The Research and Analysis on Users' Evaluation System of Fresh Community Joint Distribution Service

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Abstract. Compared with the traditional mode, community joint distribution has the advantages of integrating logistics resources and reducing operating costs. In this paper, the primary evaluation index set is obtained through questionnaire method and relevant literature analysis method. The AHP model of group decision making and the interval estimation method are applied to eliminate the weak weight index and reserve and rank the strong weight index on the index set. Further, a more effective community fresh food common distribution service evaluation system was established to provide a scientific theoretical basis and valuable reference for the future development of community fresh food common distribution.

1. Introduction

1.1. Research background
In the traditional distribution mode, logistics enterprises provide independent distribution services through self-built community business outlets and self-distributed goods personnel. This kind of distribution mode causes problems for logistics enterprises, such as low resource utilization rate, high distribution cost, poor customer experience, etc., and brings pressure to urban traffic and environment. Community joint distribution refers to the logistics mode that takes community residents as the service object and multiple logistics enterprises jointly carry out community distribution or uniformly hand over the distribution business to a third party for community distribution. Compared with the traditional distribution mode, community joint distribution integrates the logistics resources of participating enterprises, reduces the number of delivery services, shortens the total distance of delivery per unit time, and thus achieves rapid development.

1.2. Related research
David (2004) et al. concluded through the survey that joint distribution can significantly reduce logistics costs, relieve urban traffic pressure and reduce environmental pollution. Lang Zhang (2015) et al. emphatically analyzed the joint distribution mode adopted by fresh e-commerce enterprises and community logistics enterprises. Di Wang (2018) et al. analyzed the problems existing in domestic cold chain fresh logistics and proposed three joint delivery modes.

To sum up, domestic and foreign experts and scholars have made some achievements in the research...
on community fresh joint distribution. Different from the above research, this paper not only focuses on
the establishment of evaluation index system from the perspective of users, but also refers to relevant
research literature and applies appropriate theoretical model to deeply explore the main factors affecting
user satisfaction.

2. AHP group decision model and index selection method

2.1. AHP group decision model

The structure of AHP- group decision model is described as following:

Suppose that user (expert) k thinks that the relative importance of i factor relative to j factor is: \(a_{ij}^k\),
(k=1, 2, ..., m).

The comments of users (experts) are integrated in the following ways:

1) When \(i < j\), take the arithmetic average of each user (expert):
\[
\bar{a}_{ij} = \frac{1}{m} \sum_{k=1}^{m} a_{ij}^k;
\]

2) When \(i > j\),
\[
\bar{a}_{ij} = \frac{1}{\sum_{k=1}^{m} d_{ij}^k};\]
Namely \(\bar{a}_{ij}\) as \(a_{ij}^k\) harmonic mean;

3) Establish AHP-group decision comparison matrix \(A_n = (a_{ij})_{n \times n}\), \((a_{ij} > 0, a_{ii} = 1, i, j = 1, 2, 3, \ldots, n)\).

The application of the model in the indicator establishment system can achieve the goal of merging
the evaluation data of individual users. The expert evaluation data of the criterion layer are also
processed as above to construct the criterion layer group judgment matrix.

2.2. Index screening method

In the traditional EM method, the results are only point estimates and can only be used if the consistency
is satisfied. In view of this factor and users’ attention to different indicators, the weight vector interval
estimation model of analytic hierarchy process [5] is introduced to screen indicators.

(1) The method of index screening under the condition that the judgment matrix satisfies the
consistency

Based on the AHP—group decision comparison matrix established above, the implementation steps
are as follows:

1) Find the maximum eigenvalue of the comparison matrix \(A_n\)
\[
|A_n - \lambda_{\text{max}} E_n| = 0 \quad (1)
\]
\(\lambda_{\text{max}}\) is the largest eigenvalue of \(A_n\).

2) The consistency of the comparison matrix is checked by the eigenvalues
\[
CR = \frac{CI}{RI} = \frac{\lambda_{\text{max}} - n}{(n-1)RI} \quad (2)
\]

If \(CR \leq 0.1\), the comparison matrix is considered to meet the consistency requirement; otherwise, the
consistency requirement is not met. Among them:

\(CI\) — consistency index \(RI\) — average random consistency scale
\(n\) — Index number \(CR\) — consistency ratio

3) When \(A_n\) meets the consistency requirement, calculate the index relative weight vector of the
judgment matrix
\[
A_nW = \lambda_{\text{max}} W \quad (3)
\]
\(W\) — Index relative weight vector, \(W = (w_1, w_2, w_3, \ldots, w_n)^T\);
\(w_i\) — Relative weight value of index, \(i = 1, 2, 3, \ldots, n\).

