International Journal of
Innovative Management, Information & Production ISME International ⓒ 2015 ISSN 2185-5455
Volume **6**, Number **2**, June **2015** **pp.1-10**

FUZZY DECISION SUPPORT SYSTEM FOR ADMISSION EXAMIATION POLICY

WENTSUNG LAI[1], BERLIN WU[2]
[1]Department of Ed. Policy and Administration
National Chi Nan University, Taiwan, 10001
s100407904@mail1.ncnu.edu.tw

[2]Department of Mathematical Sciences
National Cheng Chi University,Taiwan, 10001
berlin@nccu.edu.tw

ABSTRACT: *Evaluating satisfaction of policy implementation was very important feedback mechanism. This study uses interval fuzzy numbers to improve the evaluation level of satisfaction. And we had done empirical research by satisfaction evaluation of admission examination policy of k-12 years' education in Taiwan. The samples were 90 principals and 90 teachers of k-12 schools. A research method was the application of fuzzy theory. Firstly, to define a new definition of fuzzy satisfaction, second to use a new function of fuzzy satisfaction to defuzzify and calculate total satisfaction by fuzzy weight. Finally, use expert decision support system to decide the level of fuzzy satisfaction. This study constructed the new model of the interval fuzzy numbers to improve the evaluation of satisfaction. Both of principals and teachers asked to do substantial modification for admission examination policy of k-12 years' education by non-testing spirit.*

Keywords: K-12 Years' Education; Admission Examination Policy; Interval Fuzzy Numbers; Fuzzy Satisfaction; Expert Decision System.

1. Introduction. K-12 years' education in Taiwan, the scores of admission examination will account for the total scores over 34%.It can be said that the key factor to compare the scores for admission. The factors of admission examination contained Testing rankings and scoring, Testing subjects and question patterns, Comparing with the sorting of testing scores, Testing time and schedule, Examination policy and non-testing spirit. Did these factors of admission examination of k-12 years' education fit to non-testing spirit? It was important issues which this study wanted to explore. Evaluating satisfaction of educational policies was an important project to improve the effectiveness. Principals and teachers were the key pushing hands to promote the k-12-year education. Thus, evaluating satisfaction of the principals and teachers were the important feedback data. The samples of this study contained the principals and teachers of high schools, junior high schools, elementary schools in k-12 years' education in Taiwan. The purposes of this study hoped to evaluate satisfaction by fuzzy methods and offered the suggestions by expert decision support system to make recommendations for admission examination policy of k-12 years' education in Taiwan.

This study surveyed by using fuzzy questionnaire. Since Zadeh found Fuzzy Theory (1965), this thinking could explain many practice phenomenons. Human thinking came

from the subjective awareness of the natural and social phenomena. Since human knowledge and language came from the subjective awareness, time, environment, so human judged things by the different fuzzy angle. Human generated fuzzy theory due to fuzzy measurement and classification principle of the human thinking way on the environment. Human gave a more robust description way to deal with the diverse and complex, ambiguous and uncertain phenomenon. Therefore, the human mind had two types, one for formal thinking, and another for fuzzy thinking. Formal thinking was logical and sequential thinking, while fuzzy thinking was the entire and integrated thinking (Tai-Ning, 1997, Song-Lian, 1994).

Recent researches had developed many fuzzy methods of statistical analysis, and focused on the fuzzy measurement to enhance the measurement of the human thinking and abilities (Fan, 2010； Hsu, Tsai & Chiang, 2009; Ravi, Shankar, Sireesha, Rao & Vani, 2010; Sun & Wu, 2007; Wu & Lin,2002). In this study, the measurement of satisfaction tested by interval fuzzy number to answer. Recent researches of fuzzy interval numbers focused to improve the measurement level of human psychology application. (Chu & Lin, 2009；Hung, Vladik, Wu & Gang, 2011； Lin & Chen, 2004； Sengupta & Pal, 2000；Yager, Detyniecki & Bouchon-Meunier, 2001).

2. Research Methods. This research method was the application of fuzzy theory to evaluate fuzzy satisfaction of admission examination policy of k-12 years' education. Research process used several methods and principles contained fuzzy theory, fuzzy satisfaction, two-dimensional questionnaire, defuzzification, fuzzy weights, constructing evaluation indicators, Rule-Base System, etc., were described as the following.

