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Application of Fuzzy AHP and TOPSIS Methods for Risk Evaluation of Gas Transmission Facility

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A B S T R A C T

Today, the use of risk assessment methods in various industries is expanding, as there are currently more than 70 different types of qualitative and quantitative risk assessment methods in the world. These methods are usually used to identify, control and mitigate the effects of hazards. Organizations should be able to select one or a combination of several types of risk assessment methods that are explored and studied in this article. In some cases, and for the direction of some sensitive processes, especially in the chemical industry, the production of explosive and combustion products such as the gas transmission company should be analyzed before determining the type of method of all methods and the best approach with regard to financial resources, requires qualitative or quantitative or qualitative and quantitative information, time limits, trained personnel limitations, the type of application of the risk identification method, the advantages, and disadvantages of each of these systems. Generally, acceptable risk levels are different for each organization or individual, depending on financial and economic resources, technological constraints, experienced human resources, discretion and management, and underlying risks such as hidden risks. Organizations usually require a system that, in addition to assessing their activities and processes can help them determine the risk situation, determine risk tolerance criteria, and accurately determine the exact risk of their processes, and ... lead them, depending on the complexity of the activity of each industry, the type of system that can bring them to the target. Is different. In this study, the assessment of the risks of gas Transmission facilities in the 9 regions, has been studied and reviewed. After identifying the various activities of the facility, which included three safety measures for equipment, personal and environmental health, and 28 sub-criteria, from previous studies and surveys, and staff comments. Then, using AHP, the fuzzy questionnaire was completed. Pairwise comparison of criteria and sub-criteria by experts and the use of excel software resulted in the weight of the sub-criteria and the compatibility rate. Then, using the verbal variables, five boost pressure facility with Fuzzy TOPSIS was ranked according to the relevant criteria, and the Rasht boost pressure gained the first rank.

Keywords: Risk Assessment, Fuzzy AHP, Fuzzy TOPSIS, Gas Transmission Facility.

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1. Introduction

Risk assessment is a logical way to determine the quantitative and qualitative risks and to investigate the potential consequences of possible accidents on individuals, materials, equipment and the environment. In fact, in this way, the effectiveness of existing control methods is identified and valuable data are provided to decide on risk reduction, hazards, refinement of control systems, and planning for their response. The launch began with the nuclear, aeronautical and electrical industries in the early 1980s. Risk assessment is a process that requires experience, expertise and high accuracy and should be done in the form of teamwork and the ability of authorities and experts.

This team activity will also be at the desired end when the evaluating team, in addition to having the required expertise, will have a common language in understanding the concepts and methods used. In assessing the risk of accidents, two parameters play a major role. The first parameter is the repeatability of that incident, and the second parameter is the severity of the consequences of the incident. The repeatability of an incident means the number of times that the incident occurred within a specified period of time and the severity of the consequences of an incident would mean the casualty resulting from that incident. None of these parameters alone is sufficient to assess the risks. Many incidents can be considered as having severe consequences, but in practice they are unlikely to occur, and vice versa, some events may occur frequently, but they have no significant outcomes. For this reason, setting the yardstick for both factors is very useful in risk assessment [1].

The methods used to identify hazards are very diverse and include some of the following:

- -Browsing safety: One of the first ways to identify safety risks is undoubtedly a safety review. In this method, the purpose is to identify the specific conditions of a process that can lead to an accident.
- Checklist analysis: Checklist analysis uses a list of cases or logical steps to investigate the status of a system.
- Question analysis: In this method, which is one of the oldest methods for identifying hazards, all information about a unit in a group meeting is discussed among experts. One of the most important features of this method is the high dependence of the quality of the results to the experience of the experts involved and it cannot be expected to identify undetected hazards.
- Checklist/question analysis: In this way, questions raised in the question analysis method are based on a checklist. This technique combines the creativity of the question analysis method and the systematic structure of the checklist method.
- Relative ranking: In this risk identification method, the characteristics of several processes or activities are compared, so that depending on the severity of the possible hazards, the need for a further review of a process is determined.
- Preliminary risk analysis: This analysis is used to identify the major hazards of a system, the causes and severity of its consequences, especially in the conceptual design phase. In general, the objectives of this analysis are:

- Identify sensitive and critical areas within the system from a safety point of view.
- Diagnosis of risks and an approximate assessment of its consequences.

- Error analysis and its effects: In this method, the system is more than mechanically checked, not the process, resulting in the best efficiency in combination with process methods.
- Error tree analysis: Error tree is a tool in risk assessment that can be applied quantitatively or quantitatively. If used in a qualitative way, a tool is used to identify hazards and, if used quantitatively, will be used in risk assessment.
- Event tree analysis: Event tree, like the error tree, is a risk assessment tool that can be applied quantitatively or quantitatively. If used in a qualitative way, it is a tool for identifying hazards and, if it is not enough, will be used in risk assessment.
- Reason-reason analysis: This is an integrated analysis of error tree analysis and event tree. One of the important features of this analysis is to establish the relationship between the consequences of an accident and the main causes of its occurrence.
- Material analysis in the process and operating conditions: Materials used or produced in the process are an important factor in detecting the hazards in the process. So the first step in identifying hazards is to collect physical and chemical properties of the material, such as toxicity, flammability, volatility, and reactivity of the materials in the process. The unit operating conditions are also important factors in identifying potential hazards in a process unit.

2. District 9 Gas Transmission

District 9 Gas Transmission operations is one of the ten regions of Iran's Gas Transmission Company. This area was established in 2007 for the purpose of efficiency, efficiency and operation, and the protection and maintenance of company's capital and timely supply of gas with a range of work in three provinces; Golestan, Mazandaran, and Guilan have begun.

This operational area is responsible for transporting gas from regions 3 and 4 from the entry points of Guilan and Golestan provinces, as well as imported gas from Turkmenistan to supply gas to the Neka River, industries and household uses in the three provinces of Falazekr and part of the provinces of Semnan and Ardebil. And this is accomplished with the help of five gas refueling facilities such as Qiqiq, Neka, Noor, Ramsar, and Rasht, as well as three centers for the operation of Gorgan, Nour, and Rasht gas pipelines (see ***Figure 1***).

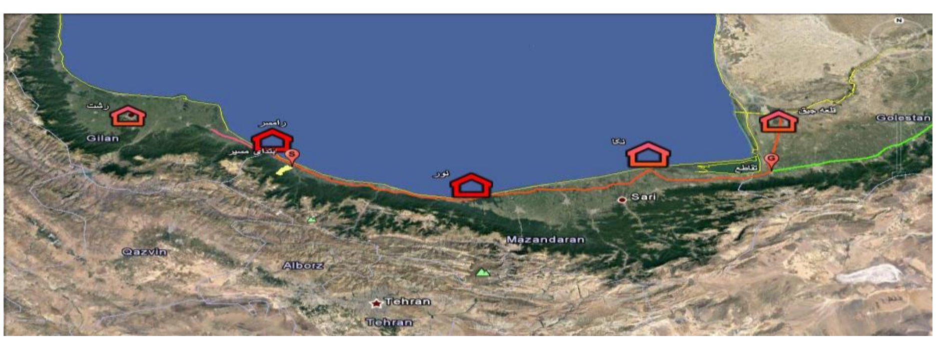

Figure 1. Pipeline of Iran gas transfer zone 9**.**

2.1. Ramsar Gas Pressure Boosting Plant:

This facility is located in Mazandaran province, Iran, on the 30-inch pipeline of Khanjiran-Rasht, 1064 km. Since 2000, it has been built with four turbo compressors (1-3 parallel arrangement) manufactured by Canada (DRESSER RAND), with total capacity The daily gas flow is about 15 million cubic meters (see ***Figure 2***).

