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Full Length Research Paper

Integration of revised simultaneous importance performance analysis and decision making trial and evaluation laboratory: A study of the mobile telecommunication industry in Taiwan

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Importance performance analysis (IPA) can help managers identify improvement strategies. However, taking subjective self statement as a measurement cannot reveal the actual importance of service attributes, especially when performance of competitors is not factored. A revised simultaneous importance performance analysis (SIPA) was used in this research and the implicit importance of service attributes with multiple regression analysis to ascertain the competitive differences between their operation and competitors. However, an SIPA is not sufficient to provide adequate information for decision making as services attributes are causal and interrelated. Thus, a decision making trial and evaluation laboratory (DEMATEL) is employed to assay the causation and the influence across service attributes for locating key factors. The mobile telecommunication industry in Taiwan was conducted with the adoption of a revised SIPA model and a DEMATEL.

Key words: Importance performance analysis (IPA), simultaneous importance performance analysis (SIPA), multiple regression analysis, decision making trial and evaluation laboratory (DEMATEL).

INTRODUCTION

In recent years, importance performance analysis (IPA) has been widely applied in various industries. Tonge and Moore (2007) used IPA and gap analysis to evaluate visitor opinion in a marine park to conduct more effective management of environmental protection. Huang et al. (2006) used IPA to investigate customer satisfaction for middle and long range highway journeys; Levenburg and Magal (2005) used IPA in formulating electronic comercial decision making and resource allocation; Aigbedo and Parameswaran (2004) used IPA to improve school canteen service; Matzler et al. (2004) used IPA in the automobile industry; Zhang and Chow (2004) exploited IPA to improve tourism guide service and Matzler et al. (2003) used IPA to improve quality of bank service and development strategies.

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Though IPA has been widely applied in various industries, Matzler and Sauerwein (2002) and Matzler et al. (2004) also point out that IPA has two types of measurements for importance of service attributes. One is called the explicit importance, where customers exhibit how important they think a given service attribute is, and the other one is how important the service attribute is for customers using the multiple regression formula, called the implicit importance. With performance as the independent variable and overall service performance as the dependent variable in the multiple regression formula, Matzler and Sauerwein (2002) proved that it is the implicit importance, not the customer self-stated that serve as the satisfaction of service attributes.

Previous research indicates that IPA can be applied in manager decision making. However, interviewee subjective statements did not adequately reveal the actual importance of service attributes. Therefore, multiple regression analysis is a better measurement of the customers' perception of the service attribute. In order

Table 1. SIPA evaluation table.

Attribute importance	Our attribute	Competitor performance	Market opportunity
High	Poor	Poor	Neglected opportunity
		Good	Competitive disadvantage
	Good	Poor	Competitive advantage
		Good	Head-to-head competition
Low	Poor	Poor	Null opportunity
		Good	False alarm
	Good	Poor	False advantage
		Good	False competition

order to take competitor performance into consideration and follow suggestions from IPA in managerial decision making, a revised analysis method adopted was used to establish the implicit importance of service performance attributes with multiple regression analysis. Simultaneous importance performance analysis (SIPA) was used to identify competitive differences between their own operation and competitors. However, when there is causation among the service attributes and one improved attribute, it will definitely change the other relevant attributes; as such, service attributes with greater influence should be considered first, knowing how such causation works on decision making and improvements is critical. A decision making trial and evaluation laboratory (DEMATEL) covers both the correlation and the interrelationship across service attributes to modify the priority of improvements of service attributes for avoiding wrong decision making and to improve service attributes and relational resources allocation.

SIPA

Though IPA is helpful in facilitating manager decision making, the performance of related service attributes of competitors is not taken into consideration. Therefore, in order to take competitor related performance into consideration and follow suggestions made by IPA on managerial decision-making, Burns (1986) suggested the use of simultaneous importance performance analysis (SIPA). There are 3 concepts in SIPA: importance, company performance and competitor performance. In the table, each attribute is either in the high or low category. The performance of the attribute can also be identified as good or poor. By taking the importance of the quality attributes and the performance of the company and competitors, quality attributes can be classified into 8 scenarios (Table 1).

