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Using Modified Fuzzy Perception-importance Analysis to Evaluate Customer Value for Global Shipping Carrier-based Logistics Service Providers

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Abstract: The main purpose of this study is to apply the modified fuzzy perception-importance (P-I) analysis to evaluate the customer value (CV) of three global shipping carrier-based logistics service providers (GSLPs) in Taiwan. To facilitate this main issue, we selected four criteria and seventeen important factors of CV. Then, the modified fuzzy P-I analysis was applied to evaluate CV factors for three GSLP companies. Finally, the results show that there are five CV factors for three GSLP companies on the 'competitive vulnerability' zone. They are providing diversity of value-added services, reliability, providing adequacy of physical facilities and equipment, increasing marketing channel and network and quick responsiveness, respectively. Moreover, some improvement strategies of CV are suggested for the GSLP companies.

Key words: Customer value, shipping, logistics, modified fuzzy perception-importance (P-I) analysis

INTRODUCTION

The global shipping carrier-based logistics service providers (GSLPs) (Ding, 2010) e.g., Maersk Logistics (Maersk Line (Denmark), rank 1 in the world in 2011); CMA-CGM Logistics (CMA-CGM Line (France), rank 3); COSCO Logistics (COSCO Line (China), rank 4); Evergreen Logistics (Evergreen Line (Taiwan), rank 6)- are emerged in the recent decade due to the fact that the acute competitions are interrelated with the main container shipping carriers in the world. Especially, many changes on the integrated business logistics services (Heaver *et al.*, 2001) have arisen to be needed to meet the customers' requirements. The container shipping carriers must pay attention to provide the total solution services of logistics management for their customers. As a result, these global container shipping carriers ultimately have been playing up their own brand names to strive for an effort to get customer satisfaction and customer value (CV) in the shipping market, while the shippers have been considering the brand name as an important criterion to consign for their shipments (Liang *et al.*, 2007). All the main market players in this field meet an important issue to provide high CV for their customers; meanwhile, the customers are searching for those who can meet their needs of providing high CV in the shipping market. A well-provided CV needs to be taken in terms of perspectives of customers due to promoting high CV would be beneficial to keep sustainable competitive advantage (Heskett, 1986). Since the GSLP with high CV

is beneficial for smoothing the customer behavior; hence, assessing the CV of GSLPs of global shipping market is an essential issue to study.

The measurement of CV is a very important research subject in the service marketing domain. For example, Ding (2009) used the fuzzy multi-criteria decision-making method to evaluate the CV for liner shipping companies in Taiwan. Lagoudis *et al.* (2006) studied the factors influencing CV by using the multi-attribute utility theory. Meyronin (2004) studied the creation of value and differentiation in services. Since the shipping industry remains a highly competitive industry in Taiwan, the operators must notice changes in consumer demands and customers' perceptions of customer value. The GSLPs must master customers' real needs in order to provide appropriate services. Therefore, the investigation of the CV required by the customer is important for shipping industry.

The importance-performance analysis (IPA) approach, as developed by Martilla and James (1977), has been used to assess improvements that meet consumer's demand items regarding service quality (Chen, 2012). The attributes can be referred to in terms of important factors of CV in the shipping industry (Ding, 2010), however, they have the characteristic of multiple criteria (Ding, 2009), and their importance weights consist of fuzzy and changing characteristics, according to customers' perceptions and demand changes, they are difficult to express in exact numbers. If the traditional measurement mode is used to handle the fuzzy nature of criteria

weights, which are expected to express the inaccuracy of decision-making information and perceived important factors of CV, it seems that the implicit information of evaluation criteria cannot be fully expressed. Therefore, this study applies the modified perception-importance analysis method (modified P-I analysis method), proposed by Lin (2010), which integrated the merits of fuzzy set theory and IPA approach to evaluate the service quality problem. Hence, the main purpose of this study is to use the modified P-I analysis method to investigate the important factors of CV for the GSLPs and identified the important factors of CV to be maintained or improved.

