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Evaluation of Residual Risks in an Oil Construction Project Using Fuzzy SAW and Risk Matrix Methods

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Abstract

Basically, the topic of risks, especially the remaining risks in projects, is very important because not paying attention to them will cause a lot of losses, including financial and time, so a smart organization should be able to make the necessary predictions in advance and be able to face new problems. and show flexibility outside the program and turn them into opportunities. In risks, there is a kind of uncertainty and ignorance about doing work in the future, which shows that risks act like a double-edged knife. In this project, first thirty important remaining risks in an oil construction project were identified with the help of experts' opinions and according to previous similar projects in five sections, and then weighting was done with the help of fuzzy methods and risk matrix. and prioritized. The results of the study show that the organization should eliminate the similar risks with a high degree of importance and turn them into opportunities in order to reduce their effects with proper planning. It should be mentioned that these risks were ranked according to 28 increasing or decreasing criteria of 5 mechanical, electrical, civil, Instrument and financial sectors. It is necessary to explain that the risks along with their results were investigated in the 2023 version of the software and the final results confirm the final data of the two methods.

Keywords: Residual risks, Oil construction project, Fuzzy method, Risk matrix method.

1 | Introduction

Project management plays an important role in the discussion of risk control. In fact, its history goes back to the early years of the 1900s, that is, when Henry Gantt, with the development of his innovative bar chart, initiated the next movement during the 1950s to 1960s in American military and aerospace projects and then He went to England, but his fame has been due to several factors, including the use of Gantt charts, his

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collaboration with Taylor in the scientific theory of management, and his fame in the study of naval ship building management, of course, he was a pioneer in allocating resources. This caused the 1950s to 1960s to be recognized as the early years of project management growth and development in the contemporary arena and the beginning of the formation and development of many methods and knowledge related to the management of the ten principles of project management and this made them famous in management [1].

The written report of the Social Security Organization (SSO) indicates that among various industries, the construction industry has the most accidents caused by work, so that in addition to the increase, it also has a very high intensity, and also because many people are working in this vast industry. Therefore, it requires special attention. In 2013, the highest number of accidents caused by the work of insured persons who were affected by occupational accidents in the field of economic activity is related to structural works with a figure equal to 5479 (26.69%) accidents. Also, the events caused by work, in addition to causing financial losses to the society, lead to the imposition of many human losses on the society [2]. Nowadays, the major part of the capital of every country, especially the developing countries, is dedicated to construction projects and its infrastructure, and one of the factors of economic growth and development of any society is the success in the implementation of its construction projects. Construction and oil projects are complex works and are inevitably described with a set of drawings and technical specifications. Project management is one of the special tools for the success of complex activities such as projects [3]. Since project planning and control includes various aspects such as goal setting, risk management, management procedures and change management, it has a significant effect on the success of construction projects. Basically, things like the occurrence of faults, land acquisition and landslides are among the risks of oil construction projects, which if not investigated, will reduce the quality of the project, increase the execution time and even cause irreparable damage, so these risks should be evaluated at the beginning of the work. and reviewed and experts' opinions should be used [4]. Fuzzification is a method in which verbal expressions and qualitative values are quantified with fuzzy numbers, so the first step in solving a problem based on rationalization in management is to make the data fuzzy. When you use the experts' point of view to compare criteria or estimate their values, they express their point of view in verbal expressions. The traditional process of quantifying people's views cannot fully reflect the human thinking style. In other words, the use of fuzzy sets is more compatible with human linguistic and sometimes ambiguous explanations. Therefore, it is better to make long-term predictions and make decisions in the real world by using fuzzy sets (using fuzzy numbers). For the first time in 1965 AD, an Iranian-born scientist and professor at Berkeley University with the title of Professor Lotfali Asgarzadeh proposed this logic. This logic is against Aristotle's two-valued logic, which said that the answer to all questions in the world is yes or no, but in fact, fuzzy logic introduces the world as it is and is more similar to human nature. Despite the many benefits of this logic, its main problem is that it cannot be a producer of human patterns because human thought patterns are often intuitive and mathematics cannot understand them and we hope that we should let overcome most of the negative results of the risks [5]. In general, major developments in the business environment have increased competition and management difficulty in organizations, so organizations need risk-taking and capable managers to adopt these inherent complexities when making important decisions. In production business environments, industries active in the food, pharmaceutical and petroleum sectors have higher risks and higher coefficients, therefore, the implementation of risk management techniques in these companies is of great importance [6]. It should be taken into account that today it is clear that the most common cause od accidents in the construction and oil industries is the variability of human performance, which is different from the traditional human error paradigm and used more modern in order to improve the progress of the project, also the discussion of administrative bureaucracy is also effective in this matter [7]. In this project, first 30 residual important risks were identified in five different departments with meetings held with experts, and according to the effects of 28 effective criteria on them, they were ranked with the help of two Fuzzy and matrix risk methods.

