Title: An Approach to Estimate the Operational Performance Metrics of a Company in the Industrial Marketing Context

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Abstract

How to measure the performance of an organization is a popular research topic which the current tourism industry concerned about. While in the traditional market research methods, most questionnaires design is set up with a binary logic state that is people record the answers with a single value state instead of the multiple values or fuzzy numbers state. Since during the survey, people are often encountered with uncertainty or imprecision problems. In order to develop a more efficient survey analysis, we provide the applications of fuzzy mode, fuzzy expect value and the fuzzy test. A new design of market survey process and analysis for measuring the performance will carry. Finally, we illustrate result of comparison between the fuzzy χ^2 test and the traditional χ^2 test. These soft computing methods will make the corresponding fuzzy techniques more practical and reasonable in the future study of management science. There are illustrated examples demonstrated to explain how to find the fuzzy mode and fuzzy median, and how to use the results to help people making performance measurement. The expected research results is that fuzzy logic model structure was revised and new results generated. This insights gained from this research can be applied in major disciplines such as accounting, marketing and finance, engineering and strategic management.

Key words: *Performance measurement, Fuzzy samples analysis, Membership function, Fuzzy mode, Fuzzy median, Soft computing, Fuzzy logic*

1. Introduction

In the management science literature there is no uniform opinion about appropriate performance measures because different fields of study have different research questions and purpose. Industry and company related performance indicators enhance the business valuation process by providing a broader, more encompassing

view of overall corporate health and a better understanding of improvement opportunity areas within a company. New methodologies are required to integrate the financial and non-financial performance indicators with the typical information used. This requires a “re-think” of the standard performance process and the exploration and application of other statistical methods and analytical techniques.

Performance is usually the final dependent variable in the marketing and strategic management literature. Since “performance improvement is at the heart of strategic management”, the ultimate aim of marketing or strategic management models is to explain organisation performance (Venkatraman and Ramanujam, 1987). The assessment of business performance or organisational performance has been the subject of extensive empirical investigation for some time now and review of the literature revealed that the results of these investigations are not conclusive. Although the importance of the performance concept is widely recognised through its extensive use as a dependent variable in empirical models, its treatment in research settings is perhaps one of the important issues research face (Venkatraman and Ramanujam, 1987; Gray and Matear,1998).

Ruekert, Walker, and Roering (1985) suggest three possible performance domains (regardless of whether perceptual or objective indicators): (1) effectiveness, (2) efficiency, and (3) adaptiveness. Effectiveness is described as the degree to which organisational goals are met. Efficiency is defined as the relationship between a firm’s outputs and inputs, possibly indicated by profitability(Dess and Robinson,1984). Adaptiveness is referred to reflect the ability of the firm to change in order to meet opportunities and threats (Ruekert, Walker, and Roering, 1985; Walker and Ruekert,1987). However, due to the broad and often conflicting

indicators used for measuring business performance, it is important to precisely delineate the domain covered by the performance variables within a given study. This requires a “re-think” of the standard performance process and the exploration and application of other statistical methods and analytical techniques.

A fuzzy model with fuzzy variables was developed and is used to approximate relationships. It is expected to show an improvement in the performance measures. For the social science field perception measurement are done by the survey or questionnaire with fuzzy to seek for people’s consensus. While most questionnaires design as well as its answers is set up with a binary logic state in the traditional market research methods, that is people record the answers with a single value state instead of the multiple values or fuzzy numbers state. To investigate the population, people’s opinions or the complexity of a subjective event more accurately, it is recommend to compute the information based on the new performance measurement approach should be more reasonable.

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of fuzzy mode, fuzzy median as well as investigate their related terms.

These statistical parameters can be quickly computed from a set of data and its basic information has been widely employed in many academic areas. Each statistics has its special application. However, traditional statistics are reflecting the result from a two-valued logic world. Fuzzy statistics provides a powerful research tool. Fuzzy set theory applications are extended to traditional statistical inferences and methods in performance measures. Fuzzy statistical analysis grows as a new discipline from the necessity to deal with vague samples and imprecise information caused by human thought in certain environments. In this research I made an attempt to link the gap between the binary logic based on multiple choice survey with a more complicated yet precise fuzzy membership function assessment, such as fuzzy mode, fuzzy median and fuzzy weight etc.

