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Assessment of Environmental and Health Risks of the Chemical Industry by Applying Fuzzy Logic: A Case Study in South Tehran, Iran

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A B S T R A C T

Background: Chemical industries in southern Tehran are one of the largest ones in Iran, requiring organized environmental risk management. Failure Modes and Effects Analysis (FMEA) can effectively decrease the risk of failure in industrial systems and processes. This case study aimed to apply the fuzzy logic approach for assessing environmental risks in chemical industries.
Methods: The present cross-sectional analytical study formed an assessment team to use their expert opinion collected as Z number. Each identified risk factor (severity, occurrence, detection) was weighted using the fuzzy analytical hierarchy process and prioritized the failure modes.
Results: Based on the results, 52.94 % of the identified environmental risks were moderate, 35.29 % were high-level, and 11.76 % were low-level risks. The main risks were occupational, health, safety, and environmental, leading to a decrease in the quality of environmental parameters, including air, water, and soil.
Conclusion: The proposed fuzzy and FMEA methods removed the problem of homogeneity of risk factor weights, data uncertainty, and prioritization of failure modes, which had a higher potential in prioritizing risks compared to the conventional FMEA methods. Additionally, the proposed model can identify risks and their roots, leading to accurate risk control tools.

1. Introduction

Chemical industries are the main sources of accidents and environmental pollution, threatening human life and environmental safety [1]. The growth in the number and capacity of chemical factories has increased the number of people (inside and outside the factories) exposed to the consequences of possible industrial accidents. Therefore, special attention to the safety of these industries has been directed [2]. Technological advances and increased use of machines have increased the risk-generation process and the possibility of accidents and environmental pollution [3, 4]. The risks of chemical leakage in the chemical industry can be extensive, including fires, environmental pollution, and poisoning of residents. Si et al. (2012) [5] reported the high degree of risks regarding the poisoning of residents caused by the chemical leakages of chemical industries in China. Environmental risks can have harmful or fatal effects on humans and the natural environment [6,7]. Studies on environmental risks represents a strategic turning point for environmental protection because of predicting and managing accidents before they occur rather than "post-

