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EVALUATING SERVICE QUALITY OF MOBILE APPLICATION STORES: A COMPARISON OF THREE TELECOMMUNICATION COMPANIES IN TAIWAN

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Abstract. *The main purpose of this paper is to apply the Lin's method – modified fuzzy perception-importance (P-I) analysis – to evaluate the service quality of mobile application stores in Taiwan. A comparison of three major telecommunication companies is empirically studied based upon the consumers' perspective. To facilitate this main issue, we selected thirty-three assessment attributes of service quality in ten dimensions, as based on the literature and characteristics of consumers in Taiwan. Then, the Lin's modified P-I analysis was applied to evaluate service quality for the selected mobile application stores of three telecommunication companies. Finally, the results of this study show that nine service qualities are valued by all mobile communication users of three telecommunication companies. These service qualities are 'answers questions rapidly', 'sincerity in responses to users' questions', 'the importance of solving users' problems', 'provision of reliable information', 'provide the application information required by users', 'stable network connection service', 'provide precise connection signal', 'importance of communication network for users' and 'mobile phone devices allow successful transactions', respectively. Moreover, this study suggested that, if companies intend to promote their business developments, they must continuously improve their service quality to promote customer satisfaction.*

Keywords: Service quality, Mobile application stores, Modified fuzzy perception-importance (P-I) analysis

1. **Introduction.** Since the mobile application store – App Store – was introduced by iPhone, it has assumed the lead in the mobile communication application market, leading its customers to download their application software from the Internet. This has resulted in a large market potential, with very high download rates, rendering mobile application stores the new developmental trend of smart mobile phone applications. Therefore, to expand the services scope and depth, three telecommunication companies in Taiwan – namely, Chunghwa Telecom, Taiwan Mobile and FET net – have established mobile application stores, i.e., Hami Apps, Match Market and S mart, respectively. However, there are very few choices in Chinese software available at the iPhone App Store or the Google Android Market. Therefore, three telecommunication companies in Taiwan have focused on the Chinese software market and introduced various Chinese software applications in order to offer users choices in software selection.

The main purpose of mobile application stores is to provide consumers with more choices and application interfaces, especially when downloading different kinds of application software. Thus, the impression of customized services can be created, and the users' adherence to terminal hardware and application platforms can be enhanced. Many operators (e.g., iPhone App Store or Google Android Market) think that the services of application stores are not aimed at profit, but assist in the sale of intelligent mobile phones and related equipments, thus increasing the added values of mobile phone devices. Therefore, it is more important for mobile application stores to perfect their service quality, especially in such a customer service oriented competitive market. If an enterprise actively promotes its service quality, its customer satisfaction will be improved eventually, thus creating customer value [7], increasing the enterprise's competitive power and profits, and further guaranteeing the enterprise's sustainable competitive advantage.

Three telecommunication companies in Taiwan have constructed a cross-software service platform in order to encompass all major mobile phone system platforms (e.g., iPhone App Store, NOKIA Ovi Store, Google Android Market and Windows Mobile Marketplace). The current platforms support only the Android system, but will extend to other platforms in the future. Under the trend of smart mobile phones, whether a mobile application store wins its customers depends on understanding the customers' needs. As the mobile application stores of various telecommunication companies provide a greater range of service selection for customers, the customers become the decision-makers, rather than the telecommunication companies, and their role will change from the communications service provider of the past to the provider of customized services meeting customers' needs of software, now and in the future.

Telecommunication companies in Taiwan suggest that their advantage in operating application stores is the large number of mobile users (i.e., 19.35 million 3G users in Taiwan at March 2011 [24]), and their introduction provides 3G users with greater choices of application services. However, do application stores operated by telecommunication companies in Taiwan meet the users' needs? Will service quality attract consumers' use and transactions? Service providers must enhance their service quality, by first measuring service quality, then determining its important factors. From the perspective of marketing, service providers' service quality is the key to customers' repurchase intentions, as well as maintenance of customer satisfaction and loyalty. Grönroos [10] suggested that customer satisfaction is experience accumulation, after demands for service quality are satisfied, and service quality is a prerequisite of customer satisfaction. There is a significant correlation between customer satisfaction and service quality. According to the gap analysis model (i.e., PZB model), as proposed by Parasuraman, Zeithaml, and Berry in 1985 and 1988 [19, 20], service quality depends on the gap between expected service and perceived service. The model could analyze the sources of service quality and assist management to improve service quality.

The measurement of service quality is a very important research subject in the service marketing domain. For example, Deng and Lee [6] evaluated the service quality of hotel operators and analyzed improvement priority and service quality. Wu et al. [21] suggested the gap analysis of service quality for culture and educational industries. Chou and Lu [3] discussed the relations among service quality, switching costs, and customer loyalty in home-delivery services. Lu and Wu [16] discussed the merits and demerits in the service quality of the Taiwan High Speed Rail. Since the telecommunication industry remains a highly competitive industry in Taiwan, the operators must notice changes in consumer demands and customers' perceptions of service quality, which is to say, the telecom service providers must master customers' real needs in order to develop and provide appropriate

products and services. Therefore, the investigation of the service quality required by the customer is extraordinarily important for mobile application stores.

The topic of the service quality of mobile application stores is new and has high research value. Although there are foreign studies on this topic, such as the Lu et al.'s study [17] on the service quality of mobile commerce in China; there are few studies on this issue in Taiwan. The assessment model, as proposed by Lu et al., has good adaptability and generalizability, and can be directly applied to similar services or research on the service quality of other types of mobile commerce. Hence, this study based on the characteristics of Taiwanese consumers and modified Lu et al.'s scales in order to analyze and compare the service quality of mobile application stores in Taiwan.

The importance-performance analysis (IPA) approach, as developed by Martilla and James [18], has been used to assess improvements that meet consumer's demand items regarding service quality. As the attributes of service quality of mobile application stores have multiple criteria [2,4,7,8], and these criteria, 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 service quality, 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 [15], in the measurement of service quality of mobile application stores. The theoretical basis of the modified P-I analysis method is derived from literature reviews related to the IPA method, fuzzy set theory [22], and multiple criteria, and the structure of data analysis is constructed based on practice. Therefore, the modified P-I analysis method is more applicable to this study than the traditional multiple criteria measurement method, as it can more correctly measure customers' evaluation of the service quality of mobile application stores. Hence, this study aimed to use the modified P-I analysis method to investigate the service qualities valued by mobile communications users, and identified the service qualities to be maintained or improved. The results can serve as reference to mobile application stores for improving service quality.

In summary, this study aimed to apply the modified P-I analysis method to analyze the service quality of mobile application stores of three telecommunications companies in Taiwan. Regarding the academic contribution of this paper, in addition to increasing the studies of the service quality of emerging application stores, this paper concludes specific measurement indicators for the service quality of mobile application stores in Taiwan, and provides a specific and feasible measurement method.

The remainder of this paper is organized as follows. Section 2 presents the service quality and its attributes. The modified P-I analysis method as the methodology is introduced in the third section. Consequently, the empirical survey is studied. Finally, conclusions are made in the last section.