2.1. Fuzzy statistics. Since fuzzy theory is generated by Zadeh (1965), the application in every research field of fuzzy statistics grows vigorously like the mushrooms after rain. It regards fuzzy logic as theoretical foundation, and extend the logic concept of the two-values logic of traditional mathematics, break through the limitation thinking of binary logic way. Just as the fuzzy statistics scholar's concern, the human thinking can't be measured or described with the single option. In other words, it should have membership of each option revealing its relative importance (Nguyen & Wu, 2006)

Different from the traditional quantized questionnaire, the fuzzy questionnaire can reflect possibility and feasibility of the human fuzzy thinking specialty even more. Because in human thinking and behavior, nearly reflect the fuzziness of things, languages shown are all fuzzy languages too (Wu, 2005). Apply the fuzzy logic to the analysis of questionnaire investigation, offer a novel idea of collecting and analyzing data, it's a concept of fuzzy theory which allow people to have multiple experiences(Jiang, Wu & Hu, 2008).

Relative to traditional data, we can not only know the finally option, but also the fuzzy thinking of participant in fuzzy data. In other words, the participant's preference is reflected more accurately in fuzzy voting.

2.2. Research framework. This framework concluded seven steps which evaluative indicators, research samples, fuzzy questionnaire design, defuzzification, fuzzy weights for total satisfaction, fuzzy decision support system to make decisions, and finally get conclusions and recommendations. This framework showed in Figure 2.1.