4) Select the index to select the weight \(\delta\), select the index
\[
\{\begin{array}{ll}
  w_i < \delta, & \text{eliminate indicators } C_i \\
  w_i > \delta, & \text{retention indicator } C_i
\end{array} \quad (4)
\]
(2) The method of index screening under the condition that the judgment matrix does not meet the consistency condition

The specific calculation steps are as follows:

1) Find the judgment matrix that satisfies the consistency requirement

\[
\tilde{A}_n = A_n - \lambda_{max}E_n
\]  

(5)

2) Substitute \( \tilde{A}_n \) into the following linear constrained equations to solve for \( w_{i_{\text{max}}} \) and \( w_{i_{\text{min}}} \)

\[
\begin{align*}
\tilde{A}_nW &< 0 \\
(w_1, w_2, w_3, \ldots, w_n)^T &\geq 0 \\
w_1 + w_2 + \ldots + w_n &= 1
\end{align*}
\]  

(6)

3) Determine the upper and lower limits of the interval

\[ w_i = w_{i_{\text{max}}} \quad w_i = w_{i_{\text{min}}} \]  

(7)

4) Let's determine the interval length of \( w_i \)

\[ L_i = (\bar{w}_i - \underline{w}_i) \]  

(8)

5) The interval weight vector

\[ W = (w_1, w_2, \ldots, w_n)^T, \text{ Among them: } w_i \in [\underline{w}_i, \bar{w}_i] \]  

(9)

6) Select the index, select the weight \( \delta \), and select the index factors

\[
\begin{align*}
\bar{w}_i &< \delta \\
\frac{\bar{w}_i}{w_i} &< L_i
\end{align*}
\]  

eliminate indicators \( C_i \) or retention indicator \( C_i \)  

(10)

This method indicates that all index weights calculated by EM method fall within the weight estimation interval [4].

3. Establishment of community fresh joint distribution service evaluation system and index selection

3.1. Index audition

Through the investigation on the community users of joint distribution, the index library was established and classified, and the 24 indicators were classified into seven categories. Its hierarchy is shown in table 1.

| Serial number | Criterion layer \((B)\) | Index Layer \((C)\) | Serial number | Criterion layer \((B)\) | Index Layer \((C)\) |
|---------------|---------------------------|-----------------|---------------|---------------------------|-----------------|
| 1             | Mode of delivery \(B_1\) | Home delivery \(C_1\) | 13            | Delivered quality \(B_4\) | Arrival intact \(C_{13}\) |
| 2             |                          | Self-fetching in delivery Cabinet \(C_2\) | 14            |                          | Arrival accuracy \(C_{14}\) |
| 3             |                          | Self-fetching in logistics site \(C_3\) | 15            | Service tariff \(B_5\) | Express price \(C_{15}\) |
| 4             |                          | Pick up from offline fresh products store \(C_4\) | 16            |                          | Cost of return \(C_{16}\) |
| 5             | Arrival service \(B_2\) | On-time delivery \(C_5\) | 17            |                          | Return-related service quality \(C_{17}\) |
| 6             |                          | Arrival time \(C_6\) | 18            | Return and exchange service \(B_6\) | The convenience of the return process \(C_{18}\) |
| 7             |                          | Quick arrival reminder \(C_7\) | 19            |                          | Response time \(C_{19}\) |
| 8             | Sign-off | Professional distribution | 20            |                          | Compensation for cargo |

Table 1. Community fresh joint distribution service evaluation index system
3.2. Screening of Indicators

Through the second user survey, determine the scale value of the comparison between indicators. In the criterion layer, the corresponding weight of the seven categories is determined by the form of expert rating. The group decision—AHP processing is carried out on the above data. The judgment matrix was input into YAAHP, the AHP analysis software. Then the maximum eigenvalue \( \lambda_{max} \) of each index matrix was obtained, and the consistency test was carried out. In the process of index selection, since the evaluation index set is large, the weight of the index to be selected is \( \delta = 0.05 \). Limited to space, I will only describe the process of selecting the indicators subordinate to \( B_3 \) and \( B_7 \).

1. There are altogether 4 indexes subordinate to \( B_3 \), and the comparison matrix A obtained after the initial treatment of group decision making AHP is:

\[
A = \begin{bmatrix}
C_8 & C_9 & C_{10} & C_{11} \\
1 & 1 & 1 & 5 \\
1 & \frac{1}{8} & 2 & 1 \\
1 & 4 & 8 & 1 \\
1 & 5 & 1 & 1
\end{bmatrix}
\]

YAAHP software was used to obtain: \( \lambda_{max} = 4.2649, \ CR = 0.0992 \).