IMPORTANT FACTORS OF CV

In this study, the concepts of important factors of CV are cited from using Johansson *et al.* (1993) four key value metrics, which are service (S), quality (Q), cost (C) and

cycle time (T), to show the CV. Johansson *et al.* (1993) indicated the value equation is $V = (S \times Q) / (C \times T)$. According to their viewpoints, 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. Therefore, based on the four key value criteria mentioned above, the important factors of CV are derived from the academic, business and management publications, official Taiwanese sources, a detailed literature review (Christopher, 1998; Ding, 2009, 2010; Johansson *et al.*, 1993; Lagoudis *et al.*, 2006; Liang *et al.*, 2007; Lu, 2003, 2007; Meyronin, 2004; Selviaridis *et al.*, 2008; Stock and Lambert, 2001) and comprehensive interviews conducted by the author with main shippers and GSLPs. Finally, four criteria and seventeen important factors of CV are listed and their codes are shown in parentheses, as shown in Table 1.

Table 1: The important factors of CV

Criteria	Important factors	Description
Service (C ₁)	Providing diversity of value-added services (C ₁₁)	Creating significantly added value for customers and providing different services for different customers are critical issues in logistics industry. It may be a business strategy to provide diversity services for serving a heterogeneous customer base
	Availability (C ₁₂)	Each element of the logistics services will benefit from the widespread adoption of any service availability via phone call, e-mail, web and internet etc. Immediately availability of services will provide customers with gaining their needs and understanding
	Reliability (C ₁₃)	The reliability in GSLPs especially emerged from the precise degree in the functions of storage, distribution, delivery and consignment
	Providing adequacy of physical facilities and equipment (C ₁₄)	Adequate physical facilities and equipment, e.g., handling equipment, storage areas and containers and chassis etc., plays an important role in complex market designed to meet rigorous market demands
	Increasing marketing channel and network (C ₁₅)	The numbers of service node and channel and marketing network can provide more convenient service for customers. Besides, serving heterogeneous customers to provide customized services making it more flexible to customers
Quality (C ₂)	Improving customer satisfaction (C ₂₁)	Experience show customer satisfaction is the most important factor influencing customer quality to achieve customer retention and customer loyalty. Satisfying customer needs is a great vital for obtaining customer acquisition to eventually gain profitability
	Safety (C ₂₂)	It is the state of being safe when logistics activities are processed in the logistics center or warehouse. Controlling the safety means high quality and low risk in handling shipments
	Accuracy and precision of shipments (C ₂₃)	Accuracy is the degree of veracity while precision is the degree of reproducibility. Both of them are important. Providing right accuracy and precision of shipments makes customer quality in high level to carry out
	Skills and knowledge of operating personnel (C ₂₄)	All involved activities that make for the functionality to work well need good human resources to have an effective organization. All personnel with superior skills and knowledge will make the logistics operations more facile
Cost (C ₃)	Capability of total quality service and integrated process management (C ₂₅)	Capabilities of total quality service provided by GSLPs will meet the customers' satisfaction. Subsequently, all shipments in warehouse to process logistics activities smoothly rely on having possession of capability of integrated process management. It makes logistics operations more fluent
	Providing reasonableness of price (C ₃₁)	Price comparison between competitors is often affected by the customer in terms of evaluating the selection of GSLPs
	Reducing related operating costs of shipments (direct costs) (C ₃₂)	Operating costs are parts of variable costs, in which they are mostly concentrated by customers. Selecting the best GSLP will compare with the lower related operating costs of shipments among these competitors. Hence, reducing these kinds of costs can attract customers to buy her services
Time (C ₄)	Reducing related overhead, charges and fees (indirect costs) (C ₃₃)	Buyers prefer to pay money when they used related services, not pay overhead, surcharges and fees without using services, especially, which customers believe they do not use these services. Too much related overhead, charges and fees are negative for evaluating the selection of GSLPs
	Reducing lead time of core logistics services (C ₄₁)	Reducing the lead time can be achieved by shortening the logistics operation time (i.e., the time taken to complete the main core operational services from marketing, warehousing to distribution)
	Implementing integrated logistics information system (C ₄₂)	The applications highlight on aiding a number of information technology (IT) and information system (IS), e.g., radio frequency identification (RFID), electronic data interchange (EDI),

