

Using Fuzzy Delphi Method in Risk Management (Case Study: Implementation of Fuzzy Delphi Method to Identify Credit Risks in Convert Financial and Credit Institutions into the Bank)

¹Elaheh Sayari, ¹Mahdi Yaghoobi and ²Mahdi Ghanaatpishe

¹Department of Electrical and Computer Engineering,
Mashhad Branch, Islamic Azad University, Mashhad, Iran

²Researcher and Expert in Banking, Iran

Abstract: Nowadays, uncertainty in management projects managers has faced numerous challenges. Old and unscientific methods do not meet their needs. Therefore different managers have benefited from the fuzzy set theory to state uncertainty. In this paper, the first stage of the risk management process is used to determine the risk of the general risks affecting the project and including conversion projects Credit and financial institutions to the banks are identified and prioritized. At this stage for identifying the risks affecting in the project process the fuzzy Delphi method was used. This method is a structured process for collecting and classifying the knowledge among a group of expert in the form of natural language which is distributed through questionnaires among individuals and controlled feedback and comments received will be done. The results showed that after the implementation the three stages of survey and achievement of consensus among experts in training and test data, finally, it was found that the integration of financial and credit risk relative to other risks can be better estimated. Also, the results with consideration of three hypotheses for the project show that if attract resources risks, profits, interest, credit and equity occurs profits will be change, if risks occur within the organization and technology will bring cost to the project and if risk of rules and regulations, events (political) institutions integration, open activities (non-professional), likely to occur on the property and the classic elite, the project will be loss.

Key words: Uncertainty • Risk Management • Fuzzy Set • Delphi • Credit Risk

INTRODUCTION

Uncertainty, it is absolutely inevitable that even the most skilled managers are faced with this problem. Traditional methods of uncertainty, is risk. Risk is an unknown factor that can significantly affect performance attainable. Risk management processes for the collection and analysis and response to risks identified in the projects, in order to maximize the results of positive events and minimizing the consequences of adverse events [1]. In project management, projects managers have to a complete understanding of the nature and the concept of risk. Risk can impact on time, productivity, quality and funding for projects [2]. In the field of project

management, the greatest effects of risks are [3]: Failure to complete the project within budget, on time and get the required quality. The aim of risk management practices, is to keep the parties involved with project from this negative impacts to manage uncertainty and unpredictable and chaotic; Managers from traditional risk management have been moving toward to accept roles and techniques which are leading to less planning and move towards more flexible learning [4]. Every project has some risks related to failure to provide clear objectives for the project. Different models for risk identification are used, such as Monte Carlo simulation, decision theory. The theoretical uncertainties are likely to be the only model that is capable of modeling uncertainties that have

Corresponding Author: Elaheh Sayari, Electrical and Computer Engineering Department, Mashhad Branch, Islamic Azad University, Mashhad, Iran.

random nature and it is incapable to modeling of uncertainties emanating from the human mind. Thus, to evaluate and rate risks in risk management due to the inherent uncertainty in the exact comparable data is not available so in this case we use the fuzzy sets [5].

Fuzzy set theory provides a flexible framework for managing uncertainty and ambiguity of human knowledge in the study of phenomena and in satisfactory shape solves many obstacles of the lack of precision and it is essentially the approximate technique that provided a qualitative aspects in terms of qualitative (linguistic terms) by linguistic variables [6]. In recent years researchers are centralized on risk identification, risk prioritization and risk management; for this reason, most decision makers evaluate the rates of risk factors through linguistic value (high, medium, low).

The purpose of this paper is study the first stage of the process of risk management (risk identification) in the form of fuzzy numbers to identify risks and the priority of their selection for their impacts on projects.

Background of the Study: Fuzzy Delphi by Kaufmann and Gupta (1988) has been introduced. Using this approach to decision-making and consensus on issues that are not clear goals and parameters, can lead to good results. An important feature of this method is to provide a flexible framework that many of the barriers related to lack of precision is covered.