From Table 1, if a service attribute falls into different scenarios of market opportunity, the corresponding competition strategy should also be modified accordingly. Detailed statements are as follows:

(1) Neglected opportunity: The importance of this service attribute is high, but neither the company nor its competitor meets the satisfaction level expected by customers. If any company can implement effective quality planning and improvements, it can achieve customer satisfaction with its service performance and gain an advantage in this aspect.

(2) Competitive disadvantage: The importance of this service attribute is high, but the company is inferior to its competitor, which is a key drawback which requires improvement.

(3) Competitive advantage: The importance of this service attribute is high and the company performs better than its competitor, successfully differentiating the company from others in the market.

(4) Head to head competition: The importance of this service attribute is high and company performance is equal to its competitor, meaning the company should at least maintain strategies.

(5) Null opportunity: Though both the company and competitors deliver adequate service quality, from the standpoint of customers, it is not an area that affects competition.

(6) False alarm: Though competitors perform better than the company, this does not affect customer brand preference or purchases.

(7) False advantage: Though the company performs better, the importance of the service attribute is low. This implies the company might be placing too much effort or resources into this attribute.

(8) False competition: Though the company and competitors have positive evaluations from customers, the attribute does not affect purchasing decisions.

After Burns (1986) introduced SIPA, Yavas and Shemwell (1997) incorporated a 16-strategy matrix in which strategies can be decided for each attribute. This appears

more complicated than SIPA. Based on SIPA, Bei and Shang (2006) provided a marketing strategy for public organization self improvement. Bei and Shang also compared service quality and operational performance between public and private banks and gas stations. In the traditional SIPA model, the importance of service attributes is measured by customer statements, but many scholars have pointed out that when attribute performance changes, so does relative attribute importance. Thus, customer stated importance does not adequately measure the actual relative importance of attributes (Matzler and Sauerwein, 2002; Garver, 2003; Matzler et al., 2004; Lee et al., 2008; Hu et al., 2009). Therefore, a revised SIPA model has been used for this research.

Revised SIPA

In this research, the implicit importance of service attributes was obtained through a multiple regression analysis and was used in SIPA for further analysis of the strength and weakness of each company. Corresponding strategies are then recommended. The steps are thus illustrated:

Step 1: Gather customer perception for the performance of service attributes. A questionnaire survey is commonly use for this step. The questionnaire measures the service attribute performance and the overall performance perception.

Step 2: Acquire implicit importance of each service attribute by performing multiple regression analysis. The performance was taken as an independent variable and the overall satisfaction as a dependent variable was a more accurate importance measurement of service attributes. The implicit importance of service attributes is defined by:

$$y = \beta_0 + \beta_1 \chi_1 + \beta_2 \chi_2 + ... + \beta_k \chi_k + \varepsilon \quad (1)$$

Where,

Y = Overall satisfaction;

χ_i = The performance of *i*th service attribute *(i* = 1, 2,…, *k*);

β_i = The importance of *i*th service attribute (*i* = 1, 2,…, *k*) and

ε = Random error.

Step 3: Use the mean of all implicit importance of service attributes and the mean of all performance to divide the IPA quadrant.

The mean of all implicit importance of service attributes is thus shown:

$$\sum_{i=1}^{k}\sum_{j=1}^{i}\omega_j\hat{\beta}_{ij} \Big/ \kappa\sum_{j=1}^{i}\omega_j \quad (2)$$

Where:

ω_j = The weight of *j*th company, and

$\hat{\beta}_{ij}$ = The importance of *i*th service attribute in *j*th company.

The mean of all performance is shown as follows:

$$\sum_{i=1}^{k}\sum_{j=1}^{i}\omega_j\bar{\chi}_{ij} \Big/ \kappa\sum_{j=1}^{i}\omega_j \quad (3)$$

Where:

$\bar{\chi}_{ij}$ = The performance of *i*th service attribute in *j*th company.

Step 4: The SIPA evaluation table collapses a three-category conceptualization and specifies the important of service attribute as either “high” or “low”. Furthermore, the comparison of competitive performance of service attribute can be categorized as “good” or “poor”.