Figure 2. Ramsar gas booster pressure.

3. Review of Literature on Risk Assessment

This section addresses past research on risk assessment methods:

Ahmed Lak, in 2005, is one of the most urgent and essential steps to increase the level of safety in existing or developing units, assessing the risks of the release of chemicals in the environment. These hazards may be caused by human errors or defective equipment. Quantitative and qualitative risk assessment in developed and developed countries is an integral part of the design of process units, but unfortunately, our country has not yet achieved its place and perhaps one of the main reasons is lack of familiarity with the basics of quantitative and qualitative risk assessment. Given the lack of this topic and the necessity of discussing and developing this knowledge, this paper attempts to generalize risk assessment and its implementation, including steps such as identifying potential hazards in a process, modeling potential hazards such as fire, explosion or consequences. Related to the toxicity of materials, the calculation of risk and its magnitude. Modeling the consequences of potential hazards in a process is one of the most important stages of risk assessment that is being carried out today by powerful computer software. In order to learn more about how to apply risk assessment, its steps on the ammonia reservoir of one of the country's petrochemical complexes, along with the modeling of the related hazards associated with the MATLAB software, which is one of the best software in the field of modeling the consequences, has been investigated [2].

The purpose of this study is to investigate the activities of PTAW 2 and 3 gas pressure boost station and to identify environmental hazards and environmental hazards using the AHP method. Initially, the work process at the station was investigated and the risk factors of the complex, which can affect the environmental values of the station to enhance the pressure of the gas supply, and identify the degree of importance of the Delphi questionnaire. In the next stage, the risk factors were determined with the assistance of experts, experts and environmental experts, and the probability of occurrence of environmental risks Bio was obtained through the AHP method and expert choice software. The intensity of the effect was determined by using a questionnaire and analyzing the failure states and its effects and determining the risk scores. In this method, the risk aspect was identified in physicochemical, biological, and socio-cultural environments. Prioritization of risks based on the obtained points in different environments where the risk of noise pollution with a score of 4.192, risk the general health of the people in the area with a score of 0.004, the risk of liquid and waste water with a score of 24.2 and risk of danger security risk reduction with a score of 2.107 have earned the highest risk score in their respective environments, and finally, strategies have been developed to control and eliminate the most important source of risk [3].

Khakpour [4] assessed the risk of road construction projects in Gas Company by AHP Phase Method. The steps of this research were as follows: First, preliminary studies and recognition of the system under investigation were carried out. Then the identified risks are ranked by fuzzy logic designed questionnaires. By collecting information about risk management, fuzzy logic, AHP, Matlab software, and the statistical analysis of SPSS and their analysis and combination, they tried to provide a model consisting of 5 steps for risk management and use in construction projects between stations. We reduce the pressure of gas by combining these methods and compare them with the fuzzy inference method. As a result, fuzzy risk priority numbers were proposed to prioritize failure states. In order to rank the target, these numbers were extracted from fuzzy state by using the "center of gravity" de fi nition methods and turned into definite numbers. The reason for using fuzzy logic in this study is to be more consistent with the nature of uncertainty and risk [4].

Azadnia [5] selected the appropriate method for mechanical and earthquake operations. The installation of pipelines has an important role in the success and completion of these projects. The choice of the appropriate method in this process is a multi-criteria decision-making component. In this paper, a proposed method is proposed for this purpose. First, we have defined the criteria and weighted the criteria using the hierarchical analysis in the fuzzy environment. Using these weights in fuzzy TOPSIS, we rank the methods of performing mechanical operations and the installation ground. The proposed methodology is implemented in a technical engineering company and its results and significance are shown in this paper [5].

Nazam [6] assessed the Fuzzy AHP and TOPSSIS method on greenhouse gas supply chain management in the textile industry. In this study, using AHP, the benchmark weight and any benchmark obtained are then obtained using the Fuzzy TOPSIS methodology of Herrisk rankings. In the textile industry studied in this regard, experts in this industry can find the impact of risk assessment on green supply chain management [6].

Roudini [7] introduced the selection of contractors at the National Gas Company in accordance with the method of AHP and Fuzzy TOPSIS in the province of Sistan Balochistan. Using Fuzzy AHP weights work experience, good experience, financial strength, design and technical capability, equipment and machinery. The headings were 0.215, 0.216, 0.205, 0.186, and 0.178, respectively. Then, three contractors in the three pessimistic, identical, optimistic conditions were ranked as the highest ranking in the Fuzzy TOPSIS technique [7].

El Khalek et al. [8] proved the infrastructure projects of pipelines across the country have a higher risk than traditional ones, because it requires high capital costs and complex site conditions. High risk exposure to cross-country pipeline infrastructure projects require particular attention from contractors to analyze and manage their risks. They cannot be eliminated but can be minimized or transferred from one project beneficiary to another. Therefore, the present research is aimed at identifying risk factors that affect the infrastructure projects of pipeline projects based on the experience of experts and the view of the company that participated in similar projects. Risk factors are categorized into risks and levels of the company's project. Risk factors are prioritized using risk assessment models that facilitate this assessment. Projects are based on their risk indicators and risk-likelihood risk assessment. The analytical process of the hierarchy was used to measure the risk factors (probability) and the fuzzy logic approach to assessing the risk factors (consequences of the risk) by using soft software such as Excel and MATLAB, risk indicators for both levels of the company; the project’s risk level has been evaluated overall. Five case studies were selected in different countries to determine this option. Test the most risk factors and implement the designed models and test them out. The results show that Project 3 is captured in Iraq with the highest risk index (39.75%); however, the 5th project in Egypt has the lowest risk index (5.24%). The results of the risk factors are in other countries in the UAE (32.81%), (17.27%) in Saudi Arabia, and (11.67%) in Libya. Therefore, the developed model can be facilitated by the use of risk-based sorting projects, which facilitate company decision-making about which project can be tracked [8].

Jozi and Sadat Pouriya [9] studied of the risks and effects of the combined cycle power plant in Yazd has been studied. After identifying different parts of the power plant in terms of safety, health and environment, a Delphi questionnaire was developed to identify the types of risks in the exploitation phase and was provided by a team of experts and experts in the electricity and environmental industries. In this research, two methods of decision making have been used to analyze the environmental risks of Yazd combined cycle power plant. For this purpose, after prioritizing AHP and TOPSIS criteria, including the hierarchical structure of AHP risk assessment using TOPSIS method, the risks were mapped with Yazd combined cycle power plant method. For pairwise comparison of each of the criteria and sub-criteria to each other in terms of impact and likelihood of risk, comparison matrix separately criteria weight by EXPERT CHOICE been formed and enter the information into the application specific vector is calculated and Arrangement of fire and explosion with weight 0.001632, hearing loss with weight 0.001296, quantity of water In the following, strategies for controlling and reducing identified risks were presented [9].

Jozzi ans Saffarian [10] identified and prioritized the risks and effects of the Abadan gas power plant. By completing 99 questionnaires of experts and experts in the electricity industry, various types of risks were identified during the exploitation phase of the Abadan gas power plant. In order to prioritize the risks, the unit was used. The relative weight of the criteria in the third step of the establishment of this method was obtained from Shannon entropy technique and special vector technique. After prioritizing heterogeneous risks, using the mentioned method, one of the most important risk-priority 0, and Abadan gas reservoirs/gas stations was determined by statistical test, one-way analysis of variance. The results indicate that the unit start-up risks with a fuel gas of 807 0 and a 0/0 change in the unit and working on a liquid fuel clutch with a weight of 603.0, delivery of fuel gas with a weight of 630/798 gas filters in the mechanical unit are one of the most important environmental hazards of Abadan gas power plant [10].

