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ABSTRACT

In this paper, based on analysis of impact factors for service quality of logistics center in chains stores, a set of assessment indexes are proposed. Then, on the basis of this set of assessment indexes, two appraisal models are put forth: one is model based on TOPSIS, the other is fuzzy comprehensive assessment model. The experimental results demonstrate that the two novel methods are effective and feasible.

***Keywords*:** Service quality, logistics center, assessment, ISM, fuzzy logic, TOPSIS

1. INTRODUCTION

If a chain store that wants to success constantly and keeps enhancing core competence, it is necessary to obtain and possess mighty competition fools. Effective logistics management is the key process for the sustainable development of chain stores. For managers usually want to get logistics competition superiority, it is significant to carry out and reinforce logistics management in chain stores. There are commonly seven individual functions in the logistics management of chain store: order, transport, inventory, packaging, warehousing, delivery, processing. And those functions act and impact themselves one another. It is well known that chain management aims at reducing the operation costs, high-efficiency operation and scale economy. The accomplishment of these objectives relied on the effective operation of logistics center. The pursuit for the objectives makes the management of chain stores more complex than that of traditional retail stores. So, it is important for researchers to pay attention to the operation of the logistics center in chain stores.

Service is the core function of the logistics center. In essence, only when free rein is given to the service function, the scale benefits may be reached fully. Thus, it is useful to study the service quality of logistics center. Whether the service quality can be accepted or not is due to customs, and whether they satisfy or not is the ultimate standard to evaluate the service level of the logistics center in a chain store. Satisfactory loyal customs construct the important parts of the core competence and source of benefits of a company. A scientific service quality approach is helpful to get accuracy data, information and the decision foundation and give advices on how to take some countermeasures to enhance service quality. Thus, we think that it is significant to set up a set of assessment indexes of service quality of logistics center and propose a comprehensive appraisal model respectively, which can help us monitor and analyze the operation state and reveal weaknesses of logistics center and give advices on planning and improving of logistics management in a chain store perfectly.

There are so many impact factors for service level of a logistics center that there are difficulties in selecting the assessment indexes and decide the weights of them. As an effective system analysis tool, ISM (interpretive structural modeling) can help us grasp the chief factors and construct the hierarchy of assessment indexes. After expert survey and consulting, a set of assessment indexes of service quality of logistics center is put forward by using ISM and the corresponding hierarchy structure is set up here. Thus, the assessment problem becomes a multiple criterion decision-making problem in nature. So, what we should do is to establish appraisal model suing multiple attribute decision-making theory. In the work here, we provide two comprehensive appraisal models: one is model based on TOPSIS, the other is fuzzy comprehensive assessment model.

2 .ASSESSMENT INDEXS OF SERVICE QUALITY IN LOGISTICS CENTER

It is dispensable for carry out service quality assessment of logistics center using a scientific appraisal system in order to identify and analyze all the relative impact factors of it and give a corresponding assessment result. Here we propose a set of assessment indexes according to ISM on the basis of comprehensive considering such impact factors as feasibility, economy, hierarchy, time, consistency et al. The steps of ISM are as follows:

(1) All experts and analysts discuss and select the elements in the system and establish an adjacent matrix.
(2) Set up reachability matrix.
(3) Carry out the further study and reasoning on the reachability matrix.
(4) Conduct the region division and hierarchy division.
(5) Acquire the reduced reachability matrix.
(6) Gain the reachability matrix with minimum edges.
(7) Draw a hierarchy directed graph.
(8) Make the further analysis and discussion on the studied system.

After the steps abovementioned, we gain a set of assessment indexes of the service performance of a logistics center, which consists of six dimensions: 1) commodity availability; 2) scale economy; 3) information; 4) date of delivery; 5) after-sale service; 6) security. Moreover, each index can be further divided into other sub-indexes. Thus, a hierarchy of assessing service quality of a logistics center is constructed.

The corresponding indexes are listed as follows:

$$U = \{U_1, U_2, U_3, U_4, U_5, U_6\} \quad (1)$$

$$U_1 = \{u_{11}, u_{12}, u_{13}\} \quad (2)$$

$$U_2 = \{u_{21}, u_{22}, u_{23}, u_{24}\} \quad (3)$$

$$U_3 = \{u_{31}, u_{32}, u_{33}, u_{34}\} \quad (4)$$

$$U_4 = \{u_{41}, u_{42}, u_{43}\} \quad (5)$$

$$U_5 = \{u_{51}, u_{52}\} \quad (6)$$

$$U_6 = \{u_{61}, u_{62}\} \quad (7)$$

Where U is the set of assessment indexes for service quality of a logistics center, U_1 is commodity availability, U_2 is scale economy, U_3 is information, U_4 is date of delivery, U_5 is after-sale service and U_6 is security. u_{11} is commodity amount, u_{12} is commodity variety, u_{13} is commodity quality. u_{21} is the total value of commodity delivered, u_{22} is the total delivery cost, u_{23} is cost ratio, u_{24} is the cost of quick response. u_{31} is information convenience, u_{32} is information timeliness, u_{33} is information accuracy, u_{34} is initiative in information releasing. u_{41} is stableness in delivery timely, u_{42} is the ability of quick delivery, u_{43} is the capability in reducing lead time of delivery. u_{51} is returnability and u_{52} is treatment speed of customer complaints. u_{61} is goods safety and u_{62} is personal safety.

3. APPRAISAL MODEL USING TOPSIS

TOPSIS (Technique for order preference by similarity to ideal solution) is a simple and feasible decision method. By introducing ideal solution and negative ideal solution, the method is capable of reflecting the multiple attributions of thing to be appraised and its corresponding appraisal result is consistent with reality.

3.1 Determine the Weights of Assessment Indexes Using AHP

The steps of determining the weights of assessment indexes using AHP are as follows:

Step 1. Construct comparison matrixes

Supposing that there are two sets $U(n), V(m)$. *U* is assessment item set which contents *n* elements, *V* is assessment indexes set which contents *m* elements. On the basis of analysis of the relationship among the *m* elements in the set *V*, we can get the hierarchic relationship of these assessment indexes. As for the indexes in a hierarchy, we can construct the judgment matrixes in each hierarchy according to the criterion they belong to. Here we assume that the judgment matrix is B, $B = (b_{ij})$, where b_{ij} denotes the relative importance degree via pairwise comparison between index *i* and index *j*.

Step 2. Computation of weights of assessment indexes and testing consistency

As to each index judgment matrix B, characteristic root method is used to calculate weight vector under a single criterion. Then, carry out consistency testing and stochastic consistency testing of the judgment matrix. If the consistency testing value CI and stochastic consistency testing value CR are all less than 0.1, the judgment matrix is satisfied with the consistency condition, and the weights of indexes are reliable. Otherwise, adjust the judgment matrix and calculate weight vector again.

Step 3. Computation of weights of assessment indexes to the overall objective

On the basis of weight vectors in each hierarchy, by further computation we can get the comprehensive weights of each index with the overall objective.

3.2 Normalization of the Values of Assessment Indexes

According to the evaluation value of *n* elements in the assessment item set *U*, we can construct decision matrix *A*. In spite of the index is profitable type, cost type or range type, it should be transformed into profitable index at first. Thus, we have:

$$A = \begin{pmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{pmatrix} \quad (8)$$

Where x_{ij} is the appraisal value of the *i*th assessment item with respect to the *j*th index.

Normalize decision matrix *A*, we can acquire the normalized decision matrix Z. $Z = (z_{ij})$, $i = 1,2,\cdots,n,\ j = 1,2,\cdots,m,$

where $z_{ij} = x_{ij} / (\sum x_{ij}^2)^{1/2}$.

3.3 Construct Normalized Matrix

Utilize the weight vector and the normalized decision matrix Z , we have the weighted normalized decision matrix V as follows:

$$V = ZW = \begin{pmatrix} v_{11} & v_{12} & \cdots & v_{1m} \\ v_{21} & v_{22} & \cdots & v_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ v_{n1} & v_{n2} & \cdots & v_{nm} \end{pmatrix} \quad (9)$$

Where *W* is the comprehensive weight matrix of the *m* indexes by using AHP.

3.4 Decide the Ideal Points for Each Index

According to the weighted normalized decision matrix V , we can determine the positive ideal points and negative ideal points for each index. If index *j* is the profitable index, we assume:

$$v_j^+ = \max\{v_{ij} \mid i = 1, \cdots, n\} \qquad j \in J \quad (10)$$

$$v_j^- = \min\{v_{ij} \mid i = 1, \cdots, n\} \qquad j \in J' \quad (11)$$

Where v_j^+ is the positive ideal solution and v_j^- is the negative ideal solution.
If index *j* belongs to cost type, we have:

$$v_j^+ = \min\{v_{ij} \mid i = 1, \cdots, n\} \qquad j \in J \quad (12)$$

$$v_j^- = \max\{v_{ij} \mid i = 1, \cdots, n\} \qquad j \in J' \quad (13)$$

Where v_j^+ , v_j^- have the same definition as in the formulae (10), (11).

