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Environmental Education for Mitigating and Assessing Environmental Impacts of Petrochemical Products (Vinyl Chloride) with Analytic Hierarchy Process (AHP) Method

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آموزش محیط‌زیست، ابزاری درجهت کاهش و ارزیابی پیامدهای محیط‌زیستی تولیدات صنایع پتروشیمی (وینیل کلراید)، با تکیه بر روش تحلیل سلسله مراتبی

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Abstract:

today, with rapid advancement of industry and technology, many concerns about the adverse consequences threaten human life. The objective of this research is to investigate environmental education as an implement to reduce and evaluate the environmental consequences of petrochemical products based on the hierarchical analysis. The methodology was a survey of a statistical group involving 30 managers and experts in the petrochemical industry. The tool for the survey has consisted of a questionnaire with a pair scale-single response. In this model, the validity of the research was confirmed by the Delphi method and obtaining the opinion of experts in the field of occupational health and reliability of the questionnaire calculated by the inconsistency rate (less than 0.1). First, three criteria including environmental impact, destruction of the natural environment, impacts on individual health, and the most important harmful effects of each criterion were identified. Among the three main criteria, the most influential factor is the environmental impact criterion with a relative weight of 0.670. The criteria for the destruction of the natural environment and health effect of petrochemical workers with a relative weight of 0.260 and 0.699, respectively, are in the next priority. The water pollution parameter with a relative weight of 0.602 is the most important among the 5 sub-criteria. The parameter of effects on the biological environment with a relative weight of 0.373 among the 3 sub-criteria, and the parameter of the respiratory system with a relative weight of 0.417 among the 5 sub-criteria have the greatest effect, respectively.

Keywords: Environmental Education, Assessment, Environmental Consequences, Vinyl Chloride, Hierarchical Analysis Method.

چکیده:

امروزه همراه با پیشرفت شتابان صنعت و فناوری، نگرانی‌های بسیاری در مورد پیامدهای سوء مرتبط با آن زندگی بشر را تهدید می‌کند. هدف از انجام پژوهش، تبیین آموزش محیط‌زیست، به‌عنوان ابزاری درجهت کاهش و ارزیابی پیامدهای محیط‌زیستی تولیدات صنایع پتروشیمی (وینیل کلراید) با تکیه بر روش تحلیل سلسله مراتبی است. روش تحقیق، از نوع پیمایشی و نمونه آماری شامل ۳۰ نفر از مدیران و کارشناسان صنعت پتروشیمی بوده است. به‌منظور ابزارِ نظرسنجی، پرسشنامه‌ای در مقیاس زوجی- تک جوابی تنظیم گردید. در این مدل، روایی پژوهش با روش دلفی و کسب نظر از افراد متخصص در حوزه بهداشت حرفه‌ای و پایایی پرسشنامه بر اساس استاندارد نرخ سازگاری (کمتر از ۰/۱) تأیید شد. ابتدا سه معیار اصلی اثرات محیط‌زیستی، تخریب محیط طبیعی و اثر بر سلامت و بهداشت افراد و مهم‌ترین آثار زیان‌بار بر هریک از مؤلفه‌ها توسط متخصصین مشخص گردیدند. یافته‌ها نشان می‌دهد که در بین ۳ معیار اصلی، بیشترین تأثیر را معیار اثرات محیط‌زیستی با وزن نسبی ۰/۰۶۷ دارد. معیار تخریب محیط طبیعی و معیار اثر بر سلامت و بهداشت افراد به ترتیب با وزن نسبی ۰/۲۶۰ و ۰/۰۶۹ در اولویت بعدی قرار دارند. پارامتر آلودگی آب با وزن نسبی ۰/۶۰۲ در بین ۵ زیر معیار دارای بیشترین اهمیت و به ترتیب پارامترِ اثرات، بر محیط بیولوژیکی با وزن نسبی ۰/۳۷۳ در بین ۳ زیر معیار و پارامتر سیستم تنفسی با وزن نسبی ۰/۴۱۷ در بین ۵ زیر معیار بیشترین اهمیت و تأثیر را دارا هستند.

