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Assessing customer value for express service providers: An empirical study from shippers' perspective in Taiwan

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ABSTRACT

Customer value is an important factor to evaluate the competitive strength for an international express service provider. It is also a key criterion to choose an express service. Hence, the main purpose of this paper was to develop a fuzzy multiple criteria decision-making (MCDM) model to assess the customer value for three express service providers in Taiwan based on the shippers' perspective. Firstly we employed some concepts of fuzzy set theory to develop a fuzzy MCDM model. Subsequently, a hierarchical structure was constructed with four criteria, twenty sub-criteria and three alternatives (i.e. *UPS*, *FedEx* and *DHL*). Then, this paper conducts an empirical study by means of a survey from the viewpoints of shippers in Taiwan. Finally, the results of this study showed that: (1) the 'time' aspect is the most important criterion affecting the customer service based on the viewpoints of exporters and importers in Taiwan; (2) the top six key factors affecting customer value for express service providers are 'land time between house and airport at both ends,' 'administrative processing time,' 'pick-up and haul time in warehouse,' 'level of accuracy,' 'level of safety,' and 'rapid turnover,' respectively; (3) *FedEx* offers the best customer value in Taiwan based on the proposed fuzzy MCDM model. Furthermore, some discussions are provided for express service companies. The main contribution of this paper is to provide a practical survey for business application on customer value of express service providers.

1. Introduction

In the past, it usually took weeks to send a letter or cargo to an overseas destination. If an accident occurred during the delivery process, the letter would fail to reach its designated recipient. Nowadays, however, the development of modern transportation technologies has shortened delivery time and reduced the risk of cargo loss. International trade has also increased due to the use of advanced transportation methods. The recent growth in international trade has also spurred increased globalization on a worldwide basis. In the wake of globalization, better efficiency and faster and less costly worldwide shipment have become the common goals of the international transportation industry.

Express services originated from letter delivery services. When customers pursuing faster speed, lower cost, better service, and higher quality found that traditional postal services failed to their expectations, express service providers – such as *UPS*, *FedEx*, and *DHL* – found a new market niche in international delivery services (Chao et al., 2013; Ding et al., 2005). To provide services beyond cargo transportation and to increase revenue and service volume, express service companies have enhanced their logistics systems and built warehouses near international airports for fast delivery service. These new actions have helped speed up cargo handling and consolidation processes and added value to air cargo transportation services, while also spurring the international express industry to design new solutions involving integrated logistics platforms and cargo distribution services. After third-party logistics providers (3PLs) reached full maturity, integrated fourth party logistics providers (4PLs) began shaping new forms of services.

The fact that the global economy has been swinging

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unpredictably between booms and recessions has caused air cargo transportation to face enormous financial risks and resulted in fierce competition. As a result, how to provide better service quality is perceived as a strategic issue as well as a tactical issue (Grönroos, 2000). Shippers are the main customers in the international express service system. From a marketing perspective, the service quality provided by an international express service company is the main factor in maintaining customers' loyalty (Chang, 2012), and providing the best service and quality, and reducing transportation time and cost, has therefore become the best competitive strategy.

Apart from the core benefits provided by their services, a growing number of express enterprises have also begun putting more emphasis upon the re-purchase intention of their customers. These companies recognize that only by fully understanding customers' needs, they can provide precisely-tailored services offering customers optimal benefit. Better customer service increases value for customers (Johansson et al., 1993), and better services also attract more new customers, and thus increase profit and revenue (Ramsey and Sohi, 1997). Kotler (2013) believed that customer value is the central concept of marketing theory, and the customer value concept has been applied in many service-related fields in order to provide a competitive advantage. One conclusion based on this concept is that companies should discover and provide satisfactory value for their customers.

Customer value is an important factor in maintaining customer satisfaction and customer loyalty in the fiercely competitive air cargo transportation market (Lam et al., 2004). Three international express service providers (*UPS*, *FedEx*, and *DHL*) have already established operations in Taiwan to serve the needs of local enterprises and individuals (Chao et al., 2013). Nevertheless, few studies have focused on customer value issues for international express service providers. Park et al. (2009) suggested that optimal customer value is one of the important assessment factors in evaluating the competitive forces acting on international express service providers, and customers select international express services based on customer value. This paper therefore assesses the customer value provided by the three express service providers in Taiwan.

Due to its characteristics, when multiple criteria decision-making (MCDM) is used to assess customer value and the effect of changes in various criteria upon group decision-making, the importance weights between various criteria tend to be characterized by ambiguity and variability. In addition, relevant decision information is hard to come by and often vague, particularly when the information involves linguistic terms (*e.g.*, low, high, poor, and good, etc.) (Zadeh, 1975; 1976). When decision makers (DMs) are expected to deal with the ambiguity of all criteria weights and to express the inaccuracy of decision information transmission via traditional decision making methods, experience has shown that it is difficult for DMs to evaluate decisions. Fuzzy set theory (Zadeh, 1965) was therefore used in this paper to deal with the uncertainties posed by vague linguistic terms, and we propose the use of a fuzzy MCDM method to assist with improvement of decision-making quality.

In summary, the main purpose of this paper is to develop a fuzzy MCDM model to improve the quality of decision-making in assessing customer value of three express service providers in Taiwan based on a shippers' perspective. This study was conducted employing the following research procedures. The relevant literature is reviewed in Sections 2, including literature concerning express service providers, customer value, and evaluation criteria of customer value. The research methodology, including fuzzy set theory and the defuzzification method, is presented in Section 3. A step-by-step fuzzy MCDM model is constructed and described in Section 4. The results of an empirical survey are examined in Section 5, and the conclusions are drawn in the last section.

2. Literature review

2.1. Express service providers

Air cargo transport services mainly include air mail, air freight, and air express (Chang, 2012). Air mail consists of ordinary letters and documents. Air freight employs all-cargo aircraft to transport general cargo. Air express involves the use of express handling processes to implement the transport of small packages, commercial documents, and samples, etc. In the wake of rapid changes in business activities, today's small, light, and compact products are especially suitable for transport by air freight. Thus, the customers' needs to transport small batches of varied products by air grow gradually. As international trade and various commercial activities gradually increase, international express operators have become important air cargo logistics service providers, and have relied on the provision of fast, economical, all-around logistics service to expand their market share.