Step 5: By simultaneously considering the importance of service attribute, our company’s performance and competitor’s performance can be identified as eight different market opportunities. All competitors proposed the appropriate marketing strategy for each market opportunity.

DEMATEL

A decision making trial and evaluation laboratory (DEMATEL) is developed by Battelle Memorial Institute (BMI) (Gabus and Fontela, 1973; Fontela and Gabus, 1976) applied to the resolution of sophisticated issues, for example, races, famine, environmental protection and energy (Fontela and Gabus, 1976). It aims to obtain the direct and indirect causation, as well as the influential strength across quality features, by applying matrix computation to complex systems and comparing the interrelations across quality features, especially visually structural matrix and causal figures, thereby expressing the causation and affecting levels across quality features of complex systems that help decision making. Thus, a DEMATEL converts complex systems to a clear causal structure that simplifies the interrelationship across quality features of complex systems into cause and effect, and therefore helps locate the core issue and

improvement of complex systems via the degree of interrelations across quantified quality features.

Recently, a DEMATEL has been widely applied to issues in various fields by researchers in Japan, Korea and Taiwan. For instance, Tamura et al. (2006) inquired the factors of the consumers' anxiety for food and the improvement by a DEMATEL. Hajime et al. (2005) applied an integrated QFD, TRIZ and DEMATEL to the resolution of a fundamental conflict during innovative engineering. Nanayo and Toshiaki (2002) conducted an integral assessment on medical systems by a revised DEMATEL, whereas Kenichi and Yoshihiro (2002) assessed the capabilities and ineffectiveness of snow-melting facilities by a DEMATEL. Kim (2006) applied an integrated PCA, AHP and DEMATEL to the impact assessment of beef cattle farming and agricultural information. Wu and Lee (2007) applied a Fuzzy DEMATEL to the core competency of managers, while Lin and Wu (2008) applied a Fuzzy DEMATEL to group decision making. Given that, a DEMATEL has been successfully applied to various fields. The steps are shown as follows:

Step 1 (Define the scale): Define the scale to show the impact levels. The values and operating definitions represent 0, 1, 2, 3 and 4 and "no impact", "middle impact", "high impact" and "great impact".

Step 2 (Build a direct-relation matrix): The assessor fills the matrix and judges the affecting level of 2 criteria, and writes down the value of Step 1 at the corresponding place. This will exert a direct-relation table. A direct-relation matrix X is exerted where x_{ij} expresses the level of how the service attribute i affects service attribute j. By integrating the opinions from experts, the value of a diagonal line is 0.

$$X = \begin{bmatrix} 0 & x_{12} & \cdots & x_{1n} \\ x_{21} & 0 & \cdots & x_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & 0 \end{bmatrix}$$

Step 3 (Build a standardized matrix): Standardize a matrix by matrix X and the method is shown as follows:

$$\lambda = \frac{1}{\max_{1 \le i \le n} \sum_{j=1}^{n} x_{ij}}$$

Define and $N = \lambda X$.

Step 4 (Build the direct/indirect relation matrix *T*): As the standardized matrix N is known, it may become the direct/indirect relation matrix T via Equation 1.

$$T = \lim_{k \to \infty} \left(N + N^2 + \cdots + N^k \right) = N(I - N)^{-1} \quad (1)$$

where I is an identity matrix.

Step 5 (Compute the overall affecting and affected strengths of the respective criteria): Estimate the total number of rows in matrix T and obtain a total value of D and R as shown in Equations (2) and (3) where D represents the level of direct or indirect impacts on other criteria and R represents the level affected by other criteria.

$$D_i = \sum_{j=1}^{n} t_{ij} \quad (i = 1,2,..., n) \quad (2)$$

$$R_j = \sum_{i=1}^{n} t_{ij} \quad (j = 1,2,...,n) \quad (3)$$

Step 6 (Estimate the prominence and relation): Define $D_k + R_k$ as the prominence, where k = i = j = 1, 2,…, n represents an overall level of affecting and affected impacts. This value shows the core level of k across all questions. Define $D_k - R_k$ as the relation that represents the level of affecting and affected differences. This value shows the causal degree of k across all questions. Positive figures refer to the likes of cause, while negative figures refer to the likes of effect.