واژه‌های کلیدی: آموزش محیط‌زیست، ارزیابی، پیامدهای محیط‌زیستی، وینیل کلراید، روش تحلیل سلسله مراتبی.

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Introduction

The earth and the environment are basic elements of human growth and evolution, and by adapting the environment, the man got acquainted with many fields of science and chose well-being as a principal standard of lifestyle. However, this fundamental element has been exposed to the hazards of human activities and is going to be deteriorated. Today, the interaction between humans and the environment is increasing. These interactions have entered economic, social, industrial, political, and cultural matters insofar as it based the intellectual frame of decision-makers upon development plans, which are not against environmental basics. As human activities and their impacts are increasing, the resulting hazards are also increasing. Since the intensity and importance of threats to earth resources, natural ecosystems, and the global population are increasing and manifesting, comprehensive and multilateral education on the responsibility against the environment is further needed (Palmer, 2004). Emergence and emphasis on concepts such as environmental assessment and industrial ecology are the backgrounds of this modern thought (Rahmani,1996). Today the key role of the petrochemical industry on the economic development of nations is obvious and the increasing need of human societies to its products, technological progress, agriculture, and thousands of chemicals with different physical, chemical, and physiological properties resulted in pollution of air in cities and work environments. Despite positive achievements, this industry produces large-scale gaseous, aerosols, and effluents, leaving direct and indirect deleterious effects on the environment and human life. In addition to other environmental concerns such as global warming, ozone depletion, water pollution, extinction, this has changed into a worldwide challenge. For this reason, because on one hand, Iran is an oil-rich country and development of petro-chemistry has accelerated in recent years, and on the other hand oil and gas industries especially petro-chemistry that discharge many hazardous pollutions to air, water and soil, further consideration and more extensive research should be conducted. Moreover, environmental protection is a strategic tool for modern trade. A healthy environment is requisite of prosperity and sustainable production, whilst ignoring the environment and the valuable resources dedicated to human for free can pose irrecoverable damages to the earth and living organisms. Living a healthy life in an increasingly industrialized world of science and technology is particularly important (Siobhan Ardakani et al., 2018). Another major environmental challenge in the oil industry throughout the world is the management of toxic residues such as chlorine hydrocarbons which are environmentally harmful due to non-degradability in nature for at least thirty years and lack of proper removal techniques. As manufacturing units in the complexes, refineries and various chemical industries are also inevitably producing some byproducts (results of chemical reactions) and sometimes the volume of such unwanted products is higher than the original capacity of the industrial unit, removal, or storage of these materials will impose great costs. When the oil is distilled and refined, and hydrocarbons such as ethylene are isolated, the products enter the petro-chemistry units and combine with other raw materials resulting in the production of ethylene dichloride and vinyl chloride monomer. Production of PVC is based on VCM, which is converted to PVC in a polymerization unit. Then, PVC is transferred to specialized units to produce plastics and other materials, directly or indirectly. The effluents of PVC and VCM units is the main problem of petro-chemistry complexes. At first, the problem

