International Journal of u-and e-Service, Science and Technology
Vol.7, No.5 (2014), pp.283-292
http://dx.doi.org/10.14257/ijunnesst.2014.7.5.25

The Research on MAHP and the Application on Logistics Distribution System under Electronic Commerce

YuqinWang

Xi'an International University
wyq-yr@163.com

Abstract

Electronic commerce isan information product and it offers us a new transaction mode. Logistics plays an important role in electronic commerce. To electronic commerce enterprise, the development of logistics can reduce the logistics distribution costs and improve the efficiency of distribution. Now, there are three logistics distribution modes under electronic commerce. They are the third party logistics distribution mode, the self-running logistics distribution mode and the alliance of the logistics distribution mode. The main problems in logistics distribution under logistics distribution are high distribution cost, low distribution quality, low degree of information management and so on. In this paper, we propose an improved AHP method-MAHP (modified AHP) to choose the logistics distribution mode. This method improves the consistency criterion, reduces the computational complexity and enhances the possibility of the consistency for the judgment matrix. The numerical analysis shows that this new method can help the electronic commerce enterprise choose the distribution model and get a broad application prospects.

Keywords: *MAHP, Distribution Model,Electronic Commerce*

1. Introduction

In our country, the logistics starts late. Therefore, the logistics cost is higher, the speed is slow and the level of the enterprise information is low. The development speed of the logistics industry is far behind the development speed of the electronic commerce. Therefore, compared with the advanced electronic commerce, the laggard logistics distribution has become an important bottleneck which restricts the development of the electronic commerce. And it also restricts the development of the electronic commerce business.

Aimingat the problem of the logistics bottleneck, the scholars discussed and studied the logistics distribution of the electronic commerce environment. Mukhopadhyay, S. K, Yao, D. Q., Yue, X. H, Haul Lee and SeunginWhang believe that the logistics is a significant part of the electronic commerce. And logistics also is an essential part of the electronic commerce activity process [1-2]. The famous scholarsBrimberg J, Mehrez A and Kent N.Gourdin thinkthat the quality of the logistics distribution is an important evaluation index of the consumer satisfaction in electronic commerce. And they propose the quality model to evaluate the electronic commerce logistics services. This quality model includes two main elements, namely consumers and sellers [3-4]. Lancioni believe that the electronic commerce can prove the whole information of the related products on line in the supply chain management. This information mainly includes the products which the current market needs and the product state for the consumer market [5]. Deborah L bales studied the logistics distribution mode of the electronic commerce mode. He thought that there are two logistics distribution modes in the current electronic commerce environment. These two modes are theself run logistics mode and the third party logistics mode [6]. Kaplin sky R. and Morris M. studied the factors which influence the electronic commerce logistics distribution. They pointed out that the main factors which influence the electronic commerce enterprise are the logistics distribution cost, the characteristics of the goods and the logistics distribution mode etc [8]. In the book "the electronic commerce and the logistics", Zhang Duo points out that logistics is an important

ISSN: 2005-4246 IJUNESST

part of the electronic commerce activities. And it is the last link in the e-commerce activities. He also points out that the logistics is also an important guarantee for achieving the entire electronic commerce activity [9].

AHP is a simple, flexible and practical multi criteria decision method of the quantitative analysis for the qualitative problem. Its characteristic is to divide all kinds of factors for the complex problem into the related order interaction. This method combines the qualitative with the quantitative to deal with a various of decision-making factors. Therefore, AHP gets a widely application in every field of the social economy.

Becauseof the disadvantages of the traditional AHP method, many scholars put forward animproved AHP method. Some scholars put forward the fuzzy AHP method [10-13]. The method combines the analytic hierarchy process with the fuzzy comprehensive evaluation. This method uses the AHP method to determine the weight of each index in the evaluation system. In addition, it uses the fuzzy comprehensive evaluation method to evaluate the fuzzy indexes. The AHP fuzzy method solves the fuzzy problems perfectly. Later, some scholars proposed an AHP-Entropy method [14-16]. The entropy method is the objective weighting method, and it determines the attribute weights according to the contact degree of each attribute or the size of the information which is provided by each attribute. The AHP-Entropy portfolio analysis method considers the index data and the subjective preference of the index for the decision makers. With the proposed of the grey theory, scholars combine the AHP method with the grey theory and put forward a Grey-AHP method [17-19]. This method disposes the decentralized information of the evaluation experts to a weight vector which describes the different grey degrees. On the basis, we make the single value processing. Then, we can get the comprehensive evaluation value of the evaluation system. Because this method combines the grey theory, it can be mainly used to handle the uncertain systems of small sample and poor information.