2 | Literature Review

Wang and Wang [8], on an article entitled the assessment of the risks of passing through substructures the existing under the tunnels worked with the help of Fuzzy method and cloud model. They believed to that in addition to the risks in while working in construction projects, some risks are also related to passing through infrastructures such as tunnels and it stays in place due to the fuzzy and randomness of the construction environment, the use of simulation methods such as Monte Carlo while produce highly fluctuating and non-uniform results that are not reliable. They with the help of analysis and analyzing previous experiences, he designed a cloud model algorithm with the help of fuzzy method and tested it in a real example and finally, the effectiveness of this model was confirmed. The final results of this research showed that calculations the cloud model is much easier than other methods and reflects the relationship between indicators and results to determine the level, there are risks and also, the accuracy of these models is very high and there is no significant difference with the main results. Other researchers also, in the future, by defining more improved methods, they can develop and strengthen the fuzzy method at global levels and be used in construction projects [8].

Daniali et al. [9], on an article titled identifying and evaluating project management risks with using gray Shannon's entropy and FMEA techniques worked, they first held many meetings with experts and Yazd civil engineering specialists have identified 30 effective risks for the management of construction projects of Yazd Municipality and then by designing the questionnaire and with the help of gray numbers, the weight of the risk factors. The diagnosis was obtained from the qualitative mode in the form of a numerical interval. Then 5 experts were used and with the help of the FMEA method. The decision matrix was formed and the weights were obtained with the help of normalization and gray entropy technique [9].

Ndaw et al. [10] worked on an article entitled "reviewing residual risks in Senegal banks". They stated that risk is a potential danger that arises from some current processes or future events. Banks take many security measures to secure safe transactions but fraud in ATM and POSE machines has increased significantly so in order to keep customers satisfied, banks should inform their customers about new protocols. African banks made regional and safe development the main focus of their work but due to lack of information, they are not allowed to assess all risks so they have to do it manually. In this research first a proposed quantitative security model that shows the impact of the risk of banking information systems in case of using FMECA is presented, which includes three stages of maturity control, types of control and criteria detection. This model was designed during meetings with the managers of Senegal's banks. The causes and effects of failures were identified and to test the validity of the work, the values obtained in the model were compared with the values of the evaluators during the work sessions and the results was satisfactory [10].

Baradaran [2] worked on an article titled "evaluation and prioritization of urban rail transport risks with the Gray Hierarchical Analysis Process (GAHP)". First, by reviewing the existing literature, the issues faced by the passengers and employees of the metro were identified. Then for a deeper investigation, by holding meetings with railway transportation engineers of Yazd municipality, 13 risks were identified with the help of 9 criteria and sub-criteria. Then with the help of gray numbers or interval in AHP, the Likert scale was performed and the matrix of paired comparisons was obtained and a non-linear and linear optimization model was used to calculate the local and global weights and the risks were finally ranked and the rations were compared. The results showed that closing the train door, conflict between passengers and getting injured while using the escalator are important risks [2].

Rahnamai et. al [3], on research titled evaluating companies' risk management using discussed the application of gray Multi Criteria Decision Making (MCDM) with entropy weight and believed that the major developments in the business environment and work have increased competition and made management difficult in organizations. They are fisted to measure management tools companies' risk, four criteria C1, C2, C3 and C4 based on the Kosovio medel for managing strategic risks, risk they defined operational risks, reporting risks and risks of non-compliance with laws and regulations. This type of research applied and with

the aim of collecting data and informational 20 Tehran Stock exchange companies during the years 2012-2017 and then with the help of these 4 criteria, the normalized weight matrix and formed and the degree of gray relation of the matrix was obtained one by one and with the help of weighted entropy method and gray analysis method, this information was put in MATLAB software and a multi-criteria decision model was used for the final ranking of companies and the results showed that this ranking it has caused recognition of the position of these listed companies in relation to the optimal points and they tried to develop strategic plans reduce this distance and revise it [3].

