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# Screening of Strategic Management Criterions in Hospitals Using Delphi-Fuzzy Method

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***Abstract*—**Nowadays, the managing and planning of hospitals is facing many problems. Failure to recognize the main criteria for strategic management to ensure long-term hospital performance can lead to many health problems. To achieve this goal, a qualitative-quantitate method titled Delphi-Fuzzy has been applied. This strategy makes it possible for experts to screen among the most important criteria in strategic management. To conduct this operation, a statistical society consisting of 20 experts in Ahwaz hospitals has been questioned. The final model confirms the key criterions after three stages of Delphi. This model provides the possibility to focus on the basic criteria and can determine the organization's main orientation.

***Keywords*—**Delphi-Fuzzy Method, hospital management, long-term planning, qualitative-quantitate method, screening of strategic criteria, strategic planning.

## I. Introduction

STRATEGIC Management is the ability to predict, visualize, increase flexibility, and empower team members to make strategic essential changes. It can be deduced from this definition that change management often relates to the role of strategic management and includes a dynamic process. A strategic manager has a direct impact on the firm's flexibility and competitive qualities. Another important point is that strategic management defines a series of basic components in uncertain environments [1].

In the hypothesis of strategic management for hospitals, it should be noted that the hospital is a complex dynamic environment in which various activities are carried out, and these activities are usually not similar. This prompts managers of healthcare organizations to use their limited resources to meet the unlimited needs of the community. Planning that involves identifying the organization's critical goals in achieving competitive advantage and identifying strategies for achieving them, taking into account the internal and external factors of the organization [2], [3].

Strategic planning is an organized and systematic effort to make fundamental decisions and take essential steps to develop the organization's strategic capabilities and help the organization respond more quickly and responsibly to change, survive and gain competitive advantage.

The term "strategy" means "art of the general" has a long history in military literature. The strategy was used until the 20th century in the monopoly of the military commanders and as an art to defeat the enemy. With the rapid and big changes of the decades of the 1960s and 1970s, the strategy was used by many industrial and commercial organizations. Strategic planning has been used in the health sector since the 1970s with the aim of providing quality, safe and effective health services and meeting the unlimited needs of the community [4].

The strategic planning process involves the strategic assessment of the organization, the codification of the mission, the outlook and values of the organization, the determination of the strategic and overall objectives of the organization, the presentation, evaluation and selection of appropriate strategies, the setting of specific objectives, the formulation of the operational plan, and the determination of the budget and financial commitment of the program. By having a strategic plan, all existing and available resources from different parts of the organization are logically used only to achieve the strategic goals of the organization. Disregarding of strategic planning in these organizations can lead to a lack of realization of organizational goals, the wasting of time and resources, and reduction of productivity.

Studies have shown the failure of a significant percentage of strategic plans in the world, and it is estimated that the failure rate of organizational change plans and strategies is 50% to 80%. Organizational strategies will cost more if they are not properly codified, implemented, and evaluated [5], [6]. The McKinsey study of 800 organizations in 2006 reflects the fact that while three-quarters of them had a strategic plan, only 45% of managers were satisfied with the success of their strategic plan. Most of their problems were in implementing strategies, communicating them to employees, adapting the organizational structure to the strategy and evaluating the performance of the organization [7].

The main reasons for the failure of strategic planning in organizations are the lack of the use of a suitable strategic planning model, commitment, support and low participation of senior executives, poor management and leadership, high corporate turnover, inadequate organizational structure, organizational structure's inflexibility, lack of funding, and resources, low knowledge and skills of employees and their resistance to change, conflicting organizational priorities, mismanagement of strategies and programs, lack of system and process orientation, lack of customer orientation, inappropriate corporate culture, lack of teamwork spirit, the lack of a culture of creativity and risk appetite and inappropriate communication [5], [8], [9].

Strategic thinking helps to shape an investment and decision-making process, including time, capacity, and cost

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for an organization. The shape and form of decision making for an organization are designed with the initial presumption. An organization is managed based on the knowledge and skills needed, healthy communication and experience. Strategic activity is growing globally in the health debate. Regarding the health of this thinking, it can be a combination of decisions about pathology, patients, treatment methods, improved alternative services, and regional or international health care programs. This research has carried out strategic planning in Ahwaz hospitals. The results of this research can provide valuable information for policymakers at the macro level and hospital managers at the micro level, in order to enhance the planning and implementation of planned programs.