Table 1: Continue

Criteria	Important factors	Description
		decision support system (DSS) and artificial intelligence (AI). The more automated the information system, the less opportunity on human error and eventually reducing the operating time
	Reducing the non-value-adding time (C ₄₃)	To make significantly improving, understanding the total activities of logistics processes is required. Eliminating out the non-value-adding activities and reducing the time spent on these useless and inefficient ones become apparent
	Quick responsiveness (C ₄₄)	The responsiveness of service should have a standard to show the service is available any time per day; it is possible that on occasion it may be unavailable for very short time periods to permit maintenance or other development activity to take place. A quick and efficient responsiveness system service will reduce the complaint to arise

MATERIALS AND METHODS

Here, some of the concepts and methods used in this study are introduced.

Fuzzy set theory: The fuzzy set theory (Zadeh, 1965) is designed to deal with the extraction of the primary possible outcome from the multiplicity of information, which is expressed in vague and imprecise terms and 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.

Triangular fuzzy numbers: In a universe of discourse X, the fuzzy subset A of X is defined by a membership function f_A(x), which maps each element x in X to obtain a real number in the interval (0,1). The function value f_A(x) represents the grade of membership of x in A.

A fuzzy number A (Dubois and Prade, 1978) in real line R is a triangular fuzzy number if its membership function f_A:R→(0,1) is

$$f_A(x) = \begin{cases} (x-c)/(a-c), & c \leq x \leq a \\ (x-b)/(a-b), & a \leq x \leq b \\ 0, & \text{otherwise} \end{cases}$$

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

Let A₁ = (c₁, a₁, b₁) and A₂ = (c₂, a₂, b₂) be fuzzy numbers. According to the extension principle (Zadeh, 1965), the algebraic operations of any two fuzzy numbers A₁ and A₂ can be expressed as:

- Fuzzy addition: A₁ ⊕ A₂ = (c₁+c₂, a₁+a₂, b₁+b₂)
- Fuzzy multiplication: k ⊗ A = (kc, ka, kb), k ≥ 0, k ∈ R, A₁ ⊗ A₂ = (c₁c₂, a₁a₂, b₁b₂), c₁ ≥ 0, c₂ ≥ 0
- Fuzzy division: A₁ ⊘ A₂ = (c₁/b₂, a₁/a₂, b₁/c₂), c₁ ≥ 0, c₂ > 0

Linguistic values: In fuzzy decision environments, two preference ratings can be used, namely, fuzzy numbers and linguistic values characterized by fuzzy numbers (Zadeh, 1975a-c). Depending on practical needs,

decision-makers (DMs) may apply one or both. In this study, the importance degree and satisfaction degree are used to analytically express the linguistic value and describe how important and satisfactory the involved important factors of CV for customers are.

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 study defines the linguistic values 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.

Modified P-I analysis: Lin (2010) proposed the modified P-I analysis method, which is based on the fuzzy set theory in combination with the IPA analysis method and applied it to service quality analysis. The Introduction section explained why this study uses the modified P-I analysis method to assess the important factors of CV. The steps of the modified P-I analysis method are as follows:

Step 1: Let:

$$\tilde{I}_{jq}^s = (c_{jq}^s, a_{jq}^s, b_{jq}^s)$$

and:

$$\tilde{P}_{jq}^s = (\xi_{jq}^s, \alpha_{jq}^s, \beta_{jq}^s)$$

j = 1, 2, ..., h, q = 1, 2, ..., n, s = 1, 2, ..., m, denotes the jth customer's fuzzy importance degree and fuzzy perception degree of the qth important factor of CV, as offered by the sth GSLP company.

Step 2: Calculate the average fuzzy importance degree and average fuzzy perception degree of the qth service quality offered by the sth GSLP company, as represented by:

$$\tilde{I}_q^S = (c_q^S, a_q^S, b_q^S)$$

$$U_R(\tilde{I}_q^S) = \frac{b_q^S - x_1}{(x_2 - x_1) - (a_q^S - b_q^S)} \quad (5)$$

where:

$$c_q^S = \sum_{j=1}^h c_{jq}^S / h, \quad a_q^S = \sum_{j=1}^h a_{jq}^S / h, \quad b_q^S = \sum_{j=1}^h b_{jq}^S / h \quad (1)$$

and:

$$U_L(\tilde{I}_q^S) = \frac{x_2 - c_q^S}{(x_2 - x_1) + (a_q^S - c_q^S)} \quad (6)$$

and

$$\tilde{P}_q^S = (\xi_q^S, \alpha_q^S, \beta_q^S),$$

Likewise, the right and left utility values of the average fuzzy perception degree are:

where:

$$\xi_q^S = \sum_{j=1}^h \xi_{jq}^S / h, \quad \alpha_q^S = \sum_{j=1}^h \alpha_{jq}^S / h, \quad \beta_q^S = \sum_{j=1}^h \beta_{jq}^S / h. \quad (2)$$

$$U_R(\tilde{P}_q^S) = \frac{\beta_q^S - y_1}{(y_2 - y_1) - (\alpha_q^S - \beta_q^S)} \quad (7)$$

Step 3: Calculate total utility values of \tilde{I}_q^S and \tilde{P}_q^S denoted by:

and:

$$U_T(\tilde{I}_q^S)$$

$$U_L(\tilde{P}_q^S) = \frac{y_2 - \xi_q^S}{(y_2 - y_1) + (\alpha_q^S - \xi_q^S)} \quad (8)$$

and:

$$U_T(\tilde{P}_q^S),$$

where:

$$U_T(\tilde{I}_q^S) = [U_R(\tilde{I}_q^S) + 1 - U_L(\tilde{I}_q^S)] / 2, \quad q=1, 2, \dots, n, s=1, 2, \dots, m \quad (3)$$

Step 4: In Lin's method, he mapped the performance of the service quality of each item in a two-dimensional matrix (Fig. 1). The importance utility is used as a horizontal axis, while the perception utility is used as a vertical axis. A straight line is drawn from the origin to the upper right at 45 degrees, while another vertical line is plotted at $\bar{U}_T(\tilde{I}^S)$. Each important factor of CV is positioned in four parts, as in Fig. 1, including (1) position I: Competitive vulnerability, (2) position II: Competitive strength, (3) position III: Irrelevant superiority and (4) position IV: Relative indifference, respectively.

and:

$$U_T(\tilde{P}_q^S) = [U_R(\tilde{P}_q^S) + 1 - U_L(\tilde{P}_q^S)] / 2, \quad q=1, 2, \dots, n, s=1, 2, \dots, m \quad (4)$$

In this study, the average value of the total utility value of the average fuzzy importance for all n important factors of CV can be represented as:

The maximizing and minimizing sets (Chen, 1985) of the average fuzzy importance degree are denoted by:

$$x_1 = \min\{c_1^S, c_2^S, \dots, c_n^S\}$$

$$\bar{U}_T(\tilde{I}^S) = \frac{\sum_{s=1}^m U_T(\tilde{I}_q^S)}{n}, \quad s=1, 2, \dots, m. \quad (9)$$

and:

$$x_2 = \max\{b_1^S, b_2^S, \dots, b_n^S\},$$

respectively. The maximizing and minimizing sets of the average fuzzy perception degree are denoted by:

$$y_1 = \min\{\xi_1^S, \xi_2^S, \dots, \xi_n^S\}$$

and:

$$y_2 = \max\{\beta_1^S, \beta_2^S, \dots, \beta_n^S\}$$

respectively. According to the Hsieh and Chen (1999) method, the right and left utility values are:

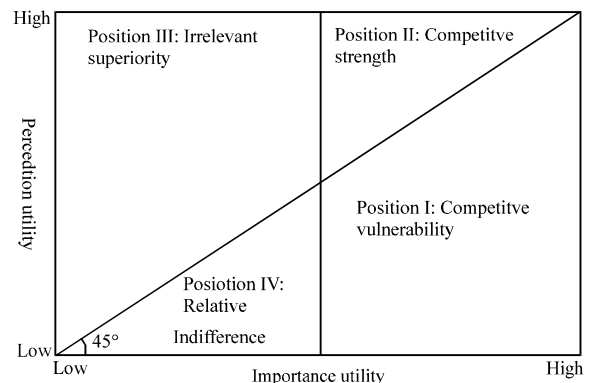


Fig. 1: Modified P-I analysis chart; Source: Lin (2010)

As shown in Fig. 1, regarding the sth GSLP company, if $U_T(\tilde{P}_q^s) \geq U_T(\tilde{I}_q^s)$, then the gap nature of the qth important factor of CV is positive (i.e., the qth important factor of CV is above the straight line of the 45 degree angle).

