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Full Length Research Paper

Fuzzy MCDM approach to evaluate service strategies of customer value for global shipping carrier-based logistics service providers

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The key purpose of this research is to develop a fuzzy multiple criteria decision-making (MCDM) algorithm to evaluate service strategies of customer value (CV) for global shipping carrier-based logistics service providers (GSLPs) based on the shippers' perspective in Taiwan. At first, a literature review was introduced. Subsequently, a proposed fuzzy MCDM algorithm is developed. Finally, the systematic approach is to perform the empirical survey via questionnaires. The result shows providing customization is the most suitable service strategy of CV for GSLPs. Differentiation, and providing long-term product values are ranked in the second and third places. The strategy of service operation and delivery system is the lowest ranked. It is suggested that the customization of services should be paid more attention by the GSLPs.

Key words: Customer value, shipping, fuzzy multiple criteria decision-making (MCDM).

INTRODUCTION

The global shipping carrier-based logistics service providers (GSLPs) are emerged due to the acute competitions and many changes among global shipping carriers (GSCs) focusing on business logistics (Ding, 2010). Total solutions of many logistics services are integrated by these GSCs, and as a result, the goals of customer satisfaction and customer value (CV) in the shipping market are striving toward by GSCs. Finally, the uses of third-parties of GSLPs in GSCs are growing rapidly.

Since providing high CV is critical for both GSLPs and shippers, evaluating critical factors of CV are an important issue to study. Based on the Johansson et al. (1993) viewpoints, the criteria of CV can be evaluated by four key value metrics, which are service, quality, cost, and cycle time, respectively. According to their reference, 'any company should concentrate on improving the product quality and/or service, and at the same time reducing the cycle time and cost to the customer.' Ding (2010) had evaluated the critical factors influencing CV for GSLPs based on the shippers' perspective in Taiwan. The initially important factors of the four key value metrics with 17 factors are derived to employ in the empirical survey via fuzzy AHP approach. Two significant contributions are showed. The first result showed that quality is the highest aspect, and the time is the lowest one. The second one showed that the top four critical factors influencing CV are reasonableness of price, related direct costs, safety, and customer satisfaction, respectively.

In the services society, there is a scramble for customers everyday. Drucker (2002) had referred that the most important task of an enterprise is creating customers, inasmuch as it includes good graces of customers and it raises creation of CV. Business practice shows that the cost of endeavoring to get a new customer is higher than to maintain an old one. To attract customers to keep the loyal ones up, how to provide suitable service strategies of creating CV to keep regular patrons is a secondly important issue.

However, experience has shown that evaluating service strategies for GSLPs is no easy matter. At the same time, since evaluating the service strategies for GSLPs with high CV is beneficial for fascinating with the purchasing behavior to shippers. It involves a multitude of complex considerations and a decision-making tool is therefore crucial (Belton and Stewart, 2002).

The evaluation of service strategies for GSLPs poses a unique characteristic of multiple criteria decision-making (MCDM). The criteria are usually subjective in nature and often changing with the decision-making conditions, which creates the ambiguous and uncertain nature among the importance weights of criteria (or sub-criteria), and the performance values of alternatives.

The author, therefore, adopts the fuzzy set theory (Zadeh, 1965), combing with MCDM method as an evaluation tool to improve the quality of the survey. Yet, we can also refer to Ding's study in 2010, he suggested that a complete hierarchy can be constructed to evaluate the attractiveness of alternatives in the future study. In this paper, some suitable service strategies on the alternatives layer would be added to construct a complete hierarchy and then to evaluate these service strategies by using a systematic approach.

Therefore, this paper is based on the Ding's study, which involved the criteria and sub-criteria influencing CV, to evaluate the service strategies of CV for GSLPs in Taiwan. In the light of this, a fuzzy MCDM approach is used to evaluate service strategies of CV for GSLPs.

In summary, the aim of this paper is to develop a fuzzy MCDM algorithm to improve the quality of decision-making in evaluating service strategies of CV for GSLPs.

The next section presents a review of some theoretical concepts and methods. Consequently, an empirical survey is studied.

Finally, some discussions and conclusions are made.

THEORETICAL CONCEPTS AND METHODS

In this section, some of the theoretical concepts and methods used in this section are briefly introduced.

These include the fuzzy set theory, trapezoidal fuzzy numbers, algebraic operations of fuzzy numbers, linguistic values, graded mean integration representation method, and systematic steps of the proposed algorithm of fuzzy MCDM, respectively.