3 | Methods

3.1 | Fuzzy

Fuzzy logic means a revision of the scientific reasoning method based on the real pattern of human thought. This way of thinking was first proposed by Max Black as the theory of illusion, and in 1965, Professor Lotfali Asgarzadeh based on Mr. Black's studies proposed the fuzzy theory, which was opposed to the Aristotelian binary logic. In fact, Lotf Alizadeh argued that humans do not need more accurate information inputs, but are able to perform comparative control between the available information. In Aristotelian logic, the answers to all questions are yes and no, but in fuzzy logic, the answers to questions are expressed qualitatively, like a person who expresses his level of satisfaction with his job with different degrees such as very satisfied, satisfied, indifferent, etc. Now, the simplest answer for the definition of fuzzy logic is that it replaces the conclusion methods in the human brain and its application is very wide, and in fact, it is a multi-valued logic that includes a gray spectrum in two black and white borders. Fuzzy sets can be explained in comparison with classical sets and the concept of degree of membership. In a classical set, every element of the set has a membership degree of one, and other elements have a membership degree of zero, that is, they are not members of that set. Unlike the classical set, the fuzzy set does not have specific and well-defined boundaries. By using fuzzy sets, errors are reduced. In MCDM approaches, although the mental abilities and abilities of experts are used to make comparisons, the quantification of experts' views in the traditional way does not allow the full reflection of human thinking style [10].

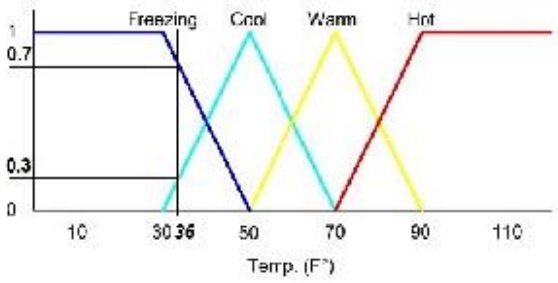

Fig. 1. An example of fuzzy logic description [11].

3.2 | Preliminaries

In the following we provide the definition of the related concepts of fuzzy numbers and gray numbers [5]. The normal convex fuzzy sets on the real number field R are called the fuzzy numbers; the regular closed convex fuzzy sets are called the closed fuzzy numbers; the regular bounded closed convex fuzzy sets are called the bounded closed fuzzy numbers. If $\tilde{A}$ is the fuzzy numbers and A_1=1-cut is a single point set, that is $A_1=\{x_0\}$, then $\tilde{A}$ is a strictly fuzzy number $\mu_{\tilde{A}}(x)$.

Let fuzzy numbers $\tilde{A}$ have membership degree. Basically, the fuzzy method has less accuracy compared to methods like MCDM and Gray approach and its smarter and faster to get the best answer but in general, the Fuzzy method has a type of uncertainty.

$$\mu\tilde{A}(x) = \begin{cases} 0, & x < a, \\ \dfrac{x-a}{b-a}, & a \le x \le b, \\ \dfrac{x-c}{b-c}, & b \le x \le c, \\ 0, & x > c. \end{cases} \quad (1)$$

Let us call Ã the triangular fuzzy numbers denoted by Ã= (a,b,c).

Let fuzzy sets E have membership functions:

$$\mu\tilde{A}(x) = \begin{cases} 1+x, & x\epsilon[-1,0], \\ 1-x, & x\epsilon[0,1], \\ 0, & \text{other.} \end{cases} \quad (2)$$

Call it a triangular fuzzy structured element. a, b, c are actually three numbers that are defined as a triangular fuzzy symbol. In fact, it is necessary to mention that the trapezoidal fuzzy number is also very useful, but here it is enough to mention only the triangular fuzzy number.

$$\mu_A(x) = \begin{cases} 0, & x \le a \\ \dfrac{x-a}{b-a}, & a < x \le b \\ 1, & x = b \\ \dfrac{c-x}{c-b}, & b < x \le c \\ 0, & x \ge c. \end{cases}$$

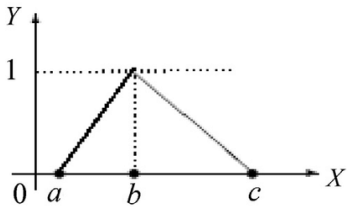

Fig. 2. An example of triangular fuzzy number [12].