This paper studies the electronic commerce logistics from the view of how the electronic commerce selects the suitable logistics distribution mode. According to the basic theory of the electronic commerce and the logistics distribution, we research the method of the electronic commerce enterprise choosing the appropriate logistics mode. At the same time, we propose a new AHP method-MAHP. This method can improve the consistency of the possibility of the judgment matrix and performance of AHP. We apply this method to choose the suitable logistics distribution mode under electronic commerce. The structure of this paper is as follows. The first part is the introduction. The second part is the steps of AHP. The third part is the study on the new modified AHP algorithm. The fourth part isnumerical analysis and the last part is the conclusion.

2. The Steps of AHP

2.1 Establishing the Hierarchical Structure Model

If we make systemanalysis, we need group all the factors firstly. Each group is a layer. There are three layers. The destination Layer is the purpose of solving the problem. The criterion layer is to achieve the intermediatelinks that the targets refer. The project layer is the measures or policies to solve the problems.

(1) Constructing the hierarchical structure model and establishing the criterion layer and the index layer

(2)Structural comparison matrix

$$A=(a_{ij})_{n\times n} \qquad (i=1,2,\cdots,n), a_{ij}=1, a_{ij}=1/a_{ji}$$

A is the judgment matrix. We set a_{ij} which shows the relative comparison value of a_i index and a_j index.

Among them, $a_{ij} > 0, \frac{1}{a_{ij}} = a_{ji}, a_{ii} = 1$. $a_{ii} = 1$

The ratio of Saaty scaling assignment is shown in table.1

Table 1. Scale Meaning of Importance Degree

a_{ij}	Index important degree
1	a_i is same important as a_j
3	a_i is a little more important than a_j
5	a_i is more important than a_j
7	a_i is a highly more important than a_j
8	a_i is a extremely more important than a_j
2,4,6,8	The importance between a_i and a_j among the above

(3)Judgment matrix A is normalized:

$$a_{ij} = a_{ij} \Big/ \sum_{k=1}^{n} a_{kj} \qquad (i = 1, 2, \cdots, n)$$

(4)Sum the row of judgmentmatrix A:

$$\omega_i = \sum_{j=1}^{n} a_{ij} \qquad (i = 1, 2, \cdots, n)$$

(5) ω_i is normalized:

$$\omega_i = \omega_i \Big/ \sum_{i=1}^{n} \omega_i \qquad (i = 1, 2, \cdots, n)$$

(6)To derive the maximum eigenvalue and its eigenvector according to

$$A\omega = \lambda_{\max}\omega .$$

(7)Consistency check

We define

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

CI is the index of consistency.

When the Judgment matrix has the character of consistency, $CI = 0$

If $\lambda_{\max} - n$ is large, CI is large. And the consistency is worse.

2.2 Calculating the Largest Eigenvalue and Eigenvector

We apply the approximate method to calculate for simplycalculation. There are two methods: One is the sum and product methodand the other one is the root method.

Sum and product method :

(1) Normalizing each line in the judgment matrix.

$$a_{ij} = a_{ij} \Big/ \sum_{k=1}^{n} a_{kj} \qquad (i = 1, 2, \cdots, n)$$

(2) Summing each line after normalization

$$\overline{\omega}_i = \sum_{j=1}^{n} a_{ij} \qquad (j = 1, 2, \cdots, n)$$

(3) Normalizing the vectorquantity $\overline{\omega} = [\overline{\omega}_1, \overline{\omega}_2, \cdots, \overline{\omega}_n]$

$$\omega = \frac{\overline{\omega}_i}{\sum_{j=1}^{n} \overline{\omega}_i}, i = 1, 2, \cdots, n$$

