Research on Green Logistics Service Providers Selection Based on Intuitionistic Language Fuzzy Entropy

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***Abstract*—Based on a comprehensive consideration of features of the selection of green logistics service providers, the paper, proposes the criteria for evaluating providers of green logistics service by combining the traditional evaluation index system, and the criteria are determined as compatibility with the users, cost of service, quality of service, service ability and adaptation with environment. In this paper, method of multi-criteria decision making, based on intuitionistic language fuzzy entropy, is adopted to evaluate and select providers of green logistics service, and the scientific and feasible nature of this decision-making process is then verified through empirical studies. It is necessary to further enrich and improve the index system and methods of green logistics service providers selection in the future according to features of companies from different industries and with different background.**

***Index Terms*—Service outsourcing, supplier selection, intuitionistic language fuzzy entropy, intuitionistic language set**

I. INTRODUCTION

With the increased environmental concerns over the past decade, there is growing recognition that issues of environmental pollution accompanying industrial development should be addressed simultaneously in the operational process of supply chain management, thus contributing to the initiative of green supply chain management. Correspondingly, all the solutions, including logistics management, for managing the overall lifecycle of products should be integrated in a more comprehensive supply chain procedure. So it is a haunted problem for many enterprises to select the best partner from a lot of logistics providers when the logistics business outsourcing is conducted. Rational selection of green logistics services providers takes advantage of the enterprises' profession and cost to achieve such goals as logistics routing optimization, the logistics links efficiency increase with every link joined together well. With the advantage of the node firms' core business, they benefit from it and consolidate their core competence. Therefore, it is significantly important for the enterprises to select logistics services providers so as to strengthen the supply chain competence as well as improve the ability to respond to the demands of end customers.

Environmental issues can impact on numerous logistical decisions throughout the supply chain such as location, sourcing of raw material, modal selection, and transport planning, among others. At present, there are a few researches on the selection of green logistics services providers. Most researchers seem to be worried either about exploring ways to achieve environmentally sustainable logistics practices and about determining strategies considered as most cost-effective for managing and responding to environmental issues in logistics[1-4]. Therefore, decisions regarding these activities at strategic, tactical, and operational level will determine the environmental impact (Quariguasi Frota Neo et al., 2008).

A recent survey conducted by Langley and Capgemini indicates that many users are, overall, dissatisfied with services provided by their logistics services providers. The survey reported that many logistics services providers failed to deliver the expected cost reduction, trustworthy relationship, and increasing needs for wider portfolio of logistics services and geographical coverage and advanced information technology [5]. Diromuald and Gurbaxani did some research on the strategy of outsourcing and gave suggestions on the establishment of outsourcing relationships, i.e. consistency between the outsourcing contract and strategic intents, complementarity of competitiveness and competencies of the companies and the outsourcing vendors, compatibility of cultures of the companies and the outsourcing vendors and continuity of designing contracts and relationships [6]. Chen et al. introduced the supplier selection problem can be viewed as a group decision-making problem with multiple criteria. Furthermore, the weights of the evaluation criteria and the performance ratings of the providers are usually imprecise, uncertain or fuzzy in real-life problems. Hence, we intend to develop a fuzzy linear assignment approach that can assist the analysts in selecting the best provider in the fuzzy environment[7]. Persson and Olhager proposed a supply chain simulation study to evaluate alternative supply chain designs with respect to quality, lead-times and costs and to increase the understanding of the interrelationships among these and other parameters, relevant for the design and operations of a supply chain[8]. Kongar applied a multiple criteria decision-making technique to study disassembly-to-order systems[9].