However, other methods have been proposed for fuzzy Delphi:

Eshy Kava *et al.* (1993) have noted the limitations of the conventional fuzzy Delphi method and are presented a new method called new fuzzy Delphi method (NFDM). This approach, is combination of two Fuzzy Delphi method with fuzzy Delphi titles over - at least and fuzzy Delphi through the fuzzy integration. NFDM has four advantages: 1) fuzzy process is integrated inevitably with the Delphi findings. 2) The number of Delphi period has decreased. 3) The semantic structure of prediction topics has been modified. 4) Certified personal characteristics are clear [7].

Chang *et al.* (2000) used interval-valued with fuzzy statistics and slope gradient search method and presented a new fuzzy Delphi method based on it [8].

Khan Mohammadi *et al.* 10 (2010), also have used The fuzzy Delphi method with the threshold for the convergence and new Delphi fuzzy having this debate have acceptable results close to the real world as well [9].

Fuzzy Set Theory: According to Science basics and principles, everything proved to be just under a rule which something is right or wrong. In logic and mathematics is the same argument. In contrast to classical logic, in 1965 fuzzy logic by Professor Lotfi Zadeh, the Iranian-born professor at UC Berkeley, a paper was presented as fuzzy sets. Although a decade ago Talk about fuzzy was faced with strong opposition scientists, mathematicians and engineers but due to deliver extraordinary results in practical issues and a significant improvement in the phenomenon, the opposition has become to encourage and praise. This logic is used in conditions of uncertainty. According to this logic, one can easily make a lot of concepts and interpretations that do not fit in small numbers and are considered a form of linguistic variables, make the mathematical formulation of them and they can be used for decision-making and reasoning [10]. So we can say that in the fuzzy environment, human reasoning is a main factor to decide. Evidence shows that the efficiency of decision-makers who employ fuzzy logic, it is possible percent increase from 3000. Fuzzy approach to decision-making can be understood intuitively, initiatives and provide human experience.

Analysis based on binary logic in the age of digital information that computers can control all circumstances is impossible. In short, effective management depends on the right decisions and properly data analyze. Therefore, using of classical logic cause the executives deviation and managers will be required to check the distance between the two options and they are a continuum. Fuzzy logic is a new approach to address the uncertainties in decisions based on classical logic. Using fuzzy logic systems, such as human memory, processing the data and information needed for management decisions and can provide approximate and inaccurate words to numerical values in the range of zero and one [11].

Show Fuzzy Sets: If U reference collection that every member of x is displayed, fuzzy set on U by couples arranged as $A = \{(x, \mu_A(x)) \mid x \in U\}$ is expressed as $\mu_A(x)$ the membership function and the membership degree is That it shows x belongs to the fuzzy set A , the range of non-negative real numbers is a function that has a maximum value and in normal case is considered to the closed interval $[0, 1]$. This degree of membership is the basic principle of fuzzy set and no definitive method for determining the membership function, this issue is more than one category, it is intuitive and empirical.

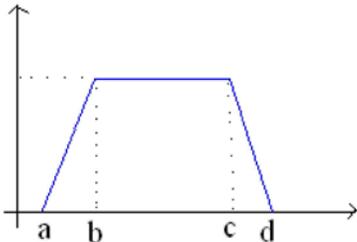


Fig. 1: Show trapezoidal fuzzy numbers

Fuzzy numbers: Normal convex fuzzy sets such as A range of real numbers R, a fuzzy number is real, if:

- There is only one $x_0 \in R$ which $\mu_A(x_0) = 1$.
- The membership function $\mu_A(x)$ is a continuous function.

Trapezoidal Fuzzy Numbers: Calculations with fuzzy numbers due to their particular structure are very time consuming and complex. To facilitate the application of fuzzy numbers, fuzzy numbers used in calculations are special. The specific numbers as numbers bell, triangular, trapezoidal, LR triangular, LR are trapezoidal. In this paper, the trapezoidal fuzzy numbers are used.