3.3 | Fuzzy SAW Relation Ranking Based on the Structured Element Method

The fuzzy SAW relation ranking based on the structured element method is described as follows:

Step 1. First according to the previous method, the type of positive or negative effect of each criterion is determined, then according to *Table1*, verbal expressions are converted into fuzzy numbers.

$$\tilde{R}=[\tilde{r}_{ij}]_{m*n} = [r_{ij}^{l},\ r_{ij}^{m}, r_{ij}^{u}]_{m*n}. \quad (3)$$

Table 1. Determining how to identify the range of risks in the risk matrix method [13].

RPN Range	Type of Risk	Actions
[0-1]	Very low	Nothing needs to be done
[2-27]	Low	It has a partial risk
[28-125]	Medium	The risk is significant and should be monitored
[126-343]	High	The risk is high and immediate action must be taken
[344-1000]	Very high	The risk is critical and urgent action must be taken

Step 2. In the second step, the fuzzy matrix is descaled using the fuzzy method in such a way that first the values of maximum, minimum and maximum-minimum values are calculated and according to the following formula and the positive or negative type of that criterion, the matrix is descaled to be:

$$n_{ij}^{+} = \frac{(r_{ij} - r_j^{min})}{(r_j^{max} - r_j^{min})} \ : \ n_{ij}^{-} = (r_j^{max} - r_{ij})/(r_j^{max} - r_j^{min}). \quad (4)$$

Step 3. Fuzzy decision matrix has normally weight. First the values of the weights obtained by the TOPSIS approach are repeated three times each to form the weights of the fuzzy method. Then, those weights of the fuzzy matrix are obtained from the product of the normalized matrix in the weight (weights) by according to the following formula. It's necessary to mention that these steps must be done step by step and carefully.

$$\tilde{Y} = [\tilde{y}_{ij}]m \times n = [\tilde{r}_{ij} \times \tilde{W}_j]m \times n \ , i = 1,2 \dots m; \quad j = 1,2 \dots n. \tag{5}$$

Step 4. In the 4 steps, the fuzzy row sum is calculated for the entire weight matrix in such a way that first the initial values, then the middle values and finally the final values are added together separately.

Step 5. The results obtained from the previous step are deterministic in such a way that each fuzzy number is DE fuzzified by centripetal method and according to the following formula like below.

These steps must be followed regularly and accurately to achieve results.

$$X_m^1 = \frac{L+M+U}{3}; X_m^2 = \frac{L+2M+U}{4}; \ X_m^3 = (L + 4M + U)/6, \tag{6}$$

$$\text{Crisp number} = z = \max(x_m^1, x_m^2, x_m^3).$$

Step 6. In the last step, the numbers obtained in each row are ranked in descending order of points to identify the most important and fundamental risks.

$$\tilde{V} = \begin{pmatrix} \tilde{v}_{11} & \tilde{v}_{12} & \cdots & \tilde{v}_{1n} \\ \tilde{v}_{21} & \tilde{v}_{22} & \cdots & \tilde{v}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{v}_{m1} & \tilde{v}_{m2} & \cdots & \tilde{v}_{mn} \end{pmatrix}. \tag{7}$$

3.4 | Ranking of Risks Based on Priority Using the Risk Matrix Method

In fact, the risk matrix is a tool that is used to evaluate and measure the risk and its visibility by considering three variables: the probability of occurrence, the probability of detection and the severity of the risk. Better capture helps, it is used, in fact, by providing the best plan to reduce risks, you are in control of the project. Its advantages include identifying major risks, presenting the risk situation visually and comprehensively, evaluating the effectiveness of the project team's risk measures, and presenting the current risk situation without the need for any knowledge.

Step 1. The values of the probability of detection, the severity and the amount of each risk are recorded according to the opinion of the supervisors.