2. Performance Measurement

Ruekert, Walker, and Roering (1985) suggest three possible performance domains (regardless of whether perceptual or objective indicators): (1) effectiveness, (2) efficiency, and (3) adaptiveness. Effectiveness is described as the degree to which organisational goals are met. Efficiency is defined as the relationship between a firm's outputs and inputs, possibly indicated by profitability. Adaptiveness is referred to reflect the ability of the firm to change in order to meet opportunities and threats (Ruekert, Walker, and Roering, 1985; Clark, 2000).

Efficiency represents the comparison of outputs (performance) from marketing to

inputs (such as marketing expenditure) of marketing with the goal of maximising the inputs relative to the outputs (Bonoma and Clark, 1988; Morgan, Clark and Gooner, 2002; Sheth and Sisodia, 2002). Efficiency is called marketing productivity, this measurement examines how best to allocate marketing activities and assets to produce the best performance. Similarly, efficiency is defined as " the outcome of a business programmes in relation to the resources employed (Walker and Ruekert, 1987, p.19). Finally, efficiency perspective suggests that marketing resources may have negative association with performance because fewer resources should be better (Bonoma and Clark, 1988).

Effectiveness is increasingly employed to measure marketing performance in some marketing and strategy literature. The effectiveness notion posits that any measure of performance should incorporate the objectives of the decision makers (Bonoma and Clark, 1988; Sheth and Sisodia, 1995). Furthermore, effectiveness is defined as a goal attainment of view of a organisation (Lewin and Minton, 1986), so this implies that the performance of organisation meets or exceeds the organisation goals are seen as effectiveness. Specifically, effectiveness is consistent with organisation performance relative to aspiration or expectation level (Lant, 1992). The purpose of implementing strategy is to achieve some set of objectives in a company when effectiveness provides an alternative measure to evaluate the performance of company's objectives. In some previous studies effectiveness has diverse and similar definition. Effectiveness is defined as a comparison of programme results to expectation for results and is used to formulate the concept of managerial performance (Jawsorski, 1988). In final, Armstrong and Collopy (1996) indicates that effectiveness is defined as success compared to competitors, which is certainly a goal framework in the marketing management literature.

The adaptability of marketing has been a measurement of marketing performance assessment. Most previous studies posit that the environment is a determinant factor of performance. Drazen and Van de Ven (1985) utilize a contingency theory perspective in their review of strategic research and suggest that organisational performance depends on the " fit" (or interaction) between variables under study. From adaptability perspective, success of a company arises when a company's strategy fits the environment (Lambkin and Day, 1989) and a company strategy fit the structure-conduct-performance (SCP) framework in the industrial organisation theory (Porter, 1981). The adaptability indicator was used on Walker and Ruekert's (1987) research as one of their three main constructs of performance.

Another performance measure is satisfaction. As Oliver(1980) states that satisfaction judgements are common across a wide variety of domains, it seems that managers should also decide how satisfaction on the performance in their firms or business units. The satisfaction approach is adapted from surveying the consumer to compare their experience in consuming a product with their expectations and satisfaction judgement(Clark,2000). However, satisfaction will not be employed to measure market performance based on two reasons. First, satisfaction is seldom used to measure market performance for a firm, industry or SBU in practice. Second, satisfaction judgement is a function of disconfirmation of expectations, and this disconfirmation judgement is driven by various aspects of the management experience(Clark, 2000).

Hofer(1983) indicates that different researches have used different performance measures. There is no uniform opinion about appropriate performance measure

because different fields of study have different research questions and ultimate purpose(Hofer,1983). Selection of appropriate performance measures is a debatable issue. It seems that there is no one correct performance measure for every purpose. Different research question should lead to different performance measures. Walker and Ruekert(1987) states that"….*they involve substantial tradeoffs; good performance on one dimension often means sacrificing performance on other*…" (p.19). Walker and Ruekert(1987) also note a temporal characteristic in the three performance dimensions, with efficiency being short term and effectiveness and adaptability being more long term in nature. However, due to the broad and often conflicting indicators used for measuring business performance, it is important to precisely delineate the domain covered by the performance variables within a given study.

An alternative to using objective measures of organisational performance is to use managerial perceptions. Perceptual measures have a variety of advantages over objective measures, including; (1) Perceptual measures avoid the accounting method problems associated with objective measures, (2) Perceptual measures are easy to obtain, and (3) Perceptual measures enable the researcher to include a variety of baselines in the measures, such as comparisons to competitors, expectations or goals, past performance, potential performance, or growth(Venkatraman and Ramanujam, 1986). Subjective performance measures have also been shown to strongly correlate with objective measures within the same firms(Dess and Robinson, 1984; Perce et al, 1984).