Kengpol et al. [11] proposed a decision support system to prevent flooding in choosing a solar power plant location. Methodologically, the Geographic Information System (GIS) is used to determine the desired location of a solar power plant. It is intended to consider qualitative and quantitative variables based on the adoption of the fuzzy analytical hierarchy process (Fuzzy AHP) and order preference technique using the TOPSIS model similar to that of the ideal solution model. These methods are systematically used to unite environmental aspects and social needs. According to a case study on the choice of a solar power plant in Thailand, quantitative and qualitative criteria should be considered before the analysis in the Fuzzy AHP-TOPSIS model. Fuzzy AHP to determine the weight of qualitative and quantitative criteria that can affect the selection process. The acceptance of Fuzzy AHP is aimed at modeling uncertain, vague and linguistic imperfections. In addition, TOPSIS, which is a multi-criteria ranking decision-making method, is used to rank alternative sites based on overall performance. The contribution of this paper to the development of a new approach that is flexible and practical to the decision maker is to provide guidelines for selecting solar power site sites for stakeholders: at the same time, desirable functions are obtained, in flood avoidance, reduction cost, time and environmental impact. A new approach to the empirical study of Major Floods in Thailand has been evaluated in the fourth quarter of 2011 to 2012. Also, analysis of the results and sensitivity analysis are presented.

4. Type of Research Method

After determining the risk assessment criteria in the proposed hybrid model, it is necessary to determine the weight of the criteria and decision options using the fuzzy hierarchy process and then use fuzzy tops for the ranking of the gas facilities. The model presented in this study is shown in ***Figure 3*** and will be explained in the following.

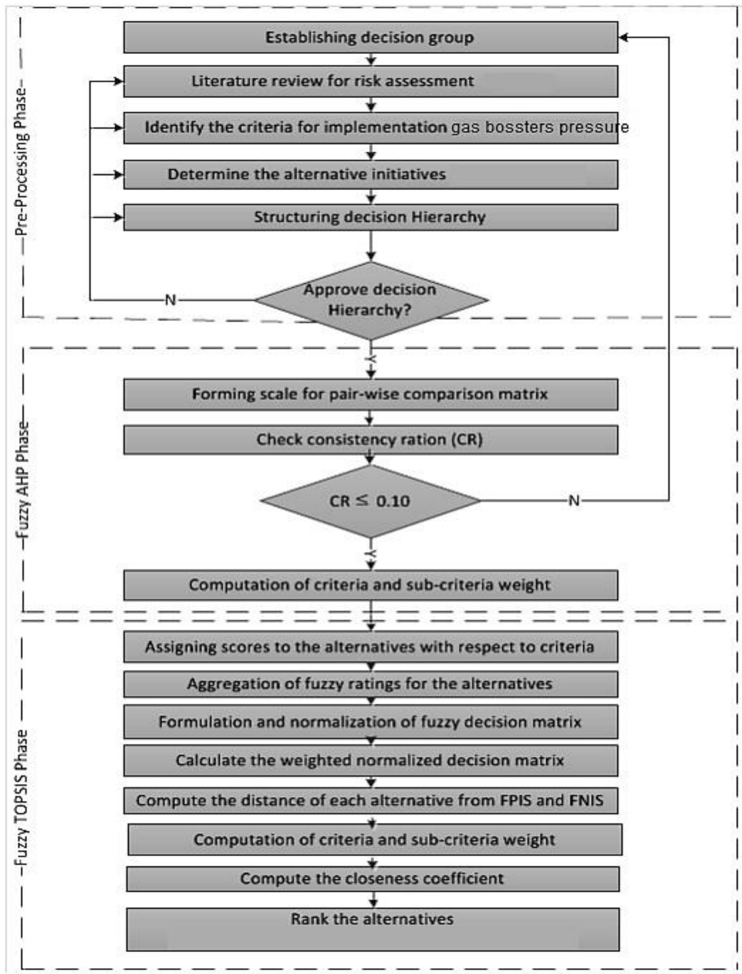

Figure 3. The model of research**.**

4.1. Identification of Criteria

In determining the criteria, according to the research, the criteria related to environmental, personal and equipment issues are used. In the next step, using expert opinions, the fuzzy hierarchy analysis structure uses these criteria to select a consistent and environmentally responsible supplier. Became in this structure, the hierarchy is at the first level of the objective, and in the second level the main criteria, which include the three criteria (the basis of the environment, health and equipment), are placed below the criteria related to each of the main criteria in the next level. Which comprise 28 sub-criteria (see ***Table 1***).

Table 1. Responsible supplier criteria.

People's health	Fire and explosion (gas leak ...)
	Electrocution
	Nervous and occupational stress (shift work ...)
	Contact hot surfaces
	Fall from height
	Respiratory poisoning (welding smoke). Flame retardant
	Noise (turbine ...)
	Ergonomic factors
	Contact with radiation
	Burns with acid and chemicals
	Hazard to pressure vessels (co2, air ...)
	Puddings in the kitchen
	Heavy fall
	Rotating systems (Milling and milling machines)
Safety Equipment	Fire and explosion (gas leak ...)
	Fix the wrong piece
	Chemicals (Acid ...
	Operation
Environmental	Oil leak from equipment and barrels
	Chemical pesticides
	Welding
	Petroleum fluids
	Chlorine leak
	Mercaptan spill
	Exhaust gas such as nox, co2
	Leakage of acids
	Methane release at startup and s/d
	Turbocharged sounding

5. AHP Hierarchical Process Analysis

The AHP method was presented by a person called Hour 2 in the 1970s. This method analyzes issues like what is done in the human brain. The hierarchical analysis process enables decision makers to determine the synergistic and simultaneous effects of many complex and uncertain situations. This process enables decision makers to tailor their goals to their goals, knowledge and experience so that their feelings and judgments are taken into consideration. To solve decision-making problems through AHP, the problem must be carefully and precisely explained and detailed in a hierarchical structure. The hierarchical analysis process is based on the following three principles:

- Principal drawing of a tree hierarchy.
- Principle of prioritization.
- The principle of logical compatibility of judgments.

The methodology of the hierarchical analysis process follows the steps for determining the degree of relative importance of the criteria.

Step 1. Generate a pairwise matrix A using the ratio scale in ***Table 2.***

Table 2. The ratio scale**.**

Fuzzy Number	Definition	Fuzzy Triangular Fuzzy Scale			Fuzzy Triangular Fuzzy Scale Reverse		
1^	The same importance	1	1	3	0.33	1.00	1.00
3^	Poor importance	1	3	5	0.20	0.33	1.00
5^	Strong	3	5	7	0.14	0.20	0.33
7^	Very strong importance	5	7	9	0.11	0.14	0.20
9^	Absolute importance	7	9	9	0.11	0.11	0.14

Step 2. Consider C1, C2,..., Cn; consider a set of elements aij represents a small judgment in each. The pair of elements Ci and Cj in matrix A are as follows:

$$A= [aij]=\begin{bmatrix} 1 & a_{12} \dots & . a_{1n} \\ \frac{1}{a_{12}} & 1 \dots & a_{2n} \\ \dots & \dots . \dots . . \dots & \dots . \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \dots \dots .1 \end{bmatrix},$$

$$aij=1 \text{ , } aji=\frac{1}{aij}, \; i.j=1, 2, \dots, n.$$

In matrix A, the problem is to determine a set of numerical weights in front of n elements C1, C2,..., Cn. If A is a matrix, then the relation between the weights and judgments with aij = $\frac{wj}{wi}$ is given for (i, j = 1, 2, 3,..., n)

The largest special magnitude of λ_{max} was provided by the hour in year 1980:

$$\lambda max=\sum_{j=1}^{n} aij \ \frac{wj}{wi}. \quad (1)$$

$$(A-\lambda maxI)X=0. \quad (2)$$

Therefore, the inconsistency index (C.I.) 1 and the random incompatibility index (R.I.) 2 indicate the rate of incompatibility (C.R.) 3 [12].