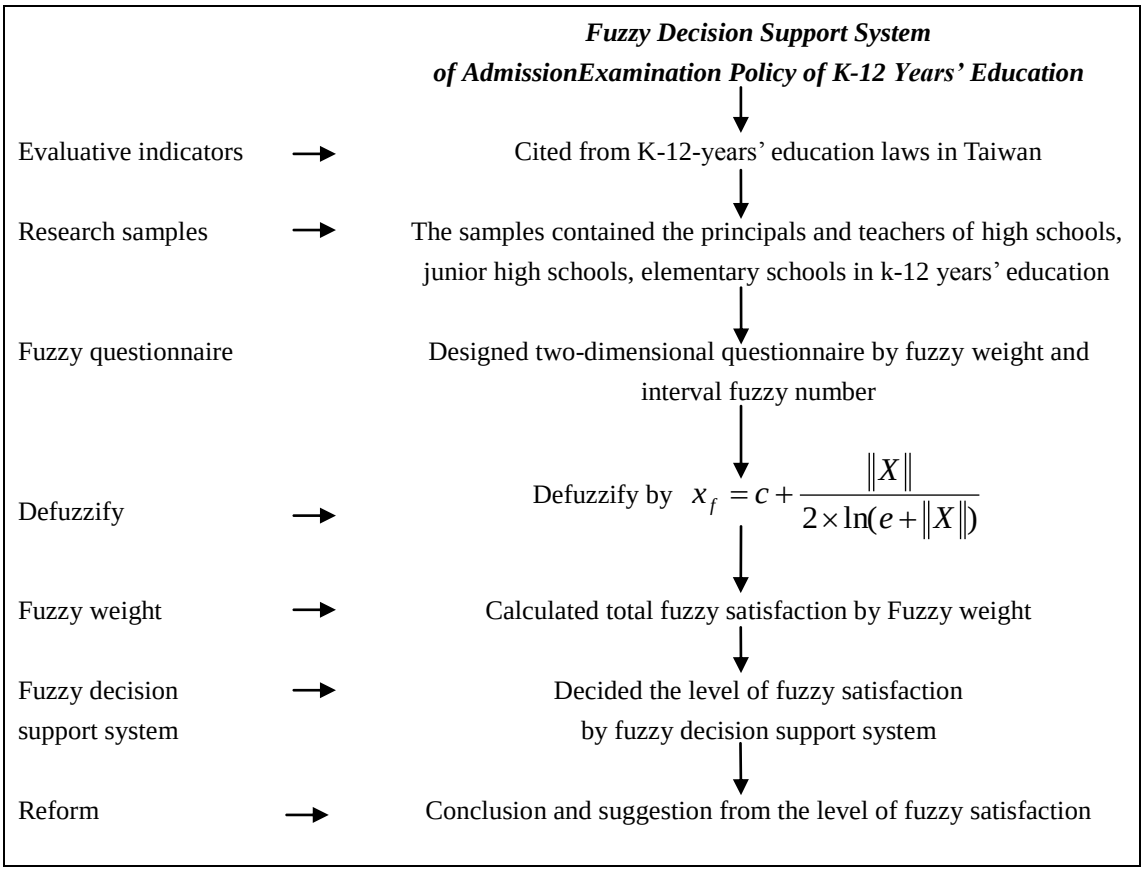

FIGURE 2.1. Research framework.

2.3. Fuzzy satisfaction.

Definition 2.1：Fuzzy satisfaction

If the maximal satisfaction of proposition was 100 points, the minimal satisfaction of proposition was 0 points. You can give a minimal points a, the maximal points b to answer the satisfaction of the proposition. We defined an interval fuzzy satisfaction (a, b) as interval fuzzy satisfaction.

2.4. Continuous fuzzy sample mean. Let U be a domain, L = $\{L_1, L_2, \cdots, L_k\}$ of k-language variables is distributed in the domain U. $\{x_i = [a_i, b_i]$, i = 1,..., n$\}$ is a set of fuzzy sample in the domain U.

$$\text{Fuzzy sample mean as } F_{\bar{x}} = \left[\frac{1}{n}\sum_{i=1}^{n} a_i, \frac{1}{n}\sum_{i=1}^{n} b_i \right]$$

2.5. Fuzzy weight (FW). Definition 2.3 Fuzzy weight (FW) we consider universe of discourse

S = $\{S_1, S_2, \cdots, S_k\}$ utility sequence $r_1 \prec r_2 \prec \cdots \prec r_f$ and S_i in r_f membership is μ_{S_I}f . Then the Fuzzy weight FW= ($FW_{S_i}, \cdots FW_{S_k}$) is defined as:

$$FW_{S_i} = \frac{\sum_{i=1}^{n} \mu_{S_i 1}}{L_1} + \frac{\sum_{i=1}^{n} \mu_{S_i 2}}{L_2} + \cdots + \frac{\sum_{i=1}^{n} \mu_{S_i f}}{L_k}; i = 1, \cdots, k$$

In the fuzzy set, membership ranges from 0 to 1, and every language variable, such as

shape, represents a possible distribution. The results of the distribution might be different from different subjects. We can average the answers from the subjects to make the utility sequence r of universe of discourse S membership reasonable distribution (Wu, 2005).

2.6. Survey by fuzzy two-dimensional questionnaire (Lai & Tien-Liu, 2013). We will put these two parts of compensation by addition. While inside these two factors, we would like to take it by the production. Since inside the factors, the variables are highly co-integrated.

In this research, we take two dimensional fuzzy data: the weight X denote by $\mu_{U,w}(X)$ as well as the memberships of satisfactory $\mu_{U,s}(a,b), a \le b$ a=minimal degree of satisfactory, b=maximal degree of satisfactorydenote by $\mu_{U,s}(Y)$ for the questionnaires on the discussion domain U= { *factor one*, *factor two*, *factor three*, *factor four*, *factor five*}. Hence a random fuzzy sample for a two dimensional case can be written as

$$\mu_U(X,Y) = \frac{[\mu_1(X),\mu_1(Y)]}{factor\ one} + \frac{[\mu_2(X),\mu_2(Y)]}{factor\ two} + \frac{[\mu_3(X),\mu_3(Y)]}{\text{factor three}} + \frac{[\mu_4(X),\mu_4(Y)]}{factor\ four} + \frac{[\mu_5(X),\mu_5(Y)]}{factor\ five}$$

Example 2.1 Suppose there are three principles are doing the survey. They are asked to write down the weight as well as the fuzzy satisfactory based on the factors of the discussion domain. Table 2.1 shows the result.

TABLE 2.1. School leader's fuzzy satisfactory indicators.