In general air cargo transport, air freight forwarders typically handle transport of cargo to an airport, customs declaration, arrangement of insurance, preparation of cargo and notification of hand-over for loading, handling of documentation, arrangement of shipping space with the airline, and transport consulting services (Chang, 2012). Nevertheless, due to forwarders' limited scale of operations, the service quality varied across the industry, and restrictions on aircraft carrying capacity (Chao and Li, 2012); they cannot effectively guarantee transport time, cargo safety, and convenient door-to-door service (Chao et al., 2013). However, in pace with the rapid evolution of the industry environment and commercial activity; demand for transport of items such as small packages, commercial documents, and gifts has increased steadily. As a result, air cargo service providers have relied on innovative, real-time, door-to-door, and convenient methods to serve their customers (Chen et al., 2015; Ku and Chen, 2013), and have also adopted air carriers' operating methods to provide rapid delivery service, which has enabled them develop integrated operating models offering high quality and high efficiency.

The international express industry employs an 'integrated air carrier' business model. This industry has integrated the air transport industry, air freight forwarders, inland transport industry, air freight depots, and customs clearance services. The companies in this industry possess extensive and intensive global transport networks (Chang, 2012), and have established regional transshipment airports (Chao and Li, 2012) in various parts of the world in order to achieve their goal of rapid, on-time global door-to-door transport service. This has enabled them to realize the full benefits of their global transport networks and allows them to help customers quickly obtain cargo (Chen et al., 2015).

The three companies *UPS*, *FedEx*, and *DHL* are the leading members of the international express industry, and all have established business locations in Taiwan. These three firms chiefly transport cargo consisting of business documents and small packages, and their profitability is greater than that of ordinary air cargo carriers. Because competition is extremely intense in the international express service market, these express firms handle all matters involving cargo during the processes of loading, transport, customs clearance, documents handling, and computer tracking, which ensures that all cargo transport processes can be completed within a specified period of time. Furthermore, the fast and reliable transport services provided by the international express industry are able to meet the needs of evolving commercial activities performed by multinational corporations. If the international express industry is able to provide adequate customer value in the future, it would continue to grow and maintain its competitiveness (Wittmer and Rowley, 2014).

2.2. Customer value

Demand for the transport of cargo possessing high unit price or requiring prompt delivery has gradually increased in recent years, and a customer-centered marketing concept has also grown in importance. As a result, in order to maintain or increase its profit (or profit margin), the international express industry has strengthened its cost control, while also increasing the depth of its customer-centered service, which has further increased customer value, and thereby won greater customer satisfaction and customer loyalty (Hussain et al., 2015; Ku and Chen, 2013). Generally speaking, loyal customers value long-term benefit, and strong customer loyalty will therefore enhance the competitiveness of both parties and reduce transaction costs (Doney and Cannon, 1997.). Nevertheless, in the past, while it was widely believed in the past that consumer satisfaction will result in customer loyalty, in the wake of changes in consumption and lifestyle, level of satisfaction and loyalty do not necessarily have a positive correlation (Neal, 1999.). This is because, although most loyal customers are satisfied, satisfied customers do not necessarily have loyalty. But while customer satisfaction does not necessarily result in loyalty, the provision of customer value is an important driving factor for achievement of customer loyalty. As a consequence, according to Kandell (2000), the key to establishing strong relationships with a customer is the customer's needs; lifetime customer value is an important corporate asset, and companies must strive to provide products and services satisfying all of their customers' needs in order to obtain the greatest benefit, retain customers, and enhance customer satisfaction.

Business models emphasizing customer value with advanced information systems are important competitive advantages for customer-centered service firms (Chen et al., 2015; Ku and Chen, 2013; Wittmer and Rowley, 2014). Day (1990) and Porter (1980) both pointed out that only those companies which continuously create values for customers can maintain deep and long-term relationships with their customers. According to Gale (1994), companies must prioritize the creation of customer value among their competitive strategies if they are to achieve an invincible position in their markets. Here customer value is generally considered to be the effectiveness, quality, benefit, or cost difference when a customer purchases a product or uses a service (Anderson and Narus, 1998; Churchill and Peter, 1998; Gale, 1994).

The concept of customer value has long existed in the field of marketing. For instance, Levitt (1960) adopted a customer-oriented perspective when stating that a product that pleases customers produces value. According to Kotler (2013), customer value consists of a customer's overall assessment of the degree to which a product satisfies the customer's needs. Kotler (2013) further explained that the value provided to a customer can be seen as the difference between the overall customer value (value of product, service, personnel, or image, etc.) and overall customer cost (cost in the form of money, time, effort, and energy, etc.), and overall customer value refers to the sum of the benefits that a customer expects to receive from a specific product or service. According to Anderson and Narus (1998), value is the resulting quality corresponding to the practical price, which is the price that the customer has the ability and willingness to pay. Lam et al. (2004) felt that customer value is the cost-benefit trade-off relationship when a customer uses a product or service. Gardial et al. (1994) and Oliver (1999) both suggested that the value perceived by customer when making a purchase will differ from the value perceived during use and after use; because of this, when purchasing and using products, consumers will consider different characteristics and results at different periods of time. Woodruff (1997) defined customer value as a customer's degree of preference after assessing a product's attributes. Holbrook (1999) defined customer value as the consumption value and consumption experience provided by all products and services, where this value is interactive, relative, and preferential.

The foregoing discussion reveals that scholars have many different perspectives concerning the essence and substance of customer value. Nevertheless, a review of the literature suggests that there are two principal viewpoints concerning customer value. These consist of a rational viewpoint (e.g., Day (1990) and Gale (1994)) and experiential viewpoint (e.g., Holbrook (1999) and Woodruff (1997)). The former viewpoint regards customers as rational decision-makers whose product purchase behavior emphasizes practicality and utility. The latter viewpoint is based on customers' consumer experience, and asserts that their purchase behavior is strongly affected by the impression left by the service process and their inner feelings. This study believes that customer value involves the lifetime value (Reichheld and Sasser, 1990) provided by the seller to the buyer, but also involves the perceived value (Grönroos, 2000; Kotler, 2013) obtained by the buyer from the seller. The former emphasizes the current value of the customer's corporate profit, while the latter emphasizes the trade-off between perceived benefit and perceived cost. Because of this, this study believes that customer value is the utility obtained by a customer when purchasing a product or service, and also the impression and inner feelings resulting from the service process. As a result, perceived value is a customer's overall assessment of a product or service.