Fuzzy set theory

The fuzzy set theory (Zadeh, 1965) is designed to deal with the extraction of the primary possible outcome from a multiplicity of information that is expressed in vague and imprecise terms. Fuzzy set theory treats vague data as possibility distributions in terms of set memberships.

Once determined and defined, the sets of memberships in possibility distributions can be effectively used in logical reasoning.

Trapezoidal fuzzy numbers

A fuzzy number *A* (Dubois and Prade, 1978) in real line $\Re$ is a trapezoidal fuzzy number, if its membership function $f_A : \Re \rightarrow [0, 1]$ is

$$f_A(x) = \begin{cases} (x-c)/(a-c), & c \le x \le a \\ 1, & a \le x \le b \\ (x-d)/(b-d), & b \le x \le d \\ 0, & otherwise \end{cases} \quad (1)$$

with $-\infty < c \le a \le b \le d < \infty$. The trapezoidal fuzzy number can be denoted by (c, a, b, d).

The *x* in interval [*a*, *b*] gives the maximal grade of $f_A(x)$, i.e. $f_A(x) = 1$; it is the most probable value of the evaluation data. In addition, *c* and *d* are the lower and upper bounds of the available area for the evaluation data. They are used to reflect the fuzziness of the evaluation data. The narrower the interval [*c*, *d*], the lower the fuzziness of the evaluation data.

Trapezoidal fuzzy numbers are easy to use and interpret. For example, 'approximately 100' and 'approximately between 100 and 110' can be represented by (95, 100, 100, 106) and (95, 100, 110, 116), respectively. They can also be represented with more leeway by (90, 100, 100, 113) and (87, 100, 110, 124), respectively. In addition, a non-fuzzy number, an exact number *a*, can be represented by (*a*, *a*, *a*, *a*). For example, 'a value of 100' can be represented by (100, 100, 100, 100).

The algebraic operations of fuzzy numbers

Let $A_1 = (c_1, a_1, b_1, d_1)$ and $A_2 = (c_2, a_2, b_2, d_2)$ be fuzzy numbers. According to the function principle (Chen, 1985), the algebraic operations of any two fuzzy numbers A_1 and A_2 can be expressed as:

(1) Fuzzy addition, $\oplus$:

$$A_1 \oplus A_2 = (c_1 + c_2, a_1 + a_2, b_1 + b_2, d_1 + d_2)$$

Where, $c_1, a_1, b_1, d_1, c_2, a_2, b_2,$ and d_2 are any real numbers.

(2) Fuzzy subtraction, $\ominus$:

$$A_1 \ominus A_2 = (c_1 - d_2, a_1 - b_2, b_1 - a_2, d_1 - c_2),$$

Where, $c_1, a_1, b_1, d_1, c_2, a_2, b_2,$ and d_2 are any real numbers.

(3) Fuzzy multiplication, $\otimes$:

(i) $k \otimes A_2 = (kc_2, ka_2, kb_2, kd_2), \quad k \in \Re, \; k \ge 0$;

(ii) $A_1 \otimes A_2 = (c_1c_2, a_1a_2, b_1b_2, d_1d_2),$

Where, $c_1, a_1, b_1, d_1, c_2, a_2, b_2,$ and d_2 are all nonzero positive real numbers.

(4) Fuzzy division, $\varnothing$:

(i) $(A_1)^{-1} = (c_1, a_1, b_1, d_1)^{-1} = (1/d_1, 1/b_1, 1/a_1, 1/c_1),$

Where, $c_1, a_1, b_1,$ and d_1 are all positive real numbers or all

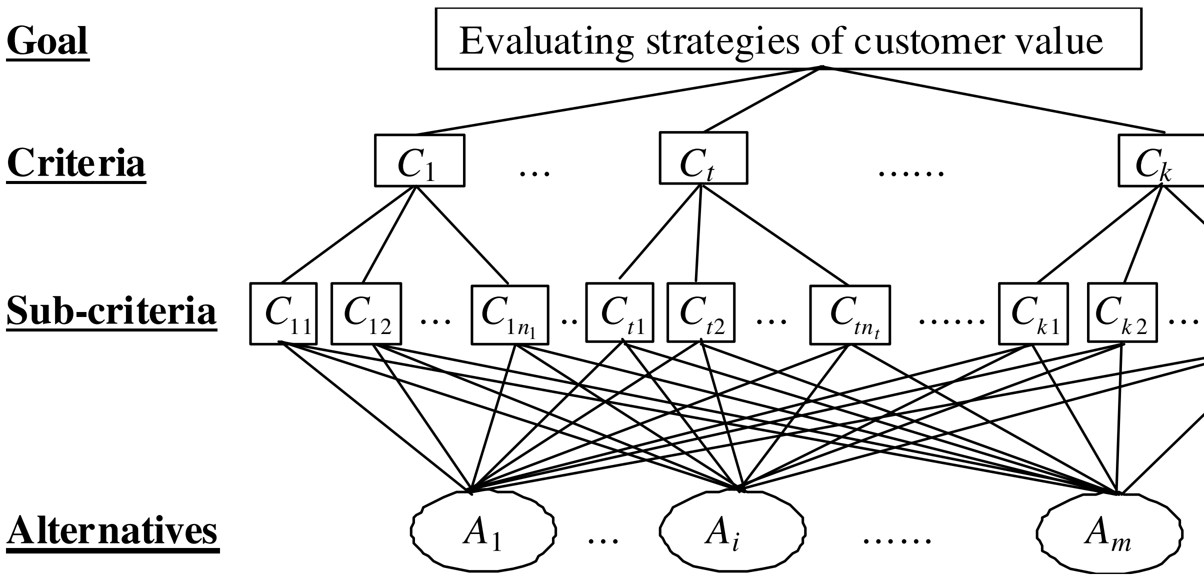

Figure 1. Hierarchy structure.

negative real numbers.

(ii) $A_1 \oslash A_2 = (c_1/d_2,\ a_1/b_2,\ b_1/a_2, d_1/c_2),$

Where, $c_1, a_1, b_1, d_1, c_2, a_2, b_2,$ and d_2 are all nonzero positive real numbers.

Linguistic values

In fuzzy decision environments, two preference ratings can be used. They are fuzzy numbers and linguistic values characterized by fuzzy numbers (Zadeh, 1975; 1976). Depending on practical needs, decision-makers may apply one or both of them. In this paper, the importance weights of criteria and sub-criteria are used the data of Ding's study in 2010. The rating set is used to analytically express the linguistic values and describe how good or poor of the involved alternatives against various sub-criteria.

In this paper, the rating set is defined as $S = \{VP, P, F, G, VG\}$; where *VP*=Very Poor, *P*=Poor, *F*=Fair, *G*=Good, and *VG*=Very Good. Here, we define the linguistic values of *VP*=(0, 0, 0.2, 0.3), *P*=(0.2, 0.3, 0.4, 0.5), *F*=(0.4, 0.5, 0.6, 0.7), *G*=(0.6, 0.7, 0.8, 0.9), and *VG*=(0.8, 0.9, 1, 1), respectively.

Graded mean integration representation method

In a fuzzy decision-making environment, ranking the alternatives under consideration is essential. For matching the fuzzy MCDM algorithm developed in this paper, and solving the problem powerfully, the graded mean integration representation (GMIR) method, proposed by Chen and Hsieh (2000), is used to rank the final ratings of alternatives.

Let $A_i = (c_i, a_i, b_i, d_i), i = 1, 2, \ldots, n,$ be *n* trapezoidal fuzzy numbers. By the GMIR method, the GMIR value $P(A_i)$ of A_i is

$$P(A_i) = \frac{c_i + 2a_i + 2b_i + d_i}{6} \tag{2}$$

Suppose $P(A_i)$ and $P(A_j)$ are the GMIR values of the trapezoidal fuzzy numbers A_i and A_j, respectively. We define:

1. $A_i > A_j \Leftrightarrow P(A_i) > P(A_j)$,
2. $A_i < A_j \Leftrightarrow P(A_i) < P(A_j)$,
3. $A_i = A_j \Leftrightarrow P(A_i) = P(A_j)$.

Fuzzy MCDM algorithm

A stepwise description of the fuzzy MCDM algorithm for evaluating the service strategies of CV for GSLPs is proposed as follows:

Step 1. Development of hierarchical structure

A hierarchy structure is the framework of system structure. It is not only useful in studying the interaction among the elements involved in each layer, but it can also help decision-makers to explore the impact of different elements on the evaluated system. Figure 1 is a complete hierarchical structure of evaluating the service strategies of CV for GSLPs with *k* criteria, $n_1 + \cdots + n_t + \cdots + n_k$ sub-criteria and *m* alternatives.

As aforementioned and according to Ding's study in 2010, four criteria and seventeen sub-criteria are adopted in this paper, and their codes are shown in parentheses. They are:

Service (C_1): This criterion includes five sub-criteria, that is, providing diversity of value-added services (C_{11}), availability (C_{12}), reliability (C_{13}), providing adequacy of physical facilities and equipment (C_{14}), and increasing marketing channel and network (C_{15}), respectively.

