n) \quad (1)$$

In order to overcome influence of different indices and different dimensions, indices herein should be standardized to the maximized indices in various methods. Maximized indices of O should be standardized by

$$e_{ij} = \frac{o_{ij} - \min\limits_{i}\{o_{ij}\}}{\max\limits_{i}\{o_{ij}\} - \min\limits_{i}\{o_{ij}\}}, (i = 1,2,\cdots,m\ ;\ j = 1,2,\cdots,n)\ . \quad (2)$$

Minimized indices of O should be standardized by

$$e_{ij} = \frac{\max\limits_{i}\{o_{ij}\} - o_{ij}}{\max\limits_{i}\{o_{ij}\} - \min\limits_{i}\{o_{ij}\}}, (i = 1,2,\cdots,m\ ;\ j = 1,2,\cdots,n) \quad (3)$$

and moderate indices of O should be standardized by

$$e_{ij} = \frac{\left|\left(\max\limits_{i}\{o_{ij}\} - \min\limits_{i}\{o_{ij}\}\right)\Big/2 - o_{ij}\right| \times 2}{\max\limits_{i}\{o_{ij}\} - \min\limits_{i}\{o_{ij}\}}, (i = 1,2,\cdots,m\ ;\ j = 1,2,\cdots,n) \quad (4)$$

to obtain $E = (e_{ij})_{m\times n}$. Then calculate P_{ij}

$$P_{ij} = e_{ij} \Big/ \sum_{i=1}^{m} e_{ij} \quad (5)$$

and calculate S_j (Entropy value of the *j* index)

$$S_j = -k\sum_{i=1}^{m} P_{ij} \ln P_{ij}\ , (j = 1,2,\cdots,n) \quad (6)$$

If $k = 1/\ln m$, define $P_{ij} = 0$ and $P_{ij} \ln P_{ij} = 0$.

Then calculate w_j (weighted Entropy of the *j* index)

$$w_j = (1 - S_j) \Big/ \sum_{j=1}^{n} (1 - S_j) \quad (7)$$

Finally calculate V_i (value of the *i* objects)

$$V_i = \sum_{j=1}^{n} w_j P_{ij}, (i = 1,2,\ldots,m)\ . \quad (8)$$

3 Evaluation index system of logistics centre location

When constructing evaluation index system of logistics centre location, four principles should by obeyed: firstly, rule of adaptation. Location of logistics centres should adapt to not only the national or local policies and regulations but also the allocation of logistics resources; secondly, rule of coordination. Location of logistics centres should coordinate with regional logistics network; thirdly, rule of cost. Constructing and operation cost should be considered when selecting sites; finally, rule of strategy. Location of logistics centres

should focus on the needs at present together with long-term development. According to the above principles and characteristics of location of logistics centres, this paper forms evaluation index system as shown in Fig. 1.

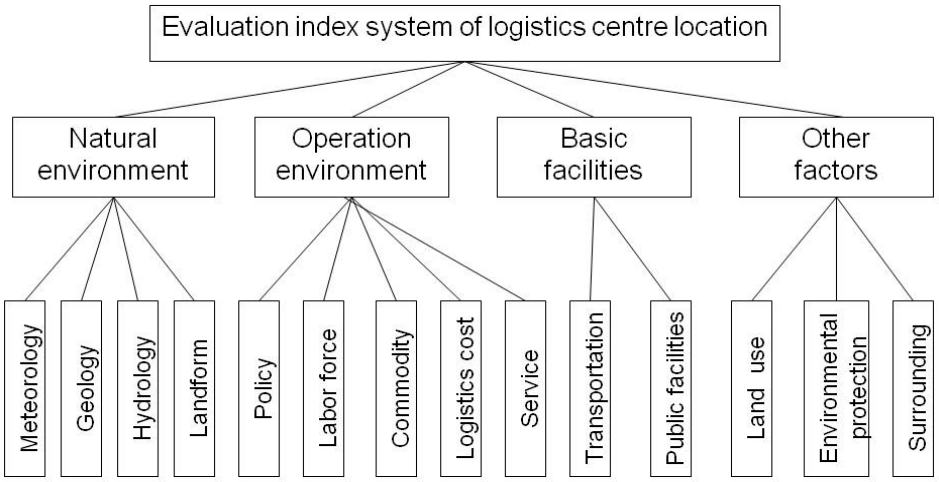

Fig. 1. Evaluation Index System of Logistics Centre Location.

