



# Service quality gaps analysis based on Fuzzy linguistic SERVQUAL with a case study in hospital out-patient services

Service quality  
gaps analysis

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## Abstract

**Purpose** – This study seeks to propose a conceptual approach to assess the perceived service quality properly using Fuzzy logic. First, it aims to verify whether it is a better solution than the Likert scale. Second, it seeks to evaluate patients' feedback towards hospital service quality using Fuzzy linguistic analysis.

**Design/methodology/approach** – The SERVQUAL questionnaire was developed according to the characteristics of each hospital's out-patient service. Three regional hospitals in Hsin-Chu, Taiwan were evaluated. After being completed and collected, first, the effectiveness of the Fuzzy linguistic scale and the Likert scale was compared. Second, gap values of each element were evaluated to find the core service quality attributes for continuous improvement. Finally, analysis of variance (ANOVA) was conducted to segment markets using certain service quality attributes and different demographic variables.

**Findings** – The result indicated that the Fuzzy linguistic scale is higher than the Likert scale in terms of reliability in the measurement. Moreover, through gap analysis and ANOVA, a better focus was achieved on the 8th, 10th, 14th, 21st and 3rd service quality attributes from the SERVQUAL measurement on which management should concentrate and which they should endeavor to work out. The 1st, 2nd, 14th and 16th items from the SERVQUAL measurement can be market segment factors, respectively.

**Originality/value** – The study successfully introduced Fuzzy linguistic analysis into the Gap theory and SERVQUAL measurements, and provided more internal consistency and stability than the Likert scale. After discussing the findings of the gap analysis and ANOVA, the organization could find the critical service quality attributes and create a value for improving or enhancing them.

**Keywords** SERVQUAL, Gap analysis, Analysis of variance, Customer satisfaction

**Paper type** Research paper



## Introduction

Measurement is a key management activity, it can provide information necessary for effective decision making, for monitoring performance and for effectively allocating

resources (Webster and Hung, 1994). Nowadays SERVQUAL is the best-known service quality measurement instrument, and has been widely used to measure service quality in various service industries. In recent research, these have included: tourism management (Juwaheer, 2004; Antony *et al.*, 2004; Tsang and Qu, 2000); library services (Yu *et al.*, 2008); the banking sector (Chi *et al.*, 2003; Jabnoun and Ai-Tamimi, 2003); electronic commerce (Durvasula *et al.*, 1999; Gounaris, 2005); retailing services (Kumar *et al.*, 2008; Ma and Niehm, 2006); information systems (Jiang *et al.*, 2000; Lee *et al.*, 2009); and the health sector (Wicks and Chin, 2008; Bakar *et al.*, 2008a; Mostafa, 2005). It applies the Gap theory between customer perceptions and expectations of service quality to determine perceived service quality (Chen *et al.*, 2007). Because of this, the correct assessment of hospital service quality for properly directing policy-makers will be an essential topic. Since Gap theory and SERVQUAL measurements were proposed (Parasuraman *et al.*, 1985, 1988, 1991), such concepts and methods have been widely accepted and applied in the domain of service quality measurement. Later, some researchers studied its effectiveness in hospital settings and demonstrated the prevalence of application for SERVQUAL in measuring medical service quality (Babakus and Mangold, 1992; O'Connor *et al.*, 2000; Sower *et al.*, 2001). Nevertheless, some arguments have been raised. However, until 1988, no such measurement methodology had been applied across all service industries to identify consumers' expectations and perceptions towards the services proffered (Coulthard, 2004).

We focus on problems regarding the Likert scale in this study. In general investigation with the Likert scale, it used crisp values to present their feelings and subjective perceptions of service quality. In fact, due to intangible and subjective information often appearing in the evaluation process, crisp values are inadequate to present the evaluation ratings of customers, so people would have difficulties in understanding the difference and uncertainties in human's semantic expression. Some research has proven that the Fuzzy linguistic scale works better than the Likert scale in terms of reliance and effectiveness. But until now, much less research has explored the Fuzzy linguistic scale instead of the Likert scale to measure service quality. Therefore, this study proposed a conceptual model to assess the perceived service quality properly using Fuzzy linguistics, to explore whether it is a better solution than on the Likert scale and to more effectively evaluate patients' feedback towards hospital service quality. Additionally, we compared the result of gap analysis between the two scales. Furthermore, the findings of gap analysis and variance analysis of different demographic variables based on Fuzzy linguistics were discussed and analyzed.