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pollution treatment" [8,9]. Since environmental risks can cause significant environmental damage and huge material losses, industries should create effective management systems to control these hazards [10]. Accordingly, safety risk management (SRM) can be used as one of the essential actions to be taken in projects. Risk management aims to identify the origin of risks, uncertainties, and their effects and to provide appropriate management responses to these risks [11]. Risk management includes planning, identification, qualitative analysis, quantitative analysis, risk response, and the control of qualitative risk analysis, which is a process that prioritizes risks for quantitative analysis based on the probability of occurrence (O) and severity (S) of impact [12]. Considering the large number of risks identified in the projects, investigating and responding to all these risks is time-consuming and costly; therefore, they should be prioritized. In the qualitative assessment stage, risks are prioritized based on their probability of occurrence and impact on the project goals. Hence, major risks are managed effectively. As a result, the high-risk and sensitive areas and dimensions of a project are given attention for the next steps [13]. In recent years, several methods have been introduced for evaluating and analyzing risks [14]. Among the risk assessment methods, some of the most widely used quantitative and qualitative methods are Preliminary Hazard Analysis (PHA), Failure Modes and Effects Analysis (FMEA), Hazard and Operability (HAZOP), Fault Tree Analysis (FTA), and Event Tree Analysis (ETA) [15]. Since failure modes are unavoidable in most systems, FMEA serves as an effective tool to ensure that potential threats to the system and associated risks are minimized [16]. FMEA is a method for identifying the potential failure modes of a product or process and the effects of failures. FMEA also critically assesses such effects on the process performance [17]. The main objective of FMEA is to identify, assess, and rank potential failure modes using a Risk Priority Number (RPN). Here, RPN is the sum of Occurrence (O), Severity (S), and Detection (D) rankings [18]. Three basic problems in risk assessment by the FMEA method are: considering the same weights for each of the risk indicators (O, S, D), expressing the score of each of the failure modes against the risk indicators numerically (between 1-10), and prioritizing the risks based on RPN; in some cases, these numbers may be the same, or if they have a small distance from each other, it is difficult to prioritize risks [19]. Therefore, the current research uses fuzzy theory to overcome the limitations of the FMEA method in assessing and prioritizing failure modes. Fuzzy logic is a highly suitable method for assessing project risks and dealing with uncertainty in human decisions. A lot of research has been conducted regarding risk assessment using the FMEA method. Shao et al. (2013) [20] assessed the cumulative environmental risk (CER) in an industrial park in China by using a physical model to identify environmental risks. They examined several stages of environmental risk management and control, including identifying and controlling the source of risks, environmental safety planning and risk warning, emergency management, assessment of environmental effects, and environmental restoration from polluting incidents. Then they classified the risk assessment map into three acceptable, warning, and reduced risk zones. In addition, Shariati (2014) [21] assessed the risk of underground mining by using FMEA in the presence of uncertainty. According to the results of this study, the fuzzy model had a higher potential in formulating the risk level. Moreover, Jozi et al. (2011) [22] evaluated the environmental risks of the Olefin Plant in Arya Sasol Petrochemical Complex using the EFMEA method to identify and classify environmental aspects during the life cycle. They concluded that 38.98 % of the identified risks were in the very high-risk category, 25.44 % in the low-risk category, 20.9 % in the moderate-risk category, and 16.68 % in the high-risk category. In another study, Boalhosni et al. (2017) assessed [23] the risks in AzarAb Industries Group using FMEA with the fuzzy AHP approach. They reported that the ranking of indicators in the FAHP method had very high compliance with the opinion of experts and the decision-making team in terms of priority and accuracy. Furthermore, Halvani et al. (2020) [24] found that due to unacceptable risks and the high rate of accidents in the gas pipeline overhaul project, an acceptable level of risks can be faced by applying appropriate control measures, which showed the effectiveness of the FMEA method. Industrial chemicals are used daily in various products and applications, including plastics and rubber, paints, fuels, manufacturing, mining, household products, and cosmetics. Due to the inappropriate expansion of industries in developing countries, including Iran, environmental attitudes have been essential for properly protecting the environment for future generations and have received the attention of officials. Therefore, one of the fundamental solutions to prevent the environmental and human problems for establishing chemical industries in the south of Tehran is to assess and manage the environmental risks in this area. This research conducted a systematic risk assessment to reduce or eliminate environmental problems. The study area in this research was determined according to the activity of the industries located in the south of Tehran city in Iran and its impact on the environment, which includes the industrial groups of petroleum products, basic chemicals, plastic products, pharmaceuticals, paints and inks, rubber products, materials Detergent and toiletries.

2. Materials and Methods

The present cross-sectional analytical research was conducted in the south of Tehran, which produces organic and inorganic chemicals, industrial gases, and special chemicals such as pharmaceutical products and essential oils. Activities such as mixing, diluting, or converting basic chemicals to produce chemical products and preparing materials such as paints, pesticides, inks, detergents, and cosmetics are also carried out in these industries.

2.1 Identification of Health-Safety-Environment (HSE) risks

First, all the different activities in terms of health, safety, and environment (HSE), as well as the statistics documented by the HSE unit in the field of annual incidents, the conditions leading to health and environmental hazards, their impact on safety were examined, and also human and environmental health were identified. Then, a checklist was prepared in consultation with experts, and the risks were identified.

2.2 Preparation of a questionnaire to determine the types of environmental risks

After forming the risk assessment team, the authors of the present study prepared a questionnaire based on the checklist of environmental, health, technical, safety, and occupational risks of the previous stage due to the lack of statistics and information. The sample size was determined by Cochran′s equation. 145 questionnaires were prepared and distributed among HSE experts of chemical industries in the south of Tehran. Cronbach′s alpha coefficient was used to determine the validity and reliability of the questionnaire based on the opinions of 15 experts, including university faculty members and HSE experts in chemical industries (Table 1).