Factor	Factor one (w ; (a, b))	Factor two (w ; (a, b))	Factor three (w ; (a, b))	Factor four (w ; (a, b))	Factor five (w ; (a, b))
$\mu_{U,A}(X,Y)$,	(.4; (50,55))	(.3; (56, 60))	(.2; (31, 34))	(.1; (70, 77))	(.1; (41, 43))
$\mu_{U,B}(X,Y)$,	(.1; (45, 49))	(.1; (40,55))	(0; (36, 43))	(.8; (66, 70))	(.8; (70, 90))
$\mu_{U,C}(X,Y)$,	(.2; (43, 40))	(.2; (43, 60))	(.5; (55, 66))	(0; (73, 80))	(0; (60, 70))
Fuzzy Mean	(.23; (46,48))	(.2; (46, 58))	(.23; (41, 48))	(.3; (70, 76))	(.3; (57, 68))

2.7. Use a new function to defuzzify and calculate fuzzy satisfaction (Wu, 2013). Definition 2.2 defines the defuzzification of interval fuzzy scores [8]. Let X = (a, b) be an interval fuzzy number; c is the range center and; $\|X\|$ = |b-a| is the whole distance. The defuzzification value of the interval fuzzy number is as x_f .

$$x_f = c + \frac{\|X\|}{2 \times \ln(e + \|X\|)} \tag{2.1}$$

$$\frac{\|X\|}{2 \times \ln(e + \|X\|)} \tag{2.2}$$

Formula 2.2 is the defuzzification function of the interval length. If $a \to b$, then x_f approaches the range center value $\frac{a+b}{2}$.

2.7.1. Calculating the domain of x_f using formula 2.1. .If test scores are expressed as percentages, the domain of x_f is calculated using Formula 2.1, because Formula 2.2

has a maximal value of 10.8 and a minimal value of 0. The domain is calculated using the following process:

$$\lim_{X\to 0}\frac{\|X\|}{2\times\ln(e+\|X\|)}=\frac{\lim_{X\to 0}\|X\|}{\lim_{X\to 0}(2\times\ln(e+\|X\|))}=\frac{0}{2}=0$$

$$\lim_{X\to 100}\frac{\|X\|}{2\times\ln(e+\|X\|)}=\frac{\lim_{X\to 100}\|X\|}{\lim_{X\to 100}(2\times\ln(e+\|X\|))}=\frac{100}{2\times\ln(e+100)}=10.8$$

$$\lim_{X\to\infty}\frac{\|X\|}{2\times\ln(e+\|X\|)}=\lim_{X\to\infty}\frac{\ln(e+\|X\|)}{2}=\frac{\lim_{X\to\infty}\ln(e+\|X\|)}{\lim_{X\to\infty}2}=\infty$$

Thus, Formula 2.2 has a minimal value of 0 and a maximal value of 10.8. Therefore, Formula 2.1 has a minimal value of c and a maximal value of (c + 10.8). If test scores are expressed as percentages, then x_f maximal value is min (100, c +10.8) and their minimal value is c.

Example 2.2 Suppose there are three principles are doing the survey. They are asked to write down the weight as well as the fuzzy satisfaction based on the factors of the discussion domain. Table 2.2 showed the results.

TABLE 2.2. School leader's fuzzy satisfactory indicators.

Factor	Factor one (w ; (a, b))	Factor two (w ; (a, b))	Factor three (w ; (a, b))	Factor four (w ; (a, b))	Factor five (w ; (a, b))
$\mu_{U,A}(X,Y)$,	(.1; (40,45))	(.3; (51, 53))	(.1; (67, 69))	(.1; (55, 59))	(.4; (43, 48))
defuzzification	(.1; 43.72)	(.3; 52.64)	(.1; 68.64)	(.1; 58.05)	(.4; 46.72)
$\mu_{U,B}(X,Y)$,	(.1; (41, 48))	(.2; (47,52))	(0; (59, 65))	(.2; (61, 67))	(.5; (22, 28))
defuzzification	(.1; 46.04)	(.2; 50.72)	(0; 63.39)	(.2; 65.39)	(.5; 26.39)
$\mu_{U,C}(X,Y)$,	(.2; (27, 29))	(.2; (44, 49))	(.1; (70, 75))	(.1; (59, 66))	(.4; (30, 37))
defuzzification	(.2; 28.64)	(.2; 47.72)	(.1; 73.72)	(.1; 64.04)	(.4; 35.04)
Fuzzy defuzzification Mean	(.13; 39.47)	(.21; 50.66)	(.07; 69.01)	(.13; 63.02)	(.42; 35.89)