Quality (C_2): This criterion includes five sub-criteria, that is, improving customer satisfaction (C_{21}), safety (C_{22}), accuracy and precision of shipments (C_{23}), skills and knowledge of operating personnel (C_{24}), and capability of total quality service and integrated process management (C_{25}), respectively.

Cost (C_3): This criterion includes three sub-criteria, that is, providing reasonableness of price (C_{31}), reducing related operating costs of shipments (direct costs) (C_{32}), and reducing related overhead, charges and fees (indirect costs) (C_{33}), respectively.

Time (C_4): This criterion includes four sub-criteria that is, reducing lead time of core logistics services (C_{41}), implementing integrated logistics information system (C_{42}), reducing the non-value-adding time (C_{43}), and quick responsiveness (C_{44}), respectively.

As for the alternatives layer, four suitable service strategies are drawn with related literature (Anderson and Vincze, 2000; Christopher, 1998; Drucker, 1992; 2002; Heskett, 1986; Heaver et al., 2001; Johansson et al., 1993; Kotler, 2000; Porter, 1985; Stock and Lambert, 2001) and interviewing with executive managers of GSLPs' companies in this paper. The four service strategies are deemed as the evaluating alternatives in this paper, and their code names are shown in parentheses:

Customization of services (A_1): It is a marketing variable, which 'describes the ability of the customer to affect personally the nature of the service delivered' (Fitzsimmons and Fitzsimmons, 1994). It is different from the standardization.

For an enterprise, the low cost is obtained by the standardization of mass production; however, for customers, they like changes and variations more. Hence, the GSLPs need to combine their input systems with the flexibility to specifically fit into a particular customer's unique needs.

Differentiation (A_2): It is a basic service strategy for sustainable competitive advantage (Porter, 1985). Anderson and Vincze (2000) referred that it is a strategy for 'distinguishing one company's product from its competitors' on the basis of greater perceived benefits and/or more value.' It is based on value-added benefits. We can recall that the keen competitions among the main GSCs, therefore, they intensely emphasize upon providing integrated logistics services to create significantly added value for their customers. Hence, the GSLPs can use this strategy for their business.

Service operation and delivery system (A_3): In fact, the service transmitted by service providers should not only focus on their core service, but also consider how, why, where, and when in the service system to ascertain the total customers' satisfaction. As we know that an effective delivery process can be an important quality improvement tool that allows a service provider to obtain customer feedback which is serviceable in improving to increase customer satisfaction, loyalty, and profit margins in shipping chain. Therefore, a service system should design well to make improvement that increases overall performance.

Long-term product values (A_4): Lester (2009) had referred that a successful product can deliver the value to its customers, and at the same time, it can create revenue to the business. A value-driven production management approach can be employed in this paper. This approach is a repeatable process based on business best practices to deliver successful products. The product value, including functional promotion and services diversification, can be made to meet the customers need. Providing long-term product values for customers is a critical strategy.

Step 2. Computation of aggregating evaluation ratings of all feasible alternatives

Assume the decision-makers are responsible for assessing the appropriateness of all feasible alternatives, under each of the sub-criteria above the feasible alternatives layer. For this, the appropriateness should be modeled for computing the aggregating evaluation ratings. This is done as follows:

Let $W_t = (c_t, a_t, b_t, d_t)$, $0 \le c_t \le a_t \le b_t \le d_t \le 1$, $t = 1, 2, \ldots, k$, be the weight of C_t. Let $W_{tj} = (c_{tj}, a_{tj}, b_{tj}, d_{tj})$, $0 \le c_{tj} \le a_{tj} \le b_{tj} \le d_{tj} \le 1$, $t = 1, 2, \ldots, k$; $j = 1, 2, \ldots, n_t$, be the weight of criterion C_{tj}. In this paper, the importance weights of W_t and W_{tj} are used from the Ding's study in 2010.

Let $m_{itjq} = (c_{itjq}, a_{itjq}, b_{itjq}, d_{itjq})$, $0 \le c_{itjq} \le a_{itjq} \le b_{itjq} \le d_{itjq} \le 1$, $i = 1, 2, \ldots, m$; $t = 1, 2, \ldots, k$; $j = 1, 2, \ldots, n_t$; $q = 1, 2, \ldots, n$, be the appropriateness rating assigned to alternative A_i by the q^{th} decision-maker for criterion C_{tj}. Then, the appropriateness rating of alternative A_i can be represented as $M_{itj} = (c_{itj}, a_{itj}, b_{itj}, d_{itj})$, where $c_{itj} = \frac{1}{n}\sum_{q=1}^{n} c_{itjq}$, $a_{itj} = \frac{1}{n}\sum_{q=1}^{n} a_{itjq}$, $b_{itj} = \frac{1}{n}\sum_{q=1}^{n} b_{itjq}$, $d_{itj} = \frac{1}{n}\sum_{q=1}^{n} d_{itjq}$.