doi:10.4304/jcp.7.2.540-546

Chouinard, D'Amours, and Aı¨t-Kadi dealt with problems related to the integration of reverse logistics activities within an organization and the coordination of this new system[10].Kongar classified metrics of the performance criteria for reverse logistics provider into five perspectives, viz., financial perspective, customer perspective, internal business processes perspective (pre-production, production, post-production), environmental perspective and learning and growth perspective using Balanced Scorecard approach. This classification helped to simplify and to standardize the vendors' selection process by deciding on the appropriate performance criteria[11].Knemeyer et al. illustrated specific needs and priorities of an organization may vary examination of the key strategic factors, such as strategic costs, overall quality, customer service, environmental concerns, and legislative concerns is crucial when implementing a reverse logistics system. In addition, key operational factors that need to be addressed consist of cost-benefit analysis, transportation, warehousing, supply management, remanufacturing and recycling and packaging [12]. Ballou and Yan et al. proposed the significance of an alliance between enterprises and 3PL depends on the following factors: ① utilizing the resources and capability of 3PL to acquire the scale benefits of logistics operation by reducing the enterprises' own logistics cost and transaction charge; ② making use of 3PL's professional capability and agility to improve the overall operating efficiency and level of customer service in the supply chain; ③reducing or avoiding the investment of enterprises' logistics establishment to give more resources for improving the enterprises' core competencies; ④developing a credit base through the supplier alliance to cultivate a symbiotic relationship by increasing the overall competition advantage of each firm. Thus, the 3PL evaluation and subsequent selection of a strategic alliance partner in a logistics value chain has an important strategic outcome to a firm to achieve superior competitive advantage[13]. Lee and Cavusgil introduced the selection of a suitable partner for strategic alliance is an important factor affecting alliance performance in logistics value chain. Finding the right partner requires careful screening and can be a time-consuming process. Developing an understanding of partners' expectations and objectives can also take time. However, many alliances are formed by chance meetings or through previous experience with the partner. While partner selection is an integral component of alliance success, very little research has devoted explicit attention to this issue. For this reason, the aim of this research is to propose an analytical approach to effectively select strategic alliance partners for the 3PL relationship[14]. Mehta et al. stated the proliferation of strategic alliances has been increasing in the last decade across logistics sectors[15]. Simchi-Levi et al. introduced three most important types of logistics value chain-related strategic alliances have attracted interest among the researchers: third-party logistics (3PL), retailer–supplier partnerships, and distributor integration[16].

To this end, organizations must analyze and document the significance of several factors, translating instinctive qualitative indicators to concise empirical measures. Majority of the previously published work suggest employing a strategic performance measurement system structure and appropriate performance metrics to be used in the measurement process. The proposed model includes tangible, intangible, quantitative, qualitative, strategic and operational factors in the decision[17].

Sarkis focused on the components and elements of green supply chain management as a foundation for the decision framework with the applicability of a dynamic nonlinear multi-attribute decision model[18].Vandenberg and Rogers illustrated that the key factors for ensuring successful outsourcing are vision, knowledge sharing, trust, value increasing and implementation and supervision of the processes [19]. Talluri and Sarkis stated that the supplier could be screened technically on a number of variables. Some of these variables can be listed as: ① an emphasis on quality at the source;② design competency; ③ process capability; ④ declining non-conformities; ⑤ declining work-in-process, lead-time, space, flow distance; ⑥ operators being cross-trained, doing preventive maintenance; ⑦ operators able to present statistical process control and quick set-up; ⑧ operators able to chart problems and process issues; ⑨ hours of operator training in total quality control/just-in-time; ⑩concurrent design[20]. Ravi, Shankar, and Tiwari proposed a combination of balanced scorecard and analytic network process to provide a more realistic and accurate representation for conducting reverse logistics operations for end-of-life computers[21]. Prahinski and Kocabasoglu created ten research propositions that could be studied empirically based on their review of the literature and their understanding of managerial concerns in reverse supply chains[22].

In China, Lu Naifang et.al tried to adjust and establish a new index system by combining the particularity of the manufacturing industry and then proposed the key elements of the selection of outsourcing suppliers of the industry [23]. Zhang Jingzhong et.al introduced the medium multi-criteria decision-making method based on VIKOR into the selection of outsourcing suppliers and made some improvements on the model, which provides new bases and methods of the selection [24].

The researches above do make contributions to the supplier selection, but there are some problems in practice, e.g. the preference of the decision-maker can not be shown during the selection process. Therefore, this thesis, based on the existing studies, aims to establish an index system for the selection of green logistics services providers as well as an evaluation model of multi-criteria decision-making method based on intuitionistic language fuzzy entropy.

II. Determination of Evaluation Indices of Green Logistics Services Providers Selection

Keeping in view the growing trend of logistics outsourcing, many user must exactly identify what it needs from the provider. Regarding logistics outsourcing, many researchers have discussed, besides other issues, the criteria for the selection of a provider. However, the selection of a proper provider, which suits the needs of the outsourcing company (hereinafter called user), is not an easy task. The complexity of this task increases with an increase in the number of selection criteria [25].