Table 1: Cronbach′s alpha coefficient of research variables

Row	Type of risk	Number of Potential risks	Cronbach′s alpha coefficients
1	Environmental	6	0.773
2	Safty	3	0.744
3	Health	3	0.781
4	Occupational	5	0.822

2.3 Analysis and assessment of environmental risks with FMEA and AHP methods

This part of the risk management process deals with qualitatively analyzing the identified risks. The fuzzy FMEA approach was applied to measure the probability of occurrence and severity of the identified risks at three levels: low, moderate, and high. After the qualitative analysis of the risks, the researchers of the present study quantified the risks in order to analyze and prioritize them.
At this stage, RPN was calculated to determine the risk of any failure mode. RPN specifies the critical value of each item. The higher the RPN was, the more important the risk patterns were. RPN was calculated through the product of three risk factors: O, S, and D. Failure modes against risk factors in a conventional way using a 10-point assessment scale for variables S, O, and D are shown in Table 2. In the next step, after quantitative analysis of environmental, health, technical, safety, and occupational risks, the Analytic Hierarchy Process (AHP) was used to weigh, rank, and prioritize the identified risk parameters and analyze the data by Expert Choice software.

Table 2: Scoring of risk factors in the FMEA method [25]

Score	Probability of detection	Severity	Detectability
1	Extremely high (≥ 1 in 2)	Hazardous with no warning	Almost uncertain
2	Very high (1 in 3)	Hazardous with warning	Very rarely
3	Frequent (1 in 8)	Extremely	Rarely
4	High (1 in 30)	Many	Very low
5	Moderately high (1 in 80)	Significant	Low
6	Moderate (1 in 400)	Moderate	Moderate
7	Relatively low (1 in 2000)	Low	Moderately high
8	Low (1 in 15,000)	Minimal	High
9	Rarely (1 in 150,000)	Very minimal	Very high
10	Nearly impossible (≤ 1 in 150,000)	None	Almost certainly

2.4 Integration of the FMEA method with fuzzy methodology

Since the FMEA approach in the classical mode emphasizes very high accuracy and definitively considers all factors, and is not compatible with complex systems and the real world, the combination of this approach with fuzzy logic is one of the available solutions to solve this problem. The fuzzy FMEA approach provides a tool capable of achieving better results with vague concepts and imprecise information. In general, this logic is considered a suitable tool in cases where sufficient data are unavailable, data collection is difficult, or data are available in the form of expressions and linguistic and mental variables [26]. Using fuzzy theory is beneficial when the relationship between existing criteria has uncertainty, or the relationship between them cannot be expressed clearly. A = (a1, a2, a3) is a triangular fuzzy number (TFN) where the numbers a1, a2, a3 are crisp values and a1 < a2 < a3 and the corresponding triangular membership function are defined according to the Equation (1) [27].

$$f_{(\tilde{A})}(X) = \begin{cases} 0, x < a_1 \\ \frac{(x - a_1)}{(x_2 - a_1)}, a_1 < x < a_2 \\ \frac{(a_3 - x)}{(a_3 - a_2)}, a_2 < x < a_3 \\ 0, x > a_3 \end{cases}$$ Equation (1)

Probabilities of S, O, and D, as used in conventional RPN calculation, are applied as inputs for the fuzzy RPN function. The membership function of these three factors is determined using linguistic variables. Table 3 summarizes the fuzzy ranking for the linguistic measures of risk detection. Table 4 shows the fuzzy ranking for the linguistic measures of risk severity.

Table 3: Fuzzy ranking for the detection of Health, Safety, and Environment risks

Rank	Probability of detection	Fuzzy number		
		a3: pessimistic	a2: possible	a1: optimistic
Almost uncertain	No chance	10	10	9
Very rarely	Very unlikely chance	10	9	8
Rarely	Unlikely chance	9	8	7
Very low	Very little chance	8	7	6
Low	Little chance	7	6	5
Moderate	Moderate chance	6	5	4
Moderately high	Moderately high chance	5	4	3
High	High chance	4	3	2
Very high	Very high chance	3	2	1
Almost certainly	Almost certain chance	2	1	1