ω is eigenvector

Root method:

(1) The factors in the judgment matrix multiply by row

$$U_{ij} = \prod_{j=1}^{n} a_{ij}$$

(2) Turning evolution for products respectively

$$u_i = n\sqrt{u_{ij}}$$

(3) Normalizing the vectorquantity

$$\omega_i = \frac{u_i}{\sum_{i=1}^{n} u_i}$$

ω_i is eigenvector

(4) Calculating the largest eigenvalue

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(A\omega_i)}{n\omega_i}$$

3 The Study on the New Modified AHP Algorithm

3.1 The Revise of the Judgment Matrix

If the elements in the judgment matrix meet $a_{ij} > 0, a_{ij} = \frac{1}{a_{ji}}, a_{ii} = 1 (i, j = 1, 2, \cdots, n)$, the matrix A is called the positive reciprocal matrix.

Definition: We assume the judgment matrix is $A = (a_{ij})_{n \times n}$. If $\forall i, j, k = 1, 2, \cdots, n$, there is $a_{ij} = a_{ik} a_{kj}$. We can call the judgment matrix A as the consistent matrix.

The consistent matrix has several properties as follows.

Theorem 1: The sufficient and necessary condition for judging $A = (a_{ij})_{n \times n}$ with the characteristic of the consistency is that the maximum eigenvalue of the matrix A is $\lambda_{\max} = n$. The normalized feature vector $\tilde{\omega} = (\tilde{\omega}_1, \tilde{\omega}_2, \cdots \tilde{\omega}_n)^T$ is the weight vector.

Theorem 2: The sufficient and necessary condition for judging $A = (a_{ij})_{n \times n}$ with the characteristic of the consistency is that there has $a_{ij} = a_{ik} a_{kj}$ for $\forall i, j, k = 1, 2, \cdots, n$.

From the definition 1 and the theorem 2, if the positive reciprocal matrix A is the consistent matrix, there must have

$$\forall i, j, k = 1, 2, \cdots, n, a_{ij} = a_{ik}a_{kj} . \quad (1)$$

We can get the sum for k from formula 1.

$$a_{ij} = \frac{1}{n}\sum_{k=1}^{n} a_{ik}a_{kj} \quad (2)$$

The positive reciprocal matrix A is the consistent matrix, the sufficient and necessary condition is formula (1). And the formula (2) is the necessary condition. That is, if the formula (2) is not infringement, the matrix A may be not the consistent matrix. Therefore, the formula (2) is the precondition for judging the consistent matrix. We construct:

$$b_{ij} = \begin{cases} \frac{1}{n}\sum_{k=1}^{n} a_{ik}a_{kj} & i < j \\ 1 & i = j \\ \frac{1}{b_{ij}} & i > j \end{cases} \quad (3)$$

$A = (a_{ij})_{n\times n}$ is not satisfied with the consistency, we use $B = (b_{ij})_{n\times n}$ as the modified matrix for the matrix A. It improves the possibility to meet the consistency. If A is a consistent matrix, $B = A$.

3.2 The Improved Consistent Test

The maximum eigenvalue of the matrix A is $\lambda_{\max}$. We assume that $\tilde{\omega}$ is the corresponding and normalized feature vector of the $\lambda_{\max}$. From the theorem (1), we can know that $\tilde{\omega} = (\tilde{\omega}_1, \tilde{\omega}_2, \cdots \tilde{\omega}_n)^T$ is the hierarchical single-sort weight vector.

$$A\tilde{\omega} = \lambda_{\max}\tilde{\omega} \quad (4)$$

The matrix A is the completely consistent matrix and its maximum eigenvalue is $\lambda_{\max} = n$. If A does not have the complete consistency, $\lambda_{\max}$ is larger than n slightly.

$$\| A\tilde{\omega} - \lambda\tilde{\omega} \| = \| A\tilde{\omega} - n\tilde{\omega} \| < \varepsilon \quad (5)$$

We use formula (5) as the test standard to test the consistency for the matrix A.