was solved to some extent with simple techniques, but the production of a highly poisonous and hazardous gas called dioxin attracted further attention to the disposal methods. This poisonous material threatens the health of both men, animals, and the environment. Because vinyl chloride is usually found in a gaseous form, the man is certainly exposed to it through breathing. 40 years ago, polyvinyl chloride plastics became the most widely used construction material and had innumerable powerful benefits while affecting air, man, organisms, soil, and earth. In recent years, by using inexpensive petrochemical materials, the use of PVC grew considerably (Neal, Andrady, 2009). In liquid form, Vinyl chloride evaporates and enters the air or soil easily and quickly. If it exists in surface parts of water or soil, it enters the atmosphere quickly through evaporation. It degrades in the air a few days after entering and changes into hazardous materials. Only a certain amount of vinyl chloride is water-soluble and it is discharged to groundwater and degrades to other materials resulting from vinyl chloride. Occupational exposure to vinyl chloride monomer is also the cause of a rare neoplasm called angiosarcoma in human populations. Exposure to low amounts of vinyl chloride monomer could lead to a mild hepatic disease of cholestasis type, thus hepatic cholestasis tests in periodic surveys in PVC producing units should be taken into consideration. Intense exposure to vinyl chloride monomer (800 p.p.m) suppresses the central nervous system and in concentrations between 100000 to 400000 PPM, it stimulates eyes and respirational tracts, causes anesthesia or even death. Epidemic studies suggested that chronic exposure to concentrations lower than 1 ppm of vinyl chloride monomer increases the genetic toxicity in human and it results in chromosomal aberrations, sister chromatid exchanges, break-in DNA chains, production of DNA adduct, alkylation of proteins and cellular micronucleus in blood lymphocytes of those exposed to it, which is classified by USEPA in A and IRAC groups in group 1 (Kleinschmidt& Elliott 1960, Attarchi et al 2006, Rahimaian Rana et al., 2014, Tromatteo et al, 1963, Lester et al. 1997, Qiu et al.2008, Fučićetal et al., 2014, Leonard et al., 1977، Zhu et al.2005،Boa et al, 1988, Barakat et al,1990, Ranjbar,2016).

As stated above, vinyl chloride is primarily used to produce polyvinyl chloride (PVC). This compound may be made of a combination of trichloroethane and tetrachloroethane and it is metabolized to metabolites with high affinity and mutagenic capacity in a dose-dependent and saturable path, which is poisonous to the liver after short- and long-term exposures to low concentrations. In various in vivo and in vitro studies, it was found to be mutagenic. There is also compelling evidence about its carcinogenicity in humans in industrial communities exposed to high concentrations. Also, a causal relationship was proved to exist between contact with vinyl chloride and hepatic angiosarcoma. The studies reveal that this is compound is also related to cancers in the respiratory system and hepatic cells, brain tumors, lung tumors, and malignant lymphatic and blood tissues. Recently, the obtained data shows that it is carcinogenic in multiple organs. Vinyl chloride received by rats, mice, and hamsters through feeding or breathing created tumors in breasts, lung, zymbal gland, skin, and hepatic angiosarcoma (Ranjbar, 2016). In the present time, thanks to information technology, education is experiencing substantial development. Environmental education as defined by the conference of IUCN/UNESCO in 1970 refers to the identification of values and explanation of concepts to create required skills and tendency to understand and identify dependencies between man, culture and the environment as well as activities such as

decision making and induction of behavioral rules in connection with the environmental quality (Palmer, 2004). In this very time, education has been agreed to be the most effective tool for dealing with future challenges and basically, it is accepted that the world of tomorrow will be formed in light of education today. Sustainable education, in its comprehensive definition, will have the potential in future decades to serves as a reliable tool and a bridge between the classroom and the society and between the classroom and the market. It should be noted that education should not and cannot be limited to not only to formal education but to any type of education even traditional ones such as learning at home or society (Lahijanian, 2007). Following the Earth summit in 1992 and the compilation of Agenda 21, environmental education towards sustainable development has been discussed. Education and development have a mutual relationship: on one side education is the background of development and on the other hand, development is a requirement of a fundamental evolution in the educational system. Therefore, in any society caring about sustainable development, appropriate education should be at the top of national plans (Lahijanian, 2011). In a sustainable viewpoint, the most important capital of any nation is human capital. A flourish of massive capitals depends upon education. Evaluation of educational methods to a selection of proper methods with the aim of promotion of environmental awareness and change of personal behaviors towards the environment is essential. Additionally, by increasing degradation of the environment and environmental values and the urgent need for environmental education, and the explosion of science and expansion of information and communication technologies, a combination of educating software and methods associated with environmental education is an inevitable necessity for increasing the efficiency. In recent decades, the researchers' attention has turned to multi-criteria decision-making models for making complicated decisions on environmental planning in education. An important topic in education is the quality of products and outlets of the education system. Coordination and interaction between the development elements should be established to achieve sustainable development (Ghiasi, 2014). Education is the most efficient mechanism of any society for combatting one of the greatest challenges of this century, i.e. sustainable development, which needs holistic people having a systemic thought, multi- and trans-disciplinary viewpoint, awareness, creativity, and participative potential. Production of human resources with the aforementioned characters requires high quality of elements and factors of an educational system intending to achieve sustainable development. In this approach, a framework should be considered for the industries with an emphasis on dimensions and indicators. Finally, education of sustainable development in industries is in the period of awareness making, so that the managers have figured its necessity, but there is no certain framework for it (Moussai, Ahmadzadeh, 2009). Environmental assessment is the best tool to reach the strategic goals of sustainable development. These studies protect the resources due to accelerated planning and prevent irreversible damages to the environment and natural resources (Baro, 2001). According to what mentioned above and appropriate tools are needed to achieve sustainable development and to prevent environmental destruction. These Tools include environmental laws, assessment, and education using software which they are the most effective and most powerful indicators of increase and promotion in social awareness.