From the research on the third-party logistics by Steven E. et. al, “benefit of customers” and “reliability” are the most important elements in selection of the third-party logistics. As a result, such evaluation indices representing the third-party logistics service characteristics as service level, service quality are listed in the index system. The strategic allied win-win relationship should be established between the logistics services providers and logistics demanders, thus, the strategic allied relationship consolidation is also an important factor from the view of enterprise alliance and history. In view of this, this paper classifies the criteria of green logistics services providers selection into compatibility with the users, cost of service, quality of service, service ability and adaptation with environment. The compatibility with the users is represented by the compatible strategic ideas, information sharing and mutual trust and sharing of benefits and risks. The cost of service is represented by service quoted price, the strain capacity of price, etc. The service quality is represented by the delivery accuracy rate and perfectness ratio of goods, etc. The service ability is represented by on-time delivery, information exchange ability, etc.

III. The Method of Multi-Criteria Programming Based on Intuitionistic Language Fuzzy Entropy

A. The fuzzy entropy of intuitionistic language numbers

The fuzzy entropy of intuitionistic language numbers is used to describe the fuzziness and amount of information of the evaluation value h_i . For the convenience of discussions, in this thesis, the intuitionistic language number a is recorded as $a=<h_{\theta(a)},(u(a),v(a),\pi(a))>$, $\pi(a)=1-\mu(a)-\nu(a)$.

The visualized constraint conditions for the fuzzy entropy of intuitionistic language numbers are as follows:

① When the intuitionistic language number is degraded into the traditional language evaluation value, $\mu(a)=1$, $\nu(a)=0$, its fuzzy entropy has the minimum value of 0.

② For the intuitionistic language number a , $a=<H_{\theta(a)},(u(a),v(a),\pi(a))>$, when $\mu(a)=\nu(a)$, there are the same amount of evidences in support of the principle or scheme being affiliated and unaffiliated with $h_{\theta(a)}$, and meanwhile, for the hesitation index $\pi(a)$, there is no way to know whether it is in support of the principle or scheme being affiliated with or unaffiliated with $h_{\theta(a)}$. In this case, the maximum value 1 is taken for the fuzzy entropy.

③ The fuzzy entropy of intuitionistic language numbers is a decreasing function about the different value of the degree of affiliation and unaffiliation, and it decreases when $|\mu(a)-\nu(a)|$ increases, and it increases when $|\mu(a)-\nu(a)|$ decreases.

When the degree of affiliation $\mu(a)$ and that of unaffiliation ν （a）of the intuitionistic language number are increasing, $\pi(a)=1-\mu(a)-\nu(a)$ is decreasing, so the more the information about the degree of affiliation of $h_{\theta(a)}$ is known, the less the fuzzy entropy of the intuitionistic language number is and vice versa. In addition, when $\mu(a)$ and $\nu(a)$ are getting close in value, the proof for and against $h_{\theta(a)}$ are getting close, the uncertainty is increasing, then the fuzzy entropy of the intuitionistic language number is increasing, and vice versa. Especially in here, when $|\mu(a)-\nu(a)=0|$,the evidences for and against $h_{\theta(a)}$ are taking 50 percent separately, then the fuzzy entropy of the intuitionistic language number should reach its maximum value, and in this case, Condition c is in accordance with Condition b.

④ The fuzzy entropy of intuitionistic language numbers is an increasing function about the fuzzy index.

Definition 1 [26]: According to the above four constraint conditions, in this thesis, the fuzzy entropy of the intuitionistic language number $a=<H_{\theta(a)},(u(a),v(a),\pi(a))>$ is defined as

$$\ell(a)=\frac{\min(\mu(a),\nu(a))+\pi(a)}{\max(\mu(a),\nu(a))+\pi(a)} \quad (1)$$

B. Problem description

For a problem that needs fuzzy multi-criteria decision making, suppose there are n plans $C=\{c_1,c_2,\cdots,c_n\}$ and l decision making principles $B=\{b_1,b_2,\cdots,b_l\}$, the corresponding weight vector is $W=\{\omega_1,\omega_2,\cdots,\omega_l\}^T$ and $\omega_j\in[0,1]$, $\omega_1+\omega_2+\cdots+\omega_l=1$, and the information of W is incomplete and $(\omega_1,\omega_2,\cdots,\omega_l)^T\in O$. The value of plan c_i under principle b_j is the intuitionistic language number $c_{ij}=<h_{\theta(c_{ij})},(\mu(c_{ij}^k),\nu(c_{ij}^k))>$. Here $\mu(c_{ij})$ and $\nu(c_{ij})$ indicate respectively the degrees of being affiliated and not being affiliated to the language evaluation value $h_{\theta(c_{ij})}$ for plan c_i under principle b_j . Suppose the decision-maker is risk neutral and then tries to order the plans.