The value of the randomized inconsistency index is extracted from the table below.

Table 3. Randomized inconsistency index.

n	3	4	5	6	7	8	9	10	11	12	13	14	15
R.I	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.48	1.56	1.57	1.59

The inconsistency index and inconsistency rate are shown as follows:

$$C.I.=\frac{\lambda max-n}{n-1}, \ C.R.=\frac{C.I}{R.I}, \quad (3)$$

0.1 upper limit of accepted C.R. If the final incompatibility rate is higher than this, the evaluation process should be re-established to improve stability and consistency.

In different situations, definitive numbers data are insufficient to model the real world systems due to the ambiguity, inaccuracy, and intrinsic nature of thinking, judgment, and human preference. Fuzzy theory was presented by Askaripour [13], and since the time of its presentation, it has grown exponentially and has found various applications in various fields. Fuzzy theory is a theory for acting in conditions of uncertainty. This theory can mathematically formulate many concepts, variables, and systems that are inaccurate and ambiguous, as is the case in most cases, and provide grounds for reasoning, deduction, control, and decision making in conditions of uncertainty.

5.1. Fuzzy Hierarchy Process Analysis (Chang's Method)

In the Fuzzy AHP technique, after mapping the decision tree hierarchy, we need to compare the paired elements of each level of the model. In the computational step, using the Fuzzy AHP definitions and concepts and determining the inconsistency rate of the coefficients of each of the matrix comparisons are calculated. Thus, for each of the rows of the matrix of pairwise comparisons, the value of Sk, which itself is a triangular fuzzy number, is obtained from the following relations [14] (see ***Table 4***).

Table 4. Fuzzy ratio scale**.**

Membership Function	Domain	Fuzzy Triangular Fuzzy Scale			Definition	Fuzzy Number
x-7/9-7	7≤ x≤ 9	7	9	9	Absolute Importance	9^
9-x/9-7	7≤ x≤ 9					
x-5/7-5	5≤ x≤ 7					
7-x/7-5	5≤ x≤ 7					
x-3/5-3	3≤ x≤5					
5-x/5-3	3≤ x≤5					
x-3/3-1	1≤ x≤ 3					
3-x/3-1	1≤ x≤ 3	1	1	3	The same importance	1^

$$SK = \sum_{j=1}^{n} M_{ki}^{J} \otimes \left[\sum_{i=1}^{m}\sum_{j=1}^{n} M_{ij}\right]^{-1}.$$

$$\sum_{i=1}^{m} M_{ij} = (\sum_{i=1}^{m} l_j \sum_{i=1}^{m} m_j \sum_{i=1}^{m} u_j) \quad i = 1.2 \ldots m.$$

$$\sum_{i=1}^{m}\sum_{j=1}^{n} M_{ij} = (\sum_{i}^{m} l_i \sum_{i}^{m} m_i \sum_{i}^{m} u_i). \tag{4}$$

$$\left[\sum_{i=1}^{m}\sum_{j=1}^{n} M_{ij}\right]^{-1} = \left[\frac{1}{\sum_{i=1}^{m} u_i}, \frac{1}{\sum_{i=1}^{m} m_i}, \frac{1}{\sum_{i=1}^{m} l_i}\right]$$

In this relationship, K represents the number of lines, and i and j represent the options and indicators, respectively

After calculating all SKs, at this stage, we must calculate the magnitude of each element of the surface according to the following equation on the other elements of that level individually. The numbers used in this method are fuzzy triangular numbers. Chang used the concept of degree of feasibility to generalize the AHP technique to the fuzzy space. The degree of feasibility is to determine how likely it is to have a fuzzy number larger than another fuzzy number. Before proposing the proposed algorithm, chang should describe the concept of the degree of probability or the degree of probability of being greater.

Consider two triangular fuzzy numbers F1= (l1, m1, u1) and F2= (l2, m2, u2) (see ***Figure 4***). If m1 ≥ m2: the probability that F1 is greater than F2 is equal to 1.

The probability that the F2 is greater than F1 is equal to the height of the area between F1 and F2.

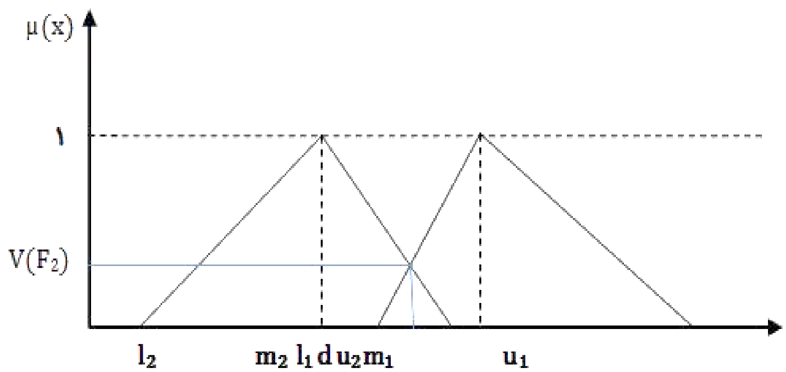

Figure 4. Triangular fuzzy number.

Therefore, the probability of a greater F1 than F2 is equal to:

$$M2 \geq M1) = \begin{cases} 1; & \text{if } m2 \geq m1 \\ 0; & \text{if } l1 \geq u2 \\ (l1 - u2) = ((m2 - u2) - (m1 - l1)); & \text{otherwise} \end{cases} \quad \textit{(5)}$$

Please note that the possibility of the possibility in a simple language is as follows: how large a fuzzy number can be than one other fuzzy number. The large size of a triangular fuzzy number of K is obtained from the following triangular fuzzy number:

$$V\ (M1 \geq M2, \ldots, Mk) = \text{Min}\ [V\ (M1 \geq M2), \ldots V\ (M1 \geq Mk)\ ]. \quad \textit{(6)}$$

Also, we use the following matrix for the weighting of the indicators in the pairwise matrix:

$$W'(xi) = \text{Min}\ [V\ (Si \geq Sk)]\ k = 1, 2, \ldots, n, k{=}/I. \quad \textit{(7)}$$

Therefore, the weight vector of the indices will be as follows, which is the same as the non-regular coefficients of the Fuzzy AHP coefficients.

$$w'=[\ w'(c1\ldots\ldots, w'(cn)]T. \quad \textit{(8)}$$

Then the weight vector of the Fuzzy AHP coefficients of the indices will be as follows.

$$w=[\ w\ (c1\ldots\ldots, w\ (cn)]T. \quad \textit{(9)}$$

6. Fuzzy TOPSIS

The TOPSIS model was proposed by Huang and Yun in 1981. This model is one of the best multi-factor decision making models and uses many uses. The basis of this technique is that the choice option should be the least distance from the path. The ideal solution (the best possible mode) and the maximum distance with the ideal negative solution (the worst possible case). The fuzzy topology technique is the generalization of the TOPSIS technique in a fuzzy environment, first developed by Chen and Hong in 1992. In this model, weights and the decision matrix are defined as fuzzy numbers, and as in classical tops according to the distance from the ideal registration and negative rankings done [12].