3. Fuzzy statistical analysis and its applications in the Performance

measurement

Zadeh (1965) developed fuzzy set theory, its applications are extended to traditional statistical inferences and methods in social sciences, including medical diagnosis or a stock investment system. For example, Lowen (1990), Dubois and Parde (1991), Tseng and Klein (1992) demonstrated the approximate reasoning econometric methods one after another. Wu and Hsu (2002) developed fuzzy time series model to overcome the bias of stock market, which might be explained unreasonable.

A fuzzy model with fuzzy variables was developed and is used to approximate relationships and model a non-linear environment. The research process was demonstrated with data from the travel agency context. The 172 strategic business units were tested with actual data using the original fuzzy logic model and then the original fuzzy logic model was revised and new results generated.

To investigate the population, people's opinions or the complexity of a subjective event more accurately, it is suggested that we had better use the fuzzy logic. Especially, when we want to know the public ideology on the environmental pollution, fuzzy statistics provides a powerful research tool. Moreover, since Zadeh (1965) developed fuzzy set theory, its applications are extended to traditional statistical inferences and methods in social sciences, including medical diagnosis or a stock investment system. For example, Lowen (1990), Ruspini (1991), Dubois and Parde (1991), Tseng and Klein (1992) demonstrated the approximate reasoning econometric methods one after another. Wu and Hsu (2002) developed fuzzy time series model to overcome the bias of stock market, which might be explained unreasonable.

There are more and more researches focus on the fuzzy statistical analysis and applications in the social science fields, such as Hwang and Wu (1995) proposed fuzzy statistical testing method to discuss the stationarity of Taiwan short-term money demand function; Guariso, Rizzoli and Werthner (1992) identified the model construction through qualitative simulation; Wu and Sun (1996), Wu and Yang (1997)

demonstrated the concepts of fuzzy statistic and applied it to social survey; Wu and Tseng (2002) used fuzzy regression method of coefficient estimation to analyze Taiwan monitoring index of economic. Recently, along with the raising of intelligent knowledge consciousness and soft-computing, many investigators focus on the application of fuzzy set in calculating the human thought or public polls under the uncertain and incomplete condition.

In considering the question related with fuzzy property, we consider the information itself has the uncertainty and fuzzy property. Hence, let's firstly give an easy and precise explanation about fuzzy numbers.

Definition 3.1 Fuzzy Number

Let U denote a universal set, $\{A_i\}_{i=1}^n$ *be a subset of discussion factors on U, and* $\Lambda(A_i)$ *be a level set of* A_i *for i=1,2,…,n. The fuzzy number of a statement or a term X over U is defined as:*

$$\mu_U(X) = \sum_{i=1}^{n} \mu_i(X) I_{A_i}(X) \tag{2.1}$$

where $\{\mu_i(X), 0 \le \mu_i(X) \le 1\}_{i=1}^n$ *are set of membership functions for corresponding factor in* $\{A_i\}_{i=1}^n$, *and .* $I_{A_i}(x) = 1$ *if* $x \in A_i$; $I_{A_i}(x) = 0$ *if* $x \notin A$. *If the domain of the universal set is continuous, then the fuzzy number can be written as :*

$\mu_U(X) = \int_{A_i \subseteq A} \mu_i(X) I_{A_i}(X)$ 。

In the research of social science, the sampling survey is always used to evaluate and understand public opinion on certain issues. The traditional survey forces people to choose one answer from the survey, but it ignores the uncertainty of human thinking. For instance, when people need to choose the answer from the survey which lists five choices including "better performance," "good performance," "Normal," "bad performance," "Very bad performance," traditional survey become quite exclusive.

The advantages of evaluation with fuzzy number include: (i) Evaluation process

becomes robust and consistent by reducing the degree of subjectivity of the evaluator. (ii) Self-potentiality is highlighted by indicating individual distinctions. (iii) Provide the evaluators with an encouraging, stimulating, self-reliant guide that emphasizes on individual characteristics. While the drawback is that the calculating process will be a little complex than the conventional one.

