

A Study of Customers Satisfaction Towards Service Quality of UKM Hospital Clinic: Base on Fuzzy Logic Controller (FLC) Measurement

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ABSTRACT

Hospitals provide the same type of service, but not all hospital provides the same quality. No one knows this better than patients. A case study to evaluate the health service quality was conducted in two clinics in Hospital UKM. To measure patients' satisfaction with HUKM, the research technique called Fuzzy Logic Controller (FLC) was used. This technique gives measurement not in a crisp value but in an interval value. It uses fairly satisfy, rather satisfy than only satisfy and not satisfy. Each of these linguistic was given degree of membership by FLC to show how far it influence the customer satisfaction. Furthermore, FLC is able to compare expectations with perceptions of service received across six dimensions of service quality, namely tangibles, reliability, responsive, assurance, empathy and accessibility and affordability. This study was aimed to determine the reliability and to measure by using the gap analysis into ratio analysis. The results of the analysis show that the instrument is reliable which may as a valuable input for engineering management especially related to their engineering planning. The study also revealed that all service dimensions were unable to meet expectation of the customers. Therefore, quality improvement and enhancement effort are recommended be implemented in HUKM.

Keywords: Fuzzy Logic Controller, service quality, customer importance, and customer satisfaction

ABSTRAK

Hospital menyediakan jenis perkhidmatan yang sama tetapi tidak semua hospital menyediakan perkhidmatan yang berkualiti. Keadaan sedemikian hanya dapat dinilai oleh pesakit yang terlibat. Satu kajian kes untuk menilai kualiti perkhidmatan kesihatan telah dilakukan terhadap dua buah klinik di Hospital UKM (HUKM). Bagi menentukan kepuasan pesakit dengan HUKM, teknik penyelidikan bernama Fuzzy Logic Controller (FLC) telah digunakan. Teknik ini memberi pengukuran bukan dalam nilai tentu tetapi dalam satu nilai jeda. Kaedah ini menggunakan kepuasan sederhana, berbanding dengan hanya setuju atau tak setuju. Setiap tatacara ini telah terarah melalui FLC bagi menunjukkan sejauh mana ia telah mempengaruhi kepuasan pelanggan. Tambahan, FLC dapat membandingkan perkhidmatan jangkaan dengan tanggapan yang

diterima merentasi enam dimensi kualiti perkhidmatan, iaitu yang tersirat, keboleh-harapan, reaksi, kepastian, empati serta kebolehcapaian dan kebolehbayaran. Kajian ini bertujuan untuk menentukan keboleh-harapan dan bagi mengukur menerusi analisis sela terhadap analisis nisbah. Keputusan analisis menunjukkan bahawa kaedah ini adalah boleh-harap yang mungkin dijadikan sebagai input penting dalam pengurusan kejuruteraan terutama yang berkaitan dengan perancangan kejuruteraan. Kajian ini juga mendapati semua dimensi perkhidmatan tidak dapat memenuhi jangkaan pelanggan. Justeru itu, pembaikan berkualiti dan usaha tambahan adalah disarankan untuk dilaksanakan di HUKM.

Kata kunci: Pengawal Logik Kabur, kualiti perkhidmatan, keutamaan pelanggan, kepuasan pelanggan

INTRODUCTION

In the past, quality in service is not as important as quality in product or production. But nowadays, this point of view will not survive since we have global market and competition to serve and maintain our customer to be loyal. Customer satisfaction is the most important factor that a service company must consider. Nowadays, fulfilling customer satisfaction in global competition, the company must increase their capabilities and competitive advantages (Rika Fatimah et al. 2002).

Vague value, uncertainty factors and 'grey' matters were occurred especially in measuring service quality and customer satisfaction. Since the measurement were strong related to subjectivity value, it need a flexible and sensitive measurement to simpler the subjectivity (Zadeh & Kacprzyk, 1992).

Many quality measurement methodology had done in both qualitative and quantitative (Petrovic-Lazarevic & Amy 2000; O'Neill 2001; Madu & Madu 2002; Sureshchandar et al. 2002). Conventional quantitative model were mostly used statistic model. Furthermore, controlling system nowadays need high accurate measurement which produced a complex system that is able to involve all variables and attributes (Donald et al. 2002).