Since \( CR < 0.1 \), A meets the consistency requirement. The weight vector \( W \) can be obtained by bringing \( \lambda_{max} \) into \( A\cdot W = \lambda_{max} W \). Performing normalization processing:

\[
W = (w_{B_3}, w_{C_9}, w_{C_{10}}, w_{C_{11}})^T = (0.1309, 0.6259, 0.1960, 0.0472)^T
\]

Because \( w_{C_{11}} = 0.0472 < \delta \), index \( C_{11} \) is eliminated.

2. There are altogether 4 indexes subordinate to \( B_7 \), and the comparison matrix A obtained after the initial treatment of group decision making AHP is:

\[
B = \begin{bmatrix}
C_{21} & C_{22} & C_{23} & C_{24} \\
1 & 6 & 7 & 3 \\
1 & 6 & 1 & 1 \\
1 & 5 & 1 & 1
\end{bmatrix}
\]

YAAHP software was used to obtain: \( \lambda_{max} = 4.4455, \ CR = 0.16685 \). Because \( CR > 0.1 \), B does not meet the requirements for consistency.

The linear programming model of interval estimation index value range is established. LINGO11.0 operation, the index value of the available on-line \( \overline{w_i} \) and logoff \( \underline{w_i} \), and the interval length \( L_i \), as shown in Table 2.
Table 2. weight of each indicator and estimated value of interval of B

| Indexes | Weighted value | $\bar{w}_1$ | $\bar{w}_2$ | $\bar{w}_3$ | $\bar{w}_4$ | EM method for weight |
|---------|----------------|-------------|-------------|-------------|-------------|---------------------|
| $C_{21}$ | $w_{21}$ | 0.6397057 | 0.6025771 | 0.0371286 | 0.6123 | 0.6123 |
| $C_{22}$ | $w_{22}$ | 0.2280890 | 0.2042436 | 0.0238454 | 0.2054 | 0.2054 |
| $C_{23}$ | $w_{23}$ | 0.04557182 | 0.04297668 | 0.0025951 | 0.0435 | 0.0435 |
| $C_{24}$ | $w_{24}$ | 0.1237621 | 0.1130741 | 0.010688 | 0.1337 | 0.1337 |

Because $\bar{w}_{23} = 0.04557182 < \delta$, index $C_{23}$ is eliminated.

3.3. Establishment of Evaluation Index System

After the index screening, a new evaluation index system is formed. Then, the pairwise comparison is conducted again to determine the relative weight of the new indicator set and finally obtain the satisfaction evaluation system of joint delivery of fresh communities, as shown in figure 1.

![Figure 1. New index system](image)

4. Conclusion

From the weight of the index layer to the target layer, the index weight of the quality, delivery experience and delivery time of cold chain goods is relatively large, which indicates that customers have high expectations on the quality and delivery of products in the joint delivery of fresh communities. The implementation place of the principle of logistics operation standardization is mainly in the enterprise. Compared with other indicators of the same kind, it gives customers a strong sense of imperceptibility. The fresh products on the market have been through the printing of two-dimensional code, bar code and other functions to achieve the origin of goods information. Therefore, based on the above factors, it can reasonably explain the elimination of the two indexes of the standardization of logistics distribution and the traceability of goods origin information.

Acknowledgments

Authors wishing to acknowledge the anonymous reviewers for their careful, insightful, and constructive comments that led to an improved version of this paper.

References:
[1] Ljungberg, David, and G. Greenbelt. "Mapping out the potential for coordinated goods distribution in city center: The case of Uppsala." International Journal of Transport Management 2.3/4(2004): p.161-172.
[2] Zhang Liang, ban Hui, Gong Tan Fei. et al. Research on community Logistics Co delivery mode
of fresh electricity supplier [J]. Journal of Chifeng University (NATURAL SCIENCE EDITION), 2015, 000(017): 114-116.

[3] Wang Di, Lin Feng. Fresh electricity supplier cold chain logistics co delivery mode research [J]. Logistics Technology, 2018, 041(008): 78-80.

[4] Gao Jie, Sun Linyan, Li Manyuan. Interval estimation: a method of AHP index screening. [J]. System Engineering Theory and Practice, 2005(10): 75-79.

[5] Ding Jian, Wang Hua, Zhao Min. A concise group decision making AHP model and new scaling method [J]. Journal of Management Engineering, 2000(01): 21-23+3.