Step 7 (Build a causal figure): A causal figure is built by a horizontal axle of $D_k + R_k$ and a vertical axle of $D_k - R_k$ in association with a 2D figure structured by a semiotic rectangle. This aims to convert a complex causation to a simplified visual structure. By estimating the figures of the coordinates ($D_k + R_k$, $D_k - R_k$) and employing the prominence ($D_k + R_k$) as a horizontal axle and the relation ($D_k - R_k$) as a vertical axle, a causal figure is built where there are coordinates concerned.

CASE STUDY

The subjects for this case are the 3 largest mobile telecommunication companies in Taiwan: Chunghwa Telecommunication (CT), Taiwan Mobile Telecommunication (TT) and Far Eastone Telecommunication (FT). Due to the trend of loosening related regulations in telecommunications, the industry has become more prosperous and the variety of telecommunication products has also greatly increased output value. Customers now demand more. In addition to traditional local calls, customers also demand mobile telecommunications and internet connection. As the size of the telecommunications market in Taiwan is quite limited, the resources of each telecommunications company and the acquisitions differ; therefore, each company has different market strategies.

Questionnaire design and sampling of the case study

There were 13 questions about service attributes shown in the questionnaire used in this research. They include: successful connection to service center (Q1), attitude of the service center clerk (Q2), professional knowledge of the service center clerk (Q3), online service provided by the telecommunications company (Q4), service provided in the shop (Q5), quality of the mobile phone signal (Q6), correctness of the mobile phone bill (Q7), e-bill service (Q8), premium programs for mobile phones (Q9), value-added service for mobile phones (Q10), internet connection service for mobile phones (Q11), 3G visual service for mobile phones (Q12) and service rate for mobile phones (Q13). However, (Q14) was a question about the overall service performance of the telecommunications company. The service performance was evaluated by a 10-point scale and each question was closed.

The questionnaire was put into a trial run in the middle of December 2009, and after the trial run was finished, the design of the questionnaire was amended accordingly. Convenience sampling was used in this research and there were 1,288 sets of formal questionnaires issued in January 2010. Among the questionnaires returned, 868 sets were effective with a response rate of 67.4%. Among these effective 868 sets of questionnaires, 320 sets belonged to CT (36.9%), 296 sets belonged to TT (34.1%) and 252 sets belonged to FT (29%).

Fifteen professionals were invited to present their opinions, and DEMATEL was adopted to analyze the causal relationships and interaction influence level between service attributes. The direct and indirect relation matrix can be obtained; at the same time, the values of each column are calculated and the prominence ($D_i + R_j$) and relation ($D_i - R_j$) can be obtained for analysis.

RESULTS

Service performance and implicit importance in mobile telecommunications companies

The performance of service attributes of that industry can be weighted based on the sales revenue of each company. If the service attribute performance of each company is compared, CT (4.774) is ranked the 1st, FT (4.229) as 2nd and TT (2.953) as 3rd (Table 2). Multiple regression analysis was used to obtain the implicit importance of each question and was used as a standard to judge the level of each service attribute (Table 3).

From the results shown in Tables 2 and 3, CT had the best performance. Though CT is inferior to FT regarding internet connection service for mobile phones (Q11) and 3G visual service for mobile phones (Q12), CT's overall service performance was still better than the average. TT's overall performance was ranked last, falling under average performance, showing that customers were less satisfied with its service. Though FS's overall service performance was better than average service performance, it was ranked the 2nd. The implicit importance of service attributes: service rate for mobile phones (Q13) and quality of mobile phone signal (Q6), are considered the most two important items. If service performance is also taken into consideration, then customers would consider the quality of the mobile phone signal (Q6) as the most important service item in which the most satisfaction is expected. In view of this, maintaining existing customers and drawing in new customers are equally important. Therefore, through customer relationship management in which the planning of the organization and marketing can be facilitated with modern technology, the individual demand of each customer can then be tracked and reacted to accordingly. Through constant communication, a company can better understand its customers for higher brand loyalty and better operational performance.