Hospital Universiti Kebangsaan Malaysia (HUKM)

Hospital Universiti Kebangsaan Malaysia (HUKM) is located at Jalan Tenteram, Cheras. HUKM has 14 level clinic block, 6 level education block, 5 block for residence the staff and 10 level for nurse's hostel.

HUKM is a teaching hospital that control by medical experts. What makes special here that those medical experts is also as lecture at

Medical Faculty. They are expert and trained well in their own field. This hospital able to accept 700 students and 600 graduate students. HUKM provide service at secunder and tertier level an also as center of reference for entire country. This hospital provide latest medical and facilities such as medical in *cochlea implant, endocrinology, endocrin surgery, neorosurgery, laproscopic surgery, hematology, neurology, neonatology, phsyciatric for children, etc.* Furthermore, HUKM is the first hospital that using information technology for the whole operational process such as telemedical in teaching, medical bussiness and meeting services.

Fuzzy Logic Controller (FLC)

FLC replaces the role of the mathematical model with another rule based model that is build from a number of smaller rules that in general only describe a small section of the whole system (Nguyen & Yager 1995). The process of inference had binding them together to produce the desired outputs (Cox 1994). The inputs and outputs of the system have remained unchanged.

FLC application has three main steps as refereed to Fig.1 which are 1) Fuzzification, 2) Inference and 3) Deffuzification.

Fuzzification, take the inputs and determine the degree of crisp input into which they belong to each of the appropriate fuzzy sets via membership functions. The input is always a crisp numerical value limited to the universe of discourse of the input variable (interval between 0,1,2,...,n) and the output is a fuzzy degree of membership (always the interval between 0 and 1). For this research purposes, there are two representation of the degree of membership function, which are:

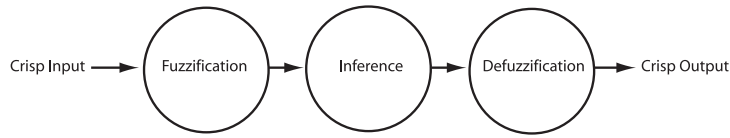


FIGURE 1. Process Steps in FLC

1. S-Curve (Sigmoid/Logistic) Representations

An S-Curve is defined using three parameters as referred to Fig.2: its zero membership value (α), its complete membership value (γ), and a third piece of information-the inflection (or crossover) point (β). This is the point at which the domain value is 50% true. The value of the curve for domain point x is given as (Eq.1),

$$S(x, \alpha, \beta, \gamma) = \begin{cases} 0 & \rightarrow x \leq \alpha \\ \frac{2(x-\alpha)/(\gamma-\alpha)^2}{1-\frac{2(x-\alpha)/(\gamma-\alpha)^2}{} } & \rightarrow \alpha \leq x \leq \beta \\ 1-\frac{2(x-\alpha)/(\gamma-\alpha)^2}{1-\frac{2(x-\alpha)/(\gamma-\alpha)^2}{} } & \rightarrow \beta \leq x \leq \gamma \\ 1 & \rightarrow x \geq \gamma \end{cases} \quad (1)$$

parameter that indicates the width of the curve's base (β). The value of the curve for domain point x is given as (Eq.2),

$$\pi(x, \beta, \gamma) = \begin{cases} S\left(x, \gamma - \beta, \gamma - \frac{\beta}{2}, \gamma\right) & \rightarrow x \leq \gamma \\ 1 - S\left(x, \gamma, \gamma + \frac{\beta}{2}, \beta\right) & \rightarrow x > \gamma \end{cases} \quad (2)$$

Inference, there are three methods that used in FLC inference. The methods are max-min, additive and probabilistic OR. For the research purposes, an additive (sum) method is being used. The formula is (Eq.3):

$$\mu_{\beta}[x] \leftarrow \min(1, \mu_{\alpha}[x_1] + \mu_{\gamma}[x_2]) \quad (3)$$