In this paper and for analyzing the

environmental impacts of vinyl chloride in the petrochemistry industry, the types of pollutions were prioritized by AHP (Saaty, 2008).

This research is intended to explain environmental education as a tool to mitigate and assess the environmental impacts of petrochemical products (vinyl chloride) based on the AHP method. Therefore, vinyl chloride which has many uses in petrochemistry plants is analyzed in this paper because its environmental and hygienic impacts were identified by environmental assessments in petrochemistry complexes in Mahshahr Special Economic Zone, hence training Expert Choice to specialized personnel on exposure to this compound and applying AHP method for reaching sustainable development should be used.

Methodology

First, a full description of the methods used in this research and then the methodology will be explained.

Delphi method:

a technique of identifying risk (hazard) level is the data collection method, in which Delphi is a subset. This method is a way of reaching consensus and agreement between experts of discipline on a certain subject. It can be useful when gathering people of different expertise in a place that is not possible. A facilitator using a questionnaire asks for experts' opinions about important risks of the project. Then, the responses are collected and summarized to be delivered to the experts again for them to study others' opinions and give their supplementary opinions. The results are circulated between the individuals several times to reach a consensus. This technique helps reduce prejudice and bias and prevents undue influence. The details of the method gradually increase, because any repetition approaches expert opinions to each other. This is a simple process but it is time-consuming, meanwhile, it severely depends on the abilities of the facilitator in compiling the questions and collecting the answers. The phases of this method are as follows:

- Identification of experts and ensuring their participation: These experts should not have necessarily performed such a project or should not have been in contact with such risks before, but they should be familiar with the project organization, employer, and their interactive requirements. Thus, anyone familiar and aware of the project and its processes could be used.
- Delphi questionnaire: The designed questions and the Delphi questionnaire should be clear enough to obtain valuable information and flexible enough to facilitate giving creative ideas. Since risk management is inherently inaccurate, efforts to create too precise questions could result in the wrong hypotheses.

a. Receive expert opinions

b. Analysis and collection of the answers

The facilitator analyses the answers precisely and identifies common parts, subjects, and considerations between different people. Then, the final results are documented and given back to the experts to be analyzed and reviewed.

- Collection of expert opinions again and repeating the process: This process is repeated for as many times as the facilitator prefers (at least 3 times) so that the answers will be extracted, analyzed, and assessed perfectly and acceptably.
- Distribution and use of the final information: When this process is repeated in enough times, the facilitator should edit the final results and explain the style, time, and location of their application. Although the Delphi technique is time-consuming, it is a logically structured method for receiving expert opinions that getting their participation

is not possible by any other method (Karami, 2019).