The aggregation appropriateness rating of alternative A_i for the n_t sub-criteria under criterion C_t $(t = 1, 2, \ldots, k)$ can be denoted as:

$$R_{it} = \frac{1}{n_t} \otimes \left[\left(M_{it1} \otimes W_{t1} \right) \oplus \left(M_{it2} \otimes W_{t2} \right) \oplus \cdots \oplus \left(M_{itj} \otimes W_{tj} \right) \oplus \cdots \oplus \left(M_{itn_t} \otimes W_{tn_t} \right) \right] \quad (3)$$

Because $M_{itj} = (c_{itj}, a_{itj}, b_{itj}, d_{itj})$ and $W_{tj} = (c_{tj}, a_{tj}, b_{tj}, d_{tj})$, we can denote $R_{it} \cong (Y_{it}, Q_{it}, G_{it}, Z_{it})$, where $Y_{it} = \sum_{j=1}^{n_t} c_{itj}\, c_{tj} / n_t$, $Q_{it} = \sum_{j=1}^{n_t} a_{itj}\, a_{tj} / n_t$, $G_{it} = \sum_{j=1}^{n_t} b_{itj}\, b_{tj} / n_t$,

$Z_{it} = \sum_{j=1}^{n_t} d_{itj}\, d_{tj} / n_t$, for $i = 1, 2, \ldots, m$; $t = 1, 2, \ldots, k$.

Furthermore, the final aggregation appropriateness rating of alternative A_i can be denoted as:

Table 1. Importance weights of all criteria and sub-criteria.

Criteria /Sub-criteria	Crisp weights	Criteria /Sub-criteria	Crisp weights
C_1	0.2642	C_{23}	0.1287
C_2	0.2950	C_{24}	0.1494
C_3	0.2252	C_{25}	0.2116
C_4	0.2156	C_{31}	0.4582
C_{11}	0.2514	C_{32}	0.3679
C_{12}	0.2312	C_{33}	0.1739
C_{13}	0.2324	C_{41}	0.3066
C_{14}	0.1469	C_{42}	0.2264
C_{15}	0.1381	C_{43}	0.2103
C_{21}	0.2414	C_{44}	0.2567
C_{22}	0.2689		

Source: Ding (2010)

$$F_i = \frac{1}{k} \otimes [(R_{i1} \otimes W_1) \oplus (R_{i2} \otimes W_2) \oplus \cdots \oplus (R_{it} \otimes W_t) \oplus \cdots \oplus (R_{ik} \otimes W_k)] \quad (4)$$

Because $W_j = (c_j, a_j, b_j, d_j)$, we can denote $F_i \cong (Y_i, Q_i, G_i, Z_i)$,

Where, $Y_i = \sum_{t=1}^{k} Y_{it}\, c_t / k$, $Q_i = \sum_{t=1}^{k} Q_{it}\, a_t / k$, $G_i = \sum_{t=1}^{k} G_{it}\, b_t / k$, $Z_i = \sum_{t=1}^{k} Z_{it}\, d_t / k$, for $i = 1, 2, \ldots, m.$

Step 3. Choice of optimal alternative

By Equation (2), the ranking value of the aggregation appropriateness rating of alternative A_i can be obtained and denoted as:

$$P(F_i) = \frac{Y_i + 2Q_i + 2G_i + Z_i}{6} \quad (5)$$

By the ranking rules proposed above, the final ranking values of the *m* alternatives can be obtained, and finally the decision-makers can choose the optimal alternative.

RESULTS

In this section, an empirical study of evaluating service strategies of CV for GSLPs in Taiwan is carried out to demonstrate the computational process as earlier described. The process of the algorithm is empirically implemented, step by step, as follows.