SIPA in mobile telecommunication companies

In this research, the strength and weakness of each company are specified by SIPA. Compared with TT, CT performs better and hence has a competitive advantage in successful connection with service center (Q1), attitude of the service center clerk (Q2), service provided in the shop (Q5), quality of mobile phone signal (Q6), correctness of mobile phone bill (Q7), premium programs for mobile phones (Q9) and service rate for mobile phones (Q13). This suggests that TT needs to pay more attention to these items and adjust its strategies. It is worthy to note, among these items, that there was only one "head to head competition" relationship between CT and TT and the other items fell into the category of "null opportunity". Items listed as "null opportunity" means there is no competition advantage to those items, such as value-added service for mobile phones, internet connection service for mobile phones or 3G visual services for mobile phones.

The competition between CT and FT is more intense for items such as successful connection to service center (Q1), attitude of the service center clerk (Q2), online service provided (Q4), service provided in the shop (Q5), quality of the mobile phone signal (Q6), correctness of the mobile phone bill (Q7) and service rate for mobile phones (Q13). Items such as value-added service for mobile phones (Q10), internet connection service for mobile phones (Q11) and 3G visual service for mobile phones (Q12) have null opportunity (Table 4).

From Table 4, CT and TT have a competitive relationship in successful connection to service centre (Q1), attitude of the service center clerk (Q2), service provided in the shop (Q5), quality of the mobile phone signal (Q6), correctness of the mobile phone bill (Q7), premium programs for mobile phones (Q9) and service rate for mobile phones (Q13), in which both companies have a competitive advantage. The importance of these service attributes is high and CT is performing better than TT, manifesting the difference of the service attributes in the market.

In terms of the competition between CT and FT, there are 7 market opportunities which fall into the category of head to head competition. All these service attributes are important. CT and FT are both favourably evaluated, which means both companies must exercise caution dealing with the competition in the 7 items already mentioned. Regardless of market opportunities in "competitive advantage" or "head to head competition", risk might still exist. Though the competitive advantage of the market opportunity might be manifested through service differentiation, the advantage might also be neutralized if CT and TT

Table 2. Results of mobile telecommunication companies' service performance.

Item	Service performance			Average performance of service attribute
	CT($\overline{X}_1$)	TT($\overline{X}_2$)	FT($\overline{X}_3$)	
Q1	4.500	3.000	3.833	3.809
Q2	4.900	3.125	3.833	4.008
Q3	4.500	3.000	2.500	3.451
Q4	5.700	4.250	5.167	5.061
Q5	4.800	3.500	4.494	4.274
Q6	7.900	3.879	5.648	5.927
Q7	6.100	3.766	6.667	5.457
Q8	5.256	2.875	4.667	4.287
Q9	5.400	3.250	3.167	4.068
Q10	3.400	2.500	3.333	3.075
Q11	1.900	0.625	3.167	1.808
Q12	2.000	0.750	3.333	1.935
Q13	5.700	3.875	5.167	4.934
Average	4.774	2.953	4.229	4.007

Note 1: Weight of sales revenue ($\omega_1 = 0.392$; $\omega_2 = 0.338$; $\omega_3 = 0.269$).

Table 3. The implicit importance of mobile telecommunication companies' service attributes.

Item	Importance			Average importance of service attribute	t-value
	CT($\hat{\beta}_1$)	TT($\hat{\beta}_2$)	FT($\hat{\beta}_3$)		
Q1	0.338	0.441	0.403	0.390	22.521*
Q2	0.317	0.429	0.403	0.378	23.045*
Q3	0.298	0.461	-0.107	0.244	12.671*
Q4	0.389	0.263	0.252	0.309	15.742*
Q5	0.206	0.583	0.364	0.376	17.309*
Q6	0.450	0.678	0.425	0.520	29.447*
Q7	0.229	0.383	0.660	0.397	20.913*
Q8	0.120	-0.077	0.162	0.065	7.130*
Q9	0.367	0.520	0.034	0.329	10.609*
Q10	0.279	0.167	-0.516	0.027	4.631*
Q11	0.352	-0.524	0.305	0.043	12.034*
Q12	0.336	-0.579	0.260	0.006	10.664*
Q13	0.272	0.967	0.611	0.598	33.692*
Average	0.304	0.286	0.250	0.283	--

Note1: *means P<0.001.

