International Journal of Farming and Allied Sciences
Available online at www.ijfas.com
©2017 IJFAS Journal-2017-6-1/1-8/ 31 Jan, 2017
ISSN 2322-4134 ©2017 IJFAS

Study evaluation of environmental risk Ramin thermal power plant using, DELPHI, AHP and FMEA methods in physicochemical environment

Ghodratolah Siahpour[1]*, Neda Orak [2]

1. M.S.c Environmental Sciences, Department of Environmental Sciences, Khuzestan Science and research Branch, Islamic Azad University, Ahvaz, Iran. 09163071047, gh.siapoor@gmail.com
2.Assistant Professor, Department of Environmental Sciences, Khuzestan Science and research Branch, Islamic Azad University, Ahvaz, Iran.

Corresponding author: Ghodratolah Siahpour

ABSTRACT: Due to the importance of power generation and the growing importance of sustainable development, which is based on the progress with regard to the ecological principle and since power projects have Considerable potential, therefore the importance of using modern methods, is doubled. The purpose of this research is to study the environmental risk of Ramin Power Plant. In this study, Delphi method was used to identify power plant risks that by prepared a list of power plant activity and its effects on the physicochemical in the form of questionnaires and conducted a survey of members of the expert group, In terms of environmental risks in the operation and maintenance phase, Four risks in mentioned environment were identified as a risk indicator Then using Analytical Hierarchy Process (AHP) and analyzes carried out by the Expert choice software, Was estimated probability of risks and by performing failure modes and effects analysis (FMEA) Two Factors the impact and probability risk detection was calculated. And risks were prioritized based on risk number**.** The study results indicate that the biggest number of risks (RPN) related to the risk of water pollution that the environment around the power plant with the amount of (14.016) which was recognized as the most significant risk.

Keywords**:** environmental risk, power plant, methods of Delphi, AHP, FMEA

INTRODUCTION

Investigate and analyze the different aspects of risk, the nature and types of risks arising from activities on the environment, is essential. With the management objective reducing the dangers in risk assessment, all activities are listed then the basic discipline to organize them described (Zaroshany, 1389).

In the process of evolution, environmental management as a broad and dynamic system for encounter to pollution and environmental degradation, precautionary approaches have been considered. In this regard, Since the late 1960s, environmental impact assessment as an activity to identify and predict the effects of a project on the welfare and human health as well as bio-geophysical environment and also to study the effects and dissemination of information were raised and law enforcement have found a special place in many countries (Monavari, 2001) .

In the following some of the sources that have been considered in this study, are mention:

(Jouzy and alidousti, 2010) title: Safety risk assessment and process Montazerghaem power plant; the results of this study, identifying the activities in the unit of failure modes and effects analysis were investigated. Therefore, after identifying the activities in the unit the failure modes and effects analysis process (FMEA) was used for risk assessment. The results of this study showed that amortized of equipment and placing them at very high altitudes

and unsafe and lack the path to access them raising the number of risk priority in first top priority and the human error is the main cause of safety hazards known in the industrial unit.
Research by (Shrivastava and Patl, 2014) with title: identify hazards and risk assessment carried out in thermal power plants in India, thermal power plants have been introduced as one of the large industries and power plants that are needed fuel from coal have been investigated which type thermal power plants has its own risks, such as rail transport of coal to power plants.
The aim of this study is focus to identify potential risks and existing dangers in chemical, physical and biological environments. The work was carried out in five stages as follows:
1- Defining System
2- Definition and Description of danger
3- Analyze the dangers
4- Selection Risks Through the screening Determine the value of danger or danger class
5- Decision for danger that Corrective action is recommended at this stage.
As is clear from the research stages, after identifying risks, taking corrective actions necessary to reduce and control the risks has been presented.
Study by (Tian and Yan, 2013) in Beijing city of China, To identify risks in power plants in the Analytic Hierarchy Process (AHP) was performed and on the basis of data obtained from satellites, In this study, according to mentioned method, Identify risks and have been weighed and analysis of data obtained showed that, area of power plant and energy production processes in power plants, more than all creation of risk and danger. The study also proves that get together satellite data, can pay to risk assessment and management of power plants.
The aim of this research is to evaluate the environmental risk Ramin power plants using three methods mentioned. Similar research has not been done in power plants and risk assessment for the mentioned power plant is new work. The results of this study were affected by a statistical society that can be very influential and this is express new issues in this field. In study used similar studies around the country and the world that the recommendations and their strengths modeled to make a good report and deserves to be prepared and start background for future studies in this field.