From the consistency ratio $CR = \frac{CI}{RI} = \frac{\lambda_{\max} - n}{(n-1)RI} < 0.1$ which put forward by the professor T.L.Saaty, we can get:

$$| \lambda_{\max} - n | < 0.1(n-1)RI \quad (6)$$

Putting the formula (6) into $\| A\tilde{\omega} - n\tilde{\omega} \| = | \lambda_{\max} - n | \circ \| \tilde{\omega} \| \leq | \lambda_{\max} - n |$ we get the formula as follows.

$$\varepsilon = 0.1(n-1)RI \quad (7)$$

$$| A\tilde{\omega} - n\tilde{\omega} | < 0.1(n-1)RI \quad (8)$$

We use formula (8) to test the satisfactory consistency of the matrix. It can omit to solve the eigenvalue of the matrix A. We only need to calculate the ranking vector. It simplifies the operation and enhances the running speed.

3.3 The Calculated Steps of the MAHP Algorithm

The first step is analyzing problems and establishing a hierarchical analysis model. The model contains the target layer, the attribute layer and the scheme layer.

The second step is adopting the 1~9 scaling method that is proposed by professor T.L.Saaty to construct the judgment matrix at each layer.

The third step is using the square root method to calculate the priority weights of each layer elements.

The fourth step is using the formula (8) to test the consistency of the judgment matrix. If the matrix meets the consistency, we execute the fifth step. If the matrix does not meet the consistency, we revise the judgment matrix by using the formula (3) and execute the third step.

The fifth step is calculating the total order weighs of each scheme.

$$\tilde{\omega}_i = \sum_{j=1}^{m} \tilde{\omega}_j \omega_i^j$$

Among them, $\tilde{\omega}_i^j$ is the ranking weight of the scheme i in attribute j. $\tilde{\omega}_j^c$ is the weight of the attribute j. m is the number of the attributes.