The present study is a qualitative-quantitative methodology that has been conducted in 2019. In this research, the Delphi method as one of the qualitative research methods is used to reach consensus in group decision making. In practice, the Delphi method is a series of questionnaires or sequential sequences with controlled feedback that it seeks to reach by consensus among a group of experts on a specific topic.

The issue of hospital management is a major issue at the national and global level and cannot be prioritized through definite methods or random processes. Therefore, the fuzzy theory is used because of the inaccessibility of accurate and complete information as well as the lack of clarity of the experts of the statistical community. In this regard, linguistic variables are an effective means of displaying inaccurate information. Using the collective wisdom of people specializing in this field helps solve the problem. So, this is a group decision that uses the fuzzy technique to convert qualitative information into quantitative and accurate information. The Delphi-Fuzzy method used in this project provides the necessary interaction between qualitative and numerical data to make the study more reliable.

The research population is experts selected from Ahwaz hospitals. A total of 20 people have been selected who identify the most important strategic criteria in the screening process. Based on this, the most important strategic hospital policies are identified from the sub-division and is to be able to save time, cost, and lead to success procedure.

The rest of this paper is organized as follows. In Section II, an overview of Delphi-Fuzzy method is given. Section III presents the mathematical algorithm of Delphi-Fuzzy technique for screening. Section IV will give experimental results and analysis by defining a test case. Finally, the research will be concluded in the last section.

## II. An Overview on the Delphi-Fuzzy Method

Access to the most trusted group of experts' agreement on a specific topic is done by using a questionnaire and an opinion poll from experts in response to their feedback. In fact, this method fully examines the opinions of the experts, with three main characteristics: Unbiased response to questionnaires, repetition of questionnaire replies and feedback from them, and statistical analysis of answering questions in a group. In the Delphi method, the mental data of the experts is decided. The Delphi method has been used in many fields of prediction and decision making. Some of its applications are prediction of organization orientation [10], segmentation of customers, and the recognition of the most appropriate group for planning [11].

In the world around us, items cannot be divided into two or more, white or black, but each topic is included in a spectrum. Using definite numbers to solve problems, including prediction and policy, will lead to outcomes that are far from reality. Meanwhile, in many cases, such as performance testing, satisfaction, or development of designs based on customers' perceptions and the use of linguistic variables by experts is more common and easy. These points have led to the emergence of a fuzzy Delphi method.

The Delphi fuzzy method was developed by Kaufman and Gupta in the 1980s [12]. The application of this method to decision making and consensus on issues where objectives and parameters are not clearly defined lead to very valuable results. An important feature of this method is to provide a flexible framework that covers many of the barriers to inaccuracy and clarity. Many of the problems in decision making are related to incomplete and inaccurate information. Also, the decisions made by the experts are based on their individual competence and are highly mental. Therefore, it is better to show data instead of definite numbers with fuzzy numbers

The implementation steps of the Delphi-Fuzzy method are in fact a combination of the Delphi method implementation and analyzes on information using the definitions of the theory of fuzzy sets. The algorithm for implementing the Delphi-Fuzzy method is depicted in Fig. 1.

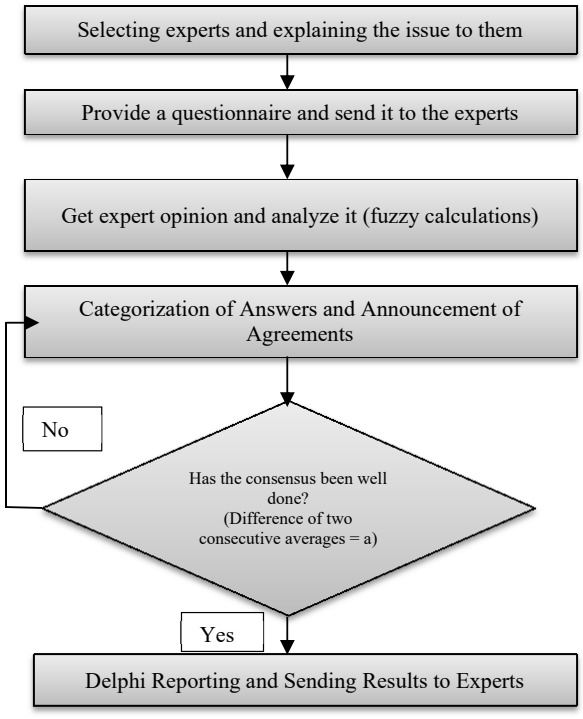


Fig. 1 Steps to Implementing the Delphi-Fuzzy Method [13]