2.3. Evaluation criteria of customer value

As discussed above, customer value is the subjectively perceived total benefit and total reduction in cost obtained by a customer after using product or service (Biegera et al., 2007), and is therefore the overall assessment of the utility of a product or service. Here benefit may consist of product attributes, brand, or service quality, while cost may take the form of time, money, or risk. Customer value therefore consists of a constant trade-off between these benefits and costs. As a consequence, customer value will gradually increase when customer benefit is steadily increasing and/or customer cost is steadily decreasing (Wittmer and Rowley, 2014).

A company is nothing when it has no customers. Customers are the arbitrators of the market, and have the right to decide whether to continue to purchase from a company; a market is formed as soon as the purchase is done. From this perspective, customer possesses an inseparable relationship with the market. Without a market, customers would lose the power of demand. If customers are removed from the market, the market will only exist as an empty shell. Because of this, companies that wish to gain dominant positions in their markets must pass the harsh test of customer choice. Companies must also understand that providing value to customers must be the core of their operations, and the creation of superior value will enable them to win even greater customer loyalty (Brodie et al., 2009; Chen et al., 2015; Hussain et al., 2015; Yang et al., 2012). Nevertheless, what value do customers want? Simply put, this is the sum of value derived from correct price, correct quality, correct delivery time, correct service, and correct features (Rui et al., 2008). The company that can provide a full range of correct values will become the best choice in the eyes of its customers, and will have a chance to become a true market leader. For instance, FedEx gives customers a strong impression of "overnight delivery." As a consequence, in order to achieve its service guarantees, FedEx has adopted superior strategic methods in its transport services, which enables it to create customer value in the form of competitive prices, convenience, and quality. This has allowed FedEx to establish the nearly impregnable status of a

market leader. It must be noted that a company must provide extraordinary shipping value to its customers if it is to make itself customers' first choice and stand out in a highly competitive environment where customers are urgently seeking the greatest value.

The international express industry is an important link in the air transport industry. How can this industry provide a correct value set to customers, and what customer value criteria do customers use when selecting the best international express firm? Traditionally, customers must make a trade-off between time and cost when selecting modes of transport, and must therefore choose the mode of transport with the greatest utility. Looking from another angle, transport companies are service firms. From the customer's perspective, transport companies must strengthen service and quality in order to create customer value. It should be noted that service and quality are two sides of the same coin; a company cannot emphasize service but neglect quality, nor can it promote its quality but failed to provide good service. As a consequence, numerous criteria must be considered in a MCDM problem. The concept of evaluation criteria is referred to the contribution of Johansson et al. (1993) four key value metrics – service (S), quality (Q), cost (C), and cycle time (T) – to show the customer value in this paper. According to viewpoints of Johansson et al. 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. Based on the four key value criteria, the sub-criteria are derived from a detail literature review (Chang, 2012; Chang et al., 2015; Chao and Li, 2012; Chao et al., 2013; Chiang and Ke, 1999; Ding et al., 2005; Ducret, 2014; Hsu, 2011; Jen et al., 1997; Johansson et al., 1993; Lam et al., 2004; Langvinienė and Sližienė, 2012; Li et al., 2004; Lin and Lee, 2009; Mizutani and Uranishi, 2003; Park et al., 2009; Pongpanich et al., 2015; Wu et al., 2013; Yoon and Park, 2015) and comprehensive interviews (with three major express service providers in Taiwan) conducted by the authors. Finally, four criteria with twenty sub-criteria were suggested, and their code names were shown in the parentheses.

(1) Service (C_1). Experience has shown superior service can not only obtain high customer satisfaction, but also achieve higher profit margins and greater market share. Five sub-criteria can be summed to measure the 'service' aspect, as follows: 'schedule and frequency (C_{11}),' 'availability of combined transport services (C_{12}),' 'diversity of value-added services (C_{13}),' 'diversity and adequacy of physical facilities and equipment (C_{14}),' and 'footholds of marketing channel and network (C_{15}),' respectively.

(2) Quality (C_2). Providing conformable quality is preferred and accepted by shippers/customers. Consumers may focus on the explicit quality of a product, which they will compare with competing products in the marketplace. Five sub-criteria are summed to measure the 'quality' aspect, as follows: 'level of accuracy (C_{21}),' 'level of safety (C_{22}),' 'level of quick response (C_{23}),' 'level of emergency handling capability (C_{24}),' and 'level of scope and depth quality (C_{25}),' respectively.

(3) Cost (C_3). Cutting costs can enable the provision of lower prices. Reducing total logistics costs could therefore create value and benefit for customers. Five sub-criteria are sorted out to measure the 'cost' aspect, as follows: 'freight (C_{31}),' 'flexible pricing (C_{32}),' 'clear pricelist (C_{33}),' 'lower operating costs of shipments (C_{34}),' and 'miscellaneous costs (C_{35}),' respectively.

(4) Time (C_4). As the saying goes, time is money. Time-based competition has become an important element in the growing market for international express services. Consumers are increasingly sensitive to the aspect of time, and speed or time is a means of differentiating carriers. Five sub-criteria are sorted out to measure the 'time' aspect, as follows: 'administrative processing time (C_{41}),' 'pick-up and haul time in warehouse (C_{42}),' 'air transit time (C_{43}),' 'rapid turnover (C_{44}),' and 'land time between house and airport at both ends (C_{45}),' respectively.

3. Methodology

In this section, some concepts and methods used to develop a fuzzy MCDM model are briefly introduced. These include the triangular fuzzy numbers and the algebraic operations, the linguistic variables, and the graded mean integration representation (GMIR) methods.

3.1. Triangular fuzzy numbers and their algebraic operations

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 uncertain data as a possibility distribution in terms of set membership. Once determined and defined, the sets of memberships in possibility distributions can be effectively used in logical reasoning.

In a universe of discourse X, a fuzzy subset M of X is defined by a membership function $f_M(x)$, which maps each element x in X to a real number in the interval [0,1]. The function value $f_M(x)$ represents the grade of membership of x in M.

A fuzzy number M (Dubois and Prade, 1978) in real line $\Re$ is a triangular fuzzy number if its membership function $f_M : \Re \to [0,1]$ is

$$f_M(x) = \begin{cases} (x-l)/(m-l), & l \le x \le m \\ (x-u)/(m-u), & m \le x \le u \\ 0, & otherwise \end{cases} \quad (1)$$

with $-\infty < l \le m \le u < \infty$. The triangular fuzzy number can be denoted by (l,m,u).