2. **Service Quality Attributes.**

Since service is intangible, perishable, cannot be stored, and reveals heterogeneity, in comparison to the quality of physical products, it is more difficult to measure. However, many scholars (e.g., Cronin and Taylor [5], Grönroos [10], Lewis and Vincent [13], Lu et al. [17], Parasuraman et al. [19,20]) have overcome such obstacles and proposed different assessment models able to measure and study service quality. Parasuraman et al. [19,20] proposed the PZB model, and developed the scale 'SERVQUAL', with the five constructs of service quality, namely, tangibles, reliability, responsiveness, assurance and empathy. They suggested that service quality is the gap between expected service and perceived service in service delivery. This model analyzes

the source of service quality, which assists management to improve service quality. In addition, Cronin and Taylor [5] proposed the scale 'SERVPERF', which measures service quality according to service performance. Lu et al. [17] modified and integrated 'SERVQUAL' and 'SERVPERF', and applied them to measure the service quality of mobile commerce in China.

The model for measuring service quality of mobile communication, as proposed by Lu et al., is applicable, and can be directly applied to other similar services or be promoted for studies of service quality of other types of mobile commerce. This study intends to partially improve the attributes of service quality according to the characteristics of Taiwanese consumers [12,14]. According to the scale content of Lu et al.'s study [17], in order to define the characteristics of Taiwanese consumers based on the opinions of consumers, experts, and scholars regarding mobile communications, thirty-three service quality attributes are listed, as shown in Table 1.

3. Methodology.

In this section, some of the concepts and methods used in this paper are introduced. These include fuzzy set theory and the modified P-I analysis approach.

3.1. Fuzzy set theory.

The fuzzy set theory [22] 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.

3.1.1. *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 [9] in real line $\Re$ is a triangular fuzzy number if its membership function $f_A : \Re \to [0, 1]$ is

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

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

Let $A_1 = (c_1, a_1, b_1)$ and $A_2 = (c_2, a_2, b_2)$ be fuzzy numbers [7,8]. According to the extension principle [22], the algebraic operations of any two fuzzy numbers A_1 and A_2 can be expressed as

1. Fuzzy addition: $A_1 \oplus A_2 = (c_1 + c_2, a_1 + a_2, b_1 + b_2)$,
2. Fuzzy multiplication: $k \otimes A = (kc, ka, kb)$, $k \ge 0$, $k \in R$, $\quad A_1 \otimes A_2 \cong (c_1c_2, a_1a_2, b_1b_2)$, $c_1 \ge 0$, $c_2 \ge 0$,
3. Fuzzy division: $A_1 \emptyset A_2 \cong (c_1/b_2, a_1/a_2, b_1/c_2)$, $c_1 \ge 0$, $c_2 > 0$.

3.1.2. *Linguistic values.* In fuzzy decision environments, two preference ratings can be used, namely, fuzzy numbers and linguistic values characterized by fuzzy numbers [23]. Depending on practical needs, decision-makers (DMs) may apply one or both. In this paper, the importance degree and satisfaction degree are used to analytically express the linguistic value, and describe how important and satisfactory the involved service quality attributes 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,

TABLE 1. Service quality attributes

Dimensions	Attributes	Explanation and description
Attitude	A_1. Friendly service attitude	Service providers are friendly when serving users.
	A_2. Assist customer with use	Service providers actively assist users with using service of application stores (such as FAQ, forum or communities).
	A_3. Recognize users' needs	Service providers recognize users' demands for software and provide appropriate service content.
Expertise	A_4. Competent professionalism during service	Service providers are competent professionals when providing services in application stores.
	A_5. Answers questions rapidly	Service providers can immediately respond to users' questions related to services in application stores (both online and customer telephone lines).
	A_6. Satisfy users' demands for applications	Service providers recognize users' trust in their professional knowledge and they are able to satisfy users' demands for applications.
Problem solving	A_7. Sincerity in responses to users' questions	When users encounter problems related to systems or applications, service providers can sincerely respond to questions.
	A_8. Cope with problems or complaints	Service providers can directly (indirectly) cope with problems and complaints.
	A_9. The importance of solving users' problems	Service providers recognize the importance of solving users' problems.
Information	A_{10}. Provision of reliable information	Users can trust the information and descriptions provided by application stores.
	A_{11}. Provide defined service time	Application stores provide defined service time (period or deadline) for users.
	A_{12}. Provide the application information required by users	Application stores provide application information required by users (downloading times, recommendations, or comments).
Equipment	A_{13}. Stable network connection service	Transactions and downloading services of application stores are connected and stable.
	A_{14}. Provide precise connection signal	When application stores conduct transactions and downloading services, communication networks can provide a precise connection signal.
	A_{15}. Importance of communication network for users	Service providers recognize the importance of communication networks for users of application store services.
	A_{16}. Mobile phone devices allow successfultransactions	Users' smart mobile phone devices can successfully accomplish transactions in overall services of application stores.
	A_{17}. Immediate response of mobile phone device	In transactions of application stores, users' smart mobile phone devices can immediately respond.
	A_{18}. Ability to provide consistent services	When brands, specifications, or system of users' smart mobile phones differ, application stores can provide consistent services.

Dimensions	Attributes	Explanation and description
Design	A_{19}. Impressive interface design	User interface designs of application stores impress users.
	A_{20}. Satisfy users' demands in interfaces	Application store user interface designs can satisfy users' operational and use demands.
	A_{21}. Importance of interface design for users	After influencing use and operations, service providers recognize the importance of interface design for users.
Situation	A_{22}. Satisfy users' communication needs	In general situations, communication networks can satisfy users' needs.
	A_{23}. Need to use mobile phones in special environments.	Service providers recognize that uses must use mobile phones in special environments, such as basements, elevators, and other areas with poor reception.
	A_{24}. Service functions in special environments	In special environments, such as basements, elevators, and other areas with poor reception, users are able to access services.
Punctuality	A_{25}. Transaction time is predictable	Users can predict transaction times in application stores.
	A_{26}. Speed of transaction information delivery	Transaction information delivery speed in application stores is rapid, and reduces users' waiting time.
	A_{27}. Importance of immediate responses	Service providers recognize the importance of immediate responses to users.
Tangibles	A_{28}. Provides feedback after completing transactions	Feedback after completing transaction is provided by application stores, and includes the details of the transaction and payment.
	A_{29}. Immediate notification of successful transaction	Rapid notification of successful transactions and downloading results in application stores.
	A_{30}. Provide customized verification	After completing transactions, service providers can provide customized results, with verification for users (all transaction information, including transaction history, verification of use, etc.)
Valence	A_{31}. Positive experience of use	After application store completes services, users have the perception of a positive experience (entertainment, recreation, information provision, etc.)
	A_{32}. Provide positive use experience	I believe that application stores can provide positive use experiences for users.
	A_{33}. Recognize experience types required by users	I believe that application stores recognize experience types required by users.

Source: The authors modified the study of Lu et al. [17]

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.

3.2. **Modified P-I analysis.** Traditionally, the IPA approach [18] is used to evaluate service quality when meeting consumers' needs. It conducts measurements, based on specific services attributes importance and performance of customers' responses in order to determine the priority of relevant attributes. It then maps the performance of service attributes in a two-dimensional matrix (see Figure 1) in order to observe whether service quality must be improved or maintained. This analysis can provide enterprises with reference for improvement of future service quality.