Step 1: Questionnaire design. In this step, four criteria, seventeen sub-criteria with four alternatives were used to design the questionnaire and to obtain information on the appropriateness of all feasible alternatives versus various sub-criteria. We used the top 500 exporters and importers in Taiwan as the population, recorded in the 'Directory of Excellent Exporters and Importers in 2008, Taiwan (ROC)' (Ministry of Economic Affairs: Taiwan, 2009). The questionnaire was filled in by the export/import department of each company on December in 2009 to April in 2010. In addition, the surveys were repeatedly completed through phone calls and over-and-over in-person interviews by the author. The reliability, that is, Cronbach's alpha, of the questionnaire was 0.8479. Finally, a total of 217 valid responses were collected, from the 500 exporters and importers, which represents 43.40% of the total population.

Step 2: The crisp weights of criteria and sub-criteria are used from Ding's study in 2010, and the importance weights are showed in Table 1. Then, we use the linguistic rating set *S* to evaluate the appropriateness ratings of four alternatives versus seventeen sub-criteria. To sum up the results surveyed in the questionnaire, the results of appropriateness ratings of four alternatives versus all sub-criteria are shown in Table 2.

Step 3: We calculate the aggregation evaluation ratings of four alternatives. By utilizing equations (3), the aggregation appropriateness ratings of four alternatives versus all sub-criteria (R_{it}) can be obtained; the results are shown in Table 3. Finally, by using equation (4) and (5), the final aggregation appropriateness ratings of four alternatives (F_i) and the ranking values can be calculated; the results can be shown in Table 4. We can see that the ranking order for the four service strategies is customization of services (A_1), differentiation (A_2), long-term product values (A_4), and service operation and delivery system (A_3), respectively. Therefore, we recommend that customization of services be the most suitable service strategy for the

Table 2. Appropriateness ratings of four alternatives versus all sub-criteria.

Sub-criteria	A_1	A_2	A_3	A_4
C_{11}	(0.5889, 0.6861, 0.7889, 0.8505)	(0.6037, 0.7037, 0.8037, 0.8606)	(0.5056, 0.5981, 0.7056, 0.7810)	(0.6037, 0.7009, 0.8037, 0.8630)
C_{12}	(0.60, 0.6991, 0.80, 0.8653)	(0.5574, 0.6519, 0.7574, 0.8208)	(0.4667, 0.5565, 0.6667, 0.7514)	(0.5454, 0.6398, 0.7454, 0.8171)
C_{13}	(0.5750, 0.6745, 0.7750, 0.8449)	(0.5194, 0.6167, 0.7194, 0.8009)	(0.4083, 0.4940, 0.6083, 0.7014)	(0.4769, 0.5671, 0.6769, 0.7583)
C_{14}	(0.5991, 0.6954, 0.7991, 0.8569)	(0.5602, 0.6565, 0.7602, 0.8264)	(0.4954, 0.5824, 0.6954, 0.7676)	(0.5380, 0.6292, 0.7380, 0.8051)
C_{15}	(0.5213, 0.6130, 0.7213, 0.7963)	(0.5296, 0.6222, 0.7296, 0.8014)	(0.4194, 0.5028, 0.6194, 0.7093)	(0.4222, 0.5069, 0.6222, 0.7120)
C_{21}	(0.5639, 0.6639, 0.7639, 0.8319)	(0.5722, 0.6699, 0.7722, 0.8319)	(0.4194, 0.5032, 0.6194, 0.7042)	(0.3537, 0.4361, 0.537, 0.6454)
C_{22}	(0.5917, 0.6921, 0.7926, 0.8565)	(0.6157, 0.7144, 0.8157, 0.8699)	(0.4120, 0.4968, 0.6120, 0.7005)	(0.3370, 0.4204, 0.5370, 0.6338)
C_{23}	(0.5630, 0.6630, 0.7630, 0.8269)	(0.5944, 0.6931, 0.7944, 0.850)	(0.4074, 0.4907, 0.6074, 0.6968)	(0.3361, 0.4208, 0.5361, 0.6310)
C_{24}	(0.5907, 0.6907, 0.7907, 0.8454)	(0.6028, 0.6977, 0.8028, 0.8523)	(0.4065, 0.4921, 0.6065, 0.6968)	(0.3343, 0.4167, 0.5343, 0.6269)
C_{25}	(0.5880, 0.6880, 0.7880, 0.8509)	(0.5009, 0.5880, 0.7009, 0.7727)	(0.3852, 0.4676, 0.5852, 0.6778)	(0.3806, 0.4662, 0.5806, 0.6699)
C_{31}	(0.6315, 0.7301, 0.8315, 0.8838)	(0.5157, 0.6120, 0.7157, 0.7926)	(0.1750, 0.2273, 0.3750, 0.4718)	(0.3972, 0.4713, 0.5972, 0.6699)
C_{32}	(0.6417, 0.7370, 0.8417, 0.8875)	(0.5880, 0.6843, 0.7880, 0.8509)	(0.1481, 0.1944, 0.3481, 0.4458)	(0.3778, 0.4481, 0.5778, 0.6514)
C_{33}	(0.5972, 0.6972, 0.7972, 0.8532)	(0.4870, 0.5843, 0.6870, 0.7685)	(0.2389, 0.2986, 0.4389, 0.5333)	(0.4824, 0.5671, 0.6824, 0.7463)
C_{41}	(0.5463, 0.6458, 0.7463, 0.8264)	(0.4426, 0.5384, 0.6426, 0.7394)	(0.3509, 0.4236, 0.5509, 0.6356)	(0.4991, 0.5856, 0.6991, 0.7616)
C_{42}	(0.5046, 0.6009, 0.7046, 0.7898)	(0.4444, 0.5421, 0.6444, 0.7407)	(0.3380, 0.4079, 0.5380, 0.6208)	(0.5176, 0.6060, 0.7176, 0.7759)
C_{43}	(0.5583, 0.6560, 0.7583, 0.8296)	(0.4926, 0.5921, 0.6926, 0.7782)	(0.3167, 0.3847, 0.5167, 0.6028)	(0.5167, 0.6064, 0.7167, 0.7759)
C_{44}	(0.4759, 0.5718, 0.6759, 0.7634)	(0.4352, 0.5315, 0.6352, 0.7296)	(0.3241, 0.3935, 0.5241, 0.6083)	(0.5426, 0.6310, 0.7426, 0.7944)