Let $M_1 = (l_1,m_1,u_1)$ and $M_2 = (l_2,m_2,u_2)$ be fuzzy numbers. According to the extension principle (Zadeh, 1965), the algebraic operations of any two fuzzy numbers M_1 and M_2 can be expressed as.

- Fuzzy addition, $\oplus$:

$$M_1 \oplus M_2 = (l_1 + l_2, m_1 + m_2, u_1 + u_2);$$

- Fuzzy subtraction, (-):

$$M_1(-)M_2 = (l_1 - u_2, m_1 - m_2, u_1 - l_2);$$

- Fuzzy multiplication, $\otimes$:

$$k \otimes M_2 = (kl_2, km_2, ku_2), \quad k \in \Re, \ k \ge 0;$$

$$M_1 \otimes M_2 \cong (l_1 l_2, m_1 m_2, u_1 u_2), \quad l_1 \ge 0, \ l_2 \ge 0.$$

- Fuzzy division, $\varnothing$:

$$(M_1)^{-1} = (l_1, m_1, u_1)^{-1} \cong (1/u_1, 1/m_1, 1/l_1), \quad l_1 > 0,$$

$$M_1 \varnothing M_2 \cong (l_1/u_2, m_1/m_2, u_1/l_2), \quad l_1 \ge 0, \ l_2 > 0.$$

3.2. Linguistic variables

In fuzzy decision environments, linguistic variables are usually converted into and represented by the triangular fuzzy numbers, which are in turn employed in the preference rating system (Chen et al., 1992). In this paper, two preference ratings consisting of triangular fuzzy numbers and linguistic variables characterized by fuzzy numbers (Zadeh, 1975; 1976) can be used. Based on practical needs and the need to match the proposed fuzzy MCDM model, the DMs may apply one or both of the preference ratings. In this article, both the importance degree and satisfaction degree are used to analytically express the linguistic variables, as well as described both how the linguistic importance and the linguistic satisfaction are influencing all criteria and sub-criteria of customer value for all alternatives.

We used Likert's 7-point scales to express the values of importance degree set and satisfaction degree set (Ding, 2009). The importance degree set is defined as $W = \{AL,VL,L,M,H,VH,AH\}$ and the satisfaction degree set as $S = \{AP,VP,P,F,G,VG,AG\}$; where AL = Absolutely Low, VL = Very Low, L = Low, M = Medium, H=High, VH=Very High, AH = Absolutely High, AP = Absolutely Poor, VP = Very Poor, P = Poor, F = Fair, G = Good, VG = Very Good, and AG = Absolutely Good. This article defines the linguistic variables of $AL = AP = (1,1,2)$, $VL = VP = (1,2,3)$, $L = P = (2,3,4)$, $M = F = (3,4,5)$, $H = G = (4,5,6)$, $VH = VG = (5,6,7)$, and $AH = AG = (6,7,7)$, respectively.

To easily estimate the fuzzy weights (importance) of all criteria and sub-criteria, as well as to calculate the fuzzy ratings (satisfaction) of all alternatives versus sub-criteria, the geometric mean is aggregated all information to demonstrate the strength by using the grade of membership. This is because that the geometric mean method is more effective in representing the multiple DMs' consensus opinions (Saaty, 1980). For the above-mentioned reasons, the triangular fuzzy numbers characterized by using the min, max and geometric mean operations is employed to convey the opinions of all DMs.

Let v_j^k, $k = 1,2,\ldots,p$, be the numerical weightings given to criterion j by DM k. Then, the fuzzy weight of the criterion j is defined as

$$B_j^w = (l_j, m_j, u_j), \text{where } l_j = \min\left\{v_j^1, v_j^2, \ldots, v_j^p\right\}, m_j = \left(\prod_{k=1}^{p} v_j^k\right)^{1/p}, \text{and } u_j = \max\left\{v_j^1, v_j^2, \ldots, v_j^p\right\}, \quad (2)$$

For example, five DMs evaluate the importance of certain criterion with linguistic variables as H, VH, M, L, and AH, respectively. Then, the fuzzy weight of certain criterion can be evaluated as (2, 4.789, 7).

We employed the same concept to assess the fuzzy ratings. Let v_i^k, $k = 1,2,\ldots,p$, be the appropriateness ratings given to certain sub-criterion i by DM k. Then, the fuzzy appropriateness rating can be denoted as

$$B_i^r = (l_i, m_i, u_i), \text{where } l_i = \min\left\{v_i^1, v_i^2, \ldots, v_i^p\right\}, m_i = \left(\prod_{k=1}^{p} v_i^k\right)^{1/p} \text{and } u_i = \max\left\{v_i^1, v_i^2, \ldots, v_i^p\right\} \quad (3)$$

For example, six DMs evaluate the appropriateness rating of an express service company (*e.g. DHL*) versus certain sub-criterion with linguistic variables as G, F, G, VG, P, and G, respectively. Then, the fuzzy rating can be shown as (2, 4.561, 7).

3.3. GMIR method

Ranking alternatives is essential and important in a fuzzy decision-making environment. To maintain consistency with the fuzzy MCDM model developed in this study, the GMIR method proposed by Chen and Hsieh (2000) was employed to rank the final ratings of all alternatives.

Let $M_i = (l_i,m_i,u_i)$, $i = 1,2,\ldots,n$, be n triangular fuzzy numbers. By the GMIR method, the representation value $G(M_i)$ of M_i is

$$G(M_i) = (l_i + 4m_i + u_i)/6 \quad (4)$$

Suppose $G(M_i)$ and $G(M_j)$ are the representation values of the triangular fuzzy numbers M_i and M_j, respectively. We define:

- $M_i > M_j \Leftrightarrow G(M_i) > G(M_j)$,
- $M_i < M_j \Leftrightarrow G(M_i) < G(M_j)$,
- $M_i = M_j \Leftrightarrow G(M_i) = G(M_j)$.

4. Fuzzy MCDM model

A stepwise description of the fuzzy MCDM model for assessing customer value for the international express service providers was proposed in the following.

4.1. Developing a hierarchical structure

A hierarchy structure is the framework of system structure. It can not only be utilized to study the interaction among the elements involved in each level but also help DMs to explore the impact of different elements against the evaluation system. Fig. 1 showed a complete hierarchical structure of assessing customer value of the express service providers with k criteria, $n_1+\cdots+n_t+\cdots n_k$ sub-criteria, and m alternatives. The concepts of hierarchical structural analysis with three distinct levels; that is, criteria level, sub-criteria level, and alternatives level, are used in this paper.