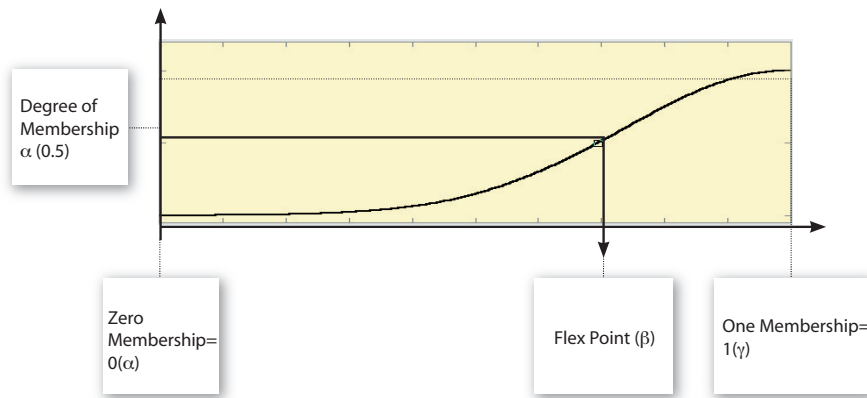


FIGURE 2. The S-Curve Function Characteristics

2. PI Curves

A PI curve is the preferred and default method of representing a fuzzy number. It provides a smooth descent gradient from the central value (the concept being approximated) to a zero membership point along the domain. The symmetric PI curve (Fig.3) is centred on a single value from the domain (γ) with a single

Defuzzification, it is the final phase of fuzzy reasoning. The evaluation of model proportions is handled through an aggregation process that produces the final fuzzy regions for each solution variable. This region is then decomposed using one of the defuzzification methods. In fuzzy models, there are several methods of determining the expected value of solution fuzzy region such

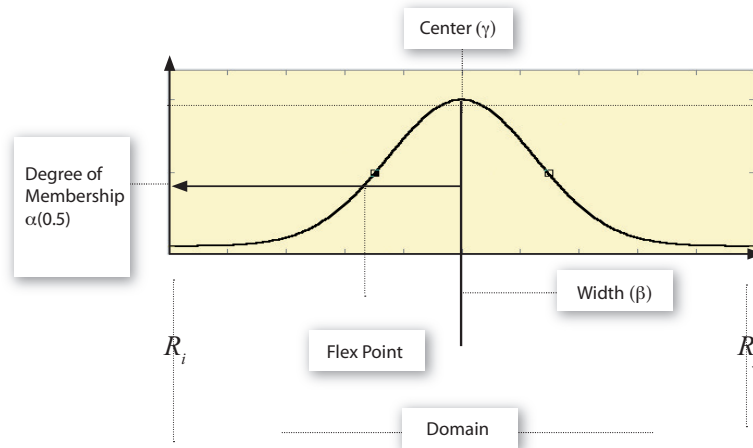


FIGURE 3. The Functional Characteristics of a PI Curve

as Bisector, Mean of Maximum (MOM), Largest of Maximum (LOM) and Smallest of Maximum (SOM). Composite Moments (Centroid) is being used for this research purposes. The formula is referred to Eq.4:

$$x \leftarrow \frac{\sum \alpha_i \cdot \mu(\alpha_i)}{\sum \mu(\alpha_i)} \quad (4)$$

Fuzzy Logic Controller for HUKM

This research had measured in three (3) measurement level for customer. These services are the level of customer's importance, the level of customer's satisfaction and the level of customer's satisfaction in over-all service. 765 respondents were involved in fulfilling the questioners.

Furthermore, this research also uses quality dimensions containing six variables, which are, tangibles, assurance, responsiveness, reliability, empathy and achievement and ability. The variables themselves contain several attributes, which are represented in questionnaire (24 items + 1 item as over-all question). Those attributes are as referred in Table 1.

The result from data processing for the mean each variable of three level services are shown in Table 3.

Fuzzification consists of steps; 1) Defining the variable universe of discourse and 2) Designing the fuzzy sets. The variable and universe of discourse for this research is shown in Table 2

while the design of fuzzy set is shown in Table 3. This research uses two representations of the degree of membership function in order to design the fuzzy sets, which are: 1) S-Curve (Sigmoid/Logistic) Representations and 2) PI Curves. Each of mean, mod and percentage of HUKM variables is shown in Table 6.