6.1. Fuzzy TOPSIS Process

The TOPSIS method was presented as one of the most practical and practical techniques in decision making with multiple classical criteria by Huang and Yun in 1981 to analyze alternative solutions among each criterion and finally to determine the most efficient alternatives. . The TOPSIS algorithm is based on the shortest distance from the ideal solution and the farthest distance from the ideal negative solution. In fact, the main idea of the TOPSIS is that it defines positive and negative solutions and measures the distance of alternatives from ideal solutions based on what was found in the alternative ranking. The chosen alternative should be the closest to PIS and the farthest to NIS. The mapping determines the index that is called the similarity coefficient (called the PIS and the distance from the NIS), and eventually this alternative method has a maximum coefficient of proximity to PIS. Although it is often difficult for decision makers to assign a precise rating to an alternative, the advantage of using the fuzzy method in this study is to overcome ambiguity in human judgment and to obtain the relative importance of traits [14].

Step 1. Assignment of points linguistic scales (options according to the criteria in ***Table 5***)

Let's assume that m has the possible substitute A = {A1, A2,... Am}, which is opposite to the criteria.

C = {C1, C2,... Cn} is evaluated. The weight of the criteria by wj (j = 1,2, ..., n) will be determined by the performance rating of each decision maker Dk (k = 1,2, ..., k) for each substitute Ai (i = 1,2,..., m), According to the criteria Cj (j = 1,2, ... n), by $\tilde{R}k=\tilde{x}ijk(i=1,2,\dots,m\ ;\ j=1,2,\dots,n\ ;\ k=1,2,\dots,k)$. It is determined by the membership function μRk (x).

Table 5. Fuzzy Linguistic Scale.

Very poor (VP)	(1, 1, 3)
Poor (P)	(1, 3, 5)
Medium (M)	(3, 5, 7)
Good (G)	(5, 7, 9)
Very good (VG)	(7, 9, 11)

Step 2. Calculate total fuzzy points for replacements. Suppose that the fuzzy ranking of all decision makers in terms of criteria is defined as fuzzy triangular numbers k = (ak, bk, ck) and k = 1, 2, ..., k. Therefore, the total fuzzy ranking with R= (a, B, c), k= 1, 2,..., k is as follows:

$$a=\min_k\{a_k\},\ b=1/k\Sigma b_k,\ c=\max_k\{c_k\}.$$

If the fuzzy ranking of the decision maker k is xijk = (aijk, bijk, cijk) and i = 1,2,3, ..., m and j = 1,2,3, ..., n. Then the integrated fuzzy ranking (xij) of the alternatives is given according to each criterion with xij= (aij, bij, cij) and are as follows:

$$a_{ij}=\min_k\{a_{ijk}\},\ b=1/k\Sigma b_{ijk},\ c=\max_k\{c_{ijk}\}. \qquad \textit{(10)}$$

Step 3. Calculate the fuzzy decision matrix. The fuzzy decision matrix for alternatives (D) is created as follows:

$$\tilde{D}=\begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} \ldots & .\tilde{x}_{1n} \\ \tilde{x}_{21} & \tilde{x}_{22} \ldots & \tilde{x}_{2n} \\ \ldots & \ldots.\ldots..\ldots\ldots. & \\ \tilde{x}_{m1} & \tilde{x}_{m2} & \ldots\ldots.\tilde{x}_{mn} \end{bmatrix}, \ i=1,2,...,m,\ j=1,2,...,n.$$

Step 4. Raw data is converted to a norm by using a linear scale conversion in order to convert the various scales for metrics to comparable scales.

The standardized decision matrix is given as follows:

$$\tilde{R}=[\tilde{r}_{ij}]_{m\times n},\ i=1,2\ldots,m,\ j=1,2\ldots,n$$

$$\tilde{r}_{ij}=(a_{ij}/c_{j*}, b_{ij}/c_{j*}, c_{ij}/c_{j*}),\quad c_{j*}=\max_i c_{ij}\text{(Benchmark profit).} \qquad \textit{(10)}$$

$$\tilde{r}_{ij}=(a_j/c_{ij}, a_j/b_{ij}, a_j/a_{ij}),\quad a_{j-}=\min_i a_{ij}\text{(Benchmark cost).}$$

Step 5. Calculate the normalization matrix. Weighted normalized matrix j for metrics from multiplication weights (wj), the evaluation criteria are calculated in the fuzzy normalization matrix of the rij.

$$\tilde{v}=[\tilde{v}ij]m\times n\ ,\ i=1,2...,m\ ,\ j=1,2...,n$$

$$\tilde{v}ij=\tilde{r}ij(.)Wj.$$

Note that νij is a TFN represented by (ãijk, bijk, cijk).

Step 6. Calculating FPIS (FPI) The ideal fuzzy solution (and FNIS) is the ideal negative fuzzy solution (for alternatives. FPIS and FNIS are calculated as follows:

$$A*=(\tilde{v}1*.\tilde{v}2*.....\tilde{v}n*)\ \tilde{v}j*=\text{maxi}\{\text{vij3}\},\ i=1.2.....m.\ j=1.2.....n. \quad (13)$$

$$A-=(\tilde{v}1-.\tilde{v}2-.....\tilde{v}n-)\ \tilde{v}j-=mini\{vij1\},\ i=1.2.....m.\ j=1.2.....n. \quad (14)$$

Step 7. Calculates the distance of each alternative from FPIS and FNIS. The distance (di +, di-) of each weighting criterion i = 1,2,..., m from FPIS and FNIS is calculated as follows:

$$di^{+}=\Sigma(\tilde{v}ij,\tilde{v}j*),\ i=1,2,\dots,m. \quad (15)$$

$$di^{-}=\Sigma(\tilde{v}ij,\tilde{v}j-),\ i=1,2,\dots,m. \quad (16)$$

d (ã,b̃) is the distance between the two fuzzy numbers α and b.

$$d(\tilde{a},\tilde{b})=\sqrt{1/3[(a1-b1)^2+(a2-b2)^2+(a3-b3)^2}]. \quad (17)$$

Step 8. Calculate the coefficient of proximity (cci) of each substitute. The proximity coefficient shows the fuzzy ideal solution and the fuzzy negative ideal solution simultaneously. The coefficient of proximity of each substitute is obtained from the following equation:

$$cci=di^{-}/(di^{-}+di^{+})\ ,i=1,2,\dots,\text{m} \quad (18)$$

Step 9. Alternative ratings. In the final stage, various alternatives are ranked according to the coefficient of proximity (cci).

7. Determine Criteria and Hierarchical Tree of Decision

In the first phase of this research, in order to determine the criteria for selecting the target, firstly, reviewing and studying the articles and books related to this subject, then, using the comments of experts and previous forms of the gas plant, were identified a number of criteria that included the general criteria for selecting the target. Were categorized so that the subject literature was first scrutinized for the collection of criteria from the most researched scientific articles and then, by interviewing experts from the relevant collections, the criteria for selection of suppliers in different groups were separated and Three groups (criteria) were considered, each group including a few subgroups Since the ultimate goal of this research is to rank the hazards of the gas plant with regard to the environmental, personal and equipment criteria, the decision tree hierarchy is shown in ***Figure 1***. As described in Section 3, in the drawing of the tree, the hierarchy of the first level decision is dedicated to the purpose of selecting the gas installation here, and at the second level the criteria and, at the next level, sub criteria for each criterion, and also at the final level of the options that are included in this research include 5 gas facilities are in area 9 gas transmission (***Figure 5***).