Hazard and Operability Studies (HAZOP)

Identification and evaluation of existing hazards are performed by HAZOP**.** This technique is an effective and systematic method for identifying hazards and operational problems of a system and determining their effects, which is often used in chemical industries and it is based on this principle: the system is safe when all operational parameters including temperature, pressure and so on are in a normal and acceptable state. A team of experts analyzes probable deviations from standard states and their probable impacts using a series of keywords. The process is accompanied by technological developments, increased use of machinery, and probable incidents in industrial environments.

AHP process

An organization or person often does not make decisions based on only one criterion, but the decision making is performed based on multiple criteria or attributes. Recently, in the decision making science, where a solution is selected from existing solutions or they are prioritized, Multiple Attribute Decision Making (MADM) methods are currently being used and include AHP, ANP, Entropy, SAW, Topics, Electre, Promethee.

AHP as a widely used method for personal and group (organizational) decision making is used for solving the unstructured problems in management, politics, economics, social sciences, medicine, engineering, genetics, geography, or anywhere scientific decision making is required. AHP (Analytical Hierarchy Process) is a multi-criteria decision-making method, which is a new technique to solve the problems partly. Not only this method has the advantages of the aforementioned methods, but due to mathematical logic, it can combine quality and quantity criteria for making a comparison between numerous alternatives. AHP is flexible and it has two functions: finding the relative importance (weight) of attributes and rating the alternatives. Similar to the way the human brain acts for decision making, decision-makers are helped to set the priorities based on their goals, knowledge, and experience so that they digitize their feelings and judgments. For solving the problems using AHP first of all a hierarchical structure or plan should be drawn. In general, it is based on the following three principles: Drawing a hierarchical tree (plan), Compilation and determination of priorities, and Logical compatibility of judgments, which the latter is surveilled by the Inconsistency Ratio and it is presented in Expert Choice outputs. This process reflects normal human behavior and thought. Also, it analyzes complicated problems based on their mutual effects and simplifies them to be solved. AHP is used when the act of decision making is facing some attributes or criteria, which can be both qualitative and quantitative. The decision-maker begins the analysis by providing a hierarchical tree (Saaty, Vargas, 2001). This tree shows comparison factors and opponent items to be assessed. Then, a series of paired comparisons were performed. These comparisons show the weight of each factor about other opponent alternatives. Finally, the logic of the analytical hierarchical process combines matrices resulted from paired comparisons so that an optimal decision is made. In phase 0, there is the goal of decision making. In phase 1, there are the criteria, and in phase 2, there the items of prioritization. The number of primary and secondary phases can be higher depending on the type of problem. The hierarchical structure includes four phases: Phase 1) goal, Phase 2) primary criteria, Phase 3) secondary criteria, and Phase 4) alternatives, the weights of

which are determined by AHP. That is, paired comparisons were made between each phase and Expert Choice helps analyze paired comparison questionnaires and determine the inconsistency ratio (Asgharpour, 2006).

If the inconsistency ratio is lower than 0.1, paired comparisons were acceptable. The following principles were the basics of AHP and all calculations, laws, and regulations were founded on these principles which include: Reciprocal Condition, Homogeneity, Dependency (Ghodsipour, 2002).

- Consistency in judgments: inconsistency ratio which is a tool to find the consistency and shows how much the priorities made by comparisons can be relied on. Comparison between two items may be a simple thing to do, but when the frequency of comparisons increases, reliance on the consistency of comparisons is not easily possible and this can only be done by using an inconsistency ratio. The experience shows that if this ratio is lower than 0.10, the consistency of comparisons is acceptable, otherwise, they should be repeated. The following steps should be taken for calculating the inconsistency ratio:

-Calculation of Weighted Sum Vector: Paired comparison matrix is multiplied by the 'relative weight' vector yielding a new vector known as 'Weighted sum Vector'.

-Calculation of consistency vector: The elements of the Weighted Sum Vector are divided into relative priority vector yielding 'consistency index' vector. With λmax, the average consistency ratio of vector elements is obtained.