GSLPs in Taiwan, based on the proposed fuzzy MCDM algorithm.

DISCUSSION

This paper aims to develop a fuzzy MCDM algorithm to evaluate service strategies of CV for GSLPs based on the shippers' perspective in Taiwan. Since evaluating service strategies of CV for GSLPs is important; hence, an empirical study based on the shippers' perspective in Taiwan is surveyed by using a proposed fuzzy MCDM approach.

At first, we introduce some theoretical concepts and methods, which mainly include fuzzy set theory, trapezoidal fuzzy numbers, algebraic operations of fuzzy numbers, linguistic values, and the GMIR method, respectively. Subsequently, a systematical fuzzy MCDM algorithm is proposed. The proposed algorithm includes three steps; that is development of hierarchical structure, computation of aggregating evaluation ratings of all feasible alternatives, and choice of optimal alternative, respectively. Finally, the systematic approach is to perform the empirical survey via questionnaires.

By using the proposed fuzzy MCDM algorithm, the result shows customization of services, ranking one, is the most suitable service strategy of CV for GSLPs. Differentiation, and providing long-term product values are ranked in the second and third places. The service strategy of service operation and delivery system is the lowest ranked. Overall speaking, the suitable service strategy of customization should be paid more attention by the GSLPs.

To be a good third-party logistics service provider for shippers and GSCs will not be a headache anymore; in case of execution of customization strategy can be provided high CV for GSLPs. In our empirical study, the result shows that customizing shipper's own products/services is the most suitable strategy to have uniquely differentiated competence. No matter what the shippers are looking for any logistics services, the GSLPs provide the total solutions based on the customization services is the most critical matter. Customization can definitely make shippers magnificent to beat their competitors in this field, and finally to outlive in the industry. Customization may provide the superior services to support customers to outlast and remain. The reason why the business of GSLPs can be facilitated is to give

Table 3. The aggregation appropriateness ratings.

R_{it}	Fuzzy ratings	R_{it}	Fuzzy ratings
$R_{A_1 1}$	(0.1161, 0.1355, 0.1561, 0.1692)	$R_{A_3 1}$	(0.0921, 0.1098, 0.1321, 0.1488)
$R_{A_1 2}$	(0.1161, 0.1361, 0.1561, 0.1688)	$R_{A_3 2}$	(0.0813, 0.0981, 0.1213, 0.1391)
$R_{A_1 3}$	(0.2098, 0.2423, 0.2764, 0.2933)	$R_{A_3 3}$	(0.0587, 0.0759, 0.1254, 0.1576)
$R_{A_1 4}$	(0.1303, 0.1547, 0.1803, 0.2007)	$R_{A_3 4}$	(0.0835, 0.1010, 0.1335, 0.1546)
$R_{A_2 1}$	(0.1114, 0.1307, 0.1514, 0.1649)	$R_{A_4 1}$	(0.1052, 0.1237, 0.1452, 0.1597)
$R_{A_2 2}$	(0.1153, 0.1343, 0.1553, 0.1670)	$R_{A_4 2}$	(0.0699, 0.0867, 0.1099, 0.1286)
$R_{A_2 3}$	(0.1791, 0.2113, 0.2458, 0.270)	$R_{A_4 3}$	(0.1350, 0.1598, 0.2016, 0.2255)
$R_{A_2 4}$	(0.1129, 0.1372, 0.1629, 0.1863)	$R_{A_4 4}$	(0.1295, 0.1515, 0.1795, 0.1941)

Table 4. Final aggregation ratings and ranking value of four alternatives.