In order to determine whether qth important factor of CV belongs to competitive strength (i.e., position II) or irrelevant superiority (i.e., position III), the values of:

$$u_T(\tilde{I}_q^s)$$

and $\bar{U}_T(I^s)$ are compared. That is, if:

$$u_T(\tilde{I}_q^s) \geq \bar{U}_T(I^s)$$

then the qth important factor of CV has competitive strength in position II. On the other hand, if:

$$u_T(\tilde{I}_q^s) < \bar{U}_T(I^s)$$

it represents the qth important factor of CV has irrelevant superiority in position III.

By the same concept, if:

$$u_T(\tilde{P}_q^s) \leq u_T(\tilde{I}_q^s)$$

the gap nature of the qth important factor of CV is negative (i.e., the important factor of CV is below the straight line at 45 degree angle). That is, if:

$$u_T(\tilde{I}_q^s) \geq \bar{U}_T(I^s)$$

then the qth important factor of CV has competitive vulnerability in position I and if:

$$u_T(\tilde{I}_q^s) < \bar{U}_T(I^s)$$

then the qth important factor of CV has relative indifference in position IV.

EMPIRICAL STUDY

Here, an empirical survey of assessing CV for GSLPs from shippers' perspective in Taiwanese shipping market is carried out to demonstrate the computational process as described above.

Questionnaire design and survey: To examine whether the important factors of CV are valued by shippers and whether they are factors that require improvement. The

questionnaire content aims to evaluate the importance and perception satisfaction of the seventeen important factors of CV, as shown in Table 1. The questionnaire of this study was based on a Likert 7-point scale. The importance and satisfaction degrees range from absolutely low (very unimportant) and absolutely poor (strongly dissatisfied) to absolutely high (very important) and absolutely good (strongly satisfied), respectively.

Regarding the reliability analysis of the questionnaire, the reliabilities Cronbach's α of importance and relative satisfaction degrees were 0.864 and 0.836, indicating good consistency of the questionnaire. As to validity analysis, the items in the questionnaire were based on some academic literature and expert opinions, thus, the questionnaire content had a content validity. In this study, the correlation coefficients of items were 0.598-0.891, hence, they were significant and indicated good construct validity.

The questionnaire survey was conducted from May to November 2011. We used 1,500 exporters and importers in Taiwan as the population, recorded in the 'Directory of Excellent Exporters and Importers in 2009, Taiwan (ROC)' (MEA, 2010). A total of 319 valid responses were collected, from the 1,500 exporters and importers, which represents 21.27% of the total population.

RESULTS AND DISCUSSION

This section conducts computations based on the steps of the modified P-I analysis method, with analysis processes described as follows:

- **Step 1:** Each respondent makes linguistic assessments of each factor of three GSLP companies and the fuzzy importance degree and fuzzy perception degree of each factor of CV can be obtained from the triangular fuzzy numbers corresponding to the linguistic values. Secondly, according to the Eq. 1 and 2, the obtained average fuzzy importance and fuzzy perception degrees of all factors of CV of three GSLP companies are shown in Table 2
- **Step 2:** Calculate the right utility value and left utility value of the average fuzzy importance degrees and average fuzzy perception degrees of the factors of CV of three GSLP companies, respectively. According to the Eq's. 5-8 and the results are shown in Table 3. Secondly, the total utility of the average fuzzy importance degrees of all factors of CV of three GSLP companies are calculated according to the Eq. 3 and 4. The results of:

Table 2: Aggregate fuzzy assessments of importance and perception

Factors of CV	GSLP company A		GSLP company B		GSLP company C	
	\tilde{I}_q	\tilde{P}_q	\tilde{I}_q	\tilde{P}_q	\tilde{I}_q	\tilde{P}_q
C ₁₁	(5.11, 6.11, 6.74)	(3.67, 4.67, 5.63)	(5.13, 6.13, 6.77)	(3.83, 4.83, 5.77)	(5.03, 6.03, 6.71)	(3.90, 4.90, 5.86)
C ₁₂	(4.78, 5.78, 6.48)	(3.74, 4.74, 5.63)	(4.77, 5.77, 6.47)	(3.87, 4.87, 5.83)	(4.76, 5.76, 6.53)	(3.96, 4.96, 5.89)
C ₁₃	(4.93, 5.93, 6.67)	(3.52, 4.52, 5.48)	(4.93, 5.93, 6.70)	(3.73, 4.73, 5.70)	(5.01, 6.01, 6.71)	(3.93, 4.93, 5.86)
C ₁₄	(5.26, 6.26, 6.78)	(3.59, 4.52, 5.48)	(5.33, 6.33, 6.80)	(4.03, 5.03, 5.97)	(5.47, 6.47, 6.88)	(3.83, 4.82, 5.75)
C ₁₅	(5.33, 6.33, 6.78)	(3.59, 4.59, 5.56)	(5.30, 6.30, 6.80)	(3.87, 4.87, 5.83)	(5.44, 6.44, 6.83)	(3.94, 4.93, 5.85)
C ₂₁	(4.63, 5.63, 6.41)	(3.74, 4.74, 5.74)	(4.73, 5.73, 6.47)	(3.53, 4.53, 5.53)	(4.85, 5.85, 6.61)	(3.93, 4.93, 5.85)
C ₂₂	(4.93, 5.93, 6.59)	(3.63, 4.63, 5.63)	(4.97, 5.97, 6.67)	(3.33, 4.33, 5.33)	(4.92, 5.92, 6.61)	(4.07, 5.07, 5.96)
C ₂₃	(4.70, 5.70, 6.56)	(3.93, 4.93, 5.93)	(4.77, 5.77, 6.50)	(4.00, 5.00, 5.97)	(5.06, 6.06, 6.71)	(4.00, 5.00, 5.94)
C ₂₄	(4.44, 5.44, 6.30)	(3.44, 4.44, 5.44)	(4.30, 5.30, 6.13)	(3.60, 4.60, 5.60)	(4.74, 5.74, 6.50)	(3.72, 4.71, 5.65)
C ₂₅	(4.33, 5.33, 6.19)	(3.41, 4.41, 5.41)	(4.40, 5.40, 6.23)	(3.53, 4.53, 5.53)	(4.75, 5.75, 6.51)	(3.69, 4.67, 5.60)
C ₃₁	(4.33, 5.33, 6.15)	(3.67, 4.67, 5.63)	(4.67, 5.67, 6.53)	(3.33, 4.30, 5.30)	(4.53, 5.53, 6.33)	(3.78, 4.76, 5.69)
C ₃₂	(4.63, 5.63, 6.52)	(3.59, 4.59, 5.56)	(4.77, 5.73, 6.57)	(3.70, 4.70, 5.70)	(4.81, 5.81, 6.56)	(3.86, 4.86, 5.78)
C ₃₃	(4.63, 5.63, 6.52)	(3.48, 4.48, 5.44)	(4.73, 5.73, 6.53)	(3.70, 4.70, 5.67)	(4.89, 5.89, 6.60)	(3.89, 4.89, 5.79)
C ₄₁	(4.78, 5.78, 6.59)	(3.78, 4.78, 5.74)	(4.77, 5.77, 6.57)	(3.40, 4.40, 5.40)	(4.79, 5.79, 6.61)	(3.86, 4.86, 5.78)
C ₄₂	(4.74, 5.74, 6.52)	(3.63, 4.63, 5.56)	(5.00, 6.00, 6.67)	(3.70, 4.70, 5.70)	(5.00, 6.00, 6.69)	(3.85, 4.83, 5.76)
C ₄₃	(4.59, 5.59, 6.33)	(3.48, 4.48, 5.44)	(4.77, 5.77, 6.53)	(3.23, 4.20, 5.20)	(4.81, 5.81, 6.58)	(3.86, 4.86, 5.76)
C ₄₄	(5.00, 6.00, 6.74)	(3.85, 4.85, 5.74)	(4.87, 5.87, 6.60)	(3.57, 4.53, 5.47)	(5.15, 6.15, 6.76)	(3.90, 4.88, 5.76)