-Definition of consistency index: n refers to the number of existing items in a problem.

-Calculation of consistency ratio: Consistency ratio is obtained by dividing the consistency index by Random Index. If the ratio is 0.1 or higher, it indicates the consistency of the comparisons (Mehregan, 2004). For a random index see Table 2.

- Sensitivity analysis: The weight of criteria has the highest effects in rating the alternatives. The decision-maker should know the degree of reliability for making decisions. Due to uncertainty in various phases of multi-criteria decision making, sensitivity analysis should be done on the problem before the selection of the final option. Therefore, sensitivity analysis is performed after the rating the alternatives. This includes recalculation of ratings by correcting the weight of each criterion. A full sensitivity analysis is possible by using Expert Choice. While weights of the other criteria remain constant, the weight of each criterion gradually increases or decreases. Following sensitivity analysis, the rating of items may vary. Analysis of all likely variations by Expert Choice, which has a powerful and user-friendly sensitivity analysis module, is possible. Generally, the use of AHP instead of other multi-criteria decision-making methods has the following reasons:

1. Quality and quantity criteria of decision making are used in this method.
2. It is an appropriate method for weighting the criteria.
3. AHP helps decision-makers insert critical aspects of the problem into a hierarchical structure, create a flexible structure according to the problem and solve complicated problems by placing the items on that structure.
4. When a decision-making problem is downsized to smaller problems and the hierarchical structure created, the relative importance of each criterion is determined in each phase, where the criteria are compared based on their effectiveness and the criteria of higher phases.
5. In this model, a large number of criteria can be taken into consideration.
6. Paired comparison in AHP allows decision-makers to extract weights of the

criteria and rates of the items from the pairwise comparison matrices.

7. The hierarchical structure is established by making paired comparisons between independent judgments, and it is preferable to synchronized prioritization of all decisions and criteria.

8. Measurability and controllability of the consistency of each matrix and decision is an important characteristic of AHP. Acceptable inconsistency range in each system depends on the decision making individual, but in general, if the inconsistency is lower than 0.1, it would be better for the decision-maker to revise his/her judgments. Thus, only a multi-criteria decision-making model can measure decision makers' judgments.

9. AHP which involves a variety of items in making a decision can analyze the sensitivity of the criteria (Ghaemi et al, 2016).

Procedure

The present paper is a survey study and the research method is descriptive-analytical, which carried out in two phases: qualitative and quantitative. Samples were selected in clusters including experts in Mahshahr Special Economic Zone. In this paper, the Delphi method, Hazard and Operability Studies (HAZOP), and AHP decision-making method were used. After the personnel was surveyed for evaluating environmental education methods about all criteria involved in a decision-making process, all criteria and indexes were prioritized in AHP as an assessment tool using Expert Choice. Numerical paired comparisons were used and preferences were quantified by a 9-point scale (see Table1). The validity of the research was supported by the Delphi method and asking for opinions of personal health specialists, and the reliability of the questionnaires was confirmed based on the consistency ratio standard (0.1>). In this case, as technical experts and HSE personnel were consulted in Mahshahr Special Economic Zone, pairwise questionnaires designed by Delphi (Tables 3 to 6) were formed including single/paired questions about five items (air, sound, solid wastes, and soil) to assess environmental impacts of vinyl chloride. These questionnaires were set by the HAZOP technique to analyze the respondents' answers about the hazards of working with vinyl chloride as the most important occupational pollution in such environments. For prioritizing, three major criteria including assessment of the impact on the environment, on the individual health and destruction of the natural environment, and the most important deleterious impacts on each parameter were performed, and then the data was analyzed by Expert Choice. By asking for opinions of specialists and experts about the collected data and the existing processes, most indexes were identified and they were selected and weighted as the main criteria in AHP (Table 3). Thirty specialists on the environment, safety, occupational health, and the personnel in the petro-chemistry unit were delivered and their importance degrees were found. Next, another questionnaire was delivered to the specialists to determine the criteria and indexes. And it was separated into physicochemical, biological, ecological and economic, and social environments. Responding to these questionnaires was in a way that the criteria were compared two by two based on the item which is more appropriate about the desirable goal and value was selected in terms of importance (Table 1). Due to the binary comparison of criteria and sub-criteria, the correlation of two criteria and two sub-criteria were compared and a score between 1 to 9 was selected. If after instructing the respondents on filling out the questionnaire, the criterion on the right hand of the table is more important than the criterion on the left side in the respondents' viewpoint a score between 1 to 9 was selected