C. Methods & Processes

The decision making processes of the problem above are as follows:

Step 1: Standardized processing

For decision making problems with multi-criterion, the commonly used principle types are benefit criteria and cost criteria. In this case, no changes are made under benefit criteria while changes should be made for the language evaluation value $h_{\theta(c_{ij})}$ under cost criteria by adopting language inverse operators, which is shown as follows:

$$h'_{\theta(c_{ij})} = neg(h_{\theta(c_{ij})}) = h_{2t-\theta(c_{ij})} \quad (2)$$

For the sake of convenience, the value of plan c_i under principle b_j is, after the above changes, still recorded as:

$$c_{ij} =< h_{\theta(c_{ij})}, (\mu(c_{ij}), v(c_{ij})) >$$

Step 2: Establishing programming model and calculating weights for the criteria

For each plan c_i, it is known from the definition of the fuzzy entropy of the intuitionistic language set that the values of plan c_i ($i = 1, 2, \cdots, n$)under principle c_j ($j = 1, 2, \cdots, l$)can form an intuitionistic language set whose fuzzy entropy is $\varphi(c_i) = \sum_{j=1}^{l} \omega_j \cdot \frac{\min(\mu(a_{ij}), v(a_{ij})) + \pi(a_{ij})}{\max(\mu(a_{ij}), v(a_{ij})) + \pi(a_{ij})}$. The smaller value of the fuzzy entropy means less fuzziness of the decision-making information and more amount of information. For a conservative decision maker, it is better to have a smaller value of the fuzzy entropy. The minimum fuzzy entropy can be determined by the following linear programming:

$$\varphi(c_i) = \sum_{j=1}^{l} \omega_j \cdot \frac{\min(\mu(a_{ij}), v(a_{ij})) + \pi(a_{ij})}{\max(\mu(a_{ij}), v(a_{ij})) + \pi(a_{ij})}$$

$$s.t \begin{cases} \omega \in \mathrm{O} \\ \sum_{j=1}^{l} \omega_j = 1 \\ \omega_j \geq 0 \end{cases} \quad (3)$$

Since every plan here is competing fairly, so the fuzzy entropy for each plan should come from the same group of weight coefficients of the criteria, and then it is necessary to integrate all the plans as follows:

$$\min \varphi(C) = \frac{1}{n} \sum_{i=1}^{n} E(c_i) = \frac{1}{n} \sum_{i=1}^{n} \sum_{j=1}^{l} \omega_j \frac{\min(\mu(a_{ij}), v(a_{ij})) + \pi(a_{ij})}{\max(\mu(a_{ij}), v(a_{ij})) + \pi(a_{ij})}$$

$$s.t \begin{cases} \omega \in \mathrm{O} \\ \sum_{j=1}^{l} \omega_j = 1 \\ \omega_j \geq 0 \end{cases} \quad (4)$$

After calculating the model of linear programming, there is an optimal solution, i.e. $W^* = (\omega_1^*, \omega_2^*, \cdots, \omega_l^*)$.

Step 3: Aggregating the criteria values of the plans

The criteria of the plans are aggregated according to formula (5) and (6), with the result of the intuitionistic language number z_i.

Definition 2 [27]: Suppose a_j $(j = 1, \cdots, n)$ is a group of intuitionistic language numbers, and $IL - WGA: \Omega^n \to \Omega$. If

$$IL - WGA(a_1, a_2, \cdots, a_n) = \prod_{j=1}^{n} a_j^{\omega_j} \quad (5)$$

Here, Ω is the set of all the intuitionistic language numbers, $\omega = (\omega_1, \omega_2, \cdots, \omega_n)^T$ is the weight vector of $a_j (j = 1, \cdots, n)$, $\omega_j \in [0,1]$, $\sum_{j=1}^{n} \omega_j = 1$, then $IL - WGA$ is regarded as the weighted arithmetic average operator of the intuitionistic language numbers. Especially, if $\omega = (\frac{1}{n}, \frac{1}{n}, \cdots, \frac{1}{n})^T$,then $IL - WGA$ is the arithmetic average operator of the intuitionistic language numbers($IL-WGA$).