4.2. Computing the aggregation ratings of all feasible alternatives

Assume a committee of DMs which is responsible for evaluating the importance of all criteria and sub-criteria, as well as the appropriateness of each sub-criterion above the feasible alternatives level. Let $W_t = (l_t,m_t,u_t)$, $t = 1,2,\ldots,k$, be the fuzzy weight of tth criterion at criteria level. Let $W_{tj} = (l_{tj},m_{tj},u_{tj})$, $t = 1,2,\ldots,k$, $j = 1,2,\ldots,n_t$, be the fuzzy weight of the jth sub-criterion C_{tj} under tth criterion at the sub-criteria level. And, let $S_{itj} = (l_{itj},m_{itj},u_{itj})$, $i = 1,2,\ldots,m$, $t = 1,2,\ldots,k$, $j = 1,2,\ldots,n_t$, be the original appropriateness rating of the alternative i under the sub-criteria C_{tj} of the sub-criteria level. To ensure compatibility between negative criteria (*i.e.*, the criteria that have negative contribution to the objective, e.g., cost criterion) and positive criteria (*i.e.*, the criteria that have

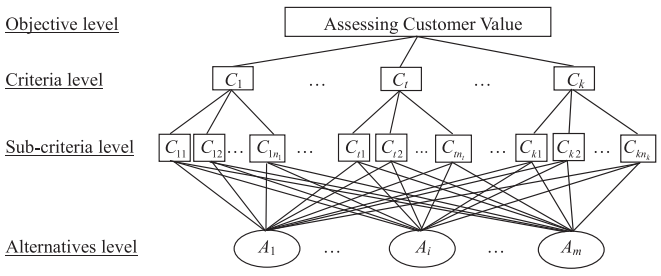

Fig. 1. Hierarchy structure.

positive contribution to the objective, e.g., benefit criterion), the fuzzy ratings estimated in values must be converted to dimensionless indices. The alternative with minimum values in negative sub-criteria or maximum values in positive sub-criteria should have the maximum rating. Based on the principle stated as above, let ptj = maxi{uitj}, qtj = mini{litj}, then the normalized appropriateness ratings N_{itj} of alternative i versus sub-criteria C_{tj} of the sub-criteria level can be defined as:

- For the positive sub-criteria

$$N_{itj} = \left(h_{itj}, e_{itj}, g_{itj}\right) = \left(l_{itj}/p_{tj}, m_{itj}/p_{tj}, u_{itj}/p_{tj}\right) \tag{5}$$

- For the negative sub-criteria

$$N_{itj} = \left(h_{itj}, e_{itj}, g_{itj}\right) = \left(q_{tj}/u_{itj}, q_{tj}/m_{itj}, q_{tj}/l_{itj}\right) \tag{6}$$

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:

$$R_{it} = (1/n_t) \otimes \left[(N_{it1} \otimes W_{t1}) \oplus (N_{it2} \otimes W_{t2}) \oplus \cdots \oplus \left(N_{itj} \otimes W_{tj}\right) \oplus \cdots \oplus \left(N_{itn_t} \otimes W_{tn_t}\right)\right] \tag{7}$$

Because $N_{itj} = (h_{itj}, e_{itj}, g_{itj})$ and $W_{tj} = (l_{tj}, m_{tj}, u_{tj})$ we can denote

$$R_{it} \cong (X_{it}, Y_{it}, Z_{it}), \text{where } X_{it} = \sum_{j=1}^{n_t} h_{itj} l_{tj}/n_t, Y_{it} = \sum_{j=1}^{n_t} e_{itj} m_{tj}/n_t,$$
$$Z_{it} = \sum_{j=1}^{n_t} g_{itj} u_{tj}/n_t, \quad \text{for } i = 1,2,\ldots,m; \quad t = 1,2,\ldots,k. \tag{8}$$

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

Because $W_t = (l_t, m_t, u_t)$ we can denote

$$F_i = (1/k) \otimes [(R_{i1} \otimes W_1) \oplus (R_{i2} \otimes W_2) \oplus \cdots \oplus (R_{it} \otimes W_t) \oplus \cdots \oplus (R_{ik} \otimes W_k)] \tag{9}$$

$$F_i \cong (X_i, Y_i, Z_i), \text{where } X_i = \sum_{t=1}^{k} X_{it} l_t/k, Y_i = \sum_{t=1}^{k} Y_{it} u_t/k, Z_i = \sum_{t=1}^{k} Z_{it} u_t/k, \quad \text{for } i = 1,2,\ldots,m. \tag{10}$$

4.3. Choice of optimal alternative

By Equation (4), the ranking value of the aggregation appropriateness rating of alternative A_i can be obtained and denoted as:

$$G(F_i) = (X_i + 4Y_i + Z_i)/6 \tag{11}$$

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

5. Empirical study

In this section, an empirical study of assessing customer value for three famous express service companies in Taiwan is utilized to demonstrate the computational process of the proposed fuzzy MCDM model.

5.1. Questionnaire design and data collection

In this step, a hierarchy structure with four criteria, twenty sub-criteria and three alternatives – *UPS* (*U*), *FeDex* (*F*), and *DHL* (*D*) – was used to design the questionnaire, which was divided into three parts. Part I measured importance weights using a 7-point Likert scale concerning four criteria and twenty sub-criteria. Part II evaluated the superiority/appropriateness of items using a 7-point Likert scale comparing three alternatives with all sub-criteria. Part III recorded basic information data concerning the customers or shippers. The 7-point Likert scales ranged from '1' for 'absolutely low' to '7' for 'absolutely high' in the case of importance weight, and '1' for 'absolutely poor' to '7' for 'absolutely good' in the case of superiority.

A pretest was conducted to help design the questionnaire items. Seven senior experts working in the express service industry, seven managers working in export/import departments, and seven academic scholars specializing in air transport management research were asked to evaluate the questionnaire pretest. The wording or explanations of a few items were modified in view of the pretest evaluation results.

With regard to reliability, Cronbach's α (Hair et al., 2010) was used to measure the consistency of all degrees of importance in the Part I questionnaire and the degrees of superiority in the Part II questionnaire. Reliability analysis revealed that coefficients in the Part I and Part II questionnaires were 0.8762 and 0.8485. Hair et al. (2010) pointed out that reliability is considered high when the value of Cronbach's α falls between 0.70 and 0.98; a value between 0.35 and 0.70 is acceptable; and a value of less than 0.35 is not acceptable and should be omitted. In this survey, both of the Cronbach's α values exceeded 0.7, which indicated a high level of reliability. As for validity analysis (Hair et al., 2010), due to the fact that the content of the questionnaire was developed via a review of the literature, and investigated the characteristics of express service industry from the perspective of managers and experts, the content validity of the questionnaire should be very good.