2. **Materials and methods**

For the purposes of this study and to obtain reliable results for nine months since the beginning of June Till February 2014 through constant presence in the exploitation phase and repairs in power plant, with interviews with workers, technicians, staffs as well as record the results and completion of the relevant checklists, took place.

2.1. ***Data*** **collection methods**

2.1.1. ***First step: Library studies on the topic***

At this stage, the information required includes the recognition range, and position Ramin thermal power plant, recognition of activities related to power plant, previous data collection and similar foundation in relation to the subject, through the following steps have been collected. To collect background information and library was modeled from literature and articles and Internal and external studies and in different parts study with the source itemized is done. In addition the data and information contained in Ramin power plant that was provided in parts of research were used.

2.1.2. ***Second step: Refer to the experts and professionals***

In order to collect information from various sources such as experts, scholars, environment professors as well as experts Ramin thermal power plant, with meetings and interviews was to collect the required information.

2.2. ***Introduction of the methods used***

So far several methods have been proposed in the field of risk Evaluation process but in this study with respect to the subject matter and Existing conditions (lack of similar information and reports) the methods of AHP, Delphi and FMEA is used.

2.2.1. ***Delphi method steps are performed in this study:***

- Formed an expert group to operate and monitor the Delphi method

The members of the group of experts Ramin thermal power plants as well as technical experts as well as technical experts Directorate General for Environmental Protection Khuzestan state and prominent educators environmental groups universities were selected.

- Adjustment questionnaire
- Check the written questionnaire (remove ambiguities inferential)
- Distribution questionnaires

Questionnaires prepared among the experts thermal power plant and environment and natural resources engineering graduate students, Assessment and land logistics and experts from the Directorate General for Environmental Protection Khuzestan state were distributed.

- The analysis of received responses
- Put the numbers

2.3. ***The method for determining the sample***

The next step method for determining the sample, the best and most logical method for determining the sample size using Cochran formula because one of the most widely used approach is to calculate the sample size and the other to determine the sample size of the studies used different methods. Two common methods is to use the formula of Charles Cochran and Morgan table. Using the Delphi questionnaire identified 88 environmental criterion. So long as we know neither variance of society nor the probability of success or failure of variable and cannot be statistic formulas used to estimate sample size, we use of Morgan table. This table gives the maximum number of samples: N size the criteria (Risk criterion), S sample size, because there are not 88 criterion in the above table and it is between 85 and 90, so the technique (try and error) that one of applied methods in thermodynamic arguments, attempted to find middle:

70	**85**
s=?	**88**
73	**90**

As a result, the sample size calculation, and taking into account the statistical condition equal to approximate amount 72 questionnaire, is calculated; S=71.086~ 72. The number of 72 questionnaire prepared in three cases, Methods FMEA, AHP, DELPHI and between the 24-member expert team which was formed different part according to Figure (1) is distributed.