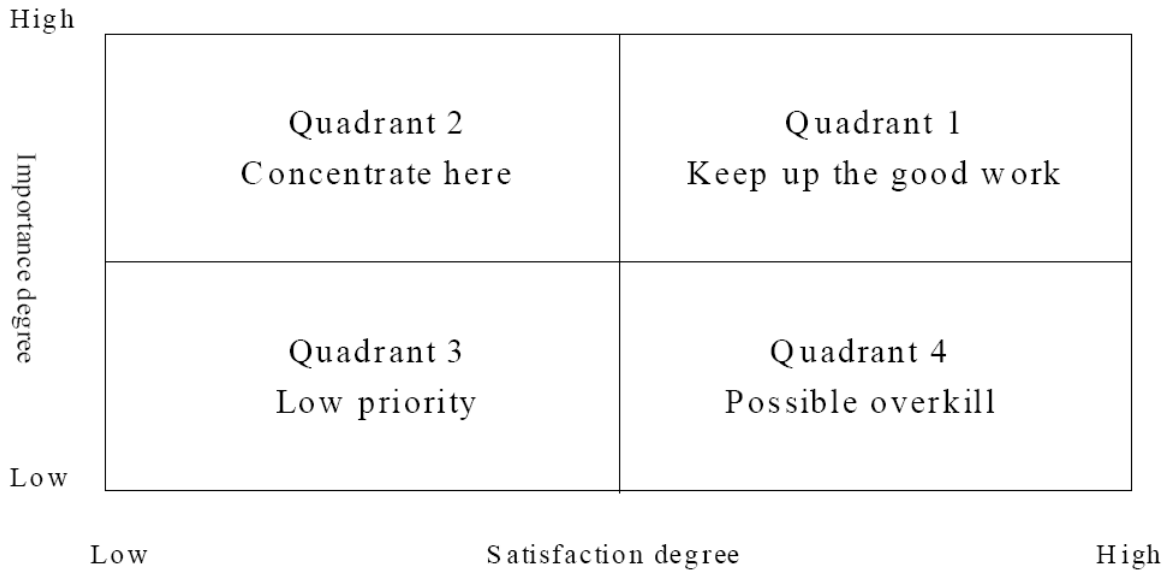

FIGURE 1. The importance-performance matrix (source: Martilla and James [18])

Lin [15] 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 paper uses the modified P-I analysis method to assess the service quality of mobile application stores. The steps of the modified P-I analysis method are as follows:

Step 1: Let $\tilde{I}^s_{jq} = (c^s_{jq}, a^s_{jq}, b^s_{jq})$ and $\tilde{P}^s_{jq} = (\xi^s_{jq}, \alpha^s_{jq}, \beta^s_{jq})$, $j = 1, 2, \ldots, h$, $q = 1, 2, \ldots, n$, $s = 1, 2, \ldots, m$, denotes the j^{th} customer's fuzzy importance degree, and fuzzy perception degree of the q^{th} service quality, as offered by the s^{th} application store.

Step 2: Calculate the average fuzzy importance degree and average fuzzy perception degree of the q^{th} service quality offered by the s^{th} application store, as represented by

$$\tilde{I}^s_q = (c^s_q, a^s_q, b^s_q), \text{ where } c^s_q = \sum_{j=1}^{h} c^s_{jq} \Big/ h,\ a^s_q = \sum_{j=1}^{h} a^s_{jq} \Big/ h,\ b^s_q = \sum_{j=1}^{h} b^s_{jq} \Big/ h, \quad (1)$$

and

$$\tilde{P}^s_q = (\xi^s_q, \alpha^s_q, \beta^s_q), \text{ where } \xi^s_q = \sum_{j=1}^{h} \xi^s_{jq} \Big/ h,\ \alpha^s_q = \sum_{j=1}^{h} \alpha^s_{jq} \Big/ h,\ \beta^s_q = \sum_{j=1}^{h} \beta^s_{jq} \Big/ h. \quad (2)$$

Step 3: Calculate total utility values of $\tilde{I}^s_q$ and $\tilde{P}^s_q$, denoted by $U_T\left(\tilde{I}^s_q\right)$ and $U_T\left(\tilde{P}^s_q\right)$, where

$$U_T\left(\tilde{I}^s_q\right) = \left[U_R\left(\tilde{I}^s_q\right) + 1 - U_L\left(\tilde{I}^s_q\right)\right] \Big/ 2, \quad q = 1, 2, \ldots, n, \quad s = 1, 2, \ldots, m \quad (3)$$

and

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

The maximizing and minimizing sets [1] of the average fuzzy importance degree are denoted by $x_1 = \min\{c_1^s, c_2^s, \ldots, c_n^s\}$ and $x_2 = \max\{b_1^s, b_2^s, \ldots, b_n^s\}$, respectively. The maximizing and minimizing sets of the average fuzzy perception degree are denoted by $y_1 = \min\{\xi_1^s, \xi_2^s, \ldots, \xi_n^s\}$ and $y_2 = \max\{\beta_1^s, \beta_2^s, \ldots, \beta_n^s\}$, respectively. According to the Hsieh and Chen's method [8], the right and left utility values are

$$U_R\left(\tilde{I}_q^s\right) = \frac{b_q^s - x_1}{(x_2 - x_1) - (a_q^s - b_q^s)} \tag{5}$$

and

$$U_L\left(\tilde{I}_q^s\right) = \frac{x_2 - c_q^s}{(x_2 - x_1) + (a_q^s - c_q^s)} \tag{6}$$

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

$$U_R\left(\tilde{P}_q^s\right) = \frac{\beta_q^s - y_1}{(y_2 - y_1) - (\alpha_q^s - \beta_q^s)} \tag{7}$$

and

$$U_L\left(\tilde{P}_q^s\right) = \frac{y_2 - \xi_q^s}{(y_2 - y_1) + (\alpha_q^s - \xi_q^s)} \tag{8}$$

Step 4: In Lin's method, he mapped the performance of the service quality of each item in a two-dimensional matrix (see Figure 2). 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 $\bar{U}_T\left(\tilde{I}^s\right)$. The service quality of each item is positioned in four parts, as in Figure 2, including (1) position I: competitive vulnerability, (2) position II: competitive strength, (3) position III: irrelevant superiority, and (4) position IV: relative indifference, respectively.