among the scores on the right, and the more important the subject is for the respondents the higher the score is. On the contrary, if the criterion on the left side of the table is of more importance for the respondents, a score between 9 to 1 was selected. The priorities of respondents' opinions are shown in Table 7 and the priorities of the criteria and sub-criteria are depicted in Tables 8 to 11. The style of collecting the required data is by library studies conducted on the pollutions resulting from different units producing VCM and field operations that included visiting petrochemical units producing this compound within the Mahshahr Special Economic Zone. Analysis of Environmental impacts of vinyl chloride was performed by hierarchical analysis and Expert Choice as well as a comparison of the relative weight of criteria and sub-criteria about each other which is illustrated in Tables 4 to 6, and the final weights will be determined as follows.

Table 1. Importance of criteria and sub-criteria to each other (Mehregan, 2004)

Level of Importance	Definition
1	Equally preferred
3	Moderately
5	Strongly
7	Very strongly
9	Extremely
2,4,6,8	Intermediate values

Table 2. Random Index of consistency (RI) (Mehregan, 2004)

n	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0	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

Table 3. The relative weight of primary criteria to each other

Criteria	Relative weight																	Criteria
individual health	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Environmental effects
Destruction of the natural environment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	individual health
Destruction of the natural environment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	environmental effects

Table 4. The relative weight of sub-criteria of environmental impacts to each other

Criteria	Relative weight																	Criteria
Air pollution	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Water pollution
Noise pollution	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Water pollution
Pollution of waste material	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Water pollution
Soil contamination	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Water pollution
Noise pollution	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Air pollution

Pollution of waste material	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Air pollution
Soil contamination	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Air pollution
Pollution of waste material	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Noise pollution
Soil contamination	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Noise pollution
Soil contamination	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Pollution of waste material

Table 5. The relative weight of sub-criteria of the destruction of the natural environment to each other

Criteria	Relative weight																	Criteria
Effect on the physical and chemical environment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effect on the biological environment
Effect on the physical and chemical environment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effect on the whole natural environment
Effect on the biological environment	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Effect on the whole natural environment

Table 6. The relative weight of sub-criteria of impacts on individual health to each other

Criteria	Relative weight																	Criteria
Hearing system	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Breathing system
Nervous system	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Breathing system
Cancer	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Breathing system
Skin	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Breathing system
Nervous system	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Hearing system
Cancer	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Hearing system
Skin	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Hearing system
Cancer	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Nervous system
Skin	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Nervous system
Skin	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Cancer

Data and information

For prioritizing environmental impacts based on the AHP model from a managerial viewpoint, the most conventional environmental impact should be selected by the trained personnel among the best environmental assessment techniques. Therefore, in this research to select the most appropriate environmental impact by the above method that is a multi-criteria decision-making process, it was used as an assessment tool and its findings were analyzed. The relative importance of criteria and sub-criteria was determined about each other (Table 1)