Note 2: weight of sales revenue ($\omega_1 = 0.392$; $\omega_2 = 0.338$; $\omega_3 = 0.269$).

Table 4. The result of SIPA of CT, TT and FT.

Item	Importance	Service performance			Market opportunity	
		CT	TT	FT	CT vs. TT	CT vs. FT
Q1	High (0.390)	Good (4.500)	Poor (3.000)	Poor (3.833)	Competitive advantage	Head-to Head fighting
Q2	High (0.378)	Good (4.900)	Poor (3.125)	Poor (3.833)	Competitive advantage	Head-to Head fighting
Q3	Low (0.244)	Good (4.500)	Poor (3.000)	Poor (2.500)	False advantage	False advantage
Q4	High (0.309)	Good (5.700)	Good (4.250)	Good (5.167)	Head-to-head competition	Head-to head competition
Q5	High (0.376)	Good (4.800)	Poor (3.500)	Good (4.494)	Competitive advantage	Head-to head competition
Q6	High (0.520)	Good (7.900)	Poor (3.879)	Good (5.648)	Competitive advantage	Head-to head competition
Q7	High (0.397)	Good (6.100)	Poor (3.766)	Good (6.667)	Competitive advantage	Head-to head competition
Q8	Low (0.065)	Good (5.256)	Poor (2.875)	Good (4.667)	False advantage	False competition
Q9	High (0.329)	Good (5.400)	Poor (3.250)	Poor (3.167)	Competitive advantage	Competitive advantage
Q10	Low (0.027)	Poor (3.400)	Poor (2.500)	Poor (3.333)	Null opportunity	Null opportunity
Q11	Low (0.043)	Poor (1.900)	Poor (0.625)	Poor (3.167)	Null opportunity	Null opportunity
Q12	Low (0.006)	Poor (2.000)	Poor (0.750)	Poor (3.333)	Null opportunity	Null opportunity
Q13	High (0.598)	Good (5.700)	Poor (3.875)	Good (5.167)	Competitive advantage	Head-to head competition

Note 1: the average importance of all service attributes is 0.283.
Note 2: the average performance of all service attributes is 4.007.

both focus on service differentiation. The competitive advantage could disappear, if differentiation is no longer required by customers. Since CT and FT have an intense head to head competition, it is very likely that either one of them will lower its product price or launch additional promotions to gain advantage. This kind of price or promotion competition could occur at any time depending on competitive pressure. Though, the competition between these two companies might lead to prosperity of the entire industry, it could also lead to a vicious circle because of respective countermeasures. Although competition is inevitable with companies in the same industry, it is better to consider all environmental influential factors. Moreover, cooperation is also an option.

Other than the competitive differences between the 3 companies, the situation in which all companies have the same competitive opportunity also exists. Regardless of comparisons, professional knowledge of the service centre clerk (Q3) and e-bill service (Q8) are both 'false advantages', meaning these two service attributes are of less importance. Though they are input with more resources than they deserve, both have little influential power over customers. Items such as value-added service for mobile phones (Q10), internet connection service for mobile phones (Q11) and 3G visual service for mobile phones (Q12) all fall into the category of null opportunity, meaning these service attributes are of less importance and are not highly valued by customers. As long as an item falls into false advantage, false competition or null opportunity categories, they are of little importance. However, customers value all service attributes provided by CT. For example, though professional knowledge of the service centre clerk (Q3) and e-bill service (Q8) are both false advantages, which do not influence customer purchase decisions, they can still establish brand loyalty, which can only be replaced by competitors at great cost and effort. Also, when a service attribute falls into the null opportunity category, it is an item either of low importance or less valued by customers. When a service attribute has no clear strength or weakness and the competitive opportunity and threat are not prominent, a more stable strategy might be more feasible.

DEMATEL in telecommunication companies

A DEMATEL was used to assay the causation across service attributes of mobile tele-

Table 5. Collation of the prominence and relation.