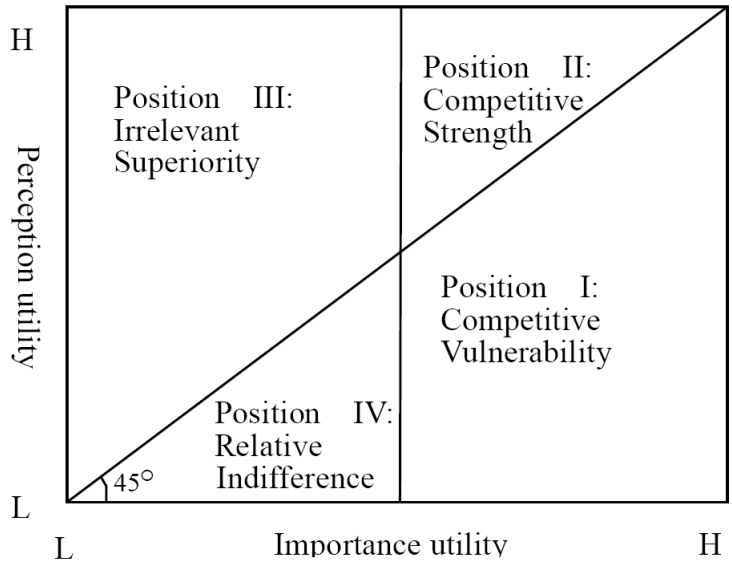

FIGURE 2. Modified P-I analysis chart (source: Lin [15])

In this paper, the average value of the total utility value of the average fuzzy importance for all n service quality items can be represented as

$$\bar{U}_T\left(\tilde{I}^s\right) = \frac{\sum_{q=1}^{n} U_T\left(\tilde{I}_q^s\right)}{n}, \quad s = 1, 2, \ldots, m. \tag{9}$$

As shown in Figure 2, regarding the s^{th} application store, if $U_T\left(\tilde{P}_q^s\right) \geq U_T\left(\tilde{I}_q^s\right)$, then the gap nature of the q^{th} service quality attribute is positive (i.e., the q^{th} service quality attribute is above the straight line of the 45 degree angle).

In order to determine whether q^{th} service quality belongs to competitive strength (i.e., position II) or irrelevant superiority (i.e., position III), the values of $U_T\left(\tilde{I}_q^s\right)$ and $\bar{U}_T\left(\tilde{I}^s\right)$ are compared. That is, if $U_T\left(\tilde{I}_q^s\right) \geq \bar{U}_T\left(\tilde{I}^s\right)$, then the q^{th} service quality has competitive strength in position II. On the other hand, if $U_T\left(\tilde{I}_q^s\right) < \bar{U}_T\left(\tilde{I}^s\right)$, it represents the q^{th} service quality has irrelevant superiority in position III.

By the same concept, if $U_T\left(\tilde{P}_q^s\right) \leq U_T\left(\tilde{I}_q^s\right)$, the gap nature of the q^{th} service quality is negative (i.e., the service quality attribute is below the straight line at 45 degree angle). That is, if $U_T\left(\tilde{I}_q^s\right) \geq \bar{U}_T\left(\tilde{I}^s\right)$, then the q^{th} service quality has competitive vulnerability in position I, and if $U_T\left(\tilde{I}_q^s\right) < \bar{U}_T\left(\tilde{I}^s\right)$, then the q^{th} service quality has relative indifference in position IV.

4. **Empirical Study.**

4.1. **Questionnaire design and survey.** To examine whether the attributes of service quality are valued by mobile communication users, and whether they are factors that require improvement. The questionnaire content aims to assess the importance and perception satisfaction of the thirty-three attributes of service quality, 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 0.902 and 0.891, indicating good consistency of the questionnaire. As to validity analysis, the items in the questionnaire were based on Lu et al. [17] and expert opinions, thus, the questionnaire content had a content validity. In this paper, the correlation coefficients of items were 0.63-0.90, hence, they were significant and indicated good construct validity.

The questionnaire survey was conducted from August to October 2010. In order to increase the return rate and representativeness of the questionnaire, the subjects were sampled from several mobile communications companies and users of mobile application stores. A total of 391 questionnaires were distributed, and 314 effective samples were returned, for a valid return rate of 80.3%.

The basic information of the questionnaire survey is reorganized in Table 2. The statistics data shows:

1. Males account for 56.7% and females 43.3%.
2. Most participants are 25-29 years old (33.4%), and 29.0% are 30-34 years old.
3. Most graduated from college or university (59.9%).

4. Most are employed in private companies (60.8%), followed by teachers and students (18.8%).
5. Most have an average monthly income of NTD 30,000-50,000 (about US$ 970-1,610) (55.7%).
6. There are 11.5% with experience of application stores for more than one year; 14.6% have 7-12 months experience, 35.7% have 4-6 months experience, 22.6% have 1-3 months experience, and 15.6% have less than one month experience.
7. There are 42.7% using Chunghwa Telecom, 27.7% use Taiwan Mobile, and 26.4% use FET net. The total number users of these three major companies accounts for 96.8%.

Table 2. Descriptive statistics data

Measure	Option	Frequency	Percentage
Gender	Male	178	56.7%
	Female	136	43.3%
Age	< 18	12	3.8%
	18-24	34	10.8%
	25-29	105	33.4%
	30-34	91	29.0%
	35-40	43	13.7%
	> 40	29	9.2%
Education	Master degree or higher	91	29.0%
	Bachelor or associate degree	188	59.9%
	High school or lower	35	11.1%
Occupation	Private company	191	60.8%
	Government	25	8.0%
	Teacher	16	5.1%
	Student	43	13.7%
	Others	39	12.4%
Monthly income (New Taiwan Dollars, NTD)	$< 10,000$	33	10.5%
	10,000-20,000	26	8.3%
	20,000-30,000	40	12.7%
	30,000-50,000	175	55.7%
	$> 50,000$	40	12.7%
Length using mobile application stores service	< 1 month	49	15.6%
	1-3 months	71	22.6%
	4-6 months	112	35.7%
	7-12 months	46	14.6%
	> 12 months	36	11.5%
Mobile network operator	Chunghwa Telecom	134	42.7%
	Taiwan Mobile	87	27.7%
	FET net	83	26.4%
	Others	10	3.2%

4.2. **Results.** This section conducts computations based on the assessment model described in Section 3.2, with analysis processes described as follows:

Step 1. Each respondent makes linguistic assessments of each service quality of mobile application stores, and the fuzzy importance degree and fuzzy perception degree of each

service quality can be obtained from the triangular fuzzy numbers corresponding to the linguistic values. Secondly, according to the Equations (1) and (2), the obtained average fuzzy importance and fuzzy perception degrees of all service quality of three mobile application stores are shown in Table 3.

