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# Construct factor evaluation model of Health Management Center selected by customers with Fuzzy Analytic Hierarchy Process

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ABSTRACT

National Health Insurance system has been continuously revised due to rapid changes of society since its establishment, which caused gradual decrease of hospital income year by year, so all hospitals take the initiative to develop self-financed items to partially increase hospital incomes, thus it is crucial to develop assessment model of Health Management Center. The research adopts Fuzzy Analytic Hierarchy Process (FAHP) for customers to make weight assessment on evaluation indexes of Health Management Center. Five major perspectives for customers' selection of Health Management Center are summarized, orderly including (1) Health Management Department (2) Personnel Service Department (3) Health Examination Service Department (4) Marketing Department (5) Environment Department. In addition, in the aspect of importance, "regularly track recheck and provide timely medical service", "provide doctor's commentary and inspection report result and follow-up ambulatory care issues" and "reasonably charge" are consider to be three major indexes in all weights. Research results can be submitted to relevant health examination institutes and personnel of the hospital for reference to earn the opportunity of developing new customers and improve service quality.



## 1. Preface

In recent years, average life expectancy has constantly increased, Directorate-General of Budget, Accounting and Statistics, Executive Yuan (2007) announced, in 2007, average life expectancy of male in Taiwan was 75.09 years old and female 81.9 years old, reaching the level of advanced countries. Also, demographics from Ministry of Interior, Executive Yuan (2007) indicated: in Taiwan area, aged population over 65 years old accounted for 10.2% of total population and reached aging society index specified by World Health Organization; health examination constantly increased examination items in recent years and purchased and used great amount of precise instrument for health examination, so at present, health examination has not been special for the aged, but diseases of the aged still occupied the majority in expenses of health care. From the viewpoint of Prevent Medical, health examination can find out situation of the patients' diseases tend to occur in the future, resulting in greatly reducing health care medical expense in the future. Current health examination institutions in the market are numerous, but there is a discrepancy in the aspects of quality and service, therefore, this research focuses on the health examination institutions targets their items selected by customers to master customers' demand for Health Management Center and provide suggestions concerning improvement and future operating direction of Health Management Center in current market.

In recent several years, health examination has been gradually accepted by people, who have not the similar feeling of entering into the hospital, and Health Management Center established in the hospital has become luxurious. In literature of health management, Chen (2001) thought that from current entire market of Health Management Center, medical market was roughly divided into Prevent Medical, Acute Care and Long Term Care. Stratmann also formulated rational decision-making model in medical treatment specially for medical expense actions in 1975. Chen (2001) thought that the main targets sought for of professional Health Evaluation Center and Health Management Center attached to the hospital are different. Effective health examination and disease screening of Huei (2009) can limit development of disease and promote public health. Hua (2009) designed to examine current conditions and problems with the system of occupational health examination in Taiwan. Ginn (2004) used a survey to investigate the factors influencing adoption of CRM in Health Examination Service Department of hospital. Tsai, Chang, and Lin (2010) use fuzzy hierarchy sensitive with Delphi method to evaluate hospital organization performance. Therefore, in recent years hospitals have established lots of Health Management Centers and positively expanded equipment and manpower because of expectation for expense increase of health examination of customers.

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## 2. Methods

### 2.1. Fuzzy Set Theory

Fuzzy Set Theory was proposed by Zadeh (1965), which was different from the crisp set and definite value of traditional mathematics, the proposed fuzzy set and Membership Degree refer to Quantification of Meaning used for solving the uncertainty, fuzziness and other phenomena in realistic environment. Relevant definitions quoted in this research are as follows:

### 2.2. Membership function (Zadeh, 1965)

The fuzzy set $\widetilde{A}$ on universe of discourse $X$ must satisfy function $\mu_{\widetilde{A}}$ on the following $X$, calling function $\mu_{\widetilde{A}}$ as membership function of $\widetilde{A}$, that is, $\chi \in X$, only exists one value $\mu_{\widetilde{A}}(\chi) \in [0,1]$, $\mu_{\widetilde{A}}(\chi)$ means level of $\chi$ belonging to $\widetilde{A}$.

### 2.3. Positive Triangular Fuzzy Number (Kaufmann & Gupta, 1991)

Positive Triangular Fuzzy Number $\widetilde{A}$ is a fuzzy set, indicated by $\mu_{\widetilde{A}} = (L, M, U)$, the definition of membership function (as shown in Fig. 1) is as follows:

$$\mu_{\widetilde{A}}(\chi)\begin{cases}\frac{X-L}{M-L}, & L \leqslant X \leqslant M\\ \frac{X-U}{M-U}, & M \leqslant X \leqslant U\\ 0 & otherwise\end{cases} \tag{1}$$