4. Numerical Analysis

(1)Determining the decision scheme and the indicator system

The logistics mode evaluation index under e-commerce is shown as figure.1

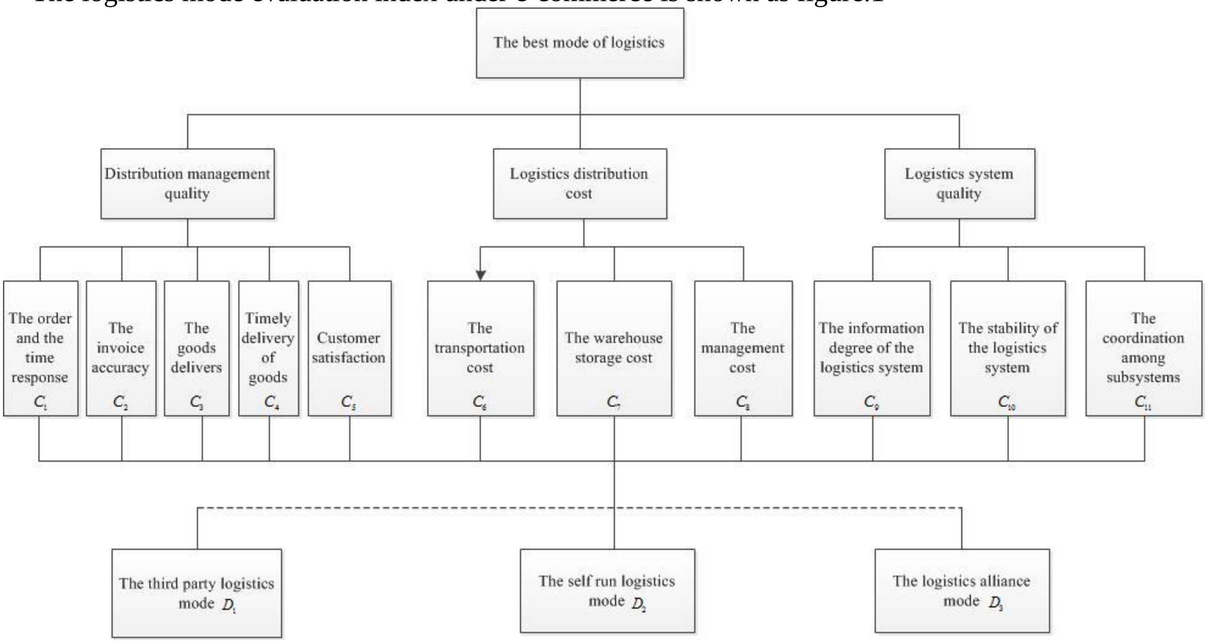

Figure 1. The Logistics Mode Evaluation Index Under E-commerce

The decision scheme includes the third party logistics distribution mode(D_1), the self-running logistics distribution mode(D_2) and the alliance of the logistics distribution mode(D_3).

The indicator system includes the distribution management quality(B_1), the logistics distribution cost(B_2) and the logistics system quality(B_3).

(2)Ensuring the evaluation scale and establishing the judgment matrix

According to the specific condition of one electric business enterprise, we evaluate this enterprise after collecting the data. The assessment method mainly aims at the evaluation index system. Then, we provide the questionnaire by using the Delphy method. At last, the experts score for the evaluation criteria and the importance of the evaluation factors. According to the statistical results of the feedback results, we construct the first layer comparison judgment matrix.

The judgment matrix of the index system layer (B layer) about the target layer is as follows.

Table.2 The First Layer Comparison Matrix

A_1	B_1	B_2	B_3
B_1	1	1/2	1/3
B_2	2	1	5
B_3	3	1/5	1

The corresponding normalized eigenvector is $\omega^2 = (0.15, 0.607, 0.24)^T$. So $\left\| A \cdot \omega^2 - n \cdot \omega^2 \right\| = 0.382 > 0.1(n-1)RI = 0.116$. The matrix does not meet the consistency. We amend this matrix according to formula (3) and get

$$\omega^2 = (0.44, 0.50, 0.05)^T$$

$$\left\| A \cdot \omega^2 - n \cdot \omega^2 \right\| = 0.022 < 0.116$$

It meets the consistency

The third layer is the criterion layer(C layer). It is the judgment matrix for the B layer. The results calculate by the characteristics method.

Table.3 The Comparison Judgment Matrix of the Distribution Management

B_1	C_1	C_2	C_3	C_4	C_5
C_1	1	1/3	1/7	1/5	1/6
C_2	3	1	1/4	1/2	1/2
C_3	7	4	1	7	5
C_4	5	2	1/7	1	1/5
C_5	6	2	1/5	5	1

We can prove that this matrix meets the consistency and $u_1^{(3)} = (0.04, 0.89, 0.52.0.11.0.24)^T$.

Table 4. The Comparison Judgment Matrix of the Logistics Distribution Cost

B_2	C_6	C_7	C_8
C_6	1	6	9
C_7	1/6	1	4
C_8	1/9	1/4	1

We can prove that this matrix meets the consistency and $u_2^{(3)} = (0.76, 0.18, 0.06)^T$.

Table 5. The Comparison Matrix of the Logistics System Quality

B_2	C_9	C_{10}	C_{11}
C_9	1	1/4	6
C_{10}	4	1	8
C_{11}	1/6	1//8	1

We can prove that this matrix meets the consistency and $u_2^{(3)} = (0.25, 0.69, 0.06)^T$. Then we can get

$$U^{(3)} = \begin{bmatrix} 0.04 & 0 & 0 \\ 0.89 & 0 & 0 \\ 0.52 & 0 & 0 \\ 0.11 & 0 & 0 \\ 0.24 & 0 & 0 \\ 0 & 0.76 & 0 \\ 0 & 0.18 & 0 \\ 0 & 0.06 & 0 \\ 0 & 0 & 0.25 \\ 0 & 0 & 0.69 \\ 0 & 0 & 0.06 \end{bmatrix}$$

Then we get the comprehensive ranking vector of the C layer about the A layer.

$$\omega^{(3)} = U^{(3)}\omega^{(2)} = (0.03, 0.06, 0.07, 0.15, 0.17, 0.04, 0.01, 0.03, 0.08, 0.01)^T .$$

The fourth layer is the solution layer (D layer). Its eleventh judgment matrix about the C layer is as follow.