3.5 Calculate the Distance to Ideal Points

Calculate the distance to the positive and negative ideal points of each item in the assessment item set *U*, and the corresponding formulae are as follows:

$$S_i^+ = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^+)^2} \qquad i = 1,2, \cdots, n. \quad (14)$$

$$S_i^- = \sqrt{\sum_{j=1}^{m} (v_{ij} - v_j^-)} \qquad i = 1,2, \cdots, n. \quad (15)$$

Where S_i^+ is the distance to positive ideal point and S_i^- is the distance to negative ideal point of each assessment item.

3.6 Calculate the Relative Access Degree

Calculate the relative access degree to the ideal points of each item in the assessment item set *U*, and sequence the elements in *U*. We have:

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \qquad i = 1,2, \cdots, n. \quad (16)$$

Where C_i is the relative access degree to the ideal points of each assessment item. According to value of C_i , we can sequence all items to be assessed. The higher C_i is, the better the item is.

4. APPRAISAL MODEL BASED ON FUZZY LOGIC

In the work here, we also formulate the appraisal of the service quality of a logistics center as a fuzzy MADM (multiple attributes decision-making) problem. We use fuzzy comprehensive assessment to achieve the final ranking scores of the service quality of logistics center. Fuzzy comprehensive assessment for a multi-layer system is to carry out comprehensive appraisal from the lowest layer to the uppermost layer step by step until the final assessment results in the uppermost layer is acquired. In the work here, what we should deal with is a three-layer system, the corresponding formulae are as follows:

$$S = W \circ R = W \circ \begin{bmatrix} \omega_1 \circ R_1 \\ \omega_2 \circ R_2 \\ \cdots\cdots \\ \omega_n \circ R_n \end{bmatrix} \quad (17)$$

Where "$\circ$" is matrix product operator, *W* is the weight vector, and *S* is the vector of the final assessment result.
As to the assessment in the second layer, the computation formula is:

$$R_i = \sum_{j=1}^{m} \omega_{ij} \circ R_{ij} \quad (18)$$

Where R_i is the assessment score of the factor U_i (*i*=1, 2, …, *n*.) in the hierarchy *U*, and ω_{ij} is the weight of the factor u_{ij} under the criterion U_i , *m* is the number of factors u_{ij} belongs to U_i , R_{ij} is the membership vector for the factor u_{ij} , which can be gained by experts judgment and statistical method, and "$\circ$" is matrix product operator.

$$S = W \circ R = \sum_{i=1}^{n} W_i R_i = (S_1, S_2, \cdots, S_m) \quad (19)$$

Where *S* is the appraisal score of service quality of a logistics center, and W_i is the weight of the factor U_i belongs to U , R_i is the assessment score of the factor U_i in the second layer, "$\circ$" is matrix product operator and *m* is the number of assessment degrees.
If $S_k = \max(S_1, S_2, \cdots, S_m)$, then the service quality of the logistics center belongs to the degree *k*.

Namely, according to magnitude of *S*, we can make conclusions about the service quality of a logistics center. By using maximum membership principle, we can decide which grade a logistics center belongs to and sequence them quantitatively.
In this appraisal model, the weights of assessment indexes can be determined by using AHP as abovementioned.

5. APPLICATION

Based on the analysis process and assessment models abovementioned, we develop a computation procedure for the two models proposed above. Then, we apply this procedure to actual service quality assessment of logistics centers, and the corresponding results are shown in Table 1. The experimental results demonstrate that the assessment conclusion is reliable and is consistent with actual state, and it should be noted that the two models proposed here is feasible and have high precision and their computation results are identical each other.

Table 1. Appraisal score for service quality of logistics center

No.	Logistics center	Model using fuzzy logic		Model using TOPSIS	
		Score	Sequence	Score	Sequence
1	Trust mart	(0.21, 0.52, 0.13, 0.14)	1	0.742	1
2	Hongqi	(0.17, 0.20, 0.47, 0.16)	2	0.657	2
3	Huhui	(0.10, 0.23, 0.44, 0.23)	3	0.601	3
4	Shuangyang	(0.05, 0.19, 0.34, 0.42)	4	0.476	4

6. CONCLUSIONS

It is significant to appraise service quality of a logistics center occasionally, determine assessment indexes and their corresponding weights and get comprehensive evaluation score are indispensable. In this paper, a set of assessment indexes are proposed by using ISM. Then, two appraisal models are put forth: one is model based on TOPSIS, the other is fuzzy comprehensive assessment model. In the two models, the weight of each index is decided by using AHP. The experimental results demonstrate that the two novel methods are effective and feasible.

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