According to the nature and extension principle of Positive Triangular Fuzzy Number (Klir & Yuan, 1995; Zimmerman, 1991), algebraic operation of the two Triangular Fuzzy Numbers $\widetilde{A}_1 = (L_1, M_1, U_1)$ and $\widetilde{A}_2 = (L_2, M_2, U_2)$ is:

$$\widetilde{A}_1 \oplus \widetilde{A}_2 = (L_1 + L_2, M_1 + M_2, U_1 + U_2) \tag{2}$$

$$\widetilde{A}_1 \otimes \widetilde{A}_2 = (L_1 \cdot L_2, M_1 \cdot M_2, U_1 \cdot U_2) \tag{3}$$

### 2.4. α-cut (Zimmerman,1991)

For the given real number $\alpha$, $\alpha \in [1,0]$; definition $A_\alpha = \{\chi | \mu_{\widetilde{A}}(\chi) \geqq \alpha, \chi \in X\}$ is α-cut of fuzzy set $\widetilde{A}$. $A_\alpha = [\widetilde{A}_1(\alpha), \widetilde{A})_u(\alpha)]$, in which $\widetilde{A}_1(\alpha), \widetilde{A}_u(\alpha)$ are respectively left and right edge points as shown in Fig. 2.

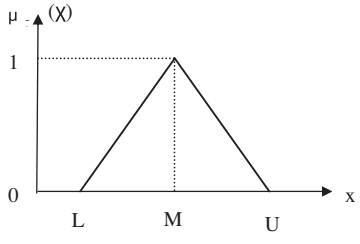


**Fig. 1.** Positive Triangular Fuzzy Number.

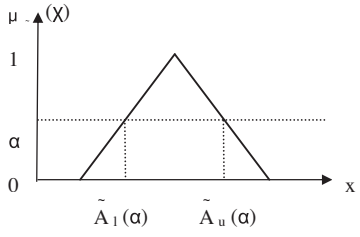


**Fig. 2.** α-cut of Positive Triangular Fuzzy Number $\widetilde{A}$.

### 2.5. Linguistic variable and fuzzification

So-called linguistic variable is to consider the phraseology used in language as variables, this research adopts methods of Chen and Hwang (1992) to respectively design five linguistic universal wording sets (quite important, very important, ordinary, not important, quite not important) to collect relevant information about importance degree of interviewees in each service item. The membership function of these linguistic values can be shown in Triangular Fuzzy Number to evaluate linguistic sequence of service quality evaluators and taken as evaluation method for each service aspect and item service quality model.

As the cognition and opinions of each evaluator are different, the delimited scope is not same either, average value concept is adopted to integrate fuzzy judgment, the formula is shown below:

$$E_{ij}^k = (1/m) \odot \left(E_{ij}^1 \oplus E_{ij}^2 \oplus \cdots \oplus E_{ij}^k\right) \tag{4}$$

In which $\odot$ refers to fuzzy number multiplication, $\oplus$ refers to fuzzy number addition, $E_{ij}^k$ refers to the average value of level $m$ evaluator reaches $j$ standard for $i$ plan, which can be shown with Triangular Fuzzy Number as follows:

$$E_{ij} = (LE_{ij}, ME_{ij}, UE_{ij}) \tag{5}$$

Endpoint values $LE_{ij}$, $ME_{ij}$ and $UE_{ij}$ in the above formula can be calculated with the plan proposed by Buckley (1985)

$$LE_{ij} = \left(\sum_{k=1}^{m} LE_{ij}^k\right) \Big/ m \tag{6}$$

$$ME_{ij} = \left(\sum_{k=1}^{m} ME_{ij}^k\right) \Big/ m \tag{7}$$

$$UE_{ij} = \left(\sum_{k=1}^{m} UE_{ij}^k\right) \Big/ m \tag{8}$$

### 2.6. Defuzzification

Transforming fuzzy number calculated by fuzzification into definite value is called defuzzification. Normal defuzzification methods include Center of Gravity Defuzzification, Center of Sum Defuzzification, Center of Largest Area Defuzzification, First of Maxima Defuzzification, Last of Maxima Defuzzification, Middle of Maxima Defuzzification and Height Defuzzification.

This research adopts the relatively simple Center of Gravity Defuzzification, according to Tseng and Klein (1989), membership function of hypothetical fuzzy set $\widetilde{A}$ is $u_{\widetilde{A}}(x_i)$, when fuzzy number is Triangular Fuzzy Number, hypothetical Triangular Fuzzy Number $\widetilde{A}_i = (L_i, M_i, U_i)$, the formula is:

$$F_i = \frac{[(U_i - L_i) + (M_i - L_i)]}{3} + L_i, \quad \forall i \tag{9}$$

### 2.7. Analytic Hierarchy Process (AHP)

AHP is proposed by Professor Saaty from University of Pittsburgh, Pennsylvania, America in 1971, applied in determination of priority, resource planning, distribution, investment portfolio and other aspects. Saaty even proposed a complete set of methodology in 1980, which aimed to systematically simplify complicated issues, utilize hierarchy structure to break down the