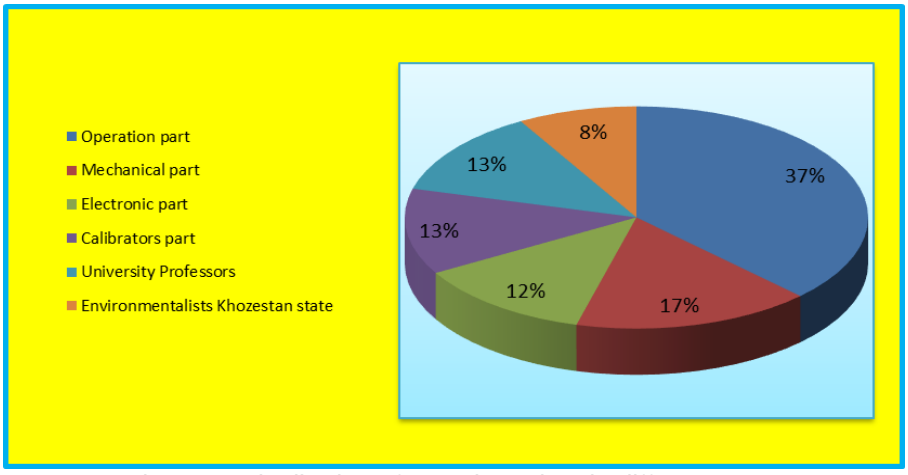


Figure 1: Distribution of questionnaires in different parts

As can be seen in the above graph most questionnaire with 37% in the operation (command room) had been distributed, because the control room of the brain that make up a power plant and pollutants resulting from fuel combustion, and waste are exported from there to the surrounding environment.

3. Results and findings

According to the Delphi questionnaires distributed among a group of experts and review questions and research hypotheses Including tables that represent expert opinions to identify activities and the important risks of Ramin thermal power plant and also use the probabilities derived from the "paired comparison analysis questionnaire" in the Analytic Hierarchy Process (AHP) by Expert choice software, the severity and probability of discovering danger as determined by the experts and at the end, Risk numeric value for each of the identified effects are obtained. In this study, according to the Analytic Hierarchy Process (AHP), and to identify the environmental aspects of physicochemical sector, And forecasts the criteria and sub-criteria relevant section were examined and in continue the hierarchical structure of environmental risks possible in units, in figure (2) is displayed.