TABLE 3. Aggregate fuzzy assessments of importance and perception

Attributes	Chunghwa Telecom		Taiwan Mobile		FET net	
	$\tilde{I}_q^s$	$\tilde{P}_q^s$	$\tilde{I}_q^s$	$\tilde{P}_q^s$	$\tilde{I}_q^s$	$\tilde{P}_q^s$
A_1	(4.90,5.90,6.60)	(4.11,5.11,5.99)	(4.67,5.67,6.37)	(3.90,4.90,5.87)	(4.85,5.85,6.56)	(3.70,4.70,5.59)
A_2	(4.82,5.82,6.54)	(3.93,4.93,5.79)	(4.67,5.67,6.43)	(3.53,4.53,5.50)	(4.70,5.70,6.44)	(3.89,4.89,5.74)
A_3	(5.06,6.06,6.65)	(3.78,4.76,5.67)	(4.67,5.67,6.40)	(3.27,4.27,5.23)	(4.74,5.74,6.56)	(3.81,4.81,5.74)
A_4	(4.79,5.79,6.61)	(3.86,4.86,5.78)	(4.77,5.77,6.57)	(3.40,4.40,5.40)	(4.78,5.78,6.59)	(3.78,4.78,5.74)
A_5	(5.00,6.00,6.69)	(3.85,4.83,5.76)	(5.00,6.00,6.67)	(3.70,4.70,5.70)	(4.74,5.74,6.52)	(3.63,4.63,5.56)
A_6	(4.81,5.81,6.58)	(3.86,4.86,5.76)	(4.77,5.77,6.53)	(3.23,4.20,5.20)	(4.59,5.59,6.33)	(3.48,4.48,5.44)
A_7	(5.15,6.15,6.76)	(3.90,4.88,5.76)	(4.87,5.87,6.60)	(3.57,4.53,5.47)	(5.00,6.00,6.74)	(3.85,4.85,5.74)
A_8	(4.97,5.97,6.65)	(3.83,4.79,5.71)	(4.90,5.90,6.57)	(3.67,4.63,5.63)	(4.59,5.59,6.44)	(3.74,4.74,5.67)
A_9	(5.10,6.10,6.72)	(3.86,4.83,5.75)	(5.00,6.00,6.63)	(3.47,4.43,5.43)	(4.89,5.89,6.67)	(3.67,4.67,5.59)
A_{10}	(5.03,6.03,6.71)	(3.90,4.90,5.86)	(5.13,6.13,6.77)	(3.83,4.83,5.77)	(5.11,6.11,6.74)	(3.67,4.67,5.63)
A_{11}	(4.76,5.76,6.53)	(3.96,4.96,5.89)	(4.77,5.77,6.47)	(3.87,4.87,5.83)	(4.78,5.78,6.48)	(3.74,4.74,5.63)
A_{12}	(5.01,6.01,6.71)	(3.93,4.93,5.86)	(4.93,5.93,6.70)	(3.73,4.73,5.70)	(4.93,5.93,6.67)	(3.52,4.52,5.48)
A_{13}	(5.47,6.47,6.88)	(3.83,4.82,5.75)	(5.33,6.33,6.80)	(4.03,5.03,5.97)	(5.26,6.26,6.78)	(3.59,4.52,5.48)
A_{14}	(5.44,6.44,6.83)	(3.94,4.93,5.85)	(5.30,6.30,6.80)	(3.87,4.87,5.83)	(5.33,6.33,6.78)	(3.59,4.59,5.56)
A_{15}	(5.22,6.22,6.75)	(3.93,4.92,5.86)	(5.17,6.17,6.67)	(3.97,4.97,5.90)	(4.93,5.93,6.56)	(3.70,4.70,5.67)
A_{16}	(5.01,6.01,6.65)	(3.99,4.99,5.93)	(4.87,5.87,6.53)	(3.87,4.87,5.83)	(4.74,5.74,6.41)	(3.85,4.85,5.81)
A_{17}	(5.03,6.03,6.68)	(3.97,4.97,5.89)	(4.77,5.77,6.47)	(3.77,4.77,5.73)	(4.63,5.63,6.37)	(3.63,4.59,5.56)
A_{18}	(4.82,5.82,6.60)	(3.93,4.93,5.88)	(4.53,5.53,6.43)	(3.73,4.73,5.70)	(4.67,5.67,6.44)	(3.81,4.81,5.78)
A_{19}	(4.68,5.68,6.51)	(3.93,4.93,5.83)	(4.50,5.50,6.27)	(3.57,4.57,5.57)	(4.48,5.48,6.26)	(3.78,4.78,5.78)
A_{20}	(4.85,5.85,6.61)	(3.93,4.93,5.85)	(4.73,5.73,6.47)	(3.53,4.53,5.53)	(4.63,5.63,6.41)	(3.74,4.74,5.74)
A_{21}	(4.92,5.92,6.61)	(4.07,5.07,5.96)	(4.97,5.97,6.67)	(3.33,4.33,5.33)	(4.93,5.93,6.59)	(3.63,4.63,5.63)
A_{22}	(5.06,6.06,6.71)	(4.00,5.00,5.94)	(4.77,5.77,6.50)	(4.00,5.00,5.97)	(4.70,5.70,6.56)	(3.93,4.93,5.93)
A_{23}	(4.74,5.74,6.50)	(3.72,4.71,5.65)	(4.30,5.30,6.13)	(3.60,4.60,5.60)	(4.44,5.44,6.30)	(3.44,4.44,5.44)
A_{24}	(4.75,5.75,6.51)	(3.69,4.67,5.60)	(4.40,5.40,6.23)	(3.53,4.53,5.53)	(4.33,5.33,6.19)	(3.41,4.41,5.41)
A_{25}	(4.69,5.69,6.47)	(3.78,4.78,5.71)	(4.43,5.43,6.37)	(3.50,4.50,5.50)	(4.30,5.30,6.15)	(3.56,4.56,5.52)
A_{26}	(4.86,5.86,6.56)	(3.75,4.75,5.69)	(4.60,5.60,6.50)	(3.50,4.50,5.50)	(4.30,5.30,6.15)	(3.63,4.63,5.59)
A_{27}	(4.96,5.96,6.65)	(3.82,4.82,5.76)	(4.80,5.80,6.63)	(3.60,4.60,5.60)	(4.52,5.52,6.41)	(3.63,4.63,5.56)
A_{28}	(4.71,5.71,6.49)	(3.86,4.86,5.79)	(4.87,5.87,6.73)	(3.60,4.60,5.60)	(4.59,5.59,6.44)	(3.89,4.89,5.89)
A_{29}	(4.79,5.79,6.53)	(3.83,4.83,5.75)	(4.97,5.97,6.73)	(3.73,4.73,5.73)	(4.67,5.67,6.44)	(3.93,4.93,5.89)
A_{30}	(4.53,5.53,6.33)	(3.78,4.76,5.69)	(4.67,5.67,6.53)	(3.33,4.30,5.30)	(4.33,5.33,6.15)	(3.67,4.67,5.63)
A_{31}	(4.81,5.81,6.56)	(3.86,4.86,5.78)	(4.73,5.73,6.57)	(3.70,4.70,5.70)	(4.63,5.63,6.52)	(3.59,4.59,5.56)
A_{32}	(4.89,5.89,6.60)	(3.89,4.89,5.79)	(4.73,5.73,6.53)	(3.70,4.70,5.67)	(4.63,5.63,6.52)	(3.48,4.48,5.44)
A_{33}	(4.83,5.83,6.57)	(3.86,4.86,5.76)	(4.57,5.57,6.43)	(3.50,4.50,5.50)	(4.74,5.74,6.56)	(3.63,4.63,5.59)

Step 2: Calculate the right utility value and left utility value of the average fuzzy importance degrees and average fuzzy perception degrees of the service quality of the three mobile application stores, respectively. According to the Equations (5), (6), (7) and (8), and the results are shown in Table 4. Secondly, the total utility of the average fuzzy importance degrees of all service qualities of the three mobile application stores are

calculated according to the Equations (3) and (4). The results of $U_T\left(\tilde{I}_q^s\right)$ and $U_T\left(\tilde{P}_q^s\right)$ are shown in Table 4. For each mobile application store, $U_T\left(\tilde{P}_q^s\right) \leq U_T\left(\tilde{I}_q^s\right)$ denotes that the nature of the gap representing the service quality attributes of three mobile application stores is negative.