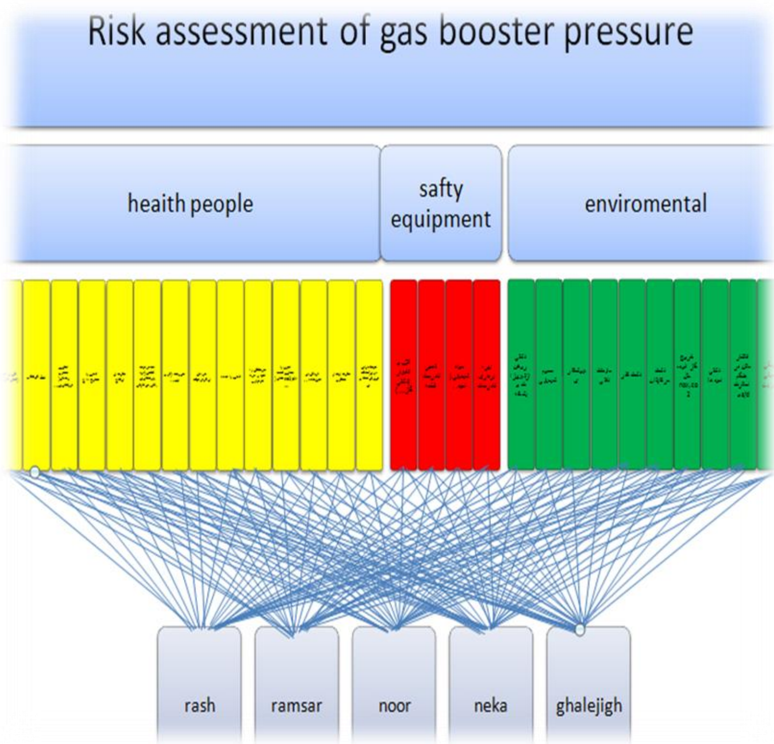

Figure 5. Hierarchical tree selection decision**.**

8. Analytical Hierarchy Process for Determining Weight Coefficients

After determining the appropriate criteria and sub-criteria, it is necessary to calculate their weight coefficients based on the AHP. To this end, the questionnaire 1 is used to determine the degree of importance of each criterion in relation to other criteria as well as the questionnaire 2 for comparing the two groups of each group; the sub-frames were compared to each other by experts. According to the paired comparisons, the weighted coefficients of the target were calculated by the Excel software and are presented in ***Tables 6*** to ***9***. At this stage, compatibility of the pairings has been achieved [15].

Table 6. Pair comparison of criteria**.**

	Health People			Safety Equipment			Environmental		
Health People	1	1	1	1.00	1	3	3	5	7
Safety Equipment	0.33	1.00	1.00	1	1	1	1	3	5
Environmental	0.14	0.20	0.33	0.20	0.33	1.00	1	1	1

Table 7. Compensation coefficient calculation of equipment safety sub-criterion.

cr	0.02

	Fire and Explosion (gas leak...)			Fix the Wrong Piece			Chemicals (Acid...)			Operation		
Fire and Explosion (gas leak ...)	1	1	1	3	5	7	5	7	9	1	3	5
Fix the Wrong Piece	0.14	0.20	0.33	1	1	1	1	3	5	1	1	3
Chemicals (Acid ...)	0.11	0.14	0.20	0.20	0.33	1.00	1	1	1	0.20	0.33	1.00
Operation	0.20	0.33	1.00	0.33	1.00	1.00	1.00	3.00	5.00	1	1	1

Table 8. Compensation coefficient calculation of health people sub-criterion.

cr 0.187940

	Fire and explosion (gas leak ...)			electrocution			Nervous and occupational stress (shift work ...			Contact hot surfaces			Fall from height			Respiratory poisoning (welding smoke. Flame retardant			Noise (turbine ...			Ergonomic factors			Contact with radiation			Burns with acid and .chemicals			Hazard to pressure vessels (co2, air			Puddings in the kitchen..			Heavy fall			Rotating systems (Milling and milling machines		
Fire and explosion (gas leak ...)	1	1	1	1	3	5	1	3	5	5	7	9	5	7	9	3	5	7	1	3	5	5	7	9	7	9	9	3	5	7	1	3	5	5	7	9	5	7	9	3	5	7
electrocution	0.20	0.33	1.00	1	1	1	1	1	3	1	3	5	5	7	9	1	3	5	0.14	0.20	0.33	1	3	5	1	3	5	1	3	5	1	3	5	5	7	9	1	3	5	1	3	5
Nervous and occupational stress (shift work ...	0.20	0.33	1.00	0.33	1.00	1.00	1	1	1	1	3	5	3	5	7	1	1	3	1	1	3	1	3	5	3	5	7	1	3	5	3	5	7	5	7	9	1	1	3	1	3	5
Contact hot surfaces	0.11	0.14	0.20	0.20	0.33	1.00	0.20	0.33	1.00	1	1	1	0.20	0.33	1.00	0.20	0.33	1.00	0.14	0.20	0.33	1	1	3	0.20	0.33	1.00	0.20	0.33	1.00	1	3	5	5	7	9	3	5	7	3	5	7
Fall from height	0.11	0.14	0.20	0.11	0.14	0.20	0.14	0.20	0.33	1	3	5	1	1	1	0.14	0.20	0.33	0.11	0.14	0.20	3	5	7	1	1	3	0.20	0.33	1.00	0.20	0.33	1.00	3	5	7	0.20	0.33	1.00	0.14	0.20	0.33
Respiratory poisoning (welding smoke. Flame retardant	0.14	0.20	0.33	0.20	0.33	1.00	0.33	1.00	1.00	1	3	5	3	5	7	1	1	1	0.14	0.20	0.33	1	1	3	1	1	3	1	3	5	0.14	0.20	0.33	3	5	7	1	3	5	0.20	0.33	1.00
Noise (turbine ...	0.20	0.33	1.00	3	5	7	0.33	1.00	1.00	3	5	7	5	7	9	3	5	7	1	1	1	5	7	9	3	5	7	1	3	5	1	3	5	7	9	9	5	7	9	1	3	5
Ergonomic factors	0.11	0.14	0.20	0.20	0.33	1.00	0.20	0.33	1.00	0.33	1.00	1.00	0.14	0.20	0.33	0.33	1.00	1.00	0.11	0.14	0.20	1	1	1	0.14	0.20	0.33	0.20	0.33	1.00	0.14	0.20	0.33	3	5	7	0.20	0.33	1.00	1	1	3
Contact with radiation	0.11	0.11	0.14	0.20	0.33	1.00	0.14	0.20	0.33	1	3	5	0.33	1.00	1.00	0.33	1.00	1.00	0.14	0.20	0.33	3	5	7	1	1	1	0.14	0.20	0.33	1	1	3	3	5	7	0.20	0.33	1.00	1	1	3
Burns with acid and chemicals	0.14	0.20	0.33	0.20	0.33	1.00	0.20	0.33	1.00	1	3	5	1	3	5	0.20	0.33	1.00	0.20	0.33	1.00	1	3	5	3	5	7	1	1	1	1	1	3	3	5	7	1	3	5	1	1	3
Hazard to pressure vessels (co2, air	0.33	1.00	1.00	0.20	0.33	1.00	0.14	0.20	0.33	0.20	0.33	1.00	1	3	5	3	5	7	0.20	0.33	1.00	3	5	7	0.33	1.00	1.00	0.33	1.00	1.00	1	1	1	5	7	9	1	3	5	1	1	3
Puddings in the kitchen...	0.11	0.14	0.20	0.11	0.14	0.20	0.11	0.14	0.20	0.11	0.14	0.20	0.14	0.20	0.33	0.14	0.20	0.33	0.11	0.11	0.14	0.14	0.20	0.33	0.14	0.20	0.33	0.14	0.20	0.33	0.11	0.14	0.20	1	1	1	0.11	0.14	0.20	0.14	0.20	0.33
Heavy fall	0.11	0.14	0.20	0.20	0.33	1.00	0.33	1.00	1.00	0.14	0.20	0.33	1	3	5	0.20	0.33	1.00	0.11	0.14	0.20	1	3	5	1	3	5	0.20	0.33	1.00	0.20	0.33	1.00	5	7	9	1	1	1	0.20	0.33	1.00
Rotating systems (Milling and milling machines	0.14	0.20	0.33	0.20	0.33	1.00	0.20	0.33	1.00	0.14	0.20	0.33	3	5	7	1	3	5	0.20	0.33	1.00	0.33	1.00	1.00	0.33	1.00	1.00	0.33	1.00	1.00	0.33	1.00	1.00	3	5	7	1	3	5	1	1	1