2.8. Evaluative indicators. In this study, evaluative indicators cited from the admission examination policy of k-12 years' education laws in Taiwan (Ministry of Education, 2013). This study through twice fuzzy Delphi methods by 15 experts and scholars to confirm 10 indicators and 5 factors as testing rankings and scoring, testing subjects and question patterns, comparing with the sorting of testing scores, testing time and schedule, examination policy and non-testing spirit. They showed in Table 2.3.

2.9. Rule-base system. Interpret information in a useful way. They are often used in artificial intelligence applications and research. Rule-base systems can be used in an expert system might help a doctor choose the correct diagnosis. Also known as the knowledge base, knowledge is stored as rules in the rule-base. Rules are of the form.

The rule-base system of k-12 years' education in admission examination policy is a method of finding a rule in a rule-base. We can express the matching policies are as follows.

TABLE 2.3. Evaluating indicators and factors for the admission examination Policy of k-12 years' education in Taiwan.

	Factors	Indicators
A	Testing rankings and scoring	1.Modified the scores of admission examination from third-ranking to five-ranking.
		2.If the scores of admission examination divided mastery level 6 points, normal level 4 points, low level 2 points.
B	Testing subjects and question patterns	1.The testing subjects concluded Chinese Composition, Chinese, Mathematics, English, Society, Nature and Science.
		2.Non-choice content concluded Chinese Composition, Mathematics proof.
C	Comparing with the sorting of testing scores	1. The scores of admission examination will account for the total scores over 34%.
		2. If the scores of admission examination were equal, next to compare with Chinese Composition,Chinese,Mathematics,English,Society, Nature and Science by order.
D	Testing time and schedule	1. Admission examination was tested at May 17, 18.
		2. Admission examination was tested at May was earlier to special enrollment at July.
E	Examination policy and non-testing spirit	1. Admission examination matched non-testing spirit in k-12 years' education in Taiwan.
		2.The design of admission examination policy could promise not to ballot after comparing sort to enroll.

Consists of a *rule-base* (permanent data); IF some condition THEN some action (Jocelyn, 1996 & Gupta, 1986). Therefore, the rule-base of the k-12 years' education in the admission examination policy of fuzzy satisfactory model is set up as below. (Lai & Tien-Liu, 2013)

Rule 1：If $0 \leqq$ *Fuzzy satisfactory* $\leqq 34$, we will substantially reform the admission examination policy of k-12 years' education.

Rule 2：If $34 <$ *Fuzzy satisfactory* $\leqq 70$, we will moderately reform the admission examination policy of k-12 years' education.

Rule 3：If $70 <$ *Fuzzy satisfactory* $\leqq 100$, we will substantially maintain the admission examination policy of k-12 years' education.

3. Empirical Study.

TABLE 3.1. School principles' fuzzy satisfactory indicators.

Factor	Factor one (w ; (a, b))	Factor two (w ; (a, b))	Factor three (w ; (a, b))	Factor four (w ; (a, b))	Factor five (w ; (a, b))
$\mu_{U,1}(X,Y)$,	(.3; (35,40))	(.1; (50, 55))	(.1; (60, 67))	(.2; (66, 69))	(.3; (23, 27))
defuzzification	(.3; 38.72)	(.1; 53.72)	(.1; 65.04)	(.2; 68.36)	(.3; 26.05)
$\mu_{U,2}(X,Y)$,	(.2; (28, 33))	(.1; (56,59))	(0; (56, 68))	(.2; (60, 67))	(.5; (30, 33))
defuzzification	(.2; 31.72)	(.1; 58.36)	(0; 64.23)	(.2;65.04)	(.5; 32.36)
$\mu_{U,3}(X,Y)$,	(.2; (38, 41))	(.2; (48, 51))	(.1; (58, 61))	(.1; (59, 70))	(.4; (34, 39))
defuzzification	(.2; 40.36)	(.2; 50.36)	(.1; 60.36)	(.1; 66.60)	(.4; 37.72)
……	……	……	……	……	……
$\mu_{U,90}(X,Y)$	(.2; (21, 24))	(.1; (45, 50))	(.2; (55, 57))	(.1; (60, 66))	(.4; (30, 32))
defuzzification	(.2; 23.36)	(.1; 48.72)	(.2; 56.64)	(.1; 64.39)	(.4; 31.65)
Total of Factor defuzzification	(.21; 25.32)	(.13; 49.92)	(.11; 61.63)	(.19; 65.37)	(.36; 31.61)
Overall Fuzzy Satisfactory	31.39				