Step 2. The three values obtained in the previous step are multiplied together to obtain RPN value of each risk.

Step 3. These obtained values are ranked according to the table below in descending order in order to identify the most important risks. It should be mentioned that these results should be compared with a more accurate method such as fuzzy, gray or artificial neural network in order to obtain the best analysis.

4 | Solution Method

In this research, an oil construction project in Iran was discussed, which includes 80 employees of the employer and 70 employees of the contractor. The remaining risks in the two parts of design and implementation were investigated in five parts: mechanical, electrical, civil, instruments and financial. 28 criteria affecting these risks along with the risks themselves were identified by holding meetings with project supervisors and experts. It should be mentioned that this project has completed 70% of its planned progress. This project includes 7 pumping stations, a number of pumps and 5 pressure breakers. This project has faced many financial problems, including lack of funds and lack of timely allocation of funds, which has caused stops along the way of the project. Also, issues such as sudden changes in maps and soil mechanics are among

the other issues that have had an impact on the progress of different parts of the project. In *Table 2*, the criteria studied in this project, some of which have been obtained from studies of previous similar projects, are listed.

Table 2. Criteria affecting risks [13].

Row	Criteria Symbol	The Concept of Criteria	The Type of Malaise
1	J 1	The level of expertise of the people of project	Incremental
2	J 2	The quality of scientific resources	Incremental
3	J 3	Individual characteristics for team work	Incremental
4	J 4	The level of access to information resources	Incremental
5	J 5	Timely injection of budget	Incremental
6	J 6	Soil mechanics	A decrease
7	J 7	Timely presentation of documents	Incremental
8	J 8	Up to date maps	Incremental
9	J 9	liquidity	A decrease
10	J 10	Cumbersome laws	A decrease
11	J 11	Reliance on domestic production	Incremental
12	J 12	Corrosion rate of parts	A decrease
13	J 13	Proper design of valve inlets	Incremental
14	J 14	Support system	Incremental
15	J 15	Degree of impact of dangerous gases	A decrease
16	J 16	inflation	A decrease
17	J 17	Sanction	A decrease
18	J 18	International developments	A decrease
19	J 19	Expert suoervision and inspection	Incremental
20	J 20	Quality of parts and equipments	Incremental
21	J 21	Knowledge level of managers relevant	Incremental
22	J 22	Compliance with standards	Incremental
23	J 23	The credibility of the company that manufacture parts and equipments	Incremental
24	J 24	The quality of personnel training	Incremental
25	J 25	Accuracy in the design of relevant drawings	Incremental
26	J 26	Project time	A decrease
27	J 27	Accuracy in the initial design of maps	Incremental
28	J 28	The use of safety equipment by employess	Incremental

This project is very importance and changes have been made many times in the field od designing its maps in order to move forward in the best possible way and get the best output and have the lowest cost.

In the next stage, from each department that was mentioned, 5 people including the head of that department were selected to answer the two questionnaires, but a total of 15 people agreed to answer the questions orally and the others due to many works, they were busy and couldn't help.

In the *Table 3*, the details of the respondents are given along with their educational qualifications and work experience.

Table 3. Gender and level of education segregation of questionaries to separation of departments [13].

Departments	Woman	Man	Diploma	Associate Degree	Bachelor	Master's Degree	P.H.D
Mechanical	0	3	0	0	2	1	0
Electrical	0	3	0	0	2	1	0
Civil	0	3	0	0	2	1	0
Instrument	0	3	0	0	3	0	0
Financial	2	3	0	0	2	1	0

Step 1. In this step we convert qualitative expressions to triangular fuzzy expressions with the help of *Table 1* and we repeat each relevant weight three times because its important and that a triangular fuzzy number consist of three components.

Step 2. The matrix obtained from the previous step is descaled with the help of the fuzzy method and *Eq. (4)*.

Step 3. In the *Step 3*, the weighted normalized matrix is obtained from the product of the normalized matrix and the weights.

Step 4. In the next step of Fuzzy SAW, the row summation of the weighted normalized matrix is done in such a way that the beginning, middle and end regions are added together separately.

Step 5. At this stage, the obtained results are defuzzied by the center of gravity method by *Eq. (6)*. It should be noted that this step is very important.