Table 6. The Comparison Judgment Matrix About C_1

C_1	D_1	D_2	D_3
D_1	1	2	7
D_2	1/2	1	6
D_3	1/7	1/6	1

Table 7. The Comparison Judgment Matrix About C_2

C_3	D_1	D_2	D_3
D_1	1	2	7
D_2	1/2	1	6
D_3	1/7	1/6	1

Table 8. The Comparison Judgment Matrix About C_3

C_2	D_1	D_2	D_3
D_1	1	1/2	8
D_2	2	1	9
D_3	1/8	1/9	1

Table.9 The Comparison Judgment Matrix About C_4

C_4	D_1	D_2	D_3
D_1	1	1	6
D_2	1	1	6
D_3	1/6	1/6	1

Table 10. The Comparison Judgment Matrix About C_5

C_5	D_1	D_2	D_3
D_1	1	1/4	9
D_2	4	1	9
D_3	1/9	1/9	1

Table 11. The Comparison Judgment Matrix About C_6

C_6	D_1	D_2	D_3
D_1	1	4	7
D_2	1/4	1	6
D_3	1/7	1/6	1

Table 12. The Comparison Judgment Matrix About C_7

C_7	D_1	D_2	D_3
D_1	1	1	5
D_2	1	1	5
D_3	1/5	1/5	1

Table 13. The Comparison Judgment Matrix About C_8

C_8	D_1	D_2	D_3
D_1	1	5	4
D_2	1/5	1	1/3
D_3	1/3	3	1

Table 14. The Comparison Judgment Matrix About C_9

C_9	D_1	D_2	D_3
D_1	1	5	8
D_2	1/5	1	1/5
D_3	1/8	1/5	1

Table 15. The Comparison Judgment Matrix About C_{10}

C_{10}	D_1	D_2	D_3
D_1	1	3	7
D_2	1/3	1	6
D_3	1/7	1/6	1

Table 16. The Comparison Judgment Matrix About C_{11}

C_{11}	D_1	D_2	D_3
D_1	1	6	1/5
D_2	1/6	1	1/3
D_3	5	3	1

By calculating, the eleventh component vectors are as follows.
$u_1^{(4)} = (0.58, 0.35, 0.07)$ $u_2^{(4)} = (0.36, 0.59, 0.05)$ $u_3^{(4)} = (0.69, 0.25, 0.06)$ $u_4^{(4)} = (0.46, 0.46, 0.08)$
$u_5^{(4)} = (0.41, 0.54, 0.05)$ $u_6^{(4)} = (0.59, 0.35, 0.06)$ $u_7^{(4)} = (0.46, 0.46, 0.09)$ $u_8^{(4)} = (0.64, 0.11, 0.26)$
$u_9^{(4)} = (0.73, 0.21, 0.06)$ $u_{10}^{(4)} = (0.64, 0.29, 0.07)$ $u_{11}^{(4)} = (0.27, 0.10, 0.63)$

Then,

$$U^{(4)} = \begin{bmatrix} 0.58 & 0.36 & 0.69 & 0.46 & 0.41 & 0.59 & 0.455 & 0.64 & 0.73 & 0.64 & 0.27 \\ 0.35 & 0.59 & 0.25 & 0.46 & 0.54 & 0.35 & 0.455 & 0.11 & 0.21 & 0.29 & 0.10 \\ 0.07 & 0.05 & 0.06 & 0.08 & 0.05 & 0.06 & 0.09 & 0.26 & 0.06 & 0.07 & 0.63 \end{bmatrix}$$

We can compute the synthesis priority vector of the D layer about the target A. $\omega^{(4)} = U^{(4)}\omega^{(3)} = (0.57, 0.36, 0.07)$

From the result, we can decide that the best distribution model of this enterprise is the third party logistics distribution mode (D_1).

5. Conclusion

In this paper, we did the below work: (1) we put forward an improved AHP method-MAHP (modified AHP). This method enhances the possibility of the consistency for the judgment matrix; (2) we establish the logistics distribution system index model under electronic commerce; (3) we apply the MAHP method to determine the index weights of the logistics distribution system index model under electronic commerce and evaluate the alternative offers. The improved algorithm can also be applied to other weight decision problems. This new method has a broad development space and an applicable prospect.