TABLE 3.2. School teachers' fuzzy satisfactory indicators.

Factor	Factor one (w ; (a, b))	Factor two (w ; (a, b))	Factor three (w ; (a, b))	Factor four (w ; (a, b))	Factor five (w ; (a, b))
$\mu_{U,1}(X,Y)$,	(.1; (40,45))	(.3; (51, 53))	(.1; (67, 69))	(.1; (55, 59))	(.4; (43, 48))
defuzzification	(.1; 43.72)	(.3; 52.64)	(.1; 68.64)	(.1; 58.05)	(.4; 46.72)
$\mu_{U,2}(X,Y)$,	(.1; (41, 48))	(.2; (47,52))	(0; (59, 65))	(.2; (61, 67))	(.5; (22, 28))
defuzzification	(.1; 46.04)	(.2; 50.72)	(0; 63.39)	(.2; 65.39)	(.5; 26.39)
$\mu_{U,3}(X,Y)$,	(.2; (27, 29))	(.2; (44, 49))	(.1; (70, 75))	(.1; (59, 66))	(.4; (30, 37))
defuzzification	(.2; 28.64)	(.2; 47.72)	(.1; 73.72)	(.1; 64.04)	(.4; 35.04)
……	……	……	……	……	……
$\mu_{U,90}(X,Y)$	(.3; (20, 27))	(.1; (50, 56))	(.1; (45, 58))	(.2; (63, 67))	(.3; (20, 25))
defuzzification	(.3; 25.04)	(.1; 54.39)	(.1; 53.86)	(.2; 66.05)	(.3; 23.72)
Total of Factor defuzzification	(.22; 33.04)	(.15; 55.73)	(.12; 60.78)	(.17; 59.95)	(.34; 32.79)
Overall Fuzzy Satisfactory	40.23				

3.1. Summary.

3.1.1. Testing rankings and scoring.

(1) School principles' fuzzy satisfactory =25.32.
(2)Rule 1：If $0 \leqq$ *Fuzzy satisfactory* $\leqq 34$, we will substantially reform the admission examination policy of k-12 years' education.
(3) School teachers' fuzzy satisfactory =33.04.
(4) Rule 1：If $0 \leqq$ *Fuzzy satisfactory* $\leqq 34$, we will substantially reform the admission examination policy of k-12 years' education.
(5) Testing rankings and scoring, it must substantially reform for the admission examination policy of k-12 years' education.

3.1.2. Testing subjects and question patterns.

(1) School principles' fuzzy satisfactory =49.92.
(2)Rule 2：If $34 <$ *Fuzzy satisfactory* $\leqq 70$, we will moderately reform the admission examination policy of k-12 years' education.
(3) School teachers' fuzzy satisfactory =55.73.
(4) Rule 2：If $34 <$ *Fuzzy satisfactory* $\leqq 70$, we will moderately reform the admission examination policy of k-12 years' education.
(5) Testing subjects and question patterns, it must moderately reform for the admission examination policy of k-12 years' education.

3.1.3. Comparing with the sorting of testing scores.

(1) School principles' fuzzy satisfactory =61.63.
(2)Rule 2：If $34 <$ *Fuzzy satisfactory* $\leqq 70$, we will moderately reform the admission examination policy of k-12 years' education.
(3) School teachers' fuzzy satisfactory =60.78.
(4) Rule 2：If $34 <$ *Fuzzy satisfactory* $\leqq 70$, we will moderately reform the admission examination policy of k-12 years' education.
(5) Comparing with the sorting of testing scores, it must moderately reform for the admission examination policy of k-12 years' education.