Proposition 1: Suppose $a_j =< h_{\theta(a_j)}, (u(a_j), v(a_j)) >$ is the intuitionistic language number, then the result after aggregation is still an intuitionistic language number, and

$$IL-WGA(a_1, a_2, \cdots, a_n) =< \prod_{j=1}^{n} h_{\theta(a_j)^{\omega_j}}, (\prod_{j=1}^{n} u(a_j)^{\omega_j}, 1-\prod_{j=1}^{n}(1-v(a_j))^{\omega_j}) > \quad (6)$$

Here, $\omega = (\omega_1, \omega_2, \cdots, \omega_n)^T$ is the weight vector of $a_j (j=1,\cdots,n)$, $\omega_j \in [0,1]$, $\sum_{j=1}^{n}\omega_j = 1$.

Step 4: Calculating the score function value and exact function value of z_i

Definition 3[26]: Suppose $a =< h_{\theta(a)}, (u(a), v(a)) >$ is an intuitionistic language number, and the reliability interval for the language value $h_{\theta(a)}$ is $[u(a), 1-v(a)]$, with the medium expected value being:

$$E(a) = h_{\theta(a)} \cdot (\mu(a) + 1 - \nu(a))/2 \quad (7)$$

Definition 4[26]: Suppose $a =< h_{\theta(a)}, (u(a), v(a)) >$ is an intuitionistic language number, then

$$S(a) = I(E(a))(\mu(a) - \nu(a)) \quad (8)$$

This is the score function of a, in which $I(h_x) = x$ is LBound function and $E(a)$ is the medium expected value of the intuitionistic language number.

Definition 5[26]: Suppose $a =< h_{\theta(a)}, (u(a), v(a)) >$ is an intuitionistic language number, then

$$H(a) = I(E(a))(\mu(a) + \nu(a)) \quad (9)$$

This is the precise function of a, in which $I(h_x) = x$ is LBound function and $E(a)$ is the medium expected value of the intuitionistic language number.

Step 5: Ordering the set of plans

Definition 6[18]: Suppose a_1 and a_2 are two intuitionistic language numbers, then

1) If $S(a_1) > S(a_2)$, then $a_1 > a_2$;

2) If $S(a_1) = S(a_2)$, and $H(a_1) = H(a_2)$, then $a_1 = a_2$;

3) If $S(a_1) = S(a_2)$, and $H(a_1) > H(a_2)$, then $a_1 > a_2$.

IV. EMPIRICAL STUDIES

Now evaluation and decision making is executed on different logistics services providers. Based on a comprehensive consideration of the features of selecting outsourcing suppliers as well as the traditional evaluation index system, the evaluation criteria for green logistics services providers are determined, namely, compatibility with the users, cost of service, quality of service, service ability and adaptation with environment, which are recorded as $B = \{b_1, b_2, \cdots, b_5\}$. The incomplete certain information of the weight coefficients f the criteria given by the decision maker are: $0.15 \le \omega_1 \le 0.20$, $0.10 \le \omega_2 \le 0.30$, $0.05 \le \omega_3 \le 0.20$, $0.05 \le \omega_4 \le 0.15$, $0.10 \le \omega_5 \le 0.30$. There are five suppliers $C = \{c_1, c_2, \cdots, c_5\}$, the criteria value of every supplier is shown in Table 1. Then the suppliers are ordered.

TABLE I. CRITERIA VALUE OF SUPPLIERS

	b_1	b_2	b_3	b_4	b_5
c_1	$< h_3, (0.8,0.1) >$	$< h_2, (0.6,0.3) >$	$< h_2, (0.8,0.2) >$	$< h_2, (0.7,0.3) >$	$< h_4, (0.9,0.1) >$
c_2	$< h_2, (0.7,0.3) >$	$< h_4, (0.9,0.1) >$	$< h_5, (0.7,0.3) >$	$< h_2, (0.5,0.5) >$	$< h_4, (0.8,0.2) >$
c_3	$< h_5, (1,0) >$	$< h_5, (0.9,0.1) >$	$< h_2, (0.7,0.2) >$	$< h_3, (0.6,0.4) >$	$< h_5, (0.9,0.1) >$
c_4	$< h_4, (0.7,0.3) >$	$< h_3, (0.6,0.2) >$	$< h_3, (0.8,0.1) >$	$< h_5, (0.7,0.1) >$	$< h_6, (0.7,0.1) >$
c_5	$< h_3, (0.8,0.2) >$	$< h_5, (0.9,0.1) >$	$< h_5, (0.6,0.3) >$	$< h_4, (1,0) >$	$< h_4, (0.6,0.3) >$