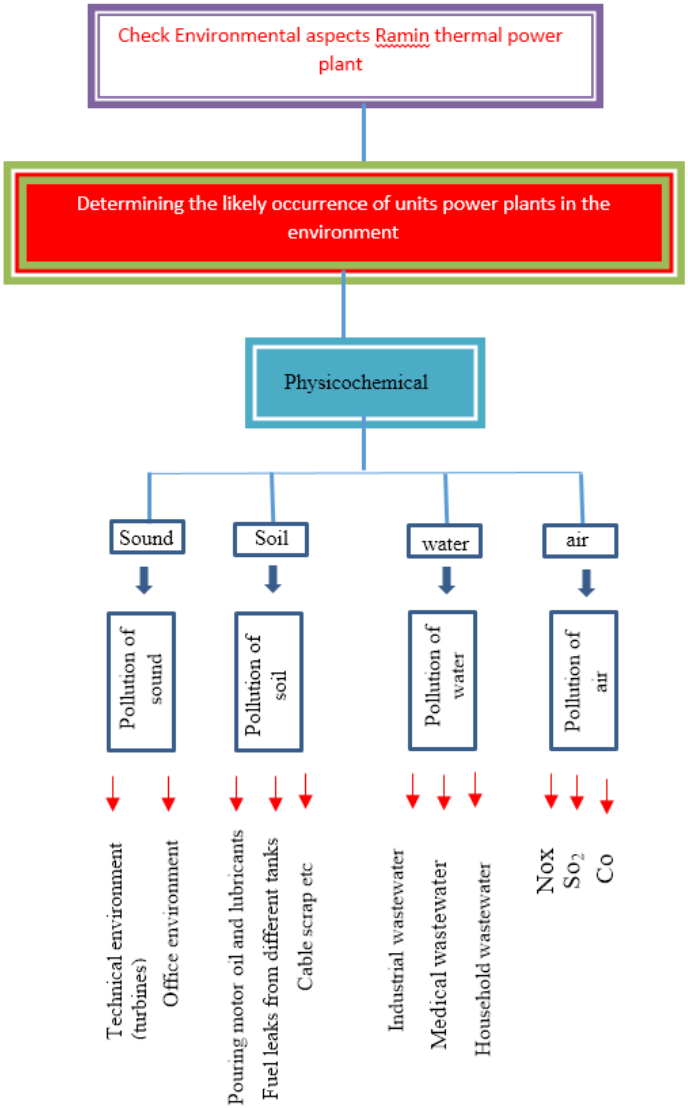


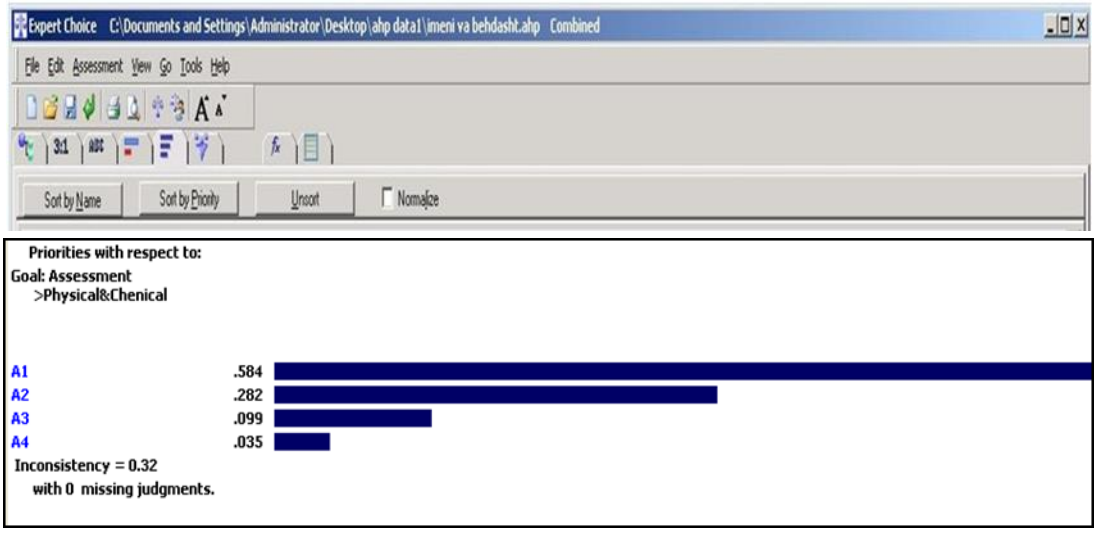
Figure (2): hierarchical structure aspects of the environment Ramin thermal power plant

3.1. Determined the possibilities for risk

To determine the probability of each risk, from bigeminal comparisons the Analytic Hierarchy Process (AHP) is used. For this purpose was drawn hierarchical structure and based on the structure drawn questionnaires Analytic Hierarchy Process Preparation and distributed and scores given by experts in order to calculate danger, Enter Expert choice software until the probability of each danger can be achieved. Table (1) along with figure (3) show scores given and obtained weights based on the exploitation phase, repairs on physicochemical.

Table (1). Bigeminal comparisons according to the exploitation phase, repairs on the physicochemical environment

physicochemical environment	water pollution	air pollution	soil pollution	sound pollution
water pollution (A1)	1	5	6	7
air pollution (A2)		1	7	8
soil pollution (A3)			1	7
sound pollution (A4)				7



Figure(3). View bigeminal comparisons of the physicochemical environment risks in the Expert choice software

Based on bigeminal comparisons conducted with Using the expert opinions in environment of Expert choice software, the results suggest that the highest probability of physicochemical risks in the environment, water pollution (A1) and the lowest probability of risk, noise pollution (A4) were identified.

3.2. Determine the severity and probability of discovering danger

After determining the probability of each effect (weight effect) in the previous step, in the following, by using FMEA method and with the help of expert opinions, to determine the severity and probability of risks detection will be discussed. For this purpose, a questionnaire containing the identified risks was distributed among Delphi experts. Table (2), shows scores given to determine the severity and probability of discovering each risks.

Table (2). Determine the severity and probability of discovering danger to the risks exploitation phase, repairs

Probability of discovering	Intensity Occurrence	Risk aspect	environment
4	6	water pollution	physicochemical
4	7	air pollution	
5	7	soil pollution	
3	5	sound pollution	

3.3. The numerical value risks

After determined the probability of occurrence (with AHP method) and severity And probability of discovering impact (with FMEA method) Using the following formula: risk numerical value (RPN) was calculated.