Table 4: Fuzzy ranking for the severity of Health, Safety, and Environment risks

Rank	Probability of occurrence	Fuzzy number		
		a3: pessimistic	a2: possible	a1: optimistic
Hazardous with no warning	Ranking of hazardous with no warning, very high	10	10	9
Hazardous with warning	Ranking of hazardous with a warning, very high	10	9	8
Extremely	Unrepairable with system damage risk	9	8	7
Many	Unrepairable with system equipment damage	8	7	6
Significant	Unrepairable with minor system damage	7	6	5
Moderate	Unrepairable without system damage	6	5	4
Low	A repairable system with significant performance loss	5	4	3
Minimal	A repairable system with low-performance loss	4	3	2
Very minimal	A repairable system with minimal loss	3	2	1
None	No effect	2	1	1

Unlike the previous cases for detection and severity, the probability of HSE risk occurrence has a trapezoidal membership function, which means that we consider two numbers for the risk probability. Between these two numbers, the degree of membership is the highest value and constant. In addition, the TFNs were used to express the opinions of expert team members about the importance of criteria (risk factors) and evaluation of options (failure modes) against the criteria and in the form of Z=(A, B) numbers (Table 5).

2.5 Conversion of the Z number to a normal fuzzy number

At this stage, TFNs were used to express the opinions of expert team members (DMs) about the importance of criteria (risk factors) and evaluation of options (failure modes) against the criteria and in the form of numbers (Z_i=A, B) (Table 4). The opinions of each team member, which were extracted as the fuzzy Z numbers at this stage, were finally placed as the input of W (matrix of weights) and D (group evaluation matrix of failure modes) matrices. Before calculating the Z number, it must be converted to a regular fuzzy number; thus, the second part of the Z number (reliability) was made non-fuzzy using Equation (2) and added to the first part (limitation). Finally, Equation (3) was used to convert the irregular Z number (weighted limitation) into a regular fuzzy number [28].

$$\tilde{x}_0(\tilde{A}) = \frac{w_r R_L^{O,S,D} + w_r R_M^{O,S,D} + w_r R_U^{O,S,D}}{3}$$

$$\tilde{\mu}'_z(x) = \tilde{\mu}'_A\left(\frac{x}{\sqrt{\alpha}}\right), x \in \sqrt{\alpha}X$$

Equations(2)and (3)

Table 5: Z numbers used in the assessment of failure modes versus risk

Restriction section (A)									Capability section (R)				
Occurrence		Severity		Detection									
Linguistic variable	Symbol	Linguistic variable	Symbol	Linguistic variable	Symbol	Fuzzy number			Variable	Symbol	Fuzzy number		
Extremely high	EH	Hazardous with no warning	HNW	Almost uncertain	AU	0	1	1	Very low	VL	0	0.1	0.1
Very high	VH	Hazardous with warning	HWW	Very rarely	VR	1	2	3	Low	L	0.1	0.2	0.3
Frequent	RF	Extremely	E	Rarely	R	2	3	4	Moderate-Low	ML	0.2	0.4	0.5
High	H	Many	MA	Very low	VL	3	4	5	Moderate	M	0.4	0.5	0.7
Moderately high	MH	Significant	S	Low	L	4	5	6	Moderate-high	MH	0.5	0.7	0.8
Moderate	M	Moderate	MO	Moderate	MO	5	6	7	High	H	0.7	0.8	1
Relatively low	RL	Low	L	Moderately high	MH	6	7	8	Very high	VH	0.8	1	1
Low	L	Minimal	MIN	High	H	7	8	9					
Rarely	R	Very minimal	VM	Very high	VH	8	9	10					
Nearly impossible	NI	None	N	Almost certainly	AC	9	10	11					