Furthermore, several differences provide into the processing of level of customer's satisfaction in over-all service. The variable and universe of discourse for this level is shown in Table 4 while the design of fuzzy sets is shown in Table 5.

Inference and Defuzzification steps are done using Matlab with Fuzzy Tools Program. The method that is used in inference is additive (sum) while in defuzzification is centroid. The inference had used twelve rules representing the expert knowledge. The rules were intensively built through focus group (Stamatis 1996; Day 1993; Bentley 1984) which involved expertise from HUKM, academicians and customers. Furthermore as quality approach, we integrated the rules by using critical approach (Juran & Frank 1988) then deploy them into quality diagram (Tague 1998).

The summaries for the solution each service level are shown in Table 7. There are 3 FLC solutions. The first one is FLC solution for Level of Customer's Importance that gives result value **3.59** as referred in Table 7. FLC provide degree of membership for each linguistic variables for this value. By identifying the FLC solutions using Matlab, the result value was calculated followed its representation and formula. This research used S-Curve formula and PI Curve formula.

TABLE 1. HUKM's variables and attributes

Variables	Attributes	Number of Items
Tangible	modern and high function of the facilities and tools, a clean and comfort situation and clear direction board in hospital, a professional and neat doctor and nurse, information list of hospital service, personal service for the patient	5
Assurance	punctual time in service's promise, a fast and good service, a professional doctor and staff, an up-to-date document as references, consistent price	5
Responsiveness	a fast service for patient, fast and good action of the doctor and staff, the ability of the doctor and staff in convincing the patient, waiting time not more than 1 hour	4
Reliability	a friendly and polite doctor and staff, a knowledgeable doctor and staff, patient being respected during the service, a complete condition explanation during the patient in service	4
Empathy	willing to accept the complain from the patient, 24 hours services, individual attention from the doctor and staff to the patients, the understanding between doctor/staff and the patients	4
Achievement & Ability	provide an enough park area, suitable cost	2

TABLE 2. Fuzzy Sets for level of customer's importance and satisfaction at HUKM

Function	Variable	Universe Of Discourse
INPUT	<i>Tangible, Assurance, Responsiveness, Reliability, Empathy, Achievement&Ability</i>	[0, 5]
OUTPUT	Level of Customer's Importance, Level of Customer's Satisfaction	[0, 5]

TABLE 3. Fuzzy Sets for level of customer's importance and satisfaction at HUKM

Function	Variable	The Linguistic Variable	Representation
INPUT	<i>Tangibles</i>	BELOW STANDARD-STANDARD-ABOVE STANDARD	S.Curve-PI Curve-S.Curve
	<i>Assurance</i>	LOW-ENOUGH-HIGH	
	<i>Responsiveness</i>	SLOW-AVERAGE-FAST	
	<i>Reliability</i>	BAD-REGULAR-GOOD	
	<i>Empathy</i>	BAD-ENOUGH-GOOD	
	<i>Achievement & Ability</i>	LOW-AVERAGE-HIGH	
OUTPUT	<i>Level of Customer's Importance</i>	PRIORITY-IMPROVE-MAINTAIN	S.Curve-PI Curve-S.Curve
	<i>Level of Customer's Satisfaction</i>	DISAPPOINTED-SATISFY-PERFECT	

TABLE 4. Variable universe of discourse for level of customer's satisfaction in over-all service at HUKM

Function	Variable	Universe Of Discourse
INPUT	<i>Very Disappointed, Disappointed, Neutral, Satisfy, Very Satisfy</i>	[0, 100]
OUTPUT	Level Customer's Satisfaction in Over-all Service	[0, 100]

TABLE 5. Fuzzy Sets for level of customer's satisfaction in over-all service at HUKM

Function	Variable	The Linguistic Variable	Representation
INPUT	<i>Very Disappointed</i>	HIGH-AVERAGE-HIGH	S.Curve-PI Curve-S.Curve
	<i>Disappointed</i>		
	<i>Neutral</i>		
	<i>Satisfy</i>		
OUTPUT	<i>Very Satisfy</i>	DISAPPOINTED-SATISFY-PERFECT	S.Curve-PI Curve-S.Curve
	<i>Level of Customer's Satisfaction in Over-all Services</i>		

After calculated the value 3.59 above, it was founded that the linguistic variables are 0 for PRIORITY, 0.62 for IMPROVE, 0.38 for MAINTAIN, in other word it means *The Level of Customer's Importance has to IMPROVE 62% most and for being MAINTAIN for 38% however it is absolutely not necessary for being in PRIORITY.*

Furthermore, using the same way, the FLC solution for level of customer's satisfaction gives result value **2.72** as refereed to Table 7, which means 0 for DISAPPOINTED, 0.98 for SATISFY, and 0.02 for PERFECT. The FLC solution for level of customer's satisfaction in over-all services gives result value **49.5** which means 0.0002 for DISAPPOINTED, 0.9998 for SATISFY, and 0 for PERFECT.

Through these solutions, it shows that HUKM services need to be improved as well as maintain the others services. The comparison is made between level of customer's importance and level of customer's satisfaction. It shows that the Importance level is higher than the Satisfaction level for **3.59 > 2.72**. The customer 98% satisfy but it will not guarantee that in near future HUKM

can maintain the customers as loyal customers since there are so many competitors. HUKM must achieve at PERFECT level. HUKM just received 0.02 or 2% for PERFECT. This value is too small to be able to compete with the competitors.

The same situation happened also at level of customer's satisfaction in over-all services. Although at this level HUKM received 99.98% customer who's satisfy but still HUKM need the customer to be at PERFECT level most because here, FLC solution, the measurement for SATISFACTION is at medium level while the highest level is at PERFECT.

The interpretation above may also give valuable input for the engineering planning in designing and providing HUKM with better facilities, layout and process flow. By identifying the satisfaction and importance level, it may support which variables and attributes that related need to be improved in the engineering planning (such as variable tangibles with its attributes modern facilities and tools as refereed in Table 1).

TABLE 6. Mean, mod and percentage of HUKM variables

Quality Dimension	Mean	
	Level of Customer's Importance	Level of Customer's Satisfaction
<i>Tangible</i>	4.58	4.12
<i>Assurance</i>	4.60	3.62
<i>Responsiveness</i>	4.64	3.40
<i>Reliability</i>	4.65	4.05
<i>Empathy</i>	4.65	4.01
<i>Achievement & Ability</i>	4.59	3.82

Satisfaction Scale	Level of Customer's Satisfaction in Over-all Services	
	Mod	Percentage (%)
<i>Very Disappointed</i>	4	4.80
<i>Disappointed</i>	26	31.00
<i>Neutral</i>	30	35.70
<i>Satisfy</i>	18	21.40
<i>Very Satisfy</i>	6	7.10

TABLE 7. The output of each measurement level of HUKM variables

Level of Measurement	Output	
	Fuzzy Result	Fuzzy Degree of Membership
<i>Level of Customer's Importance</i>	3.59	0.62 IMPROVE 0.38 MAINTAIN
<i>Level of Customer's Satisfaction</i>	2.72	0.98 SATISFY 0.02 PERFECT
<i>Level of Customer's Satisfaction in Over-all Services</i>	49.5	0.0002 DISAPPOINTED 0.9998 SATISFY

3.0 CONCLUSION

It is important for Hospital, HUKM, as one of the Service Company to define customer importance and satisfaction as their quality. There are a lot uncertainty factors and conditions for the services company, which is HUKM, to satisfy their customer in order to prevent their loyalty, because of the product that HUKM sold is intangible. Using FLC is more suitable than other tools because it is not a crisp value as solution but a fuzzy value that gives linguistic solution with each degree of membership for each variable.

This research had measured in three (3) services level of customer, however, the service quality need being more improving in order to increase the customer satisfaction to gain customer loyalty. FLC shows how far the quality of service needs to be improving through the degree of membership and then to be translated into linguistic variable in order to make easier in understanding the result.

Another contribution is in engineering planning by identifying which variables and attributes those needs to be improved. This identification may reduce the cost, time and energy since the result already focused on priority matters.

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