Step 3: The average of the total utility value of the average fuzzy importance degree $\bar{U}_T\left(\tilde{I}^s\right)$ of all n service quality items of three mobile application stores can be calculated according to the Equation (9), as shown in the last line of Table 4.

Step 4: According to the assessment results of service quality for all three mobile application stores, the service quality attributes of the three telecommunications companies are as drawn in Figures 3, 4 and 5, respectively. Finally, this paper concludes the impact points of service quality of three mobile application stores, and offers suggestions for service quality strategies, as shown in Table 5.

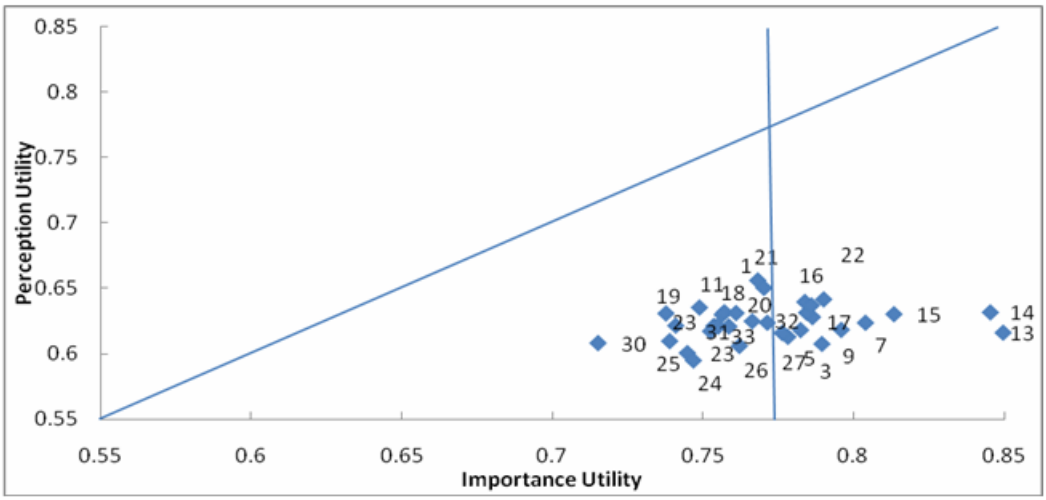

FIGURE 3. Modified P-I analysis plot chart (Chunghwa Telecom)

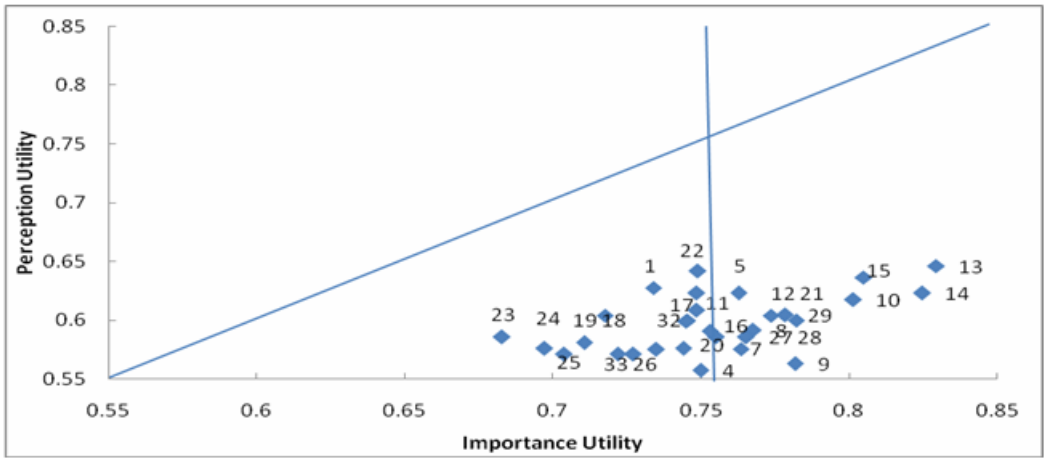

FIGURE 4. Modified P-I analysis plot chart (Taiwan Mobile)

4.3. **Discussions.** This study assesses the impact point of service quality attributes of three mobile application stores, and offers suggestions for service quality strategy according to these impact points. The strategy suggestions can help enterprises to access

TABLE 4. Total utility values and nature of gap

Attributes	Chunghwa Telecom		Taiwan Mobile		FET net		Nature of gap
	$U_T\left(\tilde{I}_q^s\right)$	$U_T\left(\tilde{P}_q^s\right)$	$U_T\left(\tilde{I}_q^s\right)$	$U_T\left(\tilde{P}_q^s\right)$	$U_T\left(\tilde{I}_q^s\right)$	$U_T\left(\tilde{P}_q^s\right)$	
A_1	0.768	0.656	0.734	0.628	0.761	0.598	Negative
A_2	0.756	0.630	0.735	0.575	0.740	0.624	Negative
A_3	0.790	0.607	0.734	0.537	0.746	0.615	Negative
A_4	0.754	0.621	0.750	0.557	0.752	0.610	Negative
A_5	0.782	0.618	0.782	0.600	0.746	0.588	Negative
A_6	0.755	0.621	0.749	0.530	0.724	0.568	Negative
A_7	0.804	0.624	0.763	0.576	0.783	0.619	Negative
A_8	0.778	0.613	0.768	0.592	0.725	0.604	Negative
A_9	0.796	0.618	0.782	0.563	0.767	0.593	Negative
A_{10}	0.786	0.628	0.801	0.618	0.798	0.594	Negative
A_{11}	0.749	0.635	0.748	0.623	0.750	0.603	Negative
A_{12}	0.784	0.631	0.774	0.604	0.772	0.573	Negative
A_{13}	0.850	0.616	0.829	0.646	0.819	0.576	Negative
A_{14}	0.845	0.632	0.825	0.623	0.829	0.584	Negative
A_{15}	0.813	0.630	0.805	0.637	0.771	0.600	Negative
A_{16}	0.784	0.640	0.763	0.623	0.744	0.621	Negative
A_{17}	0.786	0.637	0.748	0.609	0.729	0.585	Negative
A_{18}	0.757	0.632	0.718	0.604	0.735	0.616	Negative
A_{19}	0.738	0.631	0.711	0.581	0.708	0.611	Negative
A_{20}	0.761	0.631	0.744	0.576	0.730	0.606	Negative
A_{21}	0.770	0.651	0.778	0.548	0.771	0.590	Negative
A_{22}	0.790	0.642	0.749	0.642	0.741	0.632	Negative
A_{23}	0.745	0.600	0.683	0.586	0.704	0.563	Negative
A_{24}	0.747	0.595	0.697	0.576	0.688	0.558	Negative
A_{25}	0.739	0.610	0.704	0.571	0.683	0.578	Negative
A_{26}	0.762	0.606	0.727	0.571	0.683	0.589	Negative
A_{27}	0.776	0.616	0.755	0.586	0.715	0.588	Negative
A_{28}	0.741	0.621	0.765	0.586	0.725	0.627	Negative
A_{29}	0.753	0.617	0.778	0.605	0.735	0.631	Negative
A_{30}	0.715	0.608	0.736	0.544	0.687	0.594	Negative
A_{31}	0.755	0.621	0.745	0.600	0.731	0.584	Negative
A_{32}	0.766	0.625	0.745	0.599	0.731	0.568	Negative
A_{33}	0.759	0.621	0.722	0.571	0.746	0.589	Negative
$\bar{U}_T\left(\tilde{I}^s\right)$	0.771		0.753		0.742		