Item	D_i	R_j	$D_i + R_j$	$D_i - R_j$
Q1	0.53	0.00	0.53	0.53
Q2	0.18	0.21	0.39	-0.03
Q3	0.00	2.39	2.39	-2.39
Q4	0.14	2.38	2.52	-2.24
Q5	0.64	1.49	2.13	-0.85
Q6	2.97	1.14	4.11	1.83
Q7	0.28	0.00	0.28	0.28
Q8	0.48	0.20	0.68	0.28
Q9	1.66	2.05	3.71	-0.39
Q10	3.61	1.60	5.21	2.01
Q11	3.61	1.41	5.02	2.20
Q12	2.90	1.41	4.31	1.50
Q13	2.78	5.52	8.30	-2.74

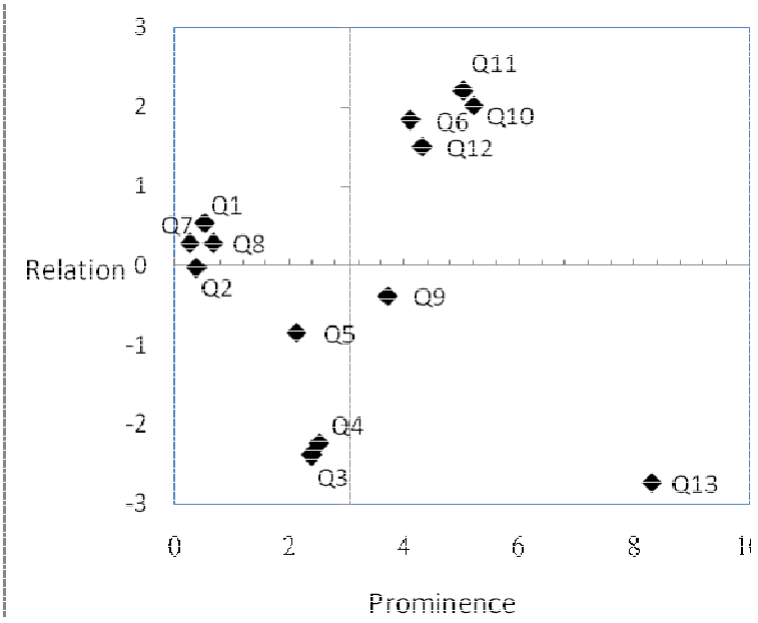

Figure 1. Distribution of service attributes.

telecommunications companies. First, build the direct relation matrix *X* and compute the direct/indirect relation matrix via standardization. Equations (2) and (3) estimate values of D_i and R_j and obtain the prominence ($D_i + R_j$) and relation ($D_i - R_j$) as shown in Table 5. The total of ($D_i + R_j$) and ($D_i - R_j$) was divided by 13 service performance attributes.

The mean served as the estimate of the central tendency of the casual matrix. There are 4 quadrants as shown in Figure 1.

From Figure 1, the service attributes of quality of the mobile phone signal (Q6), value-added service for mobile phones (Q10), internet connection service for mobile phones (Q11) and 3G visual service for mobile phones (Q12) have high prominence and high relation since they are the core items that affect others and are the cause in the causation, available to customers' selection of mobile companies. Premium programs for mobile phones (Q9) and service rate for mobile phones (Q13) have high prominence and low relation since they are the core items affected by others and are the effect in the causation. Successful connection to service center (Q1), correctness of the mobile phone bill (Q7) and e-bill

service (Q8) have low prominence and high relation. Attitude of the service center clerk (Q2), professional knowledge of the service center clerk (Q3), online service provided by the telecommunications company (Q4) and service provided in the shop (Q5) have low prominence and low relation since there are few factors affecting them.

From Tables 4 and 5 and Figure 1, among service attributes with high prominence and high relation, CT and TT and FT have competitive advantage and head to head competition regarding quality of the mobile phone signal (Q6), representing the high importance of this service attribute, which is also the core item that affects others. Therefore, quality of the mobile phone (Q6) shall be valued. Although value-added service for mobile phones (Q10), internet connection service for mobile phones (Q11) and 3G visual service for mobile phones (Q12) are the core items that affect others, the SIPA comparison indicates that CT and TT and FT have null opportunity regarding value-added service for mobile phones (Q10), internet connection service for mobile phones (Q11) and 3G visual service for mobile phones (Q12). Despite the vague advantages and disadvantages along with insignificant opportunities and threats, it is feasible to expand new markets rather than to compete in existing markets.