Tables 9. Calculate the compliance coefficient under the environmental criterion.

cr	0.16

	Oil leak from equipment and barrels			Chemical pesticides			Welding			Petroleum fluids			Chlorine leak			Mercaptan spill			Exhaust gas such as nox, ..co2			Leakage of acids			Methane release at startup and s / d...			Turbocharged sounding		
Oil leak from equipment and barrels	1	1	1	1	3	5	1	3	5	1	1	3	1	1	3	0.20	0.33	1.00	0.14	0.20	0.33	0.20	0.33	1.00	0.14	0.20	0.33	0.11	0.14	0.20
Chemical pesticides	0.33	1.00	1.00	1	1	1	3	5	7	1	3	5	1	1	3	1	1	3	0.14	0.20	0.33	1	1	3	1	3	5	0.14	0.20	0.33
Welding	0.33	1.00	1.00	0.14	0.20	0.33	1	1	1	1	3	5	0.20	0.33	1.00	1	1	3	0.14	0.20	0.33	0.20	0.33	1.00	1	3	5	0.11	0.14	0.20
Petroleum fluids	0.33	1.00	1.00	0.20	0.33	1.00	0.20	0.33	1.00	1	1	1	0.20	0.33	1.00	0.20	0.33	1.00	0.14	0.20	0.33	1	1	3	0.20	0.33	1.00	0.11	0.14	0.20
Chlorine leak	0.33	1.00	1.00	0.33	1.00	1.00	1	3	5	1	3	5	1	1	1	1	1	3	0.20	0.33	1.00	1	1	3	1	3	5	0.14	0.20	0.33
Mercaptan spill	1	3	5	0.33	1.00	1.00	0.33	1.00	1.00	1	3	5	0.33	1.00	1.00	1	1	1	0.14	0.20	0.33	1	1	3	0.20	0.33	1.00	0.11	0.14	0.20
Exhaust gas such as nox, co2	3	5	7	3	5	7	3	5	7	3	5	7	1	3	5	3	5	7	1	1	1	3	5	7	3	5	7	0.20	0.33	1.00
Leakage of acids	1	3	5	0.33	1.00	1.00	1	3	5	0.33	1.00	1.00	0.33	1.00	1.00	0.33	1.00	1.00	0.14	0.20	0.33	1	1	1	1	3	5	0.14	0.20	0.33
Methane release at startup and s / d	3	5	7	0.20	0.33	1.00	0.20	0.33	1.00	1	3	5	0.20	0.33	1.00	1	3	5	0.14	0.20	0.33	0.20	0.33	1.00	1	1	1	0.11	0.14	0.20
Turbocharged sounding	5	7	9	3	5	7	5	7	9	5	7	9	3	5	7	5	7	9	1	3	5	3	5	7	5	7	9	1	1	1

Then, we obtain criterion weight and sub-criterion through the fuzzy hierarchy of Chang, described in the previous section. We obtain the following table.

Table 10. The following is a normalized and sub-standardized.

Health People 0.542013438	Fire and explosion (gas leak ...)	0.136426	0.073945
	Electrocution	0.095498	0.051761
	Nervous and occupational stress (shift work ...	0.136426	0.073945
	Contact hot surfaces	0.058663	0.031796
	Fall from height	0.032742	0.017747
	Respiratory poisoning (welding smoke. Flame retardant	0.060027	0.032536
	Noise (turbine ...	0.136426	0.073945
	Ergonomic factors	0.005457	0.002958
	Contact with radiation	0.042292	0.022923
	Burns with acid and chemicals	0.069577	0.037712
	Hazard to pressure vessels (co2, air	0.136426	0.073945
	Puddings in the kitchen...	0	0
Safety Equipment 0.429050207	Heavy fall	0.043656	0.023662
	Rotating systems (Milling and milling machines	0.046385	0.025141
	Fire and explosion (gas leak ...)	0.546448	0.234454
	Fix the wrong piece	0.245902	0.105504
	Chemicals (Acid ...	0	0
	Operation	0.20765	0.089092
Environmental 0.028936354	Oil leak from equipment and barrels	0.052356	0.001515
	Chemical pesticides	0.109948	0.003181
	Welding	0.039267	0.001136
	Petroleum fluids	0	0
	Chlorine leak	0.091623	0.002651
	Mercaptan spill	0.04712	0.001363
	Exhaust gas such as nox, co2	0.26178	0.007575
	Leakage of acids	0.062827	0.001818
	Methane release at startup and s / d	0.073298	0.002121
	Turbocharged sounding	0.26178	0.007575

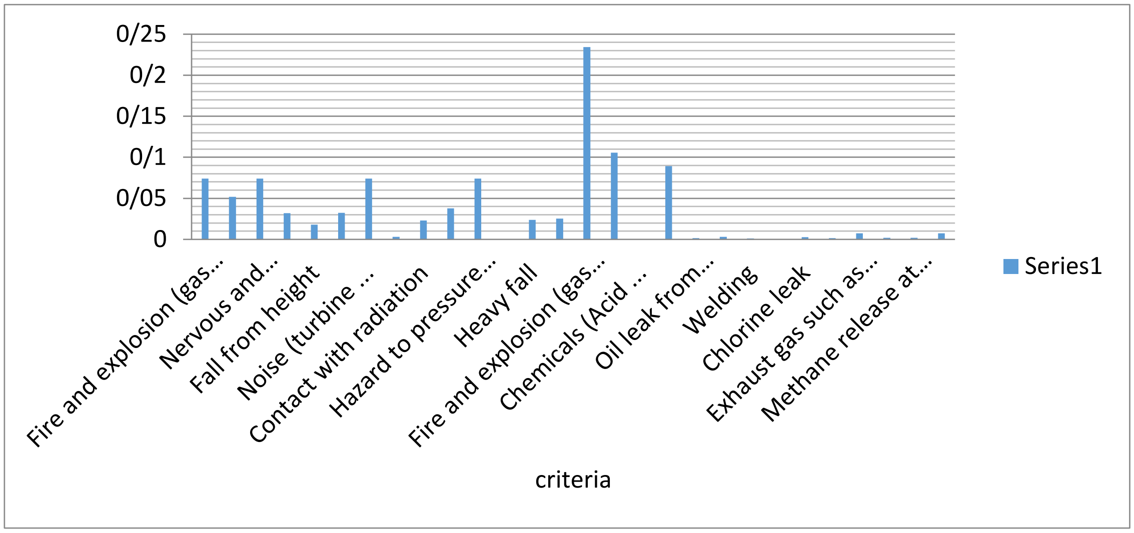

Figure 6. Weights below criteria**.**

9. Ranking and Supplier Selection Based on Fuzzy TOPSIS

At this stage, it is necessary to rank according to the weight obtained at the previous stage of the company gas plant. Therefore, the questionnaire 3 is provided to the decision makers, using the language variables of ***Table 3*** in relation to each An indicator refers to variable suppliers, for example, if the option works exactly as it decides to choose "very good" or "good" linguistic variables based on fuzzy numbers (7, 9, 9) and (5, 7, 7). The next step is to convert these linguistic variables (linguistic scales) to fuzzy numbers that have a fuzzy evaluation matrix for each M receiver using the results of the questionnaire will be formed.