We used 1500 exporters and importers recorded in the '*Directory of Excellent Exporters and Importers in 2014, ROC*' as the population. The questionnaire was completed by personnel in the export/import department of each company. To increase the response rate, questionnaires could be completed and returned by mail or e-mail, over the phone, or during the interviews conducted by the authors. Mail and e-mail messages were sent to respondents three times over a period of three months during the data collection period. Regarding the data collected through phone calls and in-person interviews, we discussed the research issues and collected the responses. To prevent sampling bias, invalid questionnaires were discarded. Although each data collection technique was associated with many types of bias, sufficient guidance was provided to prevent sampling bias. A total of 322 valid responses were ultimately collected from the 1500 exporters and importers, which represented a response rate of 21.47%. The demographic data gathered through the questionnaires indicated that most respondents were first-level or middle managers who had been working in the field for over 10 years.

5.2. Results

Following steps are taken below to compute the aggregating evaluation ratings of all feasible alternatives and then to choose the best alternative.

5.2.1. Calculate the importance weights of criteria and sub-criteria

Firstly we used 322 valid data of Part I questionnaire to measure fuzzy weights for four criteria and twenty sub-criteria. Then the GMIR method was used to evaluate the priority for all criteria and sub-criteria. Finally, the results of empirical study were shown in Table 1 and Table 2, respectively.

The findings are described as follows:

(1) Time (C_4), ranking 1, is the most important criterion affecting the customer value from the viewpoints of exporters and importers in Taiwan. Quality (C_2) and cost (C_3) are ranked in the second and third places. Service (C_1) is the lowest ranked. It is worthy to note that the aforementioned four criteria – time, quality, cost, and service – are very close with the values of importance weights of 0.268, 0.257, 0.246, and 0.229, respectively. This indicated that time, quality, cost, and service, are almost equally important in this survey. Nevertheless, these values of importance weights could be widely different among various industries.

(2) The 'land time between house and airport at both ends (C_{45})' is the key attribute for 'time' aspect. The 'level of accuracy (C_{21})' is the key one for 'quality' aspect. The 'freight (C_{31})' is the key one for 'cost' aspect. The 'schedule and frequency (C_{11})' is the key one for 'service' aspect.

(3) Daniel (1961) feels that most industries possess from 2 to 6 key elements that determine success, and a company that wishes to be successful must apply particular effort to these elements. Hence, the results show that the top six key factors affecting the customer value for express service providers in Taiwan are 'land time between house and airport at both ends (C_{45}),' 'administrative processing time (C_{41}),' 'pick-up and haul time in warehouse (C_{42}),' 'level of accuracy (C_{21}),' 'level of safety (C_{22}),' and 'rapid turnover (C_{44}),' respectively.

5.2.2. Estimate the superiority of alternatives versus all sub-criteria

We firstly used the method presented in Section 3.2 to sum 322 valid data of Part II questionnaire. The original fuzzy appropriateness ratings of three alternatives versus all sub-criteria can be obtained. The results are shown in Table 3.

Subsequently, to make certain compatibility of all negative and positive sub-criteria, we must recognize the classification. There are five negative sub-criteria in this survey, i.e. C_{35}, C_{41}, C_{42}, C_{43}, and C_{45}. The other fifteen sub-criteria are positive. Finally, we employed Equations (5) and (6) to obtain the normalized fuzzy appropriateness ratings of three alternatives versus all sub-criteria, as shown in

Table 1
The weights of all criteria.

Criteria	Fuzzy weights	GMIR values	Weights
C_1	(3, 5.388, 7)	5.259	0.229 (4)
C_2	(4, 6.096, 7)	5.897	0.257 (2)
C_3	(4, 5.717, 7)	5.645	0.246 (3)
C_4	(4, 6.478, 7)	6.152	0.268 (1)

Remark: Numbers in parentheses are ranks.

Table 2
The integrated weights of all sub-criteria.

Sub-criteria	Fuzzy weights	GMIR values	Weights	Integrated weights
C_{11}	(4, 6.364, 7)	6.076	0.208 (1)	0.0476 (15)
C_{12}	(3, 5.606, 7)	5.404	0.185 (5)	0.0424 (20)
C_{13}	(4, 6.106, 7)	5.904	0.202 (3)	0.0463 (17)
C_{14}	(4, 6.002, 7)	5.835	0.20 (4)	0.0458 (19)
C_{15}	(4, 6.251, 7)	6.001	0.205 (2)	0.0469 (16)
C_{21}	(4, 6.305, 7)	6.037	0.208 (1)	0.0534 (4)
C_{22}	(4, 6.289, 7)	6.026	0.207 (2)	0.0532 (5)
C_{23}	(4, 6.021, 7)	5.847	0.201 (3)	0.0517 (8)
C_{24}	(4, 5.794, 7)	5.696	0.196 (4)	0.0504 (10)
C_{25}	(3, 5.681, 7)	5.454	0.188 (5)	0.0483 (14)
C_{31}	(5, 6.396, 7)	6.264	0.214 (1)	0.0527 (7)
C_{32}	(3, 6.192, 7)	5.795	0.198 (3)	0.0488 (12)
C_{33}	(4, 6.098, 7)	5.899	0.202 (2)	0.0497 (11)
C_{34}	(4, 5.898, 7)	5.765	0.197 (4)	0.0485 (13)
C_{35}	(3, 5.739, 7)	5.493	0.188 (5)	0.0463 (17)
C_{41}	(4, 6.129, 7)	5.919	0.203 (2)	0.0544 (2)
C_{42}	(4, 6.091, 7)	5.894	0.202 (3)	0.0541 (3)
C_{43}	(3, 5.829, 7)	5.553	0.190 (5)	0.0509 (9)
C_{44}	(4, 5.926, 7)	5.784	0.198 (4)	0.0531 (6)
C_{45}	(4, 6.324, 7)	6.049	0.207 (1)	0.0555 (1)

Remark: Numbers in parentheses are ranks.

Table 3
Original fuzzy appropriateness ratings.