Step 1: Standardized processing

The criterion of cost is cost-oriented type, and according to formula (2), conversions are made as follows:

$$h'_{\theta(c_{12})} = neg(h_{\theta(c_{12})}) = h_{2t-\theta(c_{12})} = h_4,$$

Similarly,

$h'_{\theta(c_{22})} = h_2$, $h'_{\theta(b_{32})} = h_1$, $h'_{\theta(c_{42})} = h_3$, $h'_{\theta(c_{52})} = h_1$

For the sake of convenience, after the treatment, the value of b_i under criterion c_3 is still recorded as: $c_{i2} =< h_{\theta(c_{i2})}, (\mu(c_{i2}), \nu(c_{i2})) >$.

Step 2: Establishing models and calculating the weights of the criteria

The fuzzy entropy of the criteria value for each supplier is calculated according to Formula (1), as shown in Table 2.

TABLE 2 FUZZY ENTROPY OF THE CRITERIA VALUES FOR SUPPLIERS

	$\ell(c_{i1})$	$\ell(c_{i2})$	$\ell(c_{i3})$	$\ell(c_{i4})$	$\ell(c_{i5})$
c_1	0.22	0.57	0.25	0.43	0.11
c_2	0.43	0.11	0.43	1.00	0.25
c_3	0	0.11	0.38	0.67	0.11
c_4	0.43	0.50	0.22	0.33	0.33
c_5	0.25	0.11	0.57	0	0.57

According to Formula (4), a model is established as follows:

$$\min \sum_{i=1}^{n}\sum_{j=1}^{l}\omega_j \phi(c_{ij}) = 1.58\omega_1 + 2.22\omega_2 + 1.27\omega_3 + 1.81\omega_4 + 1.5\omega_5$$

$$s.t \begin{cases} 0.15 \le \omega_1 \le 0.25 \\ 0.20 \le \omega_2 \le 0.30 \\ 0.10 \le \omega_3 \le 0.30 \\ 0.15 \le \omega_4 \le 0.25 \\ 0.20 \le \omega_5 \le 0.30 \\ \sum_{j=1}^{l}\omega_j = 1 \end{cases}$$

By calculating the model, there is the weight coefficient of the criteria $W^* = (0.15, 0.20, 0.30, 0.15, 0.20)$.

Step 3: Aggregating the criteria values of the suppliers

The criteria values of the suppliers are aggregated according to formula (5) and (6), hence z_i, the comprehensive intuitionistic trapezoidal fuzzy value of b_i:

$z_1 = < h_{2.8}, (0.76, 0.18) >$,

$z_2 = < h_3, (0.72, 0.24) >$,

$z_3 = < h_{2.55}, (0.80, 0.20) >$,

$z_4 = < h_{3.9}, (0.71, 0.14) >$,

$z_5 = < h_{4.3}, (0.73, 0.27) >$.

Step 4: Calculating the score function value of z_i

The score function value of z_i is figured out according to formula (7) and (8):

$S(z_1) = 1.28$, $S(z_2) = 0.71$, $S(z_3) = 1.22$, $S(z_4) = 1.75$, $S(z_5) = 1.44$.

The order of the suppliers is gained, i.e. $c_4 \succ c_5 \succ c_1 \succ c_3 \succ c_2$, with c_4 being the best supplier.

V. CONCLUSION

In today's highly competitive environment, green logistics issues are gaining interest. The development of service outsourcing helps companies focus on improving strategic level, ability to obtain technology as well as special skills, and the selection of logistics services providers becomes the key to make a successful decision on outsourcing activities. In this thesis, an evaluation index system is established for the selection of green logistics services providers and the method of multi-criteria decision making based on intuitionistic language fuzzy entropy is adopted to evaluate and select green logistics services providers. Besides, the scientific and feasible nature of this decision-making process is then verified through empirical studies. However, with the change of environment and the development of science and technology, many instant factors need to be considered in practical operation and meanwhile, companies from different industries and with different background attach importance to different aspects when selecting logistics services providers. Therefore, it is necessary to enrich and improve the index system and method of selection of green logistics services providers according to the companies' own situation.

ACKNOWLEDGEMENT

The work in the paper is supported by Research Project of China Society of Logistics (2010CSLKT162), Hunan Nature Sciences Fund item(10JJ6112) and Outstanding Youth of Scientific Research Project of Hunan Provincial Education Department (09B056).

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