Example 3.1 *The use of fuzzy number in a sampling survey about company performance.*

Consider a fuzzy set of favorite games for a person as shown in Table 1. Note that in the extreme cases when a degree is given as 1 or 0, that is "good" or "bad", a standard "yes" and "no" are in a complementary relationship, as in binary logic. Let A_1 *represent for "good",* A_2 *"bad".*

Table 1 Comparing fuzzy number with integral number favorite games for

company	A_1	A_2	A_1 A_3
Degree of performance	$\mu_{A_1}(X)$	$\mu_{A_2}(X)$	*binary logic*
Company A	*1*	*0*	ˇ
Company B	*0.3*	*0.7*	ˇ
Company C	*0.8*	*0.2*	ˇ
Company D	*0,4*	*0.6*	ˇ
Company E	*0.2*	*0.8*	ˇ

Therefore, based on the binary (like or dislike) logic, we can see only the superficial feeling about individual company performance (cf, the right-most column of Table.1). With the information of fuzzy response we will see a more detailed data

representation.

Traditional statistics deals single answer or certain range of the answer through sampling survey, and unable to sufficiently reflect the complex thought of an individual. If people can use the membership function to express the degree of their feelings based on their own choices, the answer presented will be closer to real human thinking. Therefore, to collect the information based on the fuzzy mode should be the first step to take. Since a lot of times, the information itself embedded with uncertainty and ambiguity. It is nature for us to propose the fuzzy statistics, such as fuzzy mode and fuzzy median, to fit the modern requirement. In this and next section we demonstrate the definitions for fuzzy mode and fuzzy median generalized from the traditional statistics. The discrete case is simpler than the continuous one's.

Definition 3.1 Fuzzy Mode (data with multiple values)

Let U *be the universal set (a discussion domain),* $L=\{L_1,L_2,\cdots,L_k\}$ *be a set of k-linguistic variables on* U, *and* $\{FS_i, i=1,2\cdots,n\}$ *be a sequence of random fuzzy sample on* U. *For each sample* FS_i, *assign a linguistic variable* L_j *a normalized membership* $m_{ij}(\sum_{j=1}^{k} m_{ij}=1)$, *let* $S_j=\sum_{i=1}^{n} m_{ij}$, $j=1,2,\cdots,k$. *Then, the maximum value of* S_j *(with respect to* L_j*) is called the fuzzy mode (*FM*) of this sample. That is* $FM=\{L_j \mid S_j=\max_{1\le i\le k} S_i\}$.

Note : A significant level α for fuzzy mode can be defined as follows: Let U be the universe set (a discussion domain), $L=\{L_1,L_2,\cdots,L_k\}$ be a set of k-linguistic variables on U, and $\{FS_i, i=1,2\cdots,n\}$ be a sequence of random fuzzy sample on U. For each sample FS_i, assign a linguistic variable L_j a normalized membership $m_{ij}(\sum_{j=1}^{k} m_{ij}=1)$, let $S_j=\sum_{i=1}^{n} I_{ij}$, $j=1,2,\cdots,k$ $I_{ij}=1$ *if* $m_{ij}\ge\alpha$, $I_{ij}=0$ *if* $m_{ij}<\alpha$, α is the significant level. Then, the maximum value of S_j (with respect to L_j) is

called the fuzzy mode (FM) of this sample. That is $FM = \{L_j \,|\, S_j = \max_{1 \le i \le k} S_i\}$. If there are more than two sets of L_j that reach the conditions, we call that the fuzzy sample has multiple common agreement.

Definition 3.2 Fuzzy Mode (data with interval values)

Let U be the universe set (a discussion domain), $L = \{L_1, L_2, \cdots, L_k\}$ be a set of k-linguistic variables on U, and $\{FS_i = [a_i, b_i], a_i, b_i \in R, i = 1, 2, \cdots, n\}$ be a sequence of random fuzzy sample on U. For each sample FS_i, if there is an interval [c, d] which is covered by certain samples, we denote these samples as a clustering. Let MS is the set of clustering which contains the maximum number of samples, then the fuzzy mode FM is defined as

$$FM = [a, b] = \{\cap [a_i, b_i] \,|\, [a_i, b_i] \subset MS\}.$$

If $[a, b]$ does not exist (i.e. $[a, b]$ is an empty set), we say this fuzzy sample does not have fuzzy mode.

Suppose eight voters are asked to choose a chairman from four candidates. Table 3.2 is the result from the votes with two different types of voting: traditional response and fuzzy response.