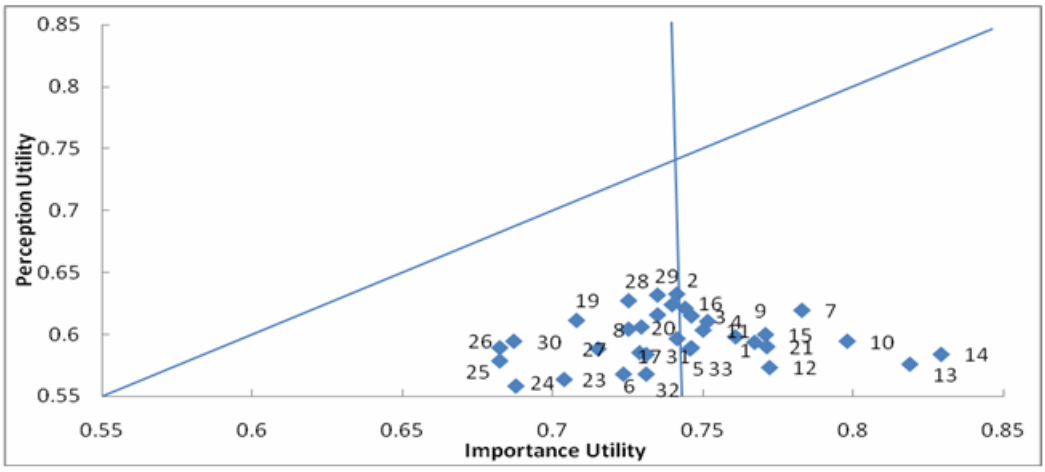

FIGURE 5. Modified P-I analysis plot chart (FET net)

TABLE 5. Attributes included in different positions for three service providers

Service Provider	Position I.	Position II.	Position III.	Position IV.
Chunghwa Telecom	A_3, A_5, A_7, A_8, A_9, A_{10}, A_{12}, A_{13}, A_{14}, A_{15}, A_{16}, A_{17}, A_{22}, A_{27}	None	None	A_1, A_2, A_4, A_6, A_{11}, A_{18}, A_{19}, A_{20}, A_{21}, A_{23}, A_{24}, A_{25}, A_{26}, A_{28}, A_{29}, A_{30}, A_{31}, A_{32}, A_{33}
Taiwan Mobile	A_5, A_7, A_8, A_9, A_{10}, A_{12}, A_{13}, A_{14}, A_{15}, A_{16}, A_{21}, A_{27}, A_{28}, A_{29}	None	None	A_1, A_2, A_3, A_4, A_6, A_{11}, A_{17}, A_{18}, A_{19}, A_{20}, A_{22}, A_{23}, A_{24}, A_{25}, A_{26}, A_{30}, A_{31}, A_{32}, A_{33}
FET net	A_1, A_3, A_4, A_5, A_7, A_9, A_{10}, A_{11}, A_{12}, A_{13}, A_{14}, A_{15}, A_{16}, A_{21}, A_{33}	None	None	A_2, A_6, A_8, A_{17}, A_{18}, A_{19}, A_{20}, A_{22}, A_{23}, A_{24}, A_{25}, A_{26}, A_{27}, A_{28}, A_{29}, A_{30}, A_{31}, A_{32}
Suggestion of service quality strategy	Require a greater effort to reverse the nature of gap from negative to positive	Maintain the fine performance	Shift some efforts to the attributes included in position I	Do not require much attention and concern

resources more efficiently, thus improving their original positions of 'competitive vulnerability' to the position of 'competitive strength' in the future. The service quality strategies located in the four quadrants are described as below.

1. Competitive vulnerability (position I). The service quality items in this quadrant have high perception importance but low satisfaction, the mobile communication users' satisfaction for the service provided by telecom service providers should be improved. The telecom service providers should make more efforts to turn the service quality gap from negative to positive. In other words, the service quality items in this quadrant should be listed as key points to be improved by telecom service providers. Meanwhile, as the improvement of these service quality items has great marginal effect on enterprises, the quality items in this quadrant should be improved first, to avoid losing customers.
2. Competitive strength (position II). The service quality items in this quadrant have high perception importance and satisfaction; they are a source of competitive advantages of mobile application stores of telecom service providers. However, according

to the survey of this study, the service quality of the three telecommunications companies is not presently within this quadrant.

3. Irrelevant superiority (position III). The service quality items in this quadrant have low perception importance but high satisfaction, the service quality items in this quadrant are not very helpful for improving customer satisfaction, and have slight marginal effect on service quality improvement. Therefore, it is not necessary to use excessive resources in this quadrant. However, the telecom service providers must maintain the original service quality for these service items, although it may be regarded as excessive resource supply. If turned into a 'competitive vulnerability' subject by adjusting resourc0es, it will eventually be adjusted to a 'competitive strength' through service improvement.
4. Relative indifference (position IV). The service quality items in this quadrant have low perception importance and satisfaction, and telecom service providers need not pay too much attention in this quadrant. The service quality items 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 service quality items can be used as reference for resource reallocation and future marketing adjustment of application stores.

There are fourteen, fourteen, and fifteen service quality attributes for the mobile communication of Chunghwa Telecom, Taiwan Mobile, FET net, respectively, and belong to position I (competitive vulnerability), as shown in Figures 3, 4 and 5, respectively. In summary, the 'competitive vulnerability' of the three telecommunication companies indicates that:

(1) The service quality items of competitive vulnerability are highly valued by mobile communication users of the three telecommunication companies. However, all three have a lower perceived satisfaction degree.
(2) The perceived satisfaction degree of the mobile communication users of the three telecommunication companies regarding the application stores should be improved. Accordingly, the three telecommunication companies should make greater efforts to turn the quality gap from negative to positive, which would enable them to promote the quality of their software services.
(3) The service quality items with relative indifference show that the mobile communication users of the three telecommunication companies have less concern regarding these service quality items, thus, the companies should not attach great importance to these items.

Based on the results of Section 4.2, there are nine service quality valued by all the mobile communication users of the three telecommunication companies in Taiwan, including 'answers questions rapidly (A_5)', 'sincerity in responses to users' questions (A_7)', 'the importance of solving users' problems (A_9)', 'provision of reliable information (A_{10})', 'provide the application information required by users (A_{12})', 'stable network connection service (A_{13})', 'provide precise connection signal (A_{14})', 'importance of communication network for users (A_{15})' and 'mobile phone devices allow successful transactions (A_{16})', respectively. Important items to be implemented were described as following:

(1) Answers questions rapidly. This service provides technical support for the mobile communication users of the application stores; support service experts diagnosed problems encountered by customers, and suggested that, responses within the experienced time period are acceptable to the customers; technical support aims to solve problems quickly, diagnose software problems, and provide troubleshooting support.