Table 3: Total Utility values and nature of gap

Factors of CV	GSLP company A		GSLP company B		GSLP company C		Nature of gap
	$U_T(\tilde{I}_q)$	$U_T(\tilde{P}_q)$	$U_T(\tilde{I}_q)$	$U_T(\tilde{P}_q)$	$U_T(\tilde{I}_q)$	$U_T(\tilde{P}_q)$	
C ₁₁	0.798	0.594	0.801	0.618	0.786	0.628	Negative
C ₁₂	0.750	0.603	0.748	0.623	0.749	0.635	Negative
C ₁₃	0.772	0.573	0.774	0.604	0.784	0.631	Negative
C ₁₄	0.819	0.576	0.829	0.646	0.850	0.616	Negative
C ₁₅	0.829	0.584	0.825	0.623	0.845	0.632	Negative
C ₂₁	0.730	0.606	0.744	0.576	0.761	0.631	Negative
C ₂₂	0.771	0.590	0.778	0.548	0.770	0.651	Negative
C ₂₃	0.741	0.632	0.749	0.642	0.790	0.642	Negative
C ₂₄	0.704	0.563	0.683	0.586	0.745	0.600	Negative
C ₂₅	0.688	0.558	0.697	0.576	0.747	0.595	Negative
C ₃₁	0.687	0.594	0.736	0.544	0.715	0.608	Negative
C ₃₂	0.731	0.584	0.745	0.600	0.755	0.621	Negative
C ₃₃	0.731	0.568	0.745	0.599	0.766	0.625	Negative
C ₄₁	0.752	0.610	0.750	0.557	0.754	0.621	Negative
C ₄₂	0.746	0.588	0.782	0.600	0.782	0.618	Negative
C ₄₃	0.724	0.568	0.749	0.530	0.755	0.621	Negative
C ₄₄	0.783	0.619	0.763	0.576	0.804	0.624	Negative
$\bar{U}_T(\tilde{I})$	0.7503		0.759		0.774		

$$U_T(\tilde{I}_q)$$

$$\bar{U}_T(\tilde{I}^s)$$

and:

$$U_T(\tilde{I}_q)$$

are shown in Table 3. For each GSLP company:

$$U_T(\tilde{P}_q) \leq U_T(\tilde{I}_q)$$

denotes that the nature of the gap representing the factors of CV of three GSLP companies is negative.

- **Step 3:** The average of the total utility value of the average fuzzy importance degree:

of all 17 factors of CV of three GSLP companies can be calculated according to the Eq. 9, as shown in the last line of Table 3

- **Step 4:** According to the assessment results of factors of CV for three GSLP companies, the factors of CV for three GSLP companies can be positioned. Finally, this study concludes the impact points of important factors of CV for three GSLP companies, as shown in Table 4

According to the Table 4, there are individually seven CV factors for three GSLP companies belong to position

Table 4: Factors included in different positions for three GSLPs

GSLP companies	Position I	Position II	Position III	Position IV
Company A	C ₁₁ , C ₁₃ , C ₁₄ , C ₁₅ , C ₂₂ , C ₄₁ , C ₄₄	None	None	C ₁₂ , C ₂₁ , C ₂₃ , C ₂₄ , C ₂₅ , C ₃₁ , C ₃₂ , C ₃₃ , C ₄₂ , C ₄₃
Company B	C ₁₁ , C ₁₃ , C ₁₄ , C ₁₅ , C ₂₂ , C ₄₂ , C ₄₄	None	None	C ₁₂ , C ₂₁ , C ₂₃ , C ₂₄ , C ₂₅ , C ₃₁ , C ₃₂ , C ₃₃ , C ₄₁ , C ₄₃
Company C	C ₁₁ , C ₁₃ , C ₁₄ , C ₁₅ , C ₂₃ , C ₄₂ , C ₄₄	None	None	C ₁₂ , C ₂₁ , C ₂₂ , C ₂₄ , C ₂₅ , C ₃₁ , C ₃₂ , C ₃₃ , C ₄₁ , C ₄₃

I (competitive vulnerability). In summary, the ‘competitive vulnerability’ of the three GSLP companies indicates that:

- For GSLP company A: The CV factors of competitive vulnerability are ‘providing diversity of value-added services,’ ‘reliability,’ ‘providing adequacy of physical facilities and equipment,’ ‘increasing marketing channel and network,’ ‘safety,’ ‘reducing lead time of core logistics services and ‘quick responsiveness, respectively. The other ones are belonging to position IV (relative indifference)
- For GSLP company B: The CV factors of competitive vulnerability are ‘providing diversity of value-added services,’ ‘reliability,’ ‘providing adequacy of physical facilities and equipment,’ ‘increasing marketing channel and network,’ ‘safety,’ ‘implementing integrated logistics information system,’ and ‘quick responsiveness,’ respectively. The other ones are belonging to position IV (relative indifference)
- For GSLP company C: The CV factors of competitive vulnerability are ‘providing diversity of value-added services,’ ‘reliability,’ ‘providing adequacy of physical facilities and equipment,’ ‘increasing marketing channel and network,’ ‘accuracy and precision of shipments,’ ‘implementing integrated logistics information system,’ and ‘quick responsiveness,’ respectively. The other ones are belonging to position IV (relative indifference)

This study evaluates the impact points of important factors of CV for three GSLP companies. We offer suggestions for CV strategy according to these impact points. The strategy suggestions can help GSLP company to access resources more efficiently, thus improving their original positions of ‘competitive vulnerability’ to the position of ‘competitive strength’ in the future. The CV strategies located in the four quadrants are described as below.

- **Competitive vulnerability, (position I):** The important factors of CV in this quadrant have high perception importance but low satisfaction, the shippers’ satisfaction for the service provided by GSLP company should be improved. The GSLP companies should make more efforts to turn the gap of important factors from negative to positive. In other words, the

important factors of CV in this quadrant should be listed as key points to be improved by GSLP companies. Meanwhile, as the improvement of these important factors has great marginal effect on enterprises, the important factors of CV in this quadrant should be improved first, to avoid losing customers

- **Competitive strength (position II):** The important factors of CV in this quadrant have high perception importance and satisfaction; they are a source of competitive advantages of GSLP companies. However, according to the survey of this study, the CV factors of the three GSLP companies are not presently within this quadrant
- **Irrelevant superiority (position III):** The CV factors in this quadrant have low perception importance but high satisfaction, the CV factors in this quadrant are not very helpful for improving customer satisfaction and have slight marginal effect on CV improvement. Therefore, it is not necessary to use excessive resources in this quadrant. However, the GSLP companies must maintain the original CV factors for these service items, although it may be regarded as excessive resource supply. If turned into a ‘competitive vulnerability’ subject by adjusting resources, it will eventually be adjusted to a ‘competitive strength’ through CV improvement
- **Relative indifference (position IV):** The CV factors in this quadrant have low perception importance and satisfaction and GSLP companies need not pay too much attention in this quadrant. The CV factors in this quadrant are not very helpful to improving customer satisfaction, it is unnecessary to use excessive resources in this quadrant. However, to avoid improper resource allocation, these CV factors can be used as reference for resource reallocation and future marketing adjustment of GSLP companies

CONCLUSIONS

This study utilized the modified fuzzy P-I analysis method to analyze the CV factors of three GSLP companies and conducted an empirical investigation by questionnaire survey. The main findings are described as follows:

- According to the experts’ suggestions, four criteria (namely service, quality, cost and cycle time) and

seventeen important factors of CV are derived from the academic literature

- To facilitate the main issue for evaluating CV factors, a modified fuzzy P-I analysis method is constructed

An empirical survey is studied via questionnaires. The results show there are individually seven CV factors for three GSLP companies belong to position I (competitive vulnerability). The other ones are belonging to position IV (relative indifference). The same CV factors position on the 'competitive vulnerability' zone are 'providing diversity of value-added services,' 'reliability,' 'providing adequacy of physical facilities and equipment,' 'increasing marketing channel and network,' and 'quick responsiveness,' respectively. Finally, we offer suggestions for CV strategy according to these impact points. The strategy suggestions can help GSLP company to access resources more efficiently, thus improving their original positions of 'competitive vulnerability' to the position of 'competitive strength' in the future.

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