A trapezoidal fuzzy number can be divided by four (a, b, c, d) show that (Fig 1) the membership function and its basic operation relations will be in equations (1) and (2) and (3) and (4) and (5).

$$\mu_A(x) = \begin{cases} 1 - \frac{b-x}{b-a} & a \leq x < b \\ 1 & b \leq x \leq c \\ 1 - \frac{x-c}{d-c} & c < x \leq d \\ \text{otherwise} & 0 \end{cases} \quad (1)$$

$$(a,b,c,d) + (e,f,g,h) = (a+e, b+f, c+g, d+h) \quad (2)$$

$$(a,b,c,d) * (e,f,g,h) = (a*e, b*f, c*g, d*h) \quad (3)$$

$$(a,b,c,d) - (e,f,g,h) = (a-e, b-f, c-g, d-h) \quad (4)$$

$$K*(a,b,c,d) = (k*a, k*b, k*c, k*d) \quad (5)$$

Risk: Risk is a function that determines the probability and extent of damage in the project. Chapman and Ward (1997) define risk in the project: recognizing the implications of unknown important events to achieve

the level of expectation performance of the project [12]. In project management, the risk is much if the happens of event probability is less in future.

Risk Management: Environmental uncertainty and competitive intensity of projects, project managers have to face numerous challenges. To effectively manage the challenges the risk management has been introduced which it is one of the new approaches to strengthen and enhance the effectiveness of the project will be used [13]. In order to reduce risks and offset losses of it, today raised any type of the risk management and each of them has a particular place. Obviously each project according to the nature of their work will experience a variety of risks and in today's changing conditions, primarily the success of any project on risk control and management of risks that may apply.

Risk management provide principles and procedures that projects management and organizations with use of them they can prospective job in evaluation, finance controls and damage financing. On this basis, systematic risk management arrangement approach to manage the risks. In order involve with answer two basic questions about future contingencies. The first question, "What will happen?" and second, "What to Do". In addition, the risk management deals with plan for potential future events. Therefore the risk management is a process of identifying, planning, risk assessment and control measures and improvement potential is clearly incidental damages, or no change in the existing circumstances, it may be Its purpose to protect the capability to produce and organize resources accidental damage occurring after the restoration of financial stability and throughput projects.

Importance of risk management: current situation:

- In all the projects, multiple decisions is possible.
- The decision condition in places and times is different.
- Future events are largely unpredictable and the uncertainty rule is universal.
- The project's degree of complexity and their interaction with the environment has a direct correlation with the level of risk management.

Other objectives of the risk management:

- Survival: keeping costs below a certain level, to keep the organization continued.
- Provide an acceptable level of anxiety.

- Stable income or earnings: create the acceptable level of revenue by limiting loss of earnings or cash flows resulting from unforeseen losses.
- Non-stop action and minimal delay.
- Time allocated for the continued growth and development.
- Identification of high-risk situations.
- Reduce the possibility to the detrimental effects of an activity through conscious action to predict adverse events and plan to avoid it.

The risk management process has four main activities: Identifying, planning, analyzing and responding to risk. In this paper, the first stage of risk management is to identify risks using the following explanations are given about it.

This stage of the risk management process is very important because lack of the each identified risks serious damage to organizations and projects. This step involves identifying potential risks of the project and documenting their characteristics and to obtain accurate and complete picture of the damage done and the resources could damage in the project (the banks and financial and credit institutions). In fact, at this stage, the factor or factors that are causing damage seems to be at risk of being identified and therefore can obtain cause a chain - risk - of harm (disability) [15].

In the process of identify risk the Delphi Method is used which this method is one of the successful of gaining consensus the way some experts question is about a specific subject. Delphi method is an iterative process of collecting anonymous judgments of experts [16].

$$A^i = (a_1^{(i)}, a_2^{(i)}, a_3^{(i)}, a_4^{(i)}), i = 1, 2, \dots, n \tag{6}$$

$$A_{ave} = (m_1, m_2, m_3, m_4) = (\frac{1}{n} \sum_{i=1}^n a_1^{(i)}, \frac{1}{n} \sum_{i=1}^n a_2^{(i)}, \frac{1}{n} \sum_{i=1}^n a_3^{(i)}, \frac{1}{n} \sum_{i=1}^n a_4^{(i)},) \tag{7}$$

A^i express the i expert opinions and A_{ave} express the average of experts opinions. a_1, a_2, a_3, a_4 are indicated as trapezoidal fuzzy numbers.