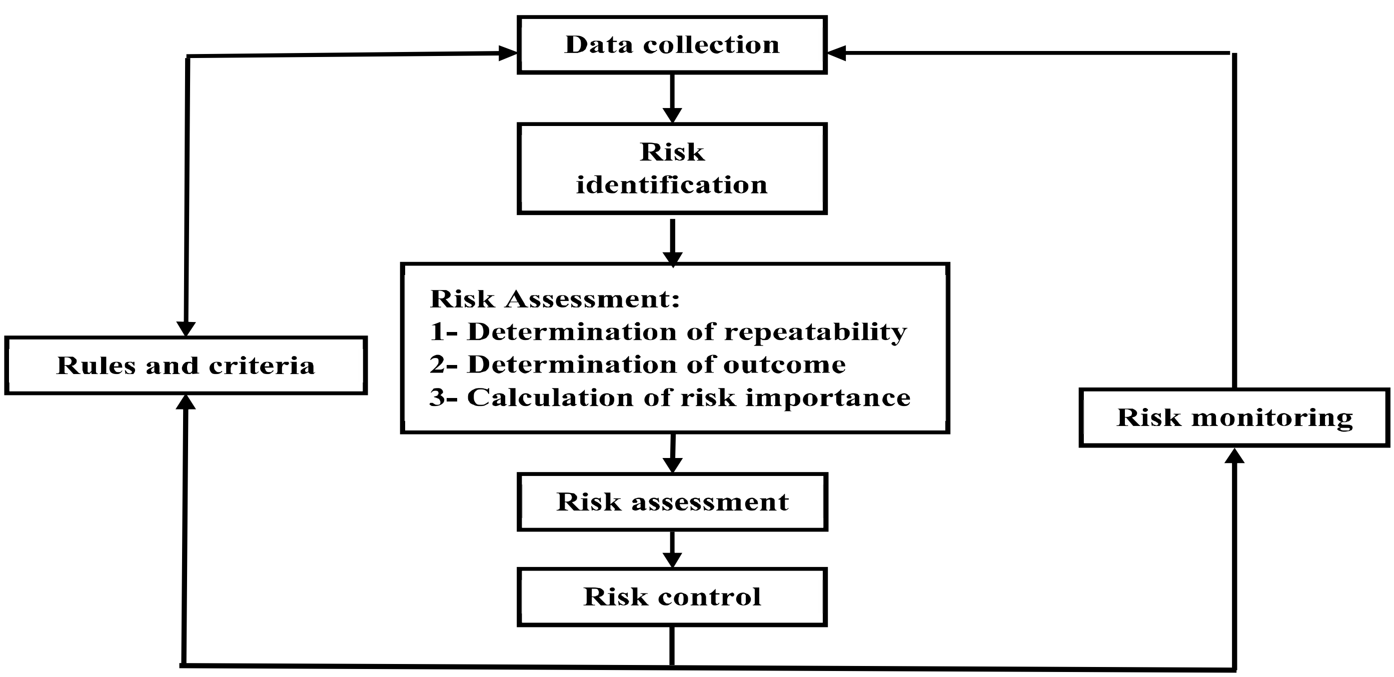

Figure 1: Flow chart of risk management steps

2.6 Conversion of the fuzzy possibility to fuzzy probability

Since the opinions provided by the experts were possible as fuzzy numbers, it was necessary to convert fuzzy possibility into fuzzy probability to ensure the consistency between real numbers and fuzzy possibility scoring. To this end, Equation (4) presented by Onisawa was used, where FPs stands for fuzzy possibility and pr for fuzzy probability. The research steps are shown in Fig 1.

$$pr = \begin{cases} \frac{1}{10^k}, & FP_s \neq 0 \\ 0, & FPs = 0 \\ K = \left[\frac{1 - FPs}{FPs}\right]^{1/3} * 2.301 \end{cases}$$

Equation (4)

3. Results and Discussion

Based on the results of the study, four categories of environmental risks were identified in chemical industries located in the south of Tehran (Table 6). In line with the data of this research in Table 5 about the most important environmental risks, Johari et al. (2019) [29] evaluated the environmental risks of Ilam Petrochemical Company in Iran and found that the main risks were air pollution, reduced water quality, and jeopardizing the regional public health. Based on Table 5, the highest RPN was related to occupational and safety risks. Fatemi et al. (2018) [30] also noticed an increase in occupational chemical accidents in recent years in Iran. Moreover, the results of the present study showed that HSE risks were among the most important types of accidents in the chemical industries in south Tehran. Sultanzadeh et al. (2019) [31] investigated 22 chemical manufacturing industries for environmental risks. Their findings confirmed the high severity of accidents in the chemical industry. The severity of accidents in the studied chemical industries was influenced by 22 individual and organizational factors, health education, HSE risk, risk management, unsafe practices, and conditions, and also the type of accidents. To determine the degree of importance of risks based on RPN values, we used the following order:

RPN_{0-90} = Low and Priority of corrective actions 4
RPN_{90-120} = Moderate and Priority of corrective actions 3
$RPN_{120-150}$ = High and Priority of corrective actions 2
$RPN_{>150}$ = Critical and Priority of corrective actions 1

The weight used in the three risk factors of Occurrence (O), severity (S), and detection (D) are presented as follows:
Detection=0.222, Severity=0.455, Occurrence=0.322

The failure modes, related causes and consequences, and assessment of results for each failure mode versus risks are presented in Table 7. Comparing the results of the environmental risk assessment of chemical industries in the south of Tehran using the fuzzy-FMEA technique revealed that 52.94 % of the identified environmental risks were of moderate importance, while 35.29 % were of high importance, 11.76 % were of low importance (Fig 2). Jozi et al. (2013) [32] identified 11 low-priority, 55 moderate-priority, and 16 high-priority environmental risks in Zagros Petrochemical Company (Iran). Bandarja et al. (2014) [33] evaluated the HSE risks at Bandar Abbas refinery (Iran) and found that 10 % of the RPN was prioritized above the risk level. In line with the current research, Fatemi et al. (2019) [29] reported that the main weakness was the lack of an effective monitoring system against chemical accidents and the lack of safety in chemical factories and warehouses. It was also reported that residents were unaware of chemical hazards and lack of medical centers equipped to manage victims of chemical accidents. After calculating RPN by the FMEA method, Rezayan et al. (2016) [34] reported that air pollutants such as CO and NOx concentrations were higher in some sampling stations compared to standard values. On the other hand, Takdestan et al. (2015) [35] reviewed the most important environmental pollutants of the plastic industry and the technologies used to reduce these pollutants. They revealed that more than 70 % of pollutants released from plastic factories were sources of air pollution. Ashna et al. (2013) [3] analyzed the results of measuring the concentration of all sources of air pollution in Larestan Cement Company (Iran) and found that the average pollution levels calculated in 60 sources exceeded the standard limit in terms of particulate matter and diffused gas and vapor. Therefore, the results of the present study were in line with the findings of their study regarding the high priority of air pollution, occupational risks, and exposure of workers to a variety of risks at the workplace. In the environmental risk assessment of Ilam Petrochemical Company (Iran), Johari et al. (2019) [28] found that the most important risks were air pollution, reduced water quality, and jeopardizing the public health of the region.

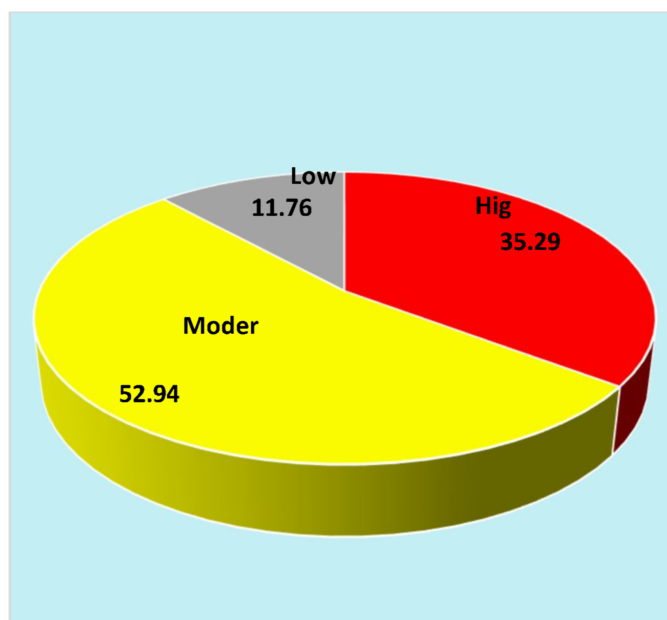

Figure 2: Frequency of high, moderate and low-importance risks caused by the activity of chemical industries in South Tehran, Ira

Table 6: Failure modes and environmental risk assessment of chemical industries in the south of Tehran (Iran) by FMEA method