Among service attributes with high prominence and low relation, CT and TT and FT have competitive advantage regarding premium programs for mobile phones (Q9), representing CT's superiority to TT and FT and demonstrating the difference of market competition. CT and TT and FT have competitive advantage and head to head competition regarding service rate for mobile phones (Q13), representing the high importance of this service attribute. Both premium programs for mobile phones (Q9) and service rate for mobile phones (Q13) are the core items affected by others, showing their necessity of urgent management; however, the direct improvement may not be needed since the good management for others may improve both.

Conclusions

In the traditional IPA model, interviewees' subjective statements serve as results of measurement, which cannot genuinely demonstrate the importance of service attributes. In addition, competitor performance on related service attributes is not taken into consideration. Therefore, in this research, a revised SIPA model was introduced. Multiple regression analysis was used to obtain implicit importance of service attributes. Based on the SIPA evaluation table, the market opportunities which belong to both the company and competitors can be then identified. However, an SIPA is not sufficient to provide adequate information for decision making as services attributes are causal and interrelated. Thus, the DEMATEL is employed to assay the causation and the influence across service attributes for locating key factors. Last, the mobile telecommunications industry in Taiwan was taken as a case for explaining how revised SIPA model and DEMATEL could be applied.

The case study was conducted with the adoption of a revised SIPA model and DEMATEL. The conclusion is as follows:

(1) According to the results of multiple regression analysis, both service rate for mobile phones and the quality of the mobile phone signal are the most important two service items for customers. If service performance is taken into consideration at the same time, then the quality of the mobile phone signal is the item that customers demand and receive the most. The service performance of CT is the best between the 3 companies. Though its performance in internet connection service for mobile phones and 3G visual service for mobile phones is inferior to that of FT, its overall service performance is still above average. Therefore, through customer relationship management, the individual demand of each customer can be tracked and reacted to accordingly to achieve higher brand loyalty and better operational performance.

(2) According to the results of the revised SIPA, CT performs better than TT in a successful connection to service centre, attitude of the service centre clerks, service provided in the shop, quality of mobile phone signal, correctness of the mobile phone bill and service rate for mobile phones, clearly differentiating the service attributes of CT from those of TT in the market. While companies in the same industry are competing against each other, they should also consider all the influential factors. In order to achieve a win-win situation, cooperation sometimes is a better alternative. On the other hand, from customer point of view, though some service attributes are false advantages or false competition, they can still potentially establish brand loyalty. For other competitors to win over customers, they require relatively high cost and effort. Also, when service attributes fall into the category of null opportunity, there is no clear strength or weakness. However, when competitive opportunities and threats are not prominent, a more stable strategy might be more feasible.

(3) In terms of the results of a DEMATEL, service attributes with high prominence and high relation such as: quality of the mobile phone signal (Q6), value-added service for mobile phones (Q10), internet connection service for mobile phones (Q11) and 3G visual service for mobile phones (Q12), are the core items affecting others and are the cause in the causation. On the other hand, service attributes with high prominence and low relation such as: premium programs for mobile phones (Q9) and service rate for mobile phones (Q13), are the core items affected by others and are the effect in the causation.

(4) Analytic results of a revised SIPA and a DEMATEL show that quality of the mobile phone signal (Q6) should be valued by respective telecommunications companies.

On the other hand, the SIPA analytic results show that there is null opportunity for CT and TT and FT regarding value-added service for mobile phones (Q10), internet connection service for mobile phones (Q11) and 3G visual service for mobile phones (Q12). Still, a DEMATEL assay tells that they are the core items affecting others. Thus, stable strategies are suggested. Also, CT has better performance regarding premium programs for mobile phones (Q9) and service rate for mobile phones (Q13) than TT with regards to premium programs for mobile phones (Q9) and service rate for mobile phones (Q13). They are the core items affected by others, showing their necessity for urgent management; however, the direct improvement may not be needed since the good management for others may improve both.

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