Step 6. In the last step, the numbers obtained from the previous step are ranked in descending order to identified the most important and critical risks. Then the most critical residual important risks are determined by priority of risk level. In *Table 4*, the final ranking results can be seen.

Table 4. Final residual risks ranking by Fuzzy SAW approach [13].

Risk	ME R3	ME R1	ME R2	ME R6	EL R6	ME R4	ME R5
Ranking	1	2	3	4	5	6	7
Risk	EL R4	EL R3	EL R5	CI R5	EL R2	CI R1	EL R1
Ranking	8	9	10	11	12	13	14
Risk	CI R2	CI R6	CI R3	CI R4	IN R6	IN R5	FI R6
Ranking	15	16	17	18	19	20	21
Risk	IN R4	IN R2	IN R3	IN R1	FI R2	FI R4	FI R3
Ranking	22	23	24	25	26	27	28
Risk	FI R5	FI R1					
Ranking	29	30					

It should be mentioned that to solve the initial fuzzy SAW method, the weights come with the help of an arbitrary method such as entropy to be used in the calculations. It should be noted that the sum of the weights is equal to one. All these items are listed in *Table 5*.

Table 5. The weights obtained by the entropy method [13].

W1	W2	W3	W4	W5	W6	W7	W8	W9	W10
0.031	0.053	0.043	0.037	0.046	0.040	0.056	0.053	0.062	0.055
W11	**W12**	**W13**	**W14**	**W15**	**W16**	**W17**	**W18**	**W19**	**W20**
0.051	0.033	0.052	0.062	0.044	0.003	0.001	0.004	0.016	0.017
W21	**W22**	**W23**	**W24**	**W25**	**W26**	**W27**	**W28**	**W total**	
0.031	0.016	0.022	0.032	0.035	0.004	0.047	0.033	1.000	

Also, to convert the verbal expressions of the 5-point Likert spectrum into triangular fuzzy, the *Table 6* was used as described below. Basically, the Likert scale is one of the methods that can help a lot to convert verbal expressions into numerical values.

Table6. converting verbal expressions to fuzzy numbers in fuzzy SAW method in this project [1].

Priorities	Codes	Fuzzy Equivalent of Priorities		
		Low limit (L)	Average limit (m)	High limit (u)
Very poor	1	1	1	3
poor	2	1	3	5
average	3	3	5	7
good	4	5	7	9
Very good	5	7	9	11

This Likert scale includes the numbers 1 meaning very low, number 3 means low, number 5 means average, number 7 means high and number 9 means very high and the questionnaire in this research is oral and in the form of survey studies.

4.2 | Solved and Ranked by Matrix Risk Approach

The second method used in this research is the use of the risk matrix in such a way that with the help of the information collected from questionnaire number one, the values of probability of occurrence, severity and amount are multiplied for each individual risk to obtain the RPN of each risk. And then the obtained numbers are sorted in descending order to determine the priority of important and critical risks. Of course, one of the problems of this method is that it depends on the degree of expertise of people and the amount of personal analysis and judgment of each person. The results are shown in the *Table 7*. It should be mentioned that electronic risks number one, mechanical risk number one and financial risk number four are among the more critical risks.

Table 7.Calculation and ranking of project risks using the risk matrix method in this project [13].

Risk Code	Probability of Occurence	Severity of Risk	Probability of Discovery	RPN	Risks Level	Ranking
EL R 1	9	9	5	405	Very high	1
ME R 1	4	10	10	400	Very high	2
FI R 4	9	9	4	324	High	3
ME R 3	4	10	7	280	High	4
CI R 5	8	8	4	256	High	5
FI R 1	6	8	5	240	High	6
FI R 2	7	8	4	224	High	7
ME R 2	3	9	8	216	High	8
IN R 5	6	9	4	216	High	9
CI R 1	8	6	4	192	High	10
IN R 1	8	8	3	192	High	11
ME R 6	5	9	4	180	High	12
ME R 5	6	5	5	150	High	13
FI R 6	5	7	4	140	High	14
ME R 4	7	9	2	126	High	15
EL R 5	7	6	3	126	High	16
FI R 5	6	7	3	126	High	17
IN R 4	9	7	2	126	High	18

It is worth mentioning that this project is a pipeline transfer project which provide food for some important refineries.