Table 3.2 Response comparison for the eight voters

Item / Voter	*traditional response*				*fuzzy response*			
	A	B	C	D	A	B	C	D
1		ˇ				0.7	0.3	
2	ˇ				0.5		0.4	0.1
3				ˇ			0.3	0.7
4			ˇ		0.4		0.6	
5		ˇ				0.6	0.4	

6				ˇ	0.4		0.4	0.6
7		ˇ				0.8	0.2	
8			ˇ				0.8	0.2
Total	1	3	2	2	1.3	2.1	3.5	1.6

From left part of Table 2.2, we can find that three are there people choose B. Hence the mode is B. But if we examine the right part of Table 2.2 for fuzzy response, we find that B only gets the total memberships 2.1. Which is less than C=3.5, the fuzzy mode. Hence we can see that the fuzzy response will illustrate people's thought more faithfully.

3.2 A χ^2-test for fuzzy categorical data

Consider a *K*-cell multinomial vector n=$\{n_1, n_2, ..., n_k\}$ with $\sum_i n_i = n$. The *Person chi-squared test* ($\chi^2 = \sum_i \sum_j \frac{n_{ij} - e_{ij}}{e_{ij}}$) is a well known statistical test for investigating the significance of the differences between observed data arranged in *K* classes and the theoretically expected frequencies in the *K* classes. It is clear that the large discrepancies between the observed data and expected cell counts will result in larger values of χ^2

However, a somewhat ambiguous question is whether (quantitative) discrete data can be considered categorical and use the traditional χ^2*-test*. For example, suppose a child is asked the following question: "*how much do you love your sister*?" If the responses is a fuzzy number (say, 70% of the time), it is certainly inappropriate to use the traditional χ^2-test for the analysis. We will present a χ^2-test for fuzzy data as follows:

Procedures for χ^2-test with fuzzy categorical data

1.Sample： *Let* U *be the universal set (a discussion domain),* $L=\{L_1, L_2, \cdots, L_k\}$ *a set of k-linguistic variables on* U *, and* $\{A_1, A_2, \cdots, A_m\}$ *and* $\{B_1, B_2, \cdots, B_n\}$ *two sets drawn from categorical populations with numbers on* U *. For each sample in* $\{A_i, B_i\}$*, assign a linguistic variable* L_j *and a normalized membership* $m_{ij}(\sum_{j=1}^{k} m_{ij}=1)$ *, and let* $Fn_{ij}=\sum_{i\in A,B} Ln_{ij}$ $i\in A,B; j=1,2,\cdots,k$ *be the total memberships in the cell ij.*

2. Hypothesis: *Two populations have the same distribution ratio.*

3. Statistics： $\chi^2=\sum_{i\in A,B}\sum_{j=1}^{c}\frac{([Fn_{ij}]-e_{ij})^2}{e_{ij}}$.(*In order to perform the Chi-square test for fuzzy data, we transfer the decimal fractions of* Fn_{ij} *in each cell of fuzzy category into the integer* $[Fn_{ij}]$ *by counting 0.5 or higher fractions as 1 and discard the rest.*)

4. Decision rule：under significance levelα, if $\chi^2>\chi_\alpha^2(k-1)$,then we reject H_0.

3.3 Performance measurement Analysis

We make a comprehensive satisfactory statistic analysis base on the survey conducted on the Taiwanese tourism industry context: Table 2 is “A comparison of traditional and fuzzy statistical analysis on performance measurement”. In order to get a consistent results we conducted a cross analysis on the performance measurement.

The results from the comparison Table 2, the results of the convention and fuzzy model survey might have some variation, mainly the fuzzy model survey considered the uncertainty of the human thoughts and its mind concentration, no enough time and irresponsible answer might cause the variance in results.