- At this point, each person's point of view and those differences mean to the next round of questionnaires will be sent back to the experts.
- After a new round of voting, according to the view presented of the first round and comparing them with the results of new round, if the difference between the two processes was less than the threshold, the process stops survey. If the difference between the two was greater than the threshold, then return to Step 4. The threshold is calculated from the following equation:

In Delphi, forecasting and decision-making provided by experts are expressed in terms of absolute numbers, while it will be far from the real world, the final numbers for decision making and long-term forecasts. However, experts of their mental abilities and competencies are used to predict this shows that the uncertainty prevailing conditions of possibility, not a probability. Possibility of uncertainty, coping with fuzzy sets and because decisions are taken based on experts' qualifications are subjective Therefore, it is better to use fuzzy sets (using fuzzy numbers) to predict long-term decisions and deal with the real world rather than a specific and definite numbers of fuzzy numbers to describe the data we use. Thus, the required form of natural language (low, medium, high) and analyzed by experts, we take this method of analysis is called fuzzy Delphi method [17].

Fuzzy Delphi method used in this study included the following steps:

- Experts chosen and described the problem to them.
- Prepared a questionnaire and sent it to the experts.
- Get experts opinions and analysis them: At this stage, the questionnaire was sent to members of the expert group and the success rate obtained with each of the components and offer and correction opinions are conclude. According to the questionnaire and linguistic variables defined in the questionnaire, the mean phases of each component are calculated. We can use different fuzzy numbers for information describing, that here instead of the average specific, analysis will be conducted based on the fuzzy mean. Mean phase of each component is calculated according to the following equations:

$$s(A_{m_2}, A_{m_1}) = \left| \frac{1}{4} \left[\begin{matrix} (a_{m_{21}} + a_{m_{22}} + a_{m_{23}} + a_{m_{24}}) - \\ (a_{m_{11}} + a_{m_{12}} + a_{m_{13}} + a_{m_{14}}) \end{matrix} \right] \right| \quad (8)$$

- If the difference between the two was less than the threshold value, the Fuzzy Delphi process ends when final numbers of last Delphi questionnaire are converted to fuzzy numbers. For converting fuzzy numbers of last Delphi questionnaire to the final numbers, mean method is presented by Lee and Lee 13, are used. This method is based on the mean and standard deviation.

For the trapezoidal fuzzy numbers mean and standard deviation is calculated as follows:

$$\bar{X}(M) = (-a^2 - b^2 + c^2 + d^2 - ab + cd) / [3(-a - b + c + d)] \quad (9)$$

$$\sigma(M) = \left\{ \left[\begin{matrix} \frac{1}{b-a} \left(\frac{b^4}{4} - \frac{ab^4}{3} + \frac{a^4}{12} \right) + \frac{1}{3}(c^3 - b^3) + \\ \frac{1}{d-c} \left(\frac{d^4}{12} - \frac{c^3d}{3} + \frac{a^4}{4} \right) \end{matrix} \right] / \left[\frac{1}{2}(-a - b + c + d) \right] \right\} \quad (10)$$

In a comparison of fuzzy numbers, each of them has greater mean, the fuzzy number is larger. In case of equality of means, each of them that are less than the standard deviation is larger.

Therefore fuzzy Delphi is one of the few prediction methods with some experts for combining ideas in the form of natural language which the important feature of this stage is to provide a flexible framework that many of the barriers related to lack of precision is covered.

Case Study: Case study that studied in this paper, is the identification an prioritization of type of effective risks in the project of conversion finance and credit institutions to the bank that for identification and prioritization of risks affecting the project fuzzy Delphi method described in the previous section is used which the implementation of fuzzy Delphi method to identify the credit risks in convert financial and credit institutions to bank is as follows and the details are explained in detail.