The most important differences between the Delphi-Fuzzy methods with the Delphi method are as follows. Experts usually consider their views in the form of the minimum value, the medium value, and the maximum value (Triangular fuzzy numbers), then the average opinion of the experts (the numbers are given) and the amount of disagreement of each expert will be calculated from the mean, and then this information will be sent to the experts for obtaining new theories. In the next step, any expert, based on the information from the previous stage, offers a new perspective or modifies his previous opinion. This process continues until the average of fuzzy numbers stabilizes sufficiently. In addition, if the study of the views of subgroups of experts is also necessary, by calculating the distance between triangular numbers, we can identify experts' opinions based on fuzzy relations in similar groups and send the relevant information to the experts.

Of course, there are other methods for the Delphi-Fuzzy method, which have been used less than the one mentioned above. Ishikawa et al. [12] have proposed two fuzzy Delphi methods with overlapping fuzzy Delphi and fuzzy Delphi through fuzzy integrity. Chang et al. [14] used an interval value with fuzzy statistics and a gradient slope search method and presented a new method for Delphi-Fuzzy.

In the articles, there are several applications of the Delphi-Fuzzy method. Ching Cheng and Yin Lin have used Delphi-Fuzzy method with group decision making, fuzzy multi-criteria and fuzzy number ranking to evaluate the best weaponry [15].

In another research, Karsak used the Delphi-Fuzzy method along with fuzzy multi-objective decision making to prioritize design needs in applying quality performance [16]. Seong Chang et al. [17] used the Delphi-Fuzzy method to estimate the reliable time interval for each activity, and then on this basis, the fuzzy completion time of the project and the critical level for each path in the project is calculated in an efficient manner. Yuan Li and Xiuwu Liao, in research using the Delphi-Fuzzy method, have tried to measure the risk level of risk factors in order to assess the risk in the corporate body [18].

In the studies, the application of the Delphi-Fuzzy method has not been found in policy making, and in particular in tax policy, although, as noted at the beginning of this section, the Delphi method has been used to determine the orientations of organizations. In this paper, the aim is to use the Delphi-Fuzzy method to determine hospital policies in Iran.

The Delphi-Fuzzy technique is based on the respondents' point of view. In this technique, the verbal expressions are used to measure the viewpoints. The verbal expression in the full reflection of the respondent's mental constraint has limitations, for example, the phrase "high" is much different for individual A, who is pessimist, with the phrase "high" by person B. If the two individuals use a definite number to quantify the view, the results will be obstructed. Therefore, by developing a suitable fuzzy spectrum, this problem can be overcome.

Delphi-Fuzzy, as in the traditional Delphi method, is very diverse and there is no unanimity in this field. There are many different perspectives on the development of fuzzy spectrum, aggregation of experts' views, phasing-out, and consensus-building.

## III. The Delphi-Fuzzy Technique for Screening

To illustrate the algorithm of implementing a Delphi-Fuzzy technique, it should be distinguished between its two uses for screening indicators and prediction. Some research has an exploratory aspect. In this category, researchers seek to identify the most important elements of a phenomenon. Some researchers are also aimed at predicting.

To determine the significance of the indexes and screening the most important indicators, Delphi technique with a fuzzy approach is beneficial. One of the main advantages of the Delphi-Fuzzy technique, compared to the traditional Delphi technique, is to screen the indexes, which can be used to scroll through items. The Delphi-Fuzzy technique implementation algorithm includes the following steps:

- Identify the proper spectrum for phrasing verbal expressions,
- Fuzzy accumulation of fuzzy quantities, and
- Defuzzifying quantities.
- Select the severity threshold of the criteria

In the Delphi-Fuzzy technique for the prime screening algorithm, we must develop a proper fuzzy spectrum for fuzzifying the verbal phrases of the respondents. For this purpose, fuzzy spectrum development techniques or common fuzzy spectra are used. For example, a triangular fuzzy spectrum for a seven-degree Likert scale in expressing the importance of the indexes, is as Table I. Where (u) is the upper bound, (l) is the lower bound and (m) is the most probable value of a fuzzy number.