Sub-criteria	*UPS*	*FedEx*	*DHL*
C_{11}	(4, 5.940, 7)	(4, 6.124, 7)	(3, 5.303, 7)
C_{12}	(4, 6.034, 7)	(4, 5.891, 7)	(4, 5.462, 7)
C_{13}	(4, 5.631, 7)	(4, 6.046, 7)	(3, 5.346, 7)
C_{14}	(4, 6.479, 7)	(4, 6.274, 7)	(3, 5.411, 7)
C_{15}	(4, 5.437, 7)	(4, 6.137, 7)	(4, 5.316, 7)
C_{21}	(4, 5.679, 7)	(4, 6.241, 7)	(4, 5.349, 7)
C_{22}	(4, 5.439, 7)	(4, 6.037, 7)	(3, 5.347, 7)
C_{23}	(4, 5.793, 7)	(4, 5.873, 7)	(4, 5.421, 7)
C_{24}	(4, 5.613, 7)	(4, 5.920, 7)	(3, 5.341, 7)
C_{25}	(4, 5.467, 7)	(4, 6.034, 7)	(4, 5.301, 7)
C_{31}	(3, 5.672, 7)	(3, 5.894, 7)	(3, 5.134, 7)
C_{32}	(3, 5.349, 7)	(3, 5.642, 7)	(3, 5.312, 7)
C_{33}	(3, 5.467, 7)	(3, 6.341, 7)	(3, 5.134, 7)
C_{34}	(3, 5.493, 7)	(3, 5.873, 7)	(3, 5.394, 7)
C_{35}	(3, 5.891, 7)	(3, 5.687, 7)	(3, 5.349, 7)
C_{41}	(4, 5.793, 7)	(4, 6.034, 7)	(3, 5.432, 7)
C_{42}	(3, 6.137, 7)	(4, 5.873, 7)	(3, 5.487, 7)
C_{43}	(4, 5.911, 7)	(4, 5.976, 7)	(4, 5.694, 7)
C_{44}	(3, 5.493, 7)	(4, 5.982, 7)	(3, 5.219, 7)
C_{45}	(4, 5.634, 7)	(4, 5.769, 7)	(4, 5.934, 7)

Table 4
Normalized fuzzy appropriateness ratings and their GMIR values.

Sub-criteria	*UPS*	GMIR values	*FedEx*	GMIR values	*DHL*	GMIR values
C_{11}	(0.571, 0.849, 1)	0.828	(0.571, 0.875, 1)	0.845	(0.429, 0.758, 1)	0.743
C_{12}	(0.571, 0.862, 1)	0.837	(0.571, 0.842, 1)	0.823	(0.571, 0.780, 1)	0.782
C_{13}	(0.571, 0.804, 1)	0.798	(0.571, 0.864, 1)	0.838	(0.429, 0.764, 1)	0.747
C_{14}	(0.571, 0.926, 1)	0.879	(0.571, 0.896, 1)	0.859	(0.429, 0.773, 1)	0.753
C_{15}	(0.571, 0.777, 1)	0.780	(0.571, 0.877, 1)	0.846	(0.571, 0.759, 1)	0.768
C_{21}	(0.571, 0.811, 1)	0.803	(0.571, 0.892, 1)	0.856	(0.571, 0.764, 1)	0.771
C_{22}	(0.571, 0.777, 1)	0.780	(0.571, 0.862, 1)	0.837	(0.429, 0.764, 1)	0.747
C_{23}	(0.571, 0.828, 1)	0.814	(0.571, 0.839, 1)	0.821	(0.571, 0.774, 1)	0.778
C_{24}	(0.571, 0.802, 1)	0.796	(0.571, 0.846, 1)	0.826	(0.429, 0.763, 1)	0.747
C_{25}	(0.571, 0.781, 1)	0.783	(0.571, 0.862, 1)	0.837	(0.571, 0.757, 1)	0.767
C_{31}	(0.429, 0.810, 1)	0.778	(0.429, 0.842, 1)	0.799	(0.429, 0.733, 1)	0.727
C_{32}	(0.429, 0.764, 1)	0.748	(0.429, 0.806, 1)	0.775	(0.429, 0.759, 1)	0.744
C_{33}	(0.429, 0.781, 1)	0.759	(0.429, 0.906, 1)	0.842	(0.429, 0.733, 1)	0.727
C_{34}	(0.429, 0.785, 1)	0.761	(0.429, 0.839, 1)	0.797	(0.429, 0.771, 1)	0.752
C_{35}	(0.429, 0.509, 1)	0.578	(0.429, 0.528, 1)	0.590	(0.429, 0.561, 1)	0.612
C_{41}	(0.429, 0.518, 0.75)	0.542	(0.429, 0.497, 1)	0.528	(0.429, 0.552, 1)	0.606
C_{42}	(0.429, 0.489, 1)	0.564	(0.429, 0.511, 1)	0.537	(0.429, 0.547, 1)	0.603
C_{43}	(0.429, 0.508, 0.75)	0.535	(0.429, 0.502, 1)	0.531	(0.429, 0.527, 0.75)	0.548
C_{44}	(0.429, 0.785, 1)	0.761	(0.571, 0.855, 1)	0.832	(0.429, 0.746, 1)	0.735
C_{45}	(0.429, 0.532, 0.75)	0.551	(0.429, 0.520, 1)	0.543	(0.429, 0.506, 0.75)	0.533

Table 4.

Furthermore, the GMIR method is used to assess the levels of satisfactory and dissatisfactory versus three companies in Table 4, as shown follows.

(1) The 'diversity and adequacy of physical facilities and equipment (C_{14}),' 'availability of combined transport services (C_{12})' and 'schedule and frequency (C_{11})' are top three satisfactory for *UPS*. Conversely, the 'land time between house and airport at both ends (C_{45}),' 'administrative processing time (C_{41})' and 'air transit time (C_{43})' are top three dissatisfactory for *UPS*.
(2) The 'diversity and adequacy of physical facilities and equipment (C_{14}),' 'level of accuracy (C_{21})' and 'footholds of marketing channel and network (C_{15})' are top three satisfactory for *FedEx*. Conversely, the 'pick-up and haul time in warehouse (C_{42}),' 'air transit time (C_{43})' and 'administrative processing time (C_{41})' are top three dissatisfactory for *FedEx*.
(3) The 'availability of combined transport services (C_{12}),' 'level of quick response (C_{23})' and 'level of accuracy (C_{21})' are top three satisfactory for *DHL*. Conversely, the 'pick-up and haul time in warehouse (C_{42}),' 'air transit time (C_{43})' and 'land time between house and airport at both ends (C_{45})' are top three dissatisfactory for *DHL*.