RPN= probability of discovering* effect severity* probability of occurrence

Table (3). A number of risks identified in the exploitation phase, repairing the physicochemical environment

	Risks identified	severity	probability of discovering	probability of occurrence	RPN
1	Water pollution	6	4	0.584	14.06
2	Air pollution	7	4	0.282	7.90
3	Soil pollution	7	5	0.99	3.465
4	Sound pollution	5	3	0.035	0.525

3.4. The results of the calculation of the index RPN or the degree of risk taking FMEA, in the physicochemical environment

For each risk by questionnaires distributed, a score was considered by the experts. Then the identified risks Was arranged In descending from the highest risk priority number 14.06 to The lowest risk priority number 0.525.then The degree of risk taking (Limits risks) can be determined in two ways.

1- Calculate the mean and standard deviation using Excel software
2- Using the formula of arithmetic mean and standard deviation

In this study to calculate the mean and standard deviation using Excel software is sufficient.

Beginning average obtained**:**

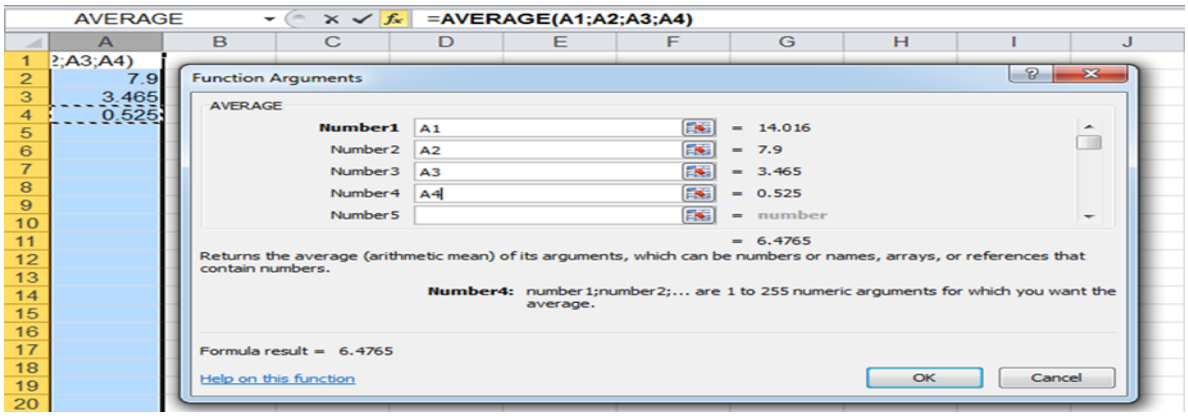


Figure (4). View calculating the average data, the physicochemical environment in Excel software

Then the standard deviation is obtained:

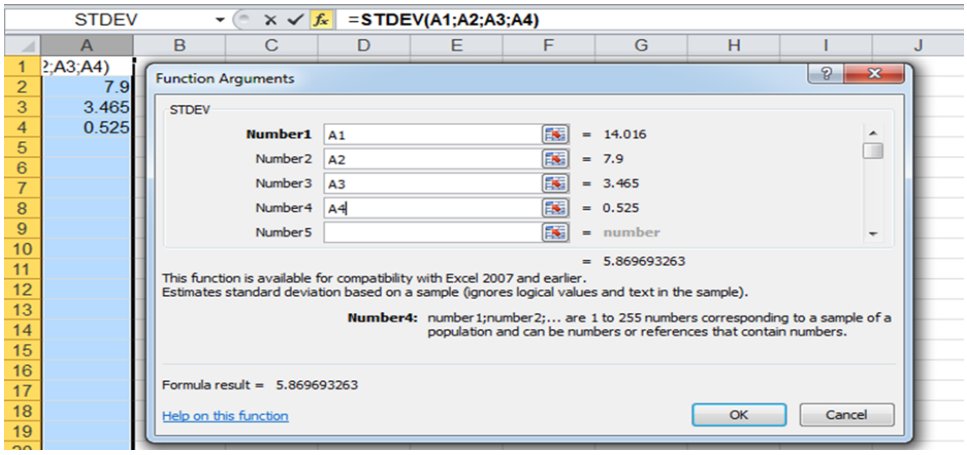


Figure (5): Show calculate the standard deviation of the data, physicochemical environment in Excel software

Now, according to the average, and standard deviation obtained (Table 4) were determined for risk analysis.