3.1 Natural environment

Meteorology including temperature, wind, rainfall, frost free period, frozen soil and evaporation should be considered when selecting sites of logistics centres. It is unwise to build a logistics centre on bad geoloical surface with silt, sand or soft soil layer. Selecting sites near the overflowing rivers or groundwater area is unsitable too. It is better to build it on flat and high landform.

3.2 Operation environment

Besides closely following favorable policies, we also should use qualified labor force to achieve mechanization and automation in modern logistics. If it is allowed, we could locate logistics centres dealing in different goods in different areas. Cost of logistics is something the most important. We can locate a logistics centre near the manufacturing centre or business centre to shorten transportation distance and reduce logistics cost. Punctual delivery is an iron rule when offering logistics services to the customers.

3.3 Basic facilities

Transportation is the core of the whole flow, therefore, we'd better select sites of logistics centres near the transportation hub, such as expressways, highways and the terminals. Besides transportation, public facilities including communication network, electricity, water, heat, fuel gas, sewage and solid waste treatment are the key to logistics centre location.

3.4 Other factors

Land cost should be fully taken into consideration in term of overall layout of land planning. Furthermore, a big logistics centre should be far away from the downtown area to avoid noises or disposals influencing environmental protection. Situation of surrounding should

be given atterntion to. We should not locate a logistics centre near the wood process centre or matallurgical enterprise for fire control.

4 Example analysis

In the following case, X City plans to select a site for building a logistics centre from site A, B, C, D and E, which thinks it is necessary to make a complete and scientific evaluation of these sites to realize the optimal selection. Specialists are invited to give scores to the above five sites based on the above indices in Tab.1 as follows:

Table 1. Original data of the indices.

Sites	Indices													
	O_{11}	O_{12}	O_{13}	O_{14}	O_{21}	O_{22}	O_{23}	O_{24}	O_{25}	O_{31}	O_{32}	O_{41}	O_{42}	O_{43}
A	10	10	10	10	10	8	10	10	8	8	10	8	5	8
B	6	6	6	6	6	9	6	10	9	8	9	9	9	9
C	8	9	9	9	9	7	9	9	7	8	9	7	9	7
D	8	8	8	8	9	7	8	9	7	9	9	8	10	8
E	9	9	8	9	9	9	9	9	9	10	10	6	10	6

Weights of indices are obtained w_j=(0.0428, 0.0403, 0.0428, 0.0403, 0.0371, 0.0888, 0.0403, 0.1468, 0.0888, 0.1559, 0.1468, 0.0462, 0.0367, 0.0462) by entropy analysis from Formula (1) to (7) according to the data of Tab. 1.

Values of evaluation sites are obtained V_i=(8.9642,8.2600,8.2610,8.3824,9.0192) by Fomula (8). Arrange the above values in proper order*:* $V_E > V_A > V_D > V_C > V_B$. X City, therefore, is advised to select E as its logistics centre location.

5 Conclusion

An evaluation model based on weighted Entropy is proposed in this paper which takes overall consideration of three qualitative and quantitative elements together with their sub-elements. This novel evaluation technique makes good use of objective information and is simple to implement. The above example indicates that “Transportation” is the most important index and “Logistics cost” and “Public facilities” are more important than others, which reflects the key roles of transportation facilities and quality-cost tradeoff in logistics centre location. This analysis offers workable and effective support and foundation for evaluation of logistics centre location and optimization of the flow of supply chain.

References

1. R. Li, W. Kong, Location of Logistics Centre Based on Fuzzy-AHP, Logistics Technique, **42** (2019)
2. J. Qun, L.Si, Location of Logistics Centre Based on Grap-AHP, Value Project, **38** (2019)
3. Y. Zhang, X. Huang, Relocation of Logistics Centre Based on DEA, Mathematics Study and Practice, **47** (2017)
4. Satty T.L., and Vargas L.G., Decision Making in Economic, Political, Social and Technologic Environments with AHP, RWS Publication, Pittsburgh (1994)
5. W. Qiu, Decision Making in Management, Beijing. China Machine Press (2002)