Table 2 Performance Measurement at α *=0.1*

Performance Measurement		Traditional Category Analysis						Fuzzy Category Analysis					
		1	2	3	4	5	Chi-Square Test	1	2	3	4	5	Chi-Square Test
1	**TW**	***3***	***6***	***10***	***29***	***14***	χ^2 ***=7.93*** ***p=0.094*** ***Reject***	***3.5***	***5.8***	***14.3***	***24.2***	***13.2***	χ^2 ***=3.76*** ***p=0.44*** ***Accept***
	CN	***1***	***1***	***11***	***14***	***2***		***0.4***	***3.8***	***10***	***11.3***	***3.6***	
2	TW	*3*	*11*	*10*	*30*	*8*	χ^2 *=3.16* *p=0.532* *Accept*	*4.2*	*9.4*	*16.1*	*24.3*	*8.0*	χ^2 *=2.4* *4* *p=0.66* *Accept*
	CN	*3*	*4*	*4*	*11*	*7*		*2.8*	*4.7*	*6.20*	*8.5*	*6.8*	
3	**TW**	***6***	***15***	***10***	***23***	***7***	χ^2 ***=10.05*** ***p=0.04*** ***Reject***	***6.2***	***14.2***	***14.9***	***17.3***	***8.1***	χ^2 ***=1.52*** ***p=0.82*** ***Accept***
	CN	***3***	***1***	***12***	***10***	***3***		***2.60***	***4.0***	***10.3***	***8.5***	***8.6***	
4	TW	*4*	*11*	*12*	*25*	*10*	χ^2 *=3.54* *p=0.47* *Accept*	*4.2*	*10.8*	*17.0*	*20.7*	*9.3*	χ^2 *=0.48* *p=0.98* *Accept*
	CN	*3*	*3*	*9*	*12*	*2*		*2.8*	*4.7*	*9.30*	*8.80*	*8.4*	
5	TW	*3*	*11*	*9*	*28*	*11*	χ^2 *=4.6* *p=0.331* *Accept*	*8.2*	*9.6*	*15.9*	*21.4*	*11.9*	χ^2 *=1.7* *0* *p=0.79* *Accept*
	CN	*1*	*1*	*7*	*13*	*7*		*0.80*	*2.0*	*7.80*	*11.3*	*7.10*	
6	TW	*1*	*11*	*16*	*19*	*15*	χ^2 *=4.17* *p=**	*1.40*	*12.0*	*17.5*	*17.6*	*13.5*	χ^2 *=2.4* *p=**
	CN	*0*	*3*	*11*	*10*	*3*		*0.40*	*3.10*	*10.5*	*9.60*	*4.90*	

*2 cells with expected counts less than 1. 3 cells with expected counts less than 5. Chi-Square approximation probably invalid.

The comparison table 2 shows that in the empirical analysis of the tourism industry, to conduct a conventional type of survey on the performance measurement has varied in the results, while the fuzzy model of survey show no variation. The research finds that the results from the conventional survey show no difference while informal survey has some disparity. The extended model shows an improvement in the business valuation process performance. The benefits from this research include the

definition of a new class of problems and a process to solve problems nature. This insights gained from this research can be applied in major disciplines such as marketing, management, strategy, finance and decision theory.

4. Major Contribution

The research will achieve the goals including new approach to solve problem, new approach enhances and extends current methods, and new approach to determine the impact of performance in the tourism marketing context.Traditional statistics deals with single answer or certain range of the answer through sampling survey, but it has difficulty in reflecting people's incomplete and uncertain thought. In other words, however, these processes often ignore the intriguing and complicated yet sometimes conflicting human logic and feeling. If people can use the membership function to express the degree of their feelings based on their own concept, the result will be closer to their real thought.

For instance, when people process a pollution assessment, they classify the distraction into two categories: pollution and non-pollution. This kind of classification is not realistic, since the pollution is a fuzzy concept (degree) and can hardly be justified by the true-false logic. Therefore, to compute the information based on the fuzzy logic should be more reasonable. The extended model shows an improvement in the business valuation process performance. The benefits from this research include the definition of a new class of problems and a process to solve problems nature. This insights gained from this research can be applied in major disciplines such as

marketing, management, strategy, finance and decision theory.

5. Conclusion and Future Research

Analysis that the questionnaire was designed for the fuzzy characteristic of numerical data by using fuzzy statistical methods will be more convincing than that by traditional statistical methods. This is because the traditional method can be overridden to get the higher score, while the fuzzy method will get the lower score. Fuzzy statistical method is more objective than traditional one. Furthermore, using the fuzzy statistical method can lead to real or specific situations.

This survey research is based upon some underlying assumptions or factors, therefore further studies can be made:

(1) Do advanced research in fuzzy expected values, fuzzy medians, and fuzzy variance.

(2) Invite psychologists to be team members to evaluate the consistency between thoughts and behavior.

(3) Develop programs of fuzzy software which can help increase the efficiency of data collecting and computing, so to be more effective to in automating fuzzy statistical methods and to overcome the greater difficulties inherent in fuzzy statistical methods.

(4) For consideration of industrial network benefit, there will be a large variance per different industries, areas, enterprise size, and time period. This study only focuses on the electronic information industry. As for comparison between different industries in sizes and areas, further study is needed.

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