(2) Sincerity in responses to users' questions. When mobile communication users encountered systematic or software problems, the service system of the application stores would provide detailed answers or refer to experts for solutions in order to answer all customers' questions.
(3) The importance of solving users' problems. The service providers must understand the importance of solving users' problems, and solve such problems based on a balance between service costs and quality in order to maintain satisfactory business connections with users.
(4) Provision of reliable information. The provision of reliable information by application stores can reduce the risks of uncertainty for mobile communication users when using the application software. As the provision of reliable information can reduce such risks, users could use the software services more easily and make faster decisions, thus improving the store utilization rate.
(5) Provide the application information required by users. The provision of application information required by users (e.g., the number of download times, recommendations, or reviews) could meet the users' requirements on software information services, thus, ensuring the service quality of the information delivered.
(6) Stable network connection service. All transactions and download services should be stable; however, as the number of mobile communication users increases, the network congestion of mobile communication causes services to deteriorate. In shopping malls, convention centers, or hotels, when numerous mobile communication users are simultaneously using the mobile application store services, thus, exceeding the load capacity of the local network, network congestion would occur, which would reduce network efficiency and affect the mobile communication users' satisfaction regarding the network service quality.
(7) Provide precise connection signal. Poor online signal cover is a common reason for abnormal mobile phone service. Mobile communication users find that mobile phones have a poor or no signal; and occasionally, even with a signal, the mobile phone may display the "for emergency call only" message. Users' mobile phones frequently search for a signal, which affects the download services and transactions of the application stores.
(8) Importance of communication network for users. Service providers should understand the importance of communication networks in application store services. In addition to speed and spread, the importance of a communication network is mobility, which allows mobile communication users to use a wireless mobile device (e.g., mobile phone or PDA) at any time and place and access the services and information transmissions provided online by the application store.
(9) Mobile phone devices allow successful transactions. From the communication functions to software downloads and transactions of the application store, smart mobile phones can smoothly download and conduct transactions. The transaction information can be directly sent from the mobile phone in order to confirm and process financial transactions at financial institutions, such as banks. Service providers can increase the rate of users' smart mobile phones and create a complete software service model for mobile application stores.

In addition to the above-mentioned nine service quality simultaneously valued by all mobile communication users, this study proposes other service quality items of value for the three companies, as detailed below:

(1) For Chunghwa Telecom

The company should provide services from customers' perspectives and based on an understanding of customers' demands. The company should learn about the users' needs from market surveys, thus improving the marketing efficiency and reducing the unnecessary services to customers. The company should handle problems encountered by mobile communication users from the application stores in a timely manner, and follow up on the service effects in order to develop long-term customer service relationships. Moreover, the company should be familiar with the transmission of various data types supported by the communication network (e.g., different transmission interfaces, speeds, and network connection capabilities), and provide transmission application services for these types in order to meet the customers' various needs regarding communication services.

To ensure a quick response mode for electronic transactions and other operations of mobile communication users, the company should provide a system structure with elasticity, scalability, compatibility, and stability for the mobile application stores. Moreover, the company should understand that errors in the responses to customers, as well as handling abnormal information, are critical issues that may increase operational risks.

(2) For Taiwan Mobile

The company should respond to the problems and complaints of mobile communication users in the application stores in a timely manner, and follow up on the service effects, in order to develop long-term customer service relationships. The service provider should realize that interface design is very important to the users, and a good interface design could make mobile communication users more confident in the use of services, thus, enabling them to learn the functions more quickly.

The company should ensure a rapid response mode for mobile communication users in electronic transactions, and understand the importance of the timely handling of any flaws in responses to customers or abnormal information. Moreover, the application stores should provide a feedback information program, including detailed transaction and payment data, to the mobile communication users upon the completion of a transaction, and inform the users about the software downloads and installation status.

(3) For FET net

The company should treat users in a friendly and professional manner, more actively understand the users' needs, and provide corresponding services. First, the company should provide services from customers' perspectives, which are based on an understanding of customers' demands. The company should learn about the users' needs from market surveys, thus improving marketing efficiency and reducing unnecessary services to customers. Meanwhile, the company should have professional knowledge in the field of telecommunications, as well as the services provided in the application store in order that the users could develop greater trust in the company.

Second, the company should provide the service times of mobile application software (define the time period or time limit based users' needs), more importantly, the service time would be clear to users. The service provider should realize that the interface design is very important to users, as a good interface design makes mobile communication users more confident in the use of services, and enables them to learn the functions more quickly.

Finally, the company should understand use experience types of the customers, as well as the approaches of providing these experiences, thus, the application stores can provide customized application software services, such as entertainment, leisure, information provision, etc, according to specific marketing objectives.

5. **Conclusions.** This study utilized the modified P-I analysis method to analyze the service quality of the mobile application stores of three telecommunication companies,

and conducted an empirical investigation by questionnaire survey. The main findings are described as follows:

(1) The questionnaire survey on the thirty-three service quality factors revealed that, none of the service quality items of the mobile application stores of the three telecommunication companies in Taiwan fall in the competitive strength region (position II). This suggests that, the importance of mobile communication users regarding service quality is higher than the perceived satisfaction level, indicating that perceived satisfaction for the mobile communication users regarding application store service should be improved. This is an issue for the consideration of all telecommunication companies.

(2) In a comparison of the service quality valued by the users of the three mobile communication companies, nine service qualities are the same, namely, 'answers questions rapidly,' 'sincerity in responses to users' questions,' 'the importance of solving users' problems,' 'provision of reliable information,' 'provide the application information required by users,' 'stable network connection service,' 'provide precise connection signal,' 'importance of communication network for users,' and 'mobile phone devices allow successful transactions,' respectively. These nine service qualities are the key factors for mobile application stores to provide good service quality.

(3) All three companies should analyze the service quality factors that are valued by customers that present lower satisfaction. This study suggested that the telecommunication companies should respond clearly and quickly to users' problems concerning application store services. When users encounter system or software problems, the services providers should be able to solve their problems efficiently, and further provide them with necessary and reliable software information and instruction. Moreover, the telecommunication companies should realize the importance of network services to mobile communication users. The provision of precise signals, smooth transactions and download processes, stable network connections, and successful completion of the transactions at the application stores through smart phones are the main factors affecting users' selections and satisfaction of services.

(4) Compared with global application stores, such as the iPhone App Store and the Google Android Market, the three application stores in Taiwan provide only about one thousand software applications, with increased software selection and download rates are far behind those of the iPhone App Store and the Google Android Market. The only distinguishable feature of the application software provided by the three telecommunication companies in Taiwan is the Chinese interface. The development trend of the application stores in Taiwan is inevitable. As the effect of using voice communication service to enhance the average revenue per user (ARPU) becomes less obvious, the telecommunication companies should increase the data flow rate of application services in order to improve the ARPU. In sum, the telecommunication companies in Taiwan should continue to improve the service quality of their application stores in order to maintain positive customer relationships.

The subjects of this study were mobile communication users in the metropolitan area of Taipei. The perceived importance and satisfaction concerning service quality of other areas may differ from the results of this study, thus, further studies should be conducted. Future studies can also apply other research frameworks or analysis methods to enrich the research findings.

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