### **Problems regarding Likert scale**

Past researches on medical treatment quality were largely based on the "structure-process-outcome" theoretical model. In recent years, there appeared to be more studies that use the concepts of Gap theory and SERVQUAL measurements to analyze the medical service quality (Lam, 1997; Carden and DelliFraine, 2004; Valentin *et al.*, 2005). In these kinds of Likert scale investigations, using crisp values present their feelings and subjective perceptions of service quality. In fact, due to intangible and subjective information often appearing in the evaluation process, crisp values are inadequate to present the evaluation ratings of customers. A more realistic way may be to use linguistic assessments instead of crisp values. In others words, a set scale of linguistic labels can be presented to the customers, who can use it to describe their

opinions. This Fuzzy linguistic assessment of service quality is much closer to human thought than methods based on crisp numbers. There have been numerous researches that use quantitative methods of Fuzzy theory (Bellman and Zadeh, 1970; Liang and Wang, 1991; Chen and Hwang, 1992; Abbott, 1996; Chen, 1996; Herrera *et al.*, 2001). These studies using Fuzzy linguistic meanings have mostly generated satisfactory conclusions; this is because most people cannot give exact crisp values to represent feelings, based on human perception, on flexibility metrics, a more realistic evaluation uses Fuzzy linguistic assessments rather than crisp values (Lin and Wu, 2008).

### Brief of SERVQUAL

Parasuraman *et al.* (1985) thinks that the cognition level of service quality is evaluated by the difference between pre-sell service expectation and after-sell service perceptions. Therefore, the bank, credit card, security agent and product maintenance, etc industries were processed using exploration study to further establish a PZB service quality model. The model is mainly to explain the reason that the service quality of the service industry cannot meet the customer demands, and considers that in order to meet the customer demands, it is necessary to break through the five service quality gaps in the model. These five gaps respectively are:

- (1) The difference between customer expectation and manager cognition.
- (2) The difference between manager cognition and service quality standard.
- (3) The difference between service quality standard and provided service.
- (4) The difference between provided service and external communication.
- (5) The difference between customer cognition service and expected service.

Parasuraman *et al.* (1985) thinks that Gap 5 is the function of Gap 1 to Gap 4, which is  $Gap\ 5 = f(Gap\ 1, Gap\ 2, Gap\ 3, Gap\ 4)$ , among which Gap 1, Gap 2, Gap 3, and Gap 4 are from the service provider, which originated from the internal organization, and Gap 5 is decided by the customer, which originated from the difference between customer expectation and actual perceptions. In order to satisfy the customer, the difference of Gap 5 needs to be shortened, therefore, directly considering the customer expected service standard and actual perceptions service standard will be allow the evaluation of the overall service quality result, which is the value of Gap 5.

Parasuraman *et al.* (1985) found 11 determining factors of service quality in the service quality model established from the difference between expected customer service and cognition service. These respectively are Tangibles, Reliability, Responsiveness, Competence, Courtesy, Credibility, Security, Access, Assurance, Communication, and Understanding. Parasuraman *et al.* (1988) used ten service dimensions as the foundation to develop 97 questions and adopted the concept of service quality is originated from the difference between customer expected service and cognition service, which is  $Q$  (service quality) =  $P$  (Perceptions) –  $E$  (Expectations), to process questionnaire investigation and analysis, using the factor analysis method to find the service quality scale with good reliability and validity. This scale is formed using five dimensions and 22 service quality questions. The scale is called “SERVQUAL”, and the five dimensions of the scale respectively are Tangibles, Reliability, Responsiveness, Assurance and Empathy. SERVQUAL is quite popular for follow up service quality research applications. It brings up the empirical study of the related industry (Ladhari, 2008), and at the same

time, it also receives comments from many scholars (Carman, 1990; Cronin and Taylor, 1992; Buttle, 1996; Llosa *et al.*, 1998; Ladhari, 2008). In addition, many scholars' researches also focus on SERVQUAL questions for amended models, such as: the "SERVPERF" presented by Cronin and Taylor (1992), the "Non-difference" concept presented by Brown *et al.* (1993), the further amendment of SERVQUAL presented by Parasuraman *et al.* (1991), and the ZBP model presented by Zeithaml *et al.* (1993), which divided the customer service expectation into three kinds; desired service, adequate service and predicted service, and the concepts of perceived service superiority, perceived service adequacy and zone of tolerance to analyze and improve the service quality.