3.1.4. Testing time and schedule.
(1) School principles' fuzzy satisfactory =65.37.
(2)Rule 2：If 34< *Fuzzy satisfactory*≦70, we will moderately reform the admission examination policy of k-12 years' education.
(3) School teachers' fuzzy satisfactory =59.95.
(4) Rule 2：If 34< *Fuzzy satisfactory*≦70, we will moderately reform the admission examination policy of k-12 years' education.
(5) Testing time and schedule, it must moderately reform for the admission examination policy of k-12 years' education.

3.1.5. Examination policy and non-testing spirit.
(1) School principles' fuzzy satisfactory =31.61.
(2) Rule 1：If 0≦*Fuzzy satisfactory*≦34, we will substantially reform the admission examination policy of k-12 years' education.
(3) School teachers' fuzzy satisfactory =32.79.
(4) Rule 1：If 0≦*Fuzzy satisfactory*≦34, we will substantially reform the admission examination policy of k-12 years' education.
(5) Examination policy and non-testing spirit, it must substantially reform for the admission examination policy of k-12 years' education.

3.1.6. Overall fuzzy satisfactory by evaluating indexes and factors of k-12 years' education.
(1) School principles' fuzzy satisfactory =31.39.
(2)Rule 1：If 0≦*Fuzzy satisfactory*≦34, we will substantially reform the admission examination policy of k-12 years' education.
(3) School teachers' fuzzy satisfactory =40.23.
(4) Rule2：If 34< *Fuzzy satisfactory*≦70, we will moderately reform the admission examination policy of k-12 years' education.
(5) Overall fuzzy satisfactory by evaluating indexes and factors, it must moderately reform for the admission examination policy of k-12 years' education.

4. Discuss. In Taiwan 2011, Ministry of Education originally announced the main religion of k-12 years' education had three core concepts of non-testing, free, and voluntary, in which examinations were divided into only three levels (Ministry of Education, 2011). Since the scores of the admission examination were only divided into three levels. It was lack of discrimination and was just similar to the qualifying examination. It could really lift the academic pressure of enrollment. Thus, junior educators, parents and students were looking forward to the implementation of k-12 years' education .The religion of non-testing, free, voluntary could radically change Taiwan's education towards the development of holistic education. But Ministry of Education in December 2012 to complete the national simulative examination found that the number of applicants before the two levels were too many (Ministry of Education, 2012). In order to resolve this order problem and do not ballot, first level must be divided into two grades as "A"and "A^{+}", second level must be divided into two grades as "B"and "B^{+}" (Ministry of Education, 2013). The results of modification become admission examination to key achievements and also officially declare the

non-testing policy of k-12 years' education cannot be honored.

It was why both of principals and teachers asked to do substantial modification for admission examination policy of k-12 years' education by non-testing spirit. School principles' fuzzy satisfactory was 31.39 and asked to substantially reform the admission examination policy of k-12 years' education. School teachers' fuzzy satisfactory was 40.23 and asked to moderately reform. Specially, the fuzzy satisfactory of the factor of "Testing rankings and scoring" and "Examination policy and non-testing spirit" both presented to substantially reform.

5. Conclusion. This study constructed a new model to improve evaluative level of policies by, fuzzy satisfaction of combining interval fuzzy numbers with two-dimensional questionnaires. Do empirical research by fuzzy satisfaction evaluation of admission examination policy of k-12 years' education in Taiwan. School principles' fuzzy satisfactory asked to substantially reform the admission examination policy of k-12 years' education and school teachers' fuzzy satisfactory asked to moderately reform. Specially, the fuzzy satisfactory of the factor of "Testing rankings and scoring" and "Examination policy and non-testing spirit" both presented to substantially reform. Therefore, both of principals and teachers asked to do substantial modification for admission examination policy of k-12 years' education by non-testing spirit.

REFERENCE

[1] Berlin, W. (2005), *Introduction to Fuzzy Statistics - Methods and Applications*,WuNan: Taipei City.

[2] Berlin, W. (2013), *New Introduction to Fuzzy Statistics - Methods and Applications*, WuNan: Taipei City.