We obtained the fuzzy questionnaire for the people's health benchmark for gas facilities in the ***Tables 11*** to ***13***.

Tables 11. Fuzzy questionnaire results and using Fuzzy TOPSIS computations for individuals' health scale for gas facilities.

	Fire and explosion (gas leak ...)			electrocution			Nervous and occupational stress (shift work ...			Contact hot surfaces			Fall from height			Respiratory poisoning (welding smoke. Flame retardant			Noise (turbine ...		
Ghalegig	3	5	7	3	5	7	3	5	7	3	5	7	1	3	5	1	3	5	3	5	7
Neka	3	5	7	3	5	7	3	5	7	3	5	7	1	3	5	1	3	5	3	5	7
Noor	3	5	7	3	5	7	3	5	7	3	5	7	1	3	5	1	3	5	3	5	7
Ramsar	5	7	9	5	7	9	7	9	11	5	7	9	3	5	7	3	5	7	5	7	9
Rasht	7	9	11	5	7	9	7	9	11	5	7	9	3	5	7	3	5	7	7	9	11

	Ergonomic factors			Contact with radiation			Burns with acid and chemicals...			Hazard to pressure vessels (co2, air			Puddings in the kitchen...			Heavy fall			Rotating systems (Milling and milling machines		
Ghalegig	3	5	7	3	5	7	3	5	7	3	5	7	1	3	5	3	5	7	3	5	7
Neka	3	5	7	3	5	7	3	5	7	3	5	7	1	3	5	3	5	7	3	5	7
Noor	3	5	7	3	5	7	3	5	7	3	5	7	1	3	5	3	5	7	3	5	7
Ramsar	5	7	9	3	5	7	3	5	7	5	7	9	1	3	5	3	5	7	3	5	7
Rasht	5	7	9	3	5	7	3	5	7	5	7	9	1	3	5	3	5	7	3	5	7

Tables 12. The fuzzy inventory results for the equipment safety standard versus gas facility.

	Fire and Explosion (gas leak ...)			Fix the Wrong Piece			Chemicals (Acid...)			Operation		
Ghalegigh	3	5	7	3	5	7	3	5	7	3	5	7
Neka	3	5	7	3	5	7	3	5	7	3	5	7
Noor	3	5	7	3	5	7	3	5	7	3	5	7
Ramsar	5	7	9	5	7	9	5	7	9	3	5	7
Rasht	7	9	11	7	9	11	5	7	9	5	7	9

Tables 13. Results of the fuzzy questionnaire for environmental criteria relative to gas facility.

	Oil leak from equipment and barrels			Chemical pesticides			Weldin g			Petroleu m fluids			Chlorin e leak			Mercapt an spill			Exhaust gas such as nox, co2…			Leakage of acids			Methane release at startup and s /d…			Turbochar ged sounding		
Ghalegigh	1	3	5	1	1	3	3	5	7	3	5	7	1	3	5	1	3	5	1	3	5	1	1	3	1	1	3	3	5	7
Neka	1	3	5	1	3	5	3	5	7	1	3	5	1	3	5	1	3	5	3	5	7	1	3	5	1	3	5	3	5	7
Noor	1	3	5	1	3	5	5	7	9	1	3	5	1	3	5	1	3	5	1	3	5	1	1	3	1	1	3	3	5	7
Ramsa	3	5	7	1	3	5	3	5	7	3	5	7	1	3	5	1	3	5	5	7	9	1	3	5	3	5	7	5	7	9
Rasht	5	7	9	1	3	5	3	5	7	5	7	9	1	3	5	1	3	5	5	7	9	3	5	7	3	5	7	7	9	11

The results of the gas supply facilities of the 9th district of gas transmission have been calculated according to the above calculations. The results are shown in ***Figure 7***.

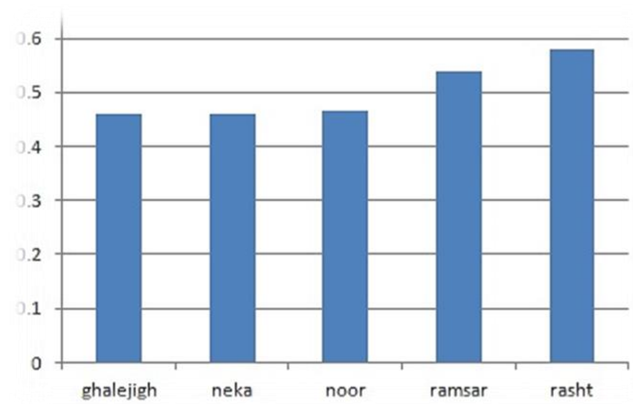

Figure 7. Ranking risk facility of 9 region in gas transmission.

10. Aggregation

In this chapter, taking into account a case study of gas logistics risks, 9 gas transmissions were analyzed to analyze the data obtained from experts' opinions according to the model presented in Section 3. First, the criteria are based on the papers and opinions of the experts and the past forms of the industry were identified and in the next step, in order to determine the weight of the criteria, a questionnaire was provided by the experts. In the Excel software, the data were analyzed and the weights of the criteria were determined, in the next step, five gas facilities were considered. According to the results of the third questionnaire, which was provided to experts and weights from the previous stage, suppliers were ranked in terms of risk and risk.

11. Results from Data Analysis and Answers to Research Questions

To answer the first question of this research, which criteria are effective on risk assessment? Risk assessment criteria needed to be met. To this end, we first reviewed and studied the relevant articles and books on this topic, and a number of criteria were considered in relation to the subject literature, and through interviewing and consulting experts in the industry Three benchmarks were determined that these criteria include 28 sub-criteria.

In the next step, in order to answer the second research question, which criteria can be the most important among the effective criteria? After completing the paired comparison questionnaire by hierarchical analysis process experts to determine the weight of the criteria, so that the data on the pairwise comparisons of the criteria relative to each other, as well as the pairwise comparisons of each of the sub-criteria for each response The data was subjected to Excel software and finally the final weight was obtained under the criteria. Also, due to the incompatibility rate less than 0.1, the weight coefficients were appropriate.

In the last step, to answer the third question, what is the ranking of suppliers with the Fuzzy TOPSIS method? Firstly, the questionnaire data used to determine the rate of each of the five regional gas facilities in relation to each criterion by experts of this company, using verbal variables, were converted to fuzzy numbers, and a cumulative fuzzy matrix was generated from the experts' opinions and then ranked by the phases of the fuzzy tops technique, the most risky installations according to the criteria in study was intended to be the facility of Rasht.

12. Proposals Based on Research Findings

Fire and explosion, noise, turbulent noise, inadequate repair of parts, stress induced by shifting and exploitation of Baei weights.

Fortunately, control measures to improve and reduce these risk factors can be done in accordance with risk assessment procedures, including:

- Periodically monitor pm and check the process equipment according to the piece's activity.
- Work instructions for each activity in the facility and define a workflow.
- Cold hot permit for repairs.
- Scheduling the flowchart for service or removal of equipment.
- Personnel period.
- Succession and industrial counseling.
- Recreational programs for employees with their families.
- To arrange staff to inform the officer with the relevant work area.

- Access materials to reduce environmental impacts.
- Design and process a process to reduce environmental impacts and greenhouse effects.
- Identify the risks and control measures and monitor them.

13. Offers for Future Studies

In general, organizations that are associated with the gas transmission company and the gas pressure boost stations can exploit this research and increase the quality level of their activities in line with the provisions in these lines. Meanwhile, roads and power transmission organization, the water and wastewater agency, as well as the oil company, are organizations that can use the results of this research. This research can be applied in the human domain, such as the ranking of personnel according to the human assessment criterion.

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