References

[1] S. K. Mukhopadhyay, D. Q. Yao and X. H. Yue, "In-formation sharing of value-adding retailer in a mixed channel hi-tech supply chain [J]", Journal of Business Re-search, vol. 61, **(2008)**,pp.950 -958.
[2] H. Lee and S. Whang,"Winning the last mile of E-Commence",McGraw.Hill Companies,Inc,**(2002)**, pp.106-121.
[3] J. Brimberg andA. Mrhtrz, "Multi-facility location using a maximin criterion and rectangular distances", Location Science, vol. 2, no. 1, **(1994)**, pp. 11-19.
[4] K. N. Gourdin,"Global Logistics Management",Competitive Advantage for the New Millennium,Blackwell Publishers Ltd.,**(2001)**.
[5] R. A. Lancioni, M. F. Smith, T. A. Oliva,"The role of the Internet in supply chain management".
[6] D. L. Bales,"The electronic commerce logistics and Implementation", Machinery Industry Press, **(2002)**, pp. 58-59.
[8] R. Kaplinsky and M. Morris,"A handbook for value chain Researchfor IDRC",**(2002)**.
[9] Z. Ze,"Electronic commerce and logistics", Beijing:Tsinghua University press,**(2000)**.
[10] S. K. Patil and R. Kantg,"A fuzzy AHP-TOPSIS framework for ranking the solutions of Knowledge Management adoption in Supply Chain to overcome its barriersExpert Systems with Applications, vol. 41, no. 2, **(2014)**, pp. 679-693.
[11] A. Calabrese, R. Costa and T. Menichini,"Using Fuzzy AHP to manage Intellectual Capital assets: An application to the ICT service industry",Expert Systems with Applications, vol. 40, no. 9, **(2013)**, pp. 3747-3755.
[12] Gül in Büyük zkan , Gizem if I,"A combined fuzzy AHP and fuzzy TOPSIS based strategic analysis of electronic service quality in healthcare industry", Expert Systems with Applications, vol. 39, **(2012)**, pp. 2341–2354.
[13] L. Gaoa and A. Hailu, "Identifying preferred management options: An integrated agent-based recreational fishing simulation model with an AHP-TOPSIS evaluation method", Ecological Modelling, vol. 249, **(2013)**, pp. 75–83.
[14] S. W. Hsiao and J. R. Chou,"A Gestalt-like perceptual measure for home page design using a fuzzy entropy approach", Int. J. Human-Computer Studies, vol. 64, **(2006)**, pp. 137–156.
[15] M. Xia and Z. Xu,"Entropy/cross entropy-based group decision making under intuitionistic fuzzy environment", Information Fusion, vol. 13, **(2012)**, pp. 31-47.
[16] T. Y. Chena and C. H. Li,"Objective weights with intuitionistic fuzzy entropy measures and computational experiment analysis", Applied Soft Computing , vol. 11, **(2011)**, pp. 5411–5423.
[17] H. Yin and B. Z. Li,"Evaluation of High New-Tech Outcome's Transformative Comprehensive Value Based on AHP-GCA method", Operations Research and Management Science, vol. 18, no. 5, **(2009)**, pp. 107-115.
[18] Q. Zhang, P. Hua and J. Zhang, "Improved AHP Assessment and Grey Relational Analysis Model for Optimizing Waterworks Sludge Treatment Process", Journal of Civil, Architectural & Environmental Engineering,vol. 32, no. 3, **(2012)**, pp. 133-144.
[19] F. Shao, W. Deng, F. J. Yi andX. B. Liu,"Comprehensive evaluation method of metropolitan public transportation system based on analysis hierarchical process and grey theory", Journal of PLA University of Science and Technology, vol. 10, no. 6, **(2009)**, pp. 536-541.

Author

Wang Yuqin. Female, born on September 4, 1979. Now she is a lecturer inXi'an International University. She has a master's degree in engineering and her research directions are logistics and supply chain management.