Type of risk	Title	Potential risk	Risk management					
			S	D	O	RPN	Rpi	Degree of risk
Environmental	FM1	Air pollution and change in air quality, emission of SO_x and NO_x pollutants, Particulates, volatile organic compounds (VOCs) in the air	6	3	7	126	0.491	H
	FM2	Pollution of surface and underground water (discharge of chemicals into sewage)	6	3	8	144	0.438	H
	FM3	Soil pollution due to increased release of heavy metals, garbage and industrial waste	6	3	7	126	0.275	H
	FM4	Noise pollution	6	3	6	108	0.283	M
	FM5	Destruction of the ecosystem and wildlife of the area due to the increase in pollutants from the factories	2	7	8	112	0.314	M
	FM6	Toxicity and non-degradability of hazardous substances (phenolic compounds in the environment)	6	6	3	108	0.305	M
Health	FM7	Human exposure to chemical pollutants and toxic or corrosive substances: epichlorohydrin, methyl ethyl ketone, sulfuric acid, phenol, chlorobenzene, toluene, acetone, etc.	7	4	5	140	0.482	H
	FM8	Explosion of steam boilers and failure of devices, etc	2	6	7	84	0.217	L
	FM9	The effect of noise pollution of equipment and machines on the hearing system of workers	7	4	4	112	0.561	M
	FM10	Non-observance of personal, social and dressing room hygiene	6	4	4	96	0.338	M
	FM11	Inhalation of SO_x and NO_x pollutants from the output of chemical factories	10	5	2	100	0.403	M
Safety	FM12	Falling of employees or objects from a height while working in various industrial units	2	9	8	144	0.653	H
	FM13	Risks caused by working with machines and equipment in various industrial units	3	4	8	96	0.577	M
	FM14	Explosion and fire caused by leakage of chemical tanks or during transportation of chemicals	2	6	9	108	0.291	M
Occupational	FM15	Disaster caused by working with flammable substances: hydrogen, propylene gas, propane, gasoline, hexane, liquid pentane, paraffin, etc.	6	2	8	96	0.334	M
	FM16	Explosion of steam boilers and failure of devices, etc	4	3	7	84	0.317	L
	FM17	Physical injuries caused by the manual activity of workers	4	4	7	112	0.526	H

4. Conclusion

In real-world applications, decision-makers or members of the FMEA team cannot express the accuracy of their evaluation with numerical values, and the assessment is typically expressed based on linguistic variables. FMEA is employed to enhance the reliability of production and the stability of processes and requires applicable functions, and is not capable of showing the weight and relative importance of risk indicators such as occurrence, severity, and detection. Therefore, the fuzzy approach is a flexible method to solve such weaknesses. The findings showed that the fuzzy FMEA approach can be a useful and suitable alternative to the conventional FMEA method when the results need to be expressed more accurately. The present study's risk assessment results using the fuzzy-FMEA technique accurately determined the risk levels. It was found that 52.94 of the identified risks were of moderate importance, 35.29% were of high importance, and 11.76% were of low importance. We can conclude from the data that environmental risks and their effects are integral to industries with high pollution potential such as chemical industries. It is reasonable to conclude that environmental, technical, safety, occupational, and health risks should always be considered and managed.