Originally, SERVQUAL was designed for non-health related services and its reliability and validity has been confirmed by several researchers (Wang, 2002). More recently, it has been extended to evaluate health care services (Babakus and Mangold, 1992; Vandamme and Leunis, 1993; Anderson, 1995; Youssef *et al.*, 1995; Lim and Tang, 2000). Medical service quality can be evaluated through a different method, however, based on the research of Bakar *et al.* (2008a, 2008b), it shows that it is quite effective using the SERVQUAL scale to evaluate the hospital functional quality, -and according to the study of Babakus and Mangold (1992), Sohail (2003) and Taner and Antony (2006), it showed that it has Reliability and Validity using the SERVQUAL scale to evaluate hospital service quality; Kilbourne *et al.* (2004) showed that administrators will still find the SERVQUAL convenient and reliable to use in a nursing home as a routine measure of service quality. Anderson (1995) thinks that out-patient services appear more suitable for SERVQUAL evaluation. Therefore, this study adopted the SERVQUAL scale to study the Fuzzy linguistic scale and hospital service quality. The study limitation of adopting SERVQUAL scale is whether the five dimensions and 22 items of SERVQUAL can completely evaluate hospital service quality. Many studies have received different conclusions through the factor analysis method. The relevant researches can refer to Vandamme and Leunis (1993), Tomes and Ng (1995), Shemwell and Yavas (1999) and Sower *et al.* (2001).

### Brief of Fuzzy theory

Ever since Fuzzy theory was proposed, it has been used extensively (Zadeh, 1965). Fuzzy theory is used in environments that meet people's thought process, providing a relatively stable description to define pluralistic and complicated ambiguous and uncertain phenomena. In a traditional crisp set, an element in the set is definitely included or excluded in the set. That is, the element cannot partially belong to a crisp set. Let  $U$  be the universe of discourse. A Fuzzy set is a set with Fuzzy boundaries, where the degree of membership of an element in the Fuzzy set  $A$  can be characterized by a membership function. The definition of a Fuzzy set is described as follows.

Let  $U$  be the universe of discourse and let  $A$  be a Fuzzy set of  $U$ . The Fuzzy set  $A$  can be represented as:

$$A = \{\langle u, u_A(x) \rangle | u \in U\}$$

where  $u_A(x): U \rightarrow [0, 1]$  is the membership function of the Fuzzy set  $A$ .

The membership function  $u_A(x)$  quantifies the grade of membership of the elements  $x$  to the fundamental set  $X$ . An element mapping to the value 0 means that the member

is not included in the given set, 1 describes a fully included member. Values strictly between 0 and 1 characterize the Fuzzy members. Figure 1 illustrates a triangular Fuzzy number in general (Lin and Wu, 2008).

These concepts have vaguely defined boundaries. Examples are height and age. These, of course, can be expressed relatively precisely numerically but humans seem to reason in a different way. To represent linguistic variables, Zadeh represented these degrees of set memberships by what he calls, possibility functions. Member functions for crisp sets are Boolean functions. In contrast, possibility functions return decimal values in the range 0 to 1. A possibility value of 0 means the object is definitely not in the set. A possibility value of 1 means the object definitely is in the set. If the universe of discourse  $U$  is a finite set,  $U = \{u_1, u_2, \dots, u_k\}$ , then the Fuzzy set  $A$  can be expressed as follows:

$$A = \frac{u_1(x)}{u_1} + \frac{u_2(x)}{u_2} \dots + \frac{u_k(x)}{u_k}.$$

If the universe of discourse  $U$  is an infinite set, then the Fuzzy set  $A$  is expressed as:

$$A = \int_U \frac{f_A(u)}{u}, u \in U.$$

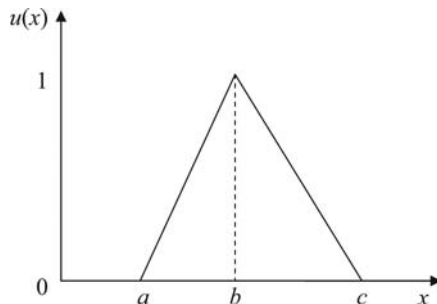
**Fuzzy linguistic SERVQUAL**

To demonstrate the proposed model, the exploratory prospect of the empirical study with questionnaire is given in measuring the service quality. The customer records his or her perception/expectation of service quality in a designed SERVQUAL questionnaire. The design of Fuzzy linguistic SERVQUAL in this study is same form of the Likert seven-point measurement, but it can be converted into Fuzzy numbers. This study applied the triangle membership function and adopts the 6th of 8 conversion scales suggested by Chen and Hwang (1992), which is shown in Figure 2.

No matter what perception and expectation of interviews, the converted Fuzzy numbers that may be generated from such a conversion scale are shown in Table I (Chen and Hwang, 1992).

It means if you select first scale – “Dissatisfied”, it will not be quantified as a crisp score, for example, 1/6, it would be converted to a Fuzzy number, which is, (0, 0.1, 0.2).

As the numbers of interviewees who receive such questionnaires are numerous, the Fuzzy numbers from all interviewees need first to be aggregated. This study uses the



**Figure 1.**  
Triangular Fuzzy number

Geometric Average Method to aggregate numerous interviewees' Fuzzy numbers, it is indicated as follows:

$$\tilde{P} = \left( \prod_{i=1}^m a_i, \prod_{i=1}^m b_i, \prod_{i=1}^m c_i \right)^{1/m} \quad (1)$$

where:

- $(a_i, b_i, c_i)$  is  $i$ th interviewee's Fuzzy number; and
- $m$  represents the interviewee's amount of  $m$ .

After generating the aggregated Fuzzy number, including perception and expectation of interviewee, the deduction method of Fuzzy calculation acquires the distance between two Fuzzy numbers, so as to calculate the difference between the interviewee's perception and expectation. The calculation of a Fuzzy deduction is as follows:

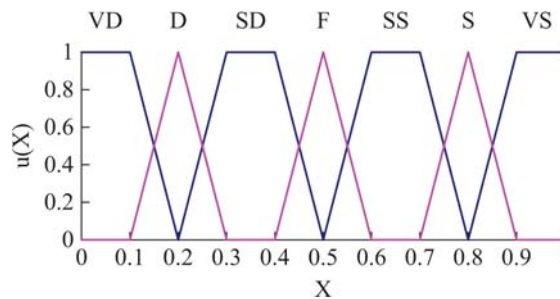
$$\tilde{A} \square \tilde{B} \square (a_1, a_2, a_3) \square (b_1, b_2, b_3) \square (a_1 - b_3, a_2 - b_2, a_3 - b_1). \quad (2)$$

Finally, the Fuzzy number needs to be converted into a crisp value, called DeFuzzy. This study adopts the Gravity Center Method, of which methods are as follows:

$$DF_i = \frac{(UR_i - LR_i) + (MR_i - LR_i)}{3} + LR_i \quad (3)$$

where:

- $DF_i$  = The crisp value after Defuzzy, it represents the gap value.
- $UR_i$  = The maximum triangle Fuzzy number.



**Figure 2.**  
Linguistic conversion  
scale

Scales selected	Triangle Fuzzy numbers
Very dissatisfied (VD)	(0, 0.1, 0.2)
Dissatisfied (D)	(0.1, 0.2, 0.3)
Slightly dissatisfied (SD)	(0.2, 0.35, 0.5)
Fair (F)	(0.4, 0.5, 0.6)
Slightly satisfied (SS)	(0.5, 0.65, 0.8)
Satisfied (S)	(0.7, 0.8, 0.9)
Very satisfied (VS)	(0.8, 0.9, 1.0)

**Table I.**  
Converted Fuzzy number



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$MR_i$  = The medium triangle Fuzzy number.

$LR_i$  = The minimum triangle Fuzzy number.

### Case study

Hospital service quality contains expertise and has an intricate professional division of work, making patients hard to make an objective and overall review on it. Therefore, this study focused on non-technology services, targeting at three large-scale and representative regional hospitals in Hsin-Chu, Taiwan. We explored customer satisfaction towards the out-patients' service quality in those hospitals by evaluating the 5th gap. We tried to capture customer expectation and actual feelings towards hospital out-patient services, and use the difference between them as a benchmark for service quality review. The questionnaires we use are based on the original dimension and elements of SERVQUAL, but the elements were adjusted accordingly with the characteristics of each hospital's out-patient service. After the relevant hospital quality control department reviewed the drafted questions and wording designed in such questionnaires, they would consolidate and conclude their opinions. Following a repeated amendment, they conducted a small-scale pre-test of such questionnaires to make sure their contents were easy-to-understand, user-friendly, and acceptable to those test subjects. Once the significance of its feasibility and reliability had been confirmed, they would dispense the formal questionnaire. The questionnaire was still given based on a form of Likert scale, but analyzed using two measurements after being completed and collected.

The data are collected from interviews of randomly sampled patients or their families in the out-patient department in each hospital during office hours. They are requested to fill out questionnaires and return them on the spot. Meanwhile, part-time workers who had been well trained in this research are reminded to dispense questionnaires proportionately across each patient's gender and age, so as not to be over-concentrated on a certain gender or age group. The three hospitals surveyed 418, 437, and 398 people, with 6, 11, and 7 invalid returned questionnaires respectively, making the total valid number to be 1,229 or 98.1 percent of the total. The statistic software SPSS 10.0 was used as our analytic tool for data collected.

Of the 1,229 valid questionnaires, males constituted 58.66 percent, or 721, and females 41.34 percent, or 508. Regarding marital status, there were 845, or 68.76 percent, who were married and 384, or 31.24 percent, who were single. There were 138 or 11.23 percent, below the age of 20; 225, or 18.31 percent, from 20 to 35; 423, or 34.42 percent, from 36 to 55; and 443, or 36.04 percent, above 56. By the classification of highest education background received, there were 497, or 40.44 percent, with an education level of elementary school or lower; 306, or 24.90 percent, with an education level of junior high school; 278, or 22.62 percent, with an education level of high school, and 148, or 12.04 percent, with an education level of college or higher.

### Result

This research adopted Cronbach's  $\alpha$  coefficient as a basis for reliability testing. Table II displays the reliability values of each and overall dimensions in two scales. The result showed the reliability value 0.8782 in the entire measurement for the Likert scale and 0.9108 for the Fuzzy linguistic scale; dimensional reliability

between 0.4363 and 0.7228 for the Likert scale and between 0.4687 and 0.7626 for the Fuzzy linguistic scale. The Fuzzy linguistic scale surpasses the Likert scale in terms of all five dimensional and totally reliability values. This indicates that the Fuzzy linguistic scale is higher than the Likert scale in terms of reliability in measurement, meaning that the Fuzzy linguistic scale creates more internal consistency and stability than the Likert scale.

Using those returned questionnaires, using the Likert scale scoring calculated the average of each element respectively. The gap score of each element can be created using the perceived average minus the expected average. Moreover, the Fuzzy linguistic scale scoring is used to do the conversion calculated in Table III. Following a consolidation of people’s opinions, the deduction method of Fuzzy calculation, the aggregated method and the Defuzzy method proposed in this study were used to acquire gap values of each element. The results are shown in the following Table III. As the result of analysis of the Likert scale showed, there were 22 question items in five dimensions, where patients’ perceptions are all below expectation, no matter whether using the Likert scale or the Fuzzy linguistic scale. Furthermore, at a 5 percent significant level, the *t*-test showed a result of significant difference, implying there were some items that need to be improved for the three regional hospitals. The 3rd, 8th, 10th, 14th, and 21st items especially showed a much more significant difference. The result of the Fuzzy linguistic scale analysis showed some differences generated by gap values, which might affect priority-setting for making improvements. Others were basically the same as the Likert scale, so the following analyses will be mainly focused on the Fuzzy linguistic scale.

The results of variance analysis conducted by demographic variables in each element in perception and expectation towards the evaluation of a hospital’s out-patient service mostly deliver no significant difference of each element. Only few elements showed a difference, as Table IV displays, which are detailed below.

*1. Gender*

The results of variance analysis conducted by gender demographic variables in the total elements in the surveyed patients’ perception and expectation towards the evaluation of a hospital’s out-patient service showed a difference existing from the 1st to 10th items. In the first item, “Modern equipment in the hospital”, females have a stronger perception than the males, but in the 10th item, “Doctors’ full attention to patient’s description of symptoms”, males have a higher perception than the females. As to the degree of expectation towards service quality, there was a difference in the 8th and 15th items. In the 8th item, “Sufficient ward privacy for out-patients receiving

**Table II.**  
Analysis and comparison  
of Cronbach’s  $\alpha$  value

Dimensions	Likert scale	Fuzzy linguistic scale
Tangibles	0.5624	0.5934
Reliability	0.4363	0.4687
Responsiveness	0.5362	0.5627
Assurance	0.7228	0.7626
Empathy	0.6318	0.6538
Total	0.8782	0.9108



Dimensions	Questions	Likert scale gap score	Fuzzy linguistic scale gap score
Tangibles	1 Modern equipment in the hospital	-0.206	-0.221
	2 Spacious and comfortable hospital environment	-0.193	-0.218
	3 Enough seats in out-patient department	-0.314	-0.302
	4 Clear guidance for hospital service	-0.086	-0.077
Reliability	5 Well-arranged schedule of out-patient services in accordance with its bulletin	-0.065	-0.098
	6 Clear guidance for out-patient services and drugs dispensing	-0.102	-0.117
	7 Disinfected hospital appliances	-0.146	-0.132
	8 Sufficient ward privacy for out-patients receiving diagnosis and treatment	-0.388	-0.432
	9 Effective management of charts	-0.113	-0.124
Responsiveness	10 Doctors' full attention to patients' description of symptoms	-0.388	-0.423
	11 Fast registration and drug-approving services	-0.124	-0.136
	12 Good service attitude of nurses and administration staff	-0.181	-0.174
	13 Detailed explanation of medical treatment process and location of out-patient department in the hospital for patients	-0.154	-0.147
Assurance	14 Doctors' sufficient time to take care of patients	-0.346	-0.386
	15 Doctors' detailed elaboration on patients' condition	-0.232	-0.262
	16 Sufficient medical information provided by the hospital	-0.187	-0.173
	17 Doctors' and nurses' professionalism	-0.156	-0.142
Empathy	18 Clear direction signs for emergency exits	-0.173	-0.165
	19 Extra services provided for patients with special needs	-0.134	-0.139
	20 Clear and detailed description for detailed medical expense	-0.134	-0.152
	21 Hospital's care for patients' conditions	-0.298	-0.312
	22 A flexible schedule of out-patient service provided for patients	-0.171	-0.158

**Table III.**  
Results of SERVQUAL

	Gender	Marriage	Age	Education
Perception	1	8	2	1
	10		8	15
			14	
Expectation	8	8	1	13
	15		14	
			16	
			20	

**Table IV.**  
The difference of the test of demographic variables

diagnosis and treatment”, female expectations surpass those of males, but in the 15th item, “Doctor’s detailed elaboration on patient’s condition”, male expectations were higher than those of females.

### *2. Marriage*

The results of variance analysis conducted by marriage demographic variables in the total elements in the surveyed patients’ perception and expectation towards evaluation of hospital’s out-patient service showed a difference only in the 8th item. In this item, “Sufficient ward privacy for out-patients receiving diagnosis and treatment”, the perceptions of the unmarried group were lower than those of the married group, but the expectations of the unmarried group were apparently higher than those of the married group.

### *3. Age*

The results of variance analysis conducted by age demographic variables in the total elements in the surveyed patients’ perception towards the evaluation of a hospital’s out-patient service show differences in the 2nd, 8th and 14th items. In the 2nd item, “Spacious and comfortable hospital environment”, the age group over 56 was significantly higher than other groups. In the 8th item, “Sufficient ward privacy for out-patients receiving diagnosis and treatment”, the age group between 20 and 35 was apparently lower than other groups. In the 14th item, “Doctors’ sufficient time to take care of patients”, the age group between 20 and 35 was obviously lower than other groups. As to the expectation degree of service quality, there were differences in the 1st, 14th, 16th, and 20th items. In the 1st item, “Modern equipment in the hospital”, the age group between 20 and 35 was significantly higher than other groups. In the 14th item, “Doctors’ sufficient time to take care of patients”, the age group between 20 and 35 was apparently higher than other groups. In the 16th item, “Sufficient medical information provided by the hospital”, the age group between 20 and 35 was obviously higher than other groups. And finally in the 20th item, “Clear and detailed description for detailed medical expense”, the age group over 56 was significantly higher than others.

### *4. Education level*

The results of variance analysis conducted by education level demographic variables in the surveyed patients’ perception towards evaluation of a hospital’s out-patient service showed differences in the 1st and 14th items. While the group with an education level of college and above was apparently lower than other groups in the 1st item, “Modern equipment in the hospital”, the group the group with an education level of elementary school or below was obviously lower than other groups in the 15th item, “Doctor’s detailed elaboration on patient’s condition”. As to the expectation degree of service quality, there was only a difference in the 13th item, “Detailed explanation of medical treatment process and location of out-patient department in the hospital for patients”, where the group the group with an education level of elementary school or below was significantly higher than other groups.

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## Discussion

### *1. Comparison of reliability and improvement priority*

Increased service quality is believed to have a positive effect on customer loyalty and profitability in the service industry. Accurate measurement is a major concern to the management (Liou and Chen, 2006). As in previous study results (Table II), the integration of Fuzzy linguistics and SERVQUAL created more reliability in five service quality dimensions and total than that of the crisp Likert scale. It can be seen from Table III that Fuzzy linguistic SERVQUAL can receive a more reliable improvement priority order, such as, according to the analysis of Fuzzy linguistics, the 21st item, "Hospital's care for patients' conditions" has a higher priority order than the 3rd item, "Enough seats in out-patient department", which is because "Hospital's care for patients' conditions", before or after receiving medical treatment, can provide more information and care to meet the medical demands of the patients before or after medical treatment; and the 20th item, medical expense description's improvement order is higher than the 7th, 13th, 19th and 17th, which is because according to the different hospital ranking and health insurance payment item, the treatment and medicine charge are also different in Taiwan. That just because the Fuzzy linguistic scale is much closer to human thought than methods based on crisp numbers, it provides a relatively stable description to define pluralistic and complicated ambiguous and uncertain phenomena than a crisp scale, researchers would gain more precise data to analyze and study; this is the great advantage of the Fuzzy linguistic SERVQUAL approach. Nonetheless, complex calculating would be its disadvantage.

In this study, the five service quality dimension reliability, Cronbach's  $\alpha$  is slightly low; especially Tangibles, Reliability and Responsiveness, these items, and their Cronbach's  $\alpha$  value respectively are 0.5934, 0.4687 and 0.5627. The study of Vandamme and Leunis (1993), which focused on the medical industry, also has a Cronbach's  $\alpha$  value lower than 0.60; and in the study of Tomes and Ng (1995), the lowest Cronbach's  $\alpha$  value is 0.64, which shows that in the study case of this study, the structure relation of five service quality dimensions and 22 service quality question items of SERVQUAL are low fitness in some dimensions. This can also be found in relevant studies (Vandamme and Leunis, 1993; Lam, 1997), because the original SERVQUAL service quality scale was not established to focus on the medical industry, therefore, the 22 service quality items of SERVQUAL must be adjusted according to the characteristics of the medical industry.

### *2. Gap analysis*

From Table III, the differences in the surveyed patients' perception and expectation towards hospital service quality for the 22 elements all indicated significant variance, and the degree of such surveyed patient's perception and expectation in these 22 elements showed that there were specific items that need to be improved for these regional hospitals in Hsin-Chu, Taiwan. Among them, there were 5 items that need to be given first priority, such as the 8th, "Sufficient ward privacy for out-patients receiving diagnosis and treatment", 10th "Doctors' full attention to patients' description of symptoms", 14th "Doctors' sufficient time to take care of patients", 21st "Hospital's care to patients' conditions", and 3rd "Enough seats in out-patient department". The 8th item, "Sufficient ward privacy for out-patients receiving

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diagnosis and treatment” and the 3rd item, “Enough seats in out-patient department” needed investment in hardware, the other three should be improved as early as possible by the hospital management. Of course, most of them are affected by the health insurance system, but the management should endeavor to work it out towards this direction no matter how hard it is.

### *3. Variance analysis of different demographic variables*

Apparently, males have a higher expectation of “Doctor’s detailed elaboration on patients’ condition” and demand a higher standard of “Modern equipment in the hospital”. The females have a higher expectation of “Sufficient ward privacy for out-patients receiving diagnosis and treatment” and a higher demand for “Doctors’ full attention to patient’s description of symptoms”. This is in accordance with people’s perception. The unmarried population has a deep expectation but low perception towards the item of “Sufficient ward privacy for out-patients receiving diagnosis and treatment”. In the suburban area of Hsin-Chu, this item should be given first priority by the hospital management. In the aspect of age population, as the age group between 20 and 35 constitutes the largest part of society and is rationally inclined, they would have higher expectation and demand for “Modern equipment in the hospital”, “Doctors’ sufficient time to take care of patients”, and “Sufficient medical information provided by the hospital” but showed a low perception level for “Sufficient ward privacy for out-patients receiving diagnosis and treatment” and “Doctors’ sufficient time to take care of patients”. The hospital management should keep an eye on this. On the other hand, the senile group makes up of the largest part of the customer base, with the section over age of 56 demanding more on “Clear and detailed description for detailed medical expense”. Thus, the hospital management should focus more on this issue. Likewise, the education degree also delivers the same question. The group with an education level of elementary school or below constitutes the largest part of the customer base, and have a higher expectation and demand for “Detailed explanation of medical treatment process and location of out-patient department in the hospital for patients” but have a low perception towards “Doctor’s detailed elaboration on patients’ condition”, which is also a direction for the hospital management to make further improvement.

### *4. Technical quality*

Grönroos (1984) divided the factors that impact service quality into two types: Technical quality and functional quality. Although the five quality dimensions of the SERVQUAL scale also include technical quality and functional quality, it is shown in the research of Bakar *et al.* (2008a, 2008b) that using the SERVQUAL scale to evaluate hospital functional quality is quite effective, Wang (2002) considered that there are some items in the hospital service quality that are difficult to evaluate for patients. This is mainly due to not having a relevant professional knowledge background, as such, technical quality regarding the hospital service is difficult to evaluate. Therefore, in addition to the items discussed in this study questionnaire, research on the number of times a patient checks-in can be added in the future studies. The number times a patient checks-in could be an important measure in the technical quality evaluation. Since in service quality, the past experience of customers is one of the three influencing factors on customer

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expectations/perceptions, and it can quantitatively measure the technical quality performance of doctors and nurses without any professional knowledge base. Therefore, it would be useful to evaluate hospital service quality.

### Conclusion

According to the study, we could make some conclusions, as follows. First, Fuzzy linguistic assessment of service quality is much closer to human thought than the methods based on crisp numbers. The study proved that the Fuzzy linguistic scale surpasses the Likert scale in terms of all five dimensional and total reliability values. This indicated that the Fuzzy linguistic scale creates more internal consistency and stability than the Likert scale. Second, Gap analysis is a main tool of the PZB model that is used to get a better focus on certain service quality elements for continuous improvement. In this case, there were five items that needed to be concentrated on and improved immediately. Finally, ANOVA analysis can be used to investigate where there might be different market segments. In this case, some service quality elements could be the market segment factors, such as the 1st item, "Modern equipment in the hospital", the 2nd item, "Sufficient ward privacy for out-patients receiving diagnosis and treatment", the 14th item, "Doctors' sufficient time to take care of patients" and the 16<sup>th</sup> item, "Sufficient medical information provided by the hospital". This research provided a theoretical contribution that introduced the widely used methodology of Fuzzy linguistics into SERVQUAL to evaluate hospital service quality much closer to human thought. In practical contribution, this study described the methodology of Fuzzy linguistic SERVQUAL, gap analysis and ANOVA, not only to correctly used the customers' responses to prioritize the service quality elements and get a better focus for quality improvement, but also more effectively and precisely provided the information needed for decision making.

The study's limitation and future research direction is that the five dimensions and 22 items of SERVQUAL cannot completely evaluate the hospital service quality, and the quality dimension and questionnaire items require further research and development of the service quality dimension and scale suitable for the medical industry; the study result of the study case is limited to the regional hospital in Hsinchu, Taiwan, the broad research focus on the Taiwan medical industry and discussion and the comparison researches of the regional and international medical industry can be processed in the future. In addition, the Fuzzy linguistic method can be applied in other service quality models to allow it to be closer to human thought and decision-making method to receive more accurate research results.

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