Implementation of Fuzzy Delphi Method to Identify Credit Risks in Convert Financial and Credit Institutions into the Bank: The main characteristics of the selected experts are: involved in the discussed problem, having the Continuous Data of problem for collaboration, should be motivated to participate in the Delphi process, a consensus data from a group feel valued for their own also. Therefore, in this paper, the sample consisted of 30 experts working in the credit and financial institutions, including the president and vice presidents and regional

vice presidents areas and branches which 22 of them for training and 8 of them were selected for the test questionnaire that all the experts responded to all of questioner sent to them.

Experts generally preferred characteristics are:

- Have a degree or higher diploma in banking.
- Minimum 10 years experience in financial and credit institutions.

for design a Delphi questionnaire, Types of risks in order to convert credit and financial institutions to bank are include: risk of attracted sources, income risk, elite classic risk, technology risks, the risk of contingent assets, the risk of (non-professional), organizational risk, rules and regulations risk, events risk (political), credit risk, merger risk, shareholder risk. Designed questioner objective is investigating the types of risks facing financial institutions and credit transfer into a bank. Mode of complete is rating the range of your agreement with each statement on the questionnaire according by linguistic variables (low, medium and high).

Implementation of the Proposed Method for Training Phase: At this point, professional training are done and questionnaire was sent only to 22 cases. The 22 elected people of the experts, including one president in the field and 2 presidents in the department of 2 people vice president and 17 other are heads of the branches.

Table 1: The trapezoidal fuzzy numbers and linguistic variables

linguistic variables	Trapezoidal fuzzy numbers
Low	(0,0,2,4)
Medium	(3,4,6,7)
High	(6,8,10,10)

Table 2: Defuzzification of fuzzy numbers in the third round poll

Questions	Final numbers
1. How much resources as possible at the beginning of the new banks will be in competition with other banks?	2.17
2. In what extent conversion financial and credit institutions to the bank effective for profitability of shareholders?	1.96
3. In what extent in conversion of credit and financial institutions to banks traditional managers will affect the progress of the project?	7.65
4. In what extend meet minimum technology requirements of each bank on conversion credit and financial institutions to the bank will be affected?	8.12
5. How much will be cost to the treasury with policy of realize conversion financial and credit institutions to the bank?	2.21
6. In what extent activity in all areas of different finance and credit is possible if conversion credit and financial institutions to bank happens?	5.77
7. How much will economic justification for the costs of organizational changes in the conversion of credit and financial institutions to bank?	5.93
8. With conversion credit and financial institutions to bank, laws and policies of the central bank how much would affect profit and interest on shareholders equity?	8.28
9. If there are some negative policies on the central bank how much will be profitable conversion financial and credit institution to the bank?	1.86
10. In what extent the word bank gives value to credit and financial institutions in commercial activities?	6.54
11. Integration of credit and financial institutions into a single bank, to what extent will affect the interests of shareholders?	7.97
12. Conversion credit and financial institutions to a bank, to what extent will affect the identity of each of the institutions?	8.44

Table 3: Defuzzification of fuzzy numbers in the third round poll

Questions	Final numbers
1. How much resources as possible at the beginning of the new banks will be in competition with other banks?	2.41
2. In what extent conversion financial and credit institutions to the bank effective for profitability of shareholders?	1.98
3. In what extent in conversion of credit and financial institutions to banks traditional managers will affect the progress of the project?	8.01
4. In what extend meet minimum technology requirements of each bank on conversion credit and financial institutions to the bank will be affected?	8.01
5. How much will be cost to the treasury with policy of realize conversion financial and credit institutions to the bank?	1.98
6. In what extent activity in all areas of different finance and credit is possible if conversion credit and financial institutions to bank happens?	5
7. How much will economic justification for the costs of organizational changes in the conversion of credit and financial institutions to bank?	7.58
8. With conversion credit and financial institutions to bank, laws and policies of the central bank how much would affect profit and interest on shareholders equity?	8.44
9. If there are some negative policies on the central bank how much will be profitable conversion financial and credit institution to the bank?	1.55
10. In what extent the word bank gives value to credit and financial institutions in commercial activities?	7.58
11. Integration of credit and financial institutions into a single bank, to what extent will affect the interests of shareholders?	8.44
12. Conversion credit and financial institutions to a bank, to what extent will affect the identity of each of the institutions?	8.44

In Table 1, there is the trapezoidal fuzzy numbers and linguistic variables.