Table 4: values needed for analysis risk in FMEA method, physicochemical environment

Average (risk index)	6.4765
Standard deviation	5.869
Total numbers	25.95
High levels of risk	12.339
low levels of risk	0.6075

As a result of the above

calculation:

High-risk venture, with RPN Numbers equal to or higher than 12.33 as high risk (the crisis) is known that need to modify and control measures are more robust. Equal numbers and lower than 0.6075 as low risk (can be neglected) is known. And numbers between these two numbers as moderate risk (middle) is known.

4. Discussion and conclusion

Now to talk about the probability of occurrence of each risk, Calculate the RPN, Identify and rank the risks Index And Conclusions The results of the research will be discussed. At first prominent research findings will be referred to and finally concluded.

4.1. Index risks and its effects as well as their most important source in physicochemical environment:

The most prominent risk identified in physicochemical environment Risk of water pollution, the numerical value risk is 14.016. The first index risk identified water pollution in physicochemical environment of Ramin thermal power plant. The most important source of water pollution, Industrial wastewater that contains grease and oil contaminants resulting from all industries From (keshto sanat karun) factory till Ramin and Zargan power plant as well as sanitary sewers which have Pollution risk TSS, CO, BOD5, and coliforms.

4.2. The conclusion of the study was to determine the most prominent risks in the area:

The most prominent risks identified in the study, is the risk of water pollution 14.016. The risk of sound pollution, the risk rankings in the study with the lowest numerical value risk 0.52, the last rank among the risks identified in the company's activities. In Table (5) all risks identified in our research have been prioritized based on risk numeric value.

Table 5. Prioritizing risks identified in our research, based on the numeric value risk

	Risks identified	**RPN**
1	Water pollution	14.016
2	Air pollution	7.90
3	Soil pollution	3.465
4	Sound pollution	0.525

It is an applied research Due to the absence of any background and report on environmental risk assessment for Ramin power plant And the importance of this issue, Need to do the research was felt And to identify activities and risks involved in Ramin thermal power plant Use the comments and suggestions of experienced, skilled and familiar with power plant operations was essential; Because Comments and suggestions of the experts could from any direction and be useful in identifying the activities and effective risk. Delphi questionnaire method was selected for this purpose until during this procedure has to be paid to identifying the activities and risks. The physicochemical environment in the operation phase, Repairs due to activity circadian Ramin thermal power plant water pollution won The highest numerical probability of the risk Equal to (0.584) and Air pollution (0.282) and soil contamination (0.99) later in the second and third positions and the lowest probability of risk in the research related to sound pollution (0.035).

4.3. Offers in physicochemical environment

As previously mentioned in the physicochemical environment highest risk score related to water pollution that the most important source water pollution, industrial effluent containing fat and oil pollution caused by the turbines, generator enclosures, and emergency diesel generators are transformer. As well as sanitary sewers which have Pollution risk TSS, CO, BOD5, and coliforms.

The proposed program for high-risk venture, in this environment, According to our calculations, risk with RPN Numbers equal to or higher than 12.33 was found Disaster risk. In this environment we currently risk of water pollution that measures to control and remove the risk of water pollution, the proposed solutions can be cited as follows:

1. For the disposal of waste at the point of discharge, dilution take place.
2. Installation of equipment for online measurement of effluent parameters on the final output first and second power plants
3. Reduction of wastewater by installing settling ponds with injecting coagulant into the sanitary sewer system, in the first power plant
4. Use of water recycling programs
5. Use of closed cycle
6. Monitored periodically to determine the status of water and monitoring of pollution sources

Acknowledgments

The author would like to thank the Doctor Orak for her unsparing efforts and effective collaboration in the research process.

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