Table 7: Assessment of failure modes versus risk factors

		Occurrence			Severity			Detection				Occurrence			Severity			Detection		
Team members	Failure modes	Crisp number	Z number		Crisp number	Z number		Crisp number	Z number		Failure modes	Crisp number	Z number		Crisp number	Z number		Crisp number	Z number	
		Rate	A	R	Rate	A	R	Rate	A	R		Rate	A	R	Rate	A	R	Rate	A	R
DM1		8	RF	H	8	MIN	VH	8	R	H		2	R	VH	3	E	H	3	H	H
DM2	FM1	7	H	VH	9	VM	H	7	VL	H	FM 10	1	NI	VH	2	HWW	M	2	VH	H
DM3		7	H	H	8	MIN	VH	8	R	VH		1	NI	H	2	HWW	VH	2	VH	VH
DM4		8	RF	VH	7	L	VH	8	R	H		1	NI	VH	3	E	VH	1	AC	VH
DM1		2	R	VH	8	MIN	H	1	AC	VH		4	RL	H	5	S	VH	1	AC	MH
DM2	FM2	2	R	H	9	VM	VH	1	AC	H	FM 11	3	L	VH	4	MA	VH	2	VH	VH
DM3		1	NI	VH	9	VM	VH	1	AC	MH		3	L	VH	5	S	VH	1	AC	VH
DM4		2	R	VH	8	MIN	VH	1	AC	VH		3	L	MH	5	S	VH	1	AC	H
DM1		9	VH	H	9	VM	VH	8	R	VH		2	R	H	3	E	VH	2	VH	VH
DM2	FM3	9	VH	VH	9	VM	VH	6	L	VH	FM 12	2	R	VH	3	E	VH	1	AC	H
DM3		8	RF	VH	10	N	H	7	VL	VH		1	NI	VH	3	E	H	3	H	VH
DM4		8	RF	VH	8	MIN	VH	6	L	H		2	R	VH	2	HWW	VH	2	VH	H
DM1		8	RF	VH	10	N	VH	8	R	VH		3	L	VH	4	MA	H	3	H	VH
DM2	FM4	8	RF	VH	9	VM	VH	7	VL	H	FM 13	3	L	VH	2	HWW	MH	3	H	VH
DM3		9	VH	MH	8	MIN	H	8	R	H		2	R	VH	3	E	VH	2	VH	VH
DM4		8	RF	H	9	VM	H	8	R	MH		3	L	H	3	E	VH	3	H	VH
DM1		5	M	H	8	MIN	H	10	AU	VH		7	H	H	8	MIN	VH	8	R	VH
DM2	FM5	6	MH	MH	9	VM	VH	9	VR	VH	FM 14	8	RF	VH	7	L	VH	8	R	H
DM3		5	M	VH	9	VM	VH	9	VR	MH		2	R	VH	8	MIN	H	1	AC	VH
DM4		5	M	VH	8	MIN	VH	10	AU	VH		2	R	H	9	VM	VH	1	AC	H
DM1		3	L	MH	6	MO	VH	5	MO	H		2	L	VH	4	MA	H	3	H	VH
DM2	FM6	3	L	VH	5	S	VH	5	MO	VH	FM 15	L	VH	5	S	H	4	MH	H	VH
DM3		3	L	VH	5	S	H	4	MH	H		R	H	6	MO	VH	5	MO	H	VH
DM4		2	R	H	6	MO	VH	5	MO	H		M	VH	5	S	VH	3	H	VH	VH
DM1		5	M	VH	5	S	VH	3	H	VH		M	VH	4	MA	H	3	H	MH	VH
DM2	FM7	5	M	VH	4	MA	H	3	H	MH	FM 16	3	L	VH	2	HWW	MH	3	H	VH
DM3		4	RL	MH	5	S	H	3	H	VH		2	R	VH	3	E	VH	2	VH	VH
DM4		4	RL	VH	5	S	VH	2	VH	H		3	L	H	3	E	VH	3	H	VH
DM1		3	L	VH	5	S	H	5	MO	VH		2	R	VH	4	MA	VH	4	MH	VH
DM2	FM8	3	L	VH	5	S	VH	5	MO	VH	FM 17	3	L	VH	5	S	H	5	MO	H
DM3		2	R	VH	4	MA	VH	4	MH	VH		3	L	H	5	S	VH	3	H	VH
DM4		3	L	VH	5	S	H	5	MO	H		2	R	VH	5	S	VH	2	VH	MH
DM1		3	L	H	5	S	VH	3	H	VH										
DM2	FM9	2	R	VH	5	S	VH	2	VH	MH										
DM3		2	R	VH	4	MA	H	3	H	VH										
DM4		3	L	VH	5	S	VH	2	VH	H										

Authors' Contributions

Hassan Azizi: preparation of the introduction sections; data collection and analysis; completion of the discussion section of the article. Mina Macki Ale Agha: Writing the research method of the article. Bita Azadbakht: Participation in data analysis. Hasan Samadyar: Participation in data analysis; research conclusions.

Conflicts of Interest

The Authors declare that there is no conflict of interest.

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