TABLE I
Triangular Fuzzy Spectrum for a Seven-Degree Likert Scale

| Triangular Fuzzy Number (l, m, u) | l | m | u |
|---|---|---|---|
| Absolutely Important | 0.9 | 1 | 1 |
| Very Important | 0.75 | 0.9 | 1 |
| Important | 0.5 | 0.75 | 0.9 |
| Medium | 0.3 | 0.5 | 0.75 |
| Trivial | 0.1 | 0.3 | 0.5 |
| Very Trivial | 0 | 0.1 | 0.3 |
| Absolutely Trivial | 0 | 0 | 0.1 |

Once selected, with the development of a suitable fuzzy spectrum, the views of the experts are gathered and recorded in a fuzzy manner. In the second step, we need to summarize the views of the experts. Different ways have been proposed for collecting expert opinions [12], [19]. If the view of each expert is represented as a triangular fuzzy number (l, m, u), then the conventional method for aggregating the $n$ expert's view is taken to be the minimum l, the mean $m$ and the maximum $u$ as is represented in (1).

$$F_{AGR} = \left( \min(l), \left\{ \frac{\sum m}{n} \right\}, \max(u) \right) \quad (1)$$

In (2), instead of simple arithmetic mean, geometric meanings is proposed.

$$F_{AGR} = \left(\min(l), \prod m, \max(u)\right) \quad (2)$$

In some cases, it is also suggested that the upper and lower bounds are also calculated with the geometric mean. We propose the fuzzy mean method to aggregate expert opinions, which is calculated as (3).

$$F_{AGR} = \left(\frac{\sum l}{n}, \frac{\sum m}{n}, \frac{\sum u}{n}\right) \quad (3)$$

The choice of the method of aggregation of experts is dependent on the researcher. The use of fuzzy aggregation methods instead of the fuzzy average makes it possible to maximize the dispersion of the views of individuals. But the problem with these methods is that the viewpoint of an optimistic person with the viewpoint of a pessimistic person greatly affects the results. If for an expert the value of $u_i$ is smaller than $\frac{\sum u}{n}$, a pessimist expert is considered. Also, if an expert has a larger $u_i$ value than $\frac{\sum u}{n}$, an expert is considered optimistic. To be more reliable, one can dismiss the optimistic and pessimistic viewer.

After fuzzy aggregation the experts' point of view, the values obtained should be defuzzified. In different ways, with the fuzzy approach, the researcher finally seeks to convert the final fuzzy values to a definite and understandable number. Generally, aggregation of triangular fuzzy numbers can be summed up by a definite amount that is related to the best average. These operations are called "defuzzifying". There are numerous and complex methods for defuzzifying [20]-[22]. One of the simplest ways to fuzzy the average fuzzy triangular numbers is as follows:

$$F_{AVG} = (L, M, U) \quad (4)$$

$$X_m^1 = \frac{L + M + U}{3} \quad (5)$$

$$X_m^2 = \frac{L + 2M + U}{4} \quad (6)$$

$$X_m^3 = \frac{L + 4M + U}{6} \quad (7)$$

$$CrispNumber = Z^0 \Rightarrow \max(X_{\max}^1, X_{\max}^2, X_{\max}^3) \quad (8)$$

There are several other methods for defuzzifying. For example, in this paper, the center of gravity method which is the center level and maximum mean of this category has been applied.

After selecting the appropriate method and defuzzifying the values for screening the items the tolerance threshold should be considered. The tolerance threshold is usually 0.7 [21], but this value can vary from research to research, according to the researcher's view. If the definitive amount of defuzzifying the expert's aggregated view is greater than the threshold of tolerance, the index is approved. If this value is less than the tolerance threshold, the index will be eliminated.