Alternatives	F_i	Ranking value	Ranking order
A_1	(0.0351, 0.0410, 0.0471, 0.0510)	0.0437	1
A_2	(0.0320, 0.0378, 0.0441, 0.0484)	0.0407	2
A_3	(0.0199, 0.0242, 0.0319, 0.0373)	0.0282	4
A_4	(0.0267, 0.0317, 0.0387, 0.0432)	0.0351	3

what the customization can be provided in the future. All the customized products/services make the GSLPs different from others. Just like the ocean carrier of Wan Hai Lines guarantees her service philosophy, "We Carry, We Care." With the GSLPs, customers' concerns are their primary concerns too. Hence, what makes the difference and dissimilitude? The customization of service strategy of CV for GSLPs may be a good explanatory statement.

Besides, the customization of service strategy should be executed; therefore, the differentiation, providing long-term product values, and service operation and delivery system can be hereby appeared and performed. Furthermore, to re-consider the resources allocation, evaluating value-added activities for GSLPs can be studied by using this fuzzy MCDM algorithm in the future studies.

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REFERENCES

Anderson CH, Vincze JW (2000). Strategic Marketing Management: Meeting the Global Marketing Challenge. Boston: Houghton Mifflin.

Belton V, Stewart TJ (2002). Multiple Criteria Decision Analysis: An Integrated Approach, London: Kluwer Academic Publisher.

Chen SH (1985). Operations on fuzzy numbers with function principle. Tamk. J. Manage. Sci., 6(1): 13 - 26.

Chen SH, Hsieh CH (2000). Representation, ranking, distance, and similarity of L-R type fuzzy number and application. Aust. J. Intel. Inform. Process. Syst., 6(4): 217-229.

Christopher M (1998). Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service (2nd ed.), London: Financial Times Professional Limited.

Ding JF (2010). Critical factors influencing customer value for global shipping carrier-based logistics service providers using fuzzy AHP approach. Afr. J. Bus. Manage., 4(7): 1299 - 1307.

Drucker, PF (1992). Managing for the Future: The Trend toward Alliances for Progress. New York: Penguin.

Drucker, PF (2002). Managing in the Next Society. New York: St. Martin's Press.

Dubois D, Prade H (1978). Operations on fuzzy numbers. Int. J. Syst. Sci., 9(6): 613-626.

Fitzsimmons JA, Fitzsimmons MJ (1994). Service Management for Competitive Advantage. New York: McGraw-Hill, Inc.

Heaver T, Meersman H, Moglia F, Voorde, EVD (2001). Co-operation and competition in international container transport: strategies for ports. Marit. Policy Manage., 28(3): 293-305.

Heskett JL (1986). Managing in the Service Economy. Boston: Harvard Business School Press.

Johansson HJ, Mchugh P, Pendlebury AJ, Wheeler III WA (1993), Business Process Reengineering: Breakpoint Strategies for Market Dominance. New York: John Wiley & Sons.

Kotler P (2000). Marketing Management: An Asian Perspective. Singapore: Prentice-Hall Inc.

Lester M (2009). Value-driven product management. in the website of http://www.softwaremag.com/pdfs/whitepapers/Value_Driven_Product

_Mgmt_IBM_WP.pdf?CFID=8792334&CFTOKEN=84393442.
Ministry of Economic Affairs: Taiwan (2009). Directory of excellent exporters and importers in 2008, Taiwan (ROC).
Porter ME (1985). Competitive Advantage: Creating and Sustaining Superior Performance, New York: Free Press.
Stock JR, Lambert DM (2001). Strategic Logistics Management (4th ed.). New York: McGraw-Hill Companies.
Zadeh LA (1965). Fuzzy sets. Inform. Control, 8(3): 338 - 353.
Zadeh LA (1975; 1976). The concept of a linguistic variable and its application to approximate reasoning, Parts 1, 2 and 3. Inform., Sci. 8(3): 199 - 249, 8(4): 301 - 357; 9(1): 43 - 80.