In Table 2, there is the result of the third phase of polls of an average defuzzification. The final numbers for each question show that risk preferences influence the conversion of credit and financial institutions to the Bank.

Implementation of the Proposed Method for Testing Phase: Fuzzy Delphi Method process (offering method for implementing the training phase) of the test with eight

experts, including 1 case of deputy head of the field and 1 vice president of the field and 1 vice president of the area and 5 department president will be done.

In Table 3, there is the result of the third phase of polls of an average defuzzification

Discussion and Analysis of Results: Training and testing stages, three fuzzy Delphi survey and considering the training and test data to identify and prioritize the risks affecting in the conversion credit and financial

institutions to bank project was successfully done and also trapezoidal fuzzy numbers Into definitive poll numbers of final stage, rank 12 risks for 22 education and 8 people were tested impact on financial and credit institutions is becoming bank is as follows:

- Integration risk 2. Laws and regulations 3. Technology 4. Shareholder's profit 5. Classic elite 6. Credit 7. Within the organization 8. Open activities (non-professional) 9. Contingent on the property 10. Attraction resources 11. Profits 12. Events (political).

Three hypotheses have been considered for this project that for each hypothesis according to its characteristics contain variables that have been attributed; all three variables are described as follows:

Hypotheses: income, expenses, losses.

Questions about income hypothesis are as follows:

- How much resources as possible at the beginning of the new banks will be in competition with other banks?
- In what extent conversion financial and credit institutions to the bank effective for profitability of shareholders?
- Integration of credit and financial institutions into a single bank, to what extent will affect the interests of shareholders?
- In what extent the word bank gives value to credit and financial institutions in commercial activities?

Variables: If attract resources risks, profits, interest, credit and equity occurs profits will be change, if risks occur within the organization and technology will bring cost to the project Questions about expenses hypothesis are as follows:

- How much will economic justification for the costs of organizational changes in the conversion of credit and financial institutions to bank?
- In what extend meet minimum technology requirements of each bank on conversion credit and financial institutions to the bank will be affected?

Variables: If risks occur within the organization and technology will bring cost to the project.

Questions about losses hypothesis are as follows:

- With conversion credit and financial institutions to bank, laws and policies of the central bank how much would affect profit and interest on shareholders equity?
- If there are some negative policies on the central bank how much will be profitable conversion financial and credit institution to the bank?
- Conversion credit and financial institutions to a bank, to what extent will affect the identity of each of the institutions?
- In what extent activity in all areas of different finance and credit is possible if conversion credit and financial institutions to bank happens?
- How much will be cost to the treasury with policy of realize conversion financial and credit institutions to the bank?
- In what extent in conversion of credit and financial institutions to banks traditional managers will affect the progress of the project?

Variables: If risk of rules and regulations, events (political) institutions integration, open activities (non-professional), likely to occur on the property and the classic elite, the project will be loss.

CONCLUSIONS

Nowadays, uncertainty in management projects, including conversion finance and credit institutions to bank project, managers have faced numerous challenges. Therefore, for effective management of these challenges, new management approaches and specific competencies designed and recommended that projects Risk management is a new approach for aimed at improving the effectiveness of project management, which has been very effective.

In this paper, one of the four steps of risk management that is used is identify risk. Also, by using fuzzy Delphi method with three stages and a survey of the views of 22 experts as using the training data and 8 experts as data test in conversion financial and credit institutions projects to banks, effective risks that affect the whole project had been identified and sorted.

Evaluate the results of this project show that integration of financial and credit institutions risk in the general trend is higher priority than all the risks of the

project. These results suggest that the risk of expert opinion about the ability to estimate is better. Using the results of the third hypothesis, also, project managers of financial institutions and credit into the bank, able to assess the risks of each of the three hypotheses, according to the considered hypothesis.

In addition, we used II type of fuzzy Delphi method in risk identification process because it covers the uncertainties better.

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