[3] Chu, T. C. & Lin Y. C. (2009), An interval arithmetic based fuzzy TOPSIS mode, *Expert Systems with Applications*, vol. 36, no. 8, pp. 10870-10876.

[4] Fan Z. P. (2010), An approach to solve group-decision-making problems with ordinal interval numbers, *IEEE Trans. Syst, Man, Cybern. B*, vol. 40, no. 5, pp. 1413-1423.

[5] Gupta, etc. (1986), Parallel algorithms and architectures for rule-based systems, *ACM SIGARCH Computer Architecture News - Special Issue: Proceedings of the 13th annual international symposium on Computer architecture (ISCA '86), Retrieved from http:// portal.acm.org/ citation.cfm?id=17356.17360*, vol. 14, no. 2, pp. 28.

[6] Hsu T. H, Tsai T. N. & Chiang P. L. (2009), Selection of the optimum promotion mix by integrating,A fuzzy linguistic decision model with genetic algorithms, *Information Sciences*, vol. 179, no. 1-2, pp.41-52.

[7] Hung, N, Vladik, K.Berlin, W.Gang, X. (2011), *Computing Statistics under Interval and Fuzzy Uncertainty, Studies in Computational Intelligence*, Springer Verlag.

[8] Jiang, S.K., Wu B. & Hu M.L. (2008), Investors' preference order of fuzzy numbers, *Computers and Mathematics*, vol.55, no. 11, pp. 2623-2630.

[9] Jocelyu, I.P. (1996), What is a rule-based system? Retrieved from *http:// www.jpaine.org/ students/ lectures/lect3/node5.html*.

[10] Lai, W.-T. & Tien-Liu, T.-K. (2013), Evaluate the employability of higher education by fuzzy data. *International Journal of Intelligent Technologies and Applied Statistics*, vol. 6, no. 1, pp. 51-64.

[11] Lin C. C. & Chen A. P. (2004), Fuzzy discriminate analysis with outlier detection by genetic algorithm, *Computers & Operations Research*, vol. 31, no. 6, pp. 877.

[12] Ministry of Education (2011), Draft of k-12-years' education laws in Taiwan, Retrieved from *http://cap.ntnu.edu.tw/*.

[13] Ministry of Education (2012), Modifying draft of k-12-years' education laws in Taiwan, Retrieved from *http://cap.ntnu.edu.tw/*.

[14] Ministry of Education (2013), K-12-years' education laws in Taiwan, Retrieved from *http:// cap.ntnu.edu.tw/*

[15] Nguyen H. & Wu B. (2006), *Fundamentals of statistics with fuzzy data*, Heidelberg: Springer-Verlag.

[16] Ravi Shankar N, Sireesha V, Srinivasa Rao K. & Vani N. (2010), Fuzzy critical path method based on metric distance ranking of fuzzy numbers, *International Journal of Mathematical Analysis*, vol. 4,no. 20, pp.995-1006.

[17] Sengupta A. & Pal T. K. (2000), On comparing interval numbers. *European Journal of Operational Research*, vol. 127, no.1, pp.28.

[18] Song-Lian, C. (1994), *Application of Fuzzy Mathematics*. Science and Technology Library, Taipei City.

[19] Sun C. M. & Wu B. (2007), New statistical approaches for fuzzy data, *International Journal of Uncertainty, Fuzziness and Knowledge-based Systems*, vol. 15.no.2, pp.89-106.

[20] Tai-Ning, C. (1997), Fuzzy concepts and fuzzy words, Language construction, *Communication*, vol. 51, pp. 74-79.

[21] Wu B. L. & Lin Y. H. (2002), The introduction of fuzzy model and its applications, *Information of Statistics with Measurement*, vol. 47, pp. 23-27.

[22] Yager R. R, Detyniecki M. & Bouchon-Meunier B. (2001), A context-dependent method for ordering fuzzy numbers using probabilities, *Information Sciences*, vol. 138, no. 1, pp. 237.

[23] Zadeh, L.A. (1965),Fuzzy Sets, *Information and Control*, vol. 8, no. 3, pp. 338-353.

[24] Zimmermann, H. J. (1991), *Fuzzy Set Theory and Its Applications*, Kluwer Academic, Boston.