## IV. Experimental Results and Analysis

The process of realizing strategic management through the Delphi-Fuzzy method is as follows:

### A. Selection of Experts

An important point in the implementing of Delphi technique is the panel size of the experts [23]. The usual size panel of experts is 8 to 12 [24] or between 11 and 18 people [25].

In the present study, the combination of the Delphi team consists of individuals who have knowledge and expertise in the subject matter of the research. When there is a consensus among the members of the working group, the number is recommended to be between 10 and 20 people. The members of the Delphi team have been selected for this study by 20 individuals with inaccurate sampling. Based on this, at first, 10 candidates were nominated by the researcher for the purpose of conducting the research. The candidates include the following features:

1) The director of different departments of hospitals.
2) A faculty member of Ahvaz Jundishapur University of Medical Sciences.

Additionally, each of these individuals was requested to introduce other people who are eligible to participate in this study on the basis of these features, at least 10 others (as the second and third qualifying groups) were identified, with a total of 10, the total number of members of the working group reached 20. Fig. 2 shows how to access these people.

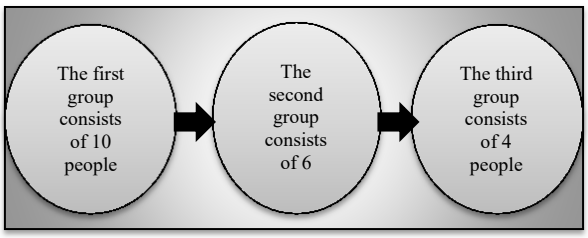


Fig. 2 Selection of workgroup members

### B. Definition of Linguistic Variables

The questionnaire was designed with the aim of advising the experts on the relevance of the proposals with the concept of hospital strategy management, so experts should express the "amount" through the variables of these values. This difference in tastes and personal opinions can add to the uncertainty of the problem, so it will be difficult to use variables with definite values by experts. Therefore, it is clear that the qualitative variables give more freedom to the experts.

The use of qualitative variables such as low, moderate, high

and will solve the above problems to a large extent. But it creates another problem. The mentality of people is not equal to the qualitative variables (i.e. low or high). Different characteristics of people's mental expressions affect qualitative variables, and as some people have a rigorous attitude and some an easy attitude, some people are optimistic and others are pessimistic. As a result, analysis for variables derived from subjectivity and different interpretations will be worthless. For this reason, in the Delphi method combined with fuzzy rules, by defining the range of qualitative variables for experts, they will respond to questions with the same mindset. Therefore, qualitative variables are presented as fuzzy numbers. This has been described in the previous section with enough details.

In this study, the Delphi-Fuzzy method has been implemented to three stages, and the process will be continued so that the difference of the average between two successive stages is less than 0.1.

### *C. First Round*

In the first round, the questionnaire is presented in Table II, in which the fuzzy mean of expert comments are received and new proposals are also recorded regarding experts suggestion. The fuzzy average of expert comments is written for each criterion to determine the defuzzified averages. In addition, the tolerance threshold is 0.7. The first round consists of six criteria; also, the range of experts is asked to introduce a maximum of four other key criteria (the grey rows). The first-round results are given in Table III. The accepted factors regarding threshold are grey.

TABLE II
THE QUESTIONNAIRE EXPRESSIONS

| Row | Expressions |
|---|---|
| Question 1 | Existence of a hospital replacement system |
| Question 2 | Identification of hospital-centered values |
| Question 3 | Attention to four perspectives (financial, customers, processes and staff) |
| Question 4 | The existence of administrative and institutional health in the hospital |
| Question 5 | The moral of evolutionism in the hospital |
| Question 6 | The existence of an enterprise entrepreneurship system |
| Question 7 | The existence of a knowledge management system in the hospital |
| Question 8 | Pay attention to the causal relationship of the four perspectives |
| Question 9 | Transparent hospital performance |
| Question 10 | Identification of Cultural Values Affecting Hospital Function |

TABLE III
FIRST ROUND RESULTS

| Row | l | m | u | Defuzzified Average |
|---|---|---|---|---|
| Question 1 | 0.51 | 0.7 | 0.9 | 0.7 |
| Question 2 | 0.52 | 0.63 | 0.83 | 0.66 |
| Question 3 | 0.9 | 0.97 | 0.98 | 0.95 |
| Question 4 | 0.22 | 0.58 | 0.6 | 0.47 |
| Question 5 | 0.62 | 0.78 | 0.9 | 0.77 |
| Question 6 | 0.35 | 0.56 | 0.59 | 0.5 |

### *D. Second Round*

In this round, the improved agent list has been upgraded to 10 key items, and once again the questionnaire is provided to the experts. The difference in defuzzified average in the first and second rounds is more than 0.1. So, we need a third round of Delphi. The second-round results are given in Table IV.