4.3 | Solving by MATLAB Software

In addition to the two mentioned methods, MATLAB 2023 software was used in this research. In this way, 6 input triangular fuzzy membership functions, 6 triangular fuzzy membership functions for function output and 6 conditions for the considered function were defined as follows. This work was done to investigate the trend relationship between defined fuzzy numbers and weights. The results are favorable.

Table 8. Input/output data types in MATLAB software [13].

MATLAB Data Type	Symbol	Number Range
Input	Z1	[0,0,0]
	Z2	[1,1,3]
	Z3	[1,3,5]
	Z4	[3,5,7]
	Z5	[5,7,9]
	Z6	[7,9,11]
Output	EH1	[0,8.5,17]
	EH2	[17, 25.5 , 34]
	EH3	[34 , 42.5 , 51]
	EH4	[51 , 59.5 , 68]
	EH5	[68, 76.5 , 85]
	EH6	[85 , 93.5 , 100]

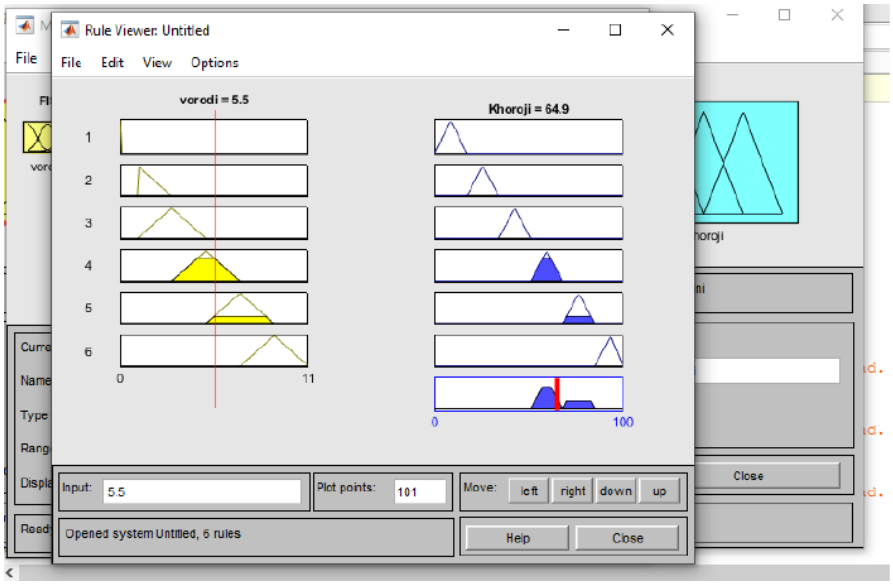

Fig. 3. The final output of Fuzzy logic in MATLAB software [13].

5 | Conclusion

The ranking of remaining and important risks by two fuzzy methods have differences, which shows the difference in the nature of these two methods.

The ranking of the remaining risks by the risk matrix method, which was obtained using the information of questionnaire number one, has differences with other methods, the reasons of which can be attributed to the difference in the framework and shape of these methods.

According to the opinions of specialists, supervisors and experts and the analysis of their answers, it was found that the factors that caused the project to slow down and to some extent stop in the time frames, such as the lack of timely budget injection, insufficient budget injection in order to Renovation and repairs of equipment, exchange rate fluctuations and international sanctions have caused the disconnection of relations with related countries and companies.

The use of a small study sample in this research is one of the things that had an impact on the results, which of course was the limited number of people who were familiar with risk.

5.1 | Suggestions for Future Researchers

I. Applying the issue of remaining risks in private or government companies in new fields and sciences or other countries: In order to obtain more complete information and prevent conservative answers by some respondents, in future research, researchers should ask more and more conceptual questions in all stages and with methods such as checklists, more flexible and free interviews or They even use an electronic questionnaire to get better and more accurate results.

II. Using combined methods and merging different methods together, such as neural method with fuzzy method or fuzzy method with artificial intelligence.

III. More accurate planning for important and critical risks and additional budget allocation: In order to better investigate the relationship between the risks and the solutions proposed by the experts and the project supervisors, the effects of the relationship between both should be investigated with the help of more accurate methods and in similar future projects.

Conflict of Interest

The authors declare no conflict of interest.

Data Availability

All data are included in the text.

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