5.2.3. Compute the aggregation appropriateness ratings of three alternatives

We utilized the Equation (7) to obtain the aggregation appropriateness ratings (R_{it}) of three alternatives versus all sub-criteria, the results are shown in Table 5. Then, the final aggregation appropriateness ratings (F_i) of three alternatives can be evaluated by using the Equation (9), the results are shown in Table 6.

Table 6
The final aggregation appropriateness ratings (F_i) and representation value.

F_i	Final fuzzy ratings	Representation value	Ranking
F_U	(7.0571, 26.1254, 47.1625)	$G(F_U) = 26.4535$	2
F_F	(7.1714, 27.4863, 46.55)	$G(F_F) = 27.2778$	1
F_D	(6.5714, 25.0928, 47.775)	$G(F_D) = 25.7863$	3

5.2.4. Choose the best carrier of customer value

The order of final fuzzy ratings for three express service companies is $G(F_F) > G(F_U) > G(F_D)$. It is obvious, based on the ranking rules proposed in Section 3.3, the *FedEx* is determined as the highest customer value of express service companies from the viewpoints of exporters and importers in Taiwan. Therefore, it can recommend that *FedEx* is the best express service company of customer value from the viewpoints of exporters and importers in Taiwan.

In here, it is worthy to point out that two factors – 'pick-up and haul time in warehouse' and 'administrative processing time' – are getting higher important weights, however, lower satisfactory scores for *FedEx*. According to the concept of importance-performance analysis (IPA), proposed by Martilla and James (1977), there is a two-dimensional matrix, which is composed by (i) 'keep up the good work' – represents the importance and satisfaction values are both relatively higher than the their threshold values; (ii)'concentrate here' – represents the importance value is higher than the importance threshold value, but the satisfaction value is lower than the satisfaction threshold value; (iii) 'low priority' – represents the importance and satisfaction values are both lower than their threshold values; and (iv) 'possible overkill' – represents the importance value is lower than the

Table 5
The aggregation appropriateness ratings (R_{it}).

R_{it}	Fuzzy ratings	R_{it}	Fuzzy ratings	R_{it}	Fuzzy ratings
R_{U1}	(2.1714, 5.1135, 7)	R_{F1}	(2.1714, 5.2845, 7)	R_{D1}	(1.8286, 4.6493, 7)
R_{U2}	(2.1714, 4.8135, 7)	R_{F2}	(2.1714, 5.1788, 7)	R_{D2}	(1.9429, 4.6015, 7)
R_{U3}	(1.6286, 4.4458, 7)	R_{F3}	(1.6286, 4.7771, 7)	R_{D3}	(1.6286, 4.3247, 7)
R_{U4}	(1.6286, 3.4255, 5.950)	R_{F4}	(1.7429, 3.4875, 5.60)	R_{D4}	(1.6286, 3.4803, 6.30)

importance threshold value, but the satisfaction value is higher than the satisfaction threshold value. Therefore, the two factors belong to the quadrant of 'concentrate here.' It is suggest that the *FedEx* must obtain the voice of customer (VOC) to improve their customer demands. VOC represents an understanding of customers' needs and desires as obtained from market surveys, and VOC enables the company to provide even better products and services, which ensures customer satisfaction and the creation of customer value. In customer needs-oriented consumer markets, listening to VOC can help companies seek out a balance point between customer needs and corporate capabilities, discover new customer value, and draft appropriate strategies. VOC is therefore a tool for expanding market share and boosting profit (Yang et al., 2013). In addition, how to evaluate if the needs of VOCs provided by the *FedEx* can satisfy the needs of customers and what kind of solutions can be used to remedy their VOCs were the further recommendations.

Moreover, two factors – 'land time between house and airport at both ends' and 'administrative processing time' – for *UPS*; and the other two factors – 'pick-up and haul time in warehouse' and 'land time between house and airport at both ends' – for *DHL* are both getting higher important weights and lower satisfactory scores. Hence, the two express service companies – *UPS* and *DHL* – are suggested using the same ways to evaluate their VOCs and solutions in the further study.

6. Conclusions

In the international air cargo transportation market, customer value provided by international express service providers has become an important factor when shippers choose an express service. Customer value is also very important for an international express service provider to maintain customer loyalty and competitive advantages. The main purpose of this paper was to develop a fuzzy MCDM model to empirically evaluate the customer value for three express service providers in Taiwan. The chief contribution of this study is its analysis of the customer value provided by the three major international express firms from the perspective of Taiwan's importers and exporters. Operating models and customer value criteria drafted on the basis of this study's findings can shed light on the criteria that customers emphasize or are satisfied with. This will allow the determination of which express firm offers the greatest customer value, and allow customers to select the best company. The findings of this study are therefore provided to importers and exporters in Taiwan as a reference when choosing air express firms. Finally, some important results of this study show that:

(1) The 'time' aspect is the most important criterion affecting the customer service based on the viewpoints of exporters and importers in Taiwan.
(2) The top six key factors affecting customer value for express service providers are 'land time between house and airport at both ends,' 'administrative processing time,' 'pick-up and haul time in warehouse,' 'level of accuracy,' 'level of safety,' and 'rapid turnover,' respectively.
(3) The empirical study showed that the *FedEx* is the best express service company of customer value in Taiwan based on the proposed fuzzy MCDM model.

To sum up, two merits of the proposed fuzzy MCDM model are listed as follows: (1) the positive and negative criteria are considered in this approach; (2) the proposed model not only release the limitation of crisp values, but also facilitate its implementation as a computer-based decision support system for evaluating customer value of express service company in a fuzzy environment. However, the evaluation criteria only consider qualitative views in this model; the quantitative views can be added in the fuzzy MCDM model to assist with improving the decision-making quality in the future study.

In addition, this paper focused on customer value for three express service companies in Taiwan, however, the results can not be clarified on generalisability of it having a wider range of customer value than most express service companies in other countries. We think our paper can be contributed to the customer value for three express service companies in Taiwan. The empirical results can be provided to the three express service companies in Taiwan, as reference for the formulation of policy of customer value and implementation for the cooperation's policy. If the readers are interesting in the similar cases in terms of customer value, customer service, customer quality, and so on, thus they can apply the same procedures of fuzzy MCDM model on the customer management in the future.

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