and after weighting and formation of a relevant matrix using Expert Choice, weights of the criteria were calculated based on their importance compared to one another towards the main target that is a selection of the most appropriate environmental impact. Relative weights of selected criteria compared to one another were stated based on the contents of Table 3. A paired comparison of the criteria is shown in Diagram 1. During paired comparison for every set, consistency analysis was carried out the software. As already stated, this criterion should be lower than 0.1. The data obtained from prioritization and identification of the most important pollutants resulting from vinyl chloride was analyzed by assessment and AHP decision making methods. In this chapter, the data derived from the paired comparison questionnaires were analyzed. Inconsistency ratios of paired comparisons were studied, and final alternatives and criteria were rated after all paired comparison questionnaires were analyzed. Three major criteria of impacts were recognized: environmental impacts, destruction of the natural environment, and impacts on individual health (Table 7). Priorities of these three criteria gained by Expert Choice and their reasons are shown in Diagram 1 and Diagram 2, respectively. As illustrated in Diagram 2, the inconsistency ratio is 0.09 (lower than 0.1), i.e. consistency of the comparisons is acceptable. Table 8 shows the prioritization of major criteria, in which the environmental impacts (relative weight=0.670) have the greatest influence and importance regarding the hazards of working with vinyl chloride.

Table 7. Environmental criteria

No.	Criteria
1	Environmental effects
2	Environmental effects
3	Individual Health

Table 8. Prioritization of major criteria

No.	Criteria	Weight	Priority	No.
1	environmental effects	0.670	1	1
2	environmental effects	0.260	2	2
3	Individual Health	0.069	3	3

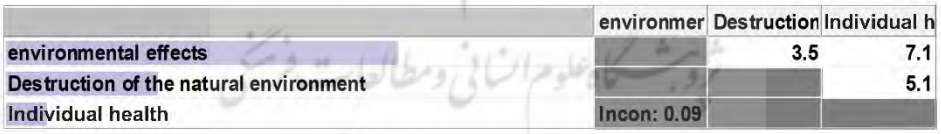

Diagram 1. Paired comparison of major criteria (Source: Expert Choice output)

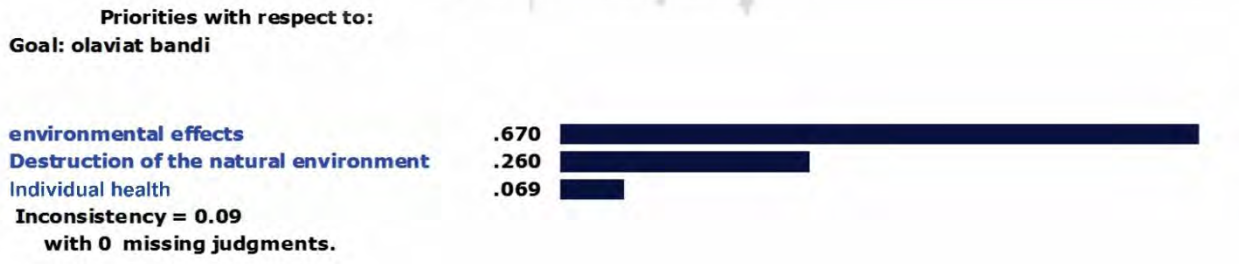

Diagram 2. Prioritization survey of major criteria Source: Expert Choice output)

Prioritization of environmental impacts criterion towards hazards of working with vinyl chloride

After modeling in Expert Choice and importing paired comparisons matrices, weights of the sub-criteria were obtained.

Prioritization reasons of 5 sub-criteria of environmental impacts criterion were reviewed by paired comparison using Expert Choice as shown in Diagram 3, and the priorities are shown in Diagram 4. As seen in Table 9, the relative weights of water pollution and noise pollution sub-criteria (0.260 and 0.051, respectively) are the next priorities. According to diagram 4 inconsistency ratio of paired comparisons was 0.01 (lower than 0.10) indicating that these comparisons were acceptable.

	water pollu	air pollutio	Noise	Pollution of	Soil contar
water pollution		2.5	12.5	12.5	14.286
air pollution			6.53	5.19	5.92
Noise				1.46	1.19
Pollution of waste material					1.72
Soil contamination	Incon: 0.01				

Diagram 3. Paired comparison of environmental impacts sub-criterion (Source: Expert Choice output)