### *E. Third Round*

Once again, the questionnaire is filled. This time, the difference of defuzzified average between round two and three is less than 0.1, and the process is stopped because we have achieved a good consensus. The third-round results are given in Table V.

TABLE IV
SECOND ROUND RESULTS

| Row | l | m | u | Defuzzified Average |
|---|---|---|---|---|
| Question 1 | 0.31 | 0.50 | 0.70 | 0.50 |
| Question 2 | 0.67 | 0.83 | 0.93 | 0.81 |
| Question 3 | 0.60 | 0.77 | 0.88 | 0.75 |
| Question 4 | 0.58 | 0.73 | 0.84 | 0.72 |
| Question 5 | 0.52 | 0.68 | 0.8 | 0.67 |
| Question 6 | 0.41 | 0.56 | 0.71 | 0.56 |
| Question 7 | 0.37 | 0.54 | 0.68 | 0.53 |
| Question 8 | 0.54 | 0.75 | 0.89 | 0.73 |
| Question 9 | 0.48 | 0.67 | 0.80 | 0.65 |
| Question 10 | 0.58 | 0.76 | 0.86 | 0.73 |

TABLE V
THIRD ROUND RESULTS

| Row | l | m | u | Defuzzified Average |
|---|---|---|---|---|
| Question 1 | 0.26 | 0.45 | 0.65 | 0.45 |
| Question 2 | 0.71 | 0.89 | 0.95 | 0.85 |
| Question 3 | 0.58 | 0.77 | 0.84 | 0.73 |
| Question 4 | 0.57 | 0.72 | 0.83 | 0.79 |
| Question 5 | 0.53 | 0.69 | 0.81 | 0.68 |
| Question 6 | 0.35 | 0.56 | 0.59 | 0.50 |
| Question 7 | 0.33 | 0.54 | 0.60 | 0.49 |
| Question 8 | 0.66 | 0.81 | 0.89 | 0.80 |
| Question 9 | 0.38 | 0.67 | 0.75 | 0.60 |
| Question 10 | 0.60 | 0.80 | 0.86 | 0.75 |

The questionnaire is approved and the threshold of tolerance is 0.7. Therefore, factors 2, 3, 4, 8, and 10 are confirmed as the most important factors and their prioritization is as in Table VI.

TABLE VI
RANKING OF THE MOST IMPORTANT FACTORS

| Ranking | Row | Expressions |
|---|---|---|
| 1 | Question 2 | Identification of hospital-centred values |
| 2 | Question 8 | Pay attention to the causal relationship of the four perspectives |
| 3 | Question 4 | The existence of administrative and institutional health in the hospital |
| 4 | Question 10 | Identification of Cultural Values Affecting Hospital Function |
| 5 | Question 3 | Attention to four perspectives (financial, customers, processes and staff) |

## V. CONCLUSION

In this paper, by using the Delphi-Fuzzy method and using the viewpoint of 20 opinion polls in the field of hospital

management, various suggestions have been considered. Finally, among the 10 criteria, five criteria are considered as the main ones in the strategic management of the hospital. These are prioritized as below:

1. Identification of hospital-centered values.
2. Pay attention to the causal relationship of the four perspectives.
3. The existence of administrative and institutional health in the hospital.
4. Identification of cultural values affecting hospital function.
5. Attention to four perspectives (financial, customers, processes and staff).

This research identifies the major concerns of long-term planning for hospitals in strategic management subjects. Incorporating a qualitative-quantitate method lead to more accuracy in this investigation. By considering these factors, the strategic manager can guarantee cost saving, while providing fast response for the handled organization. Including more factors in the evaluation process of hospitals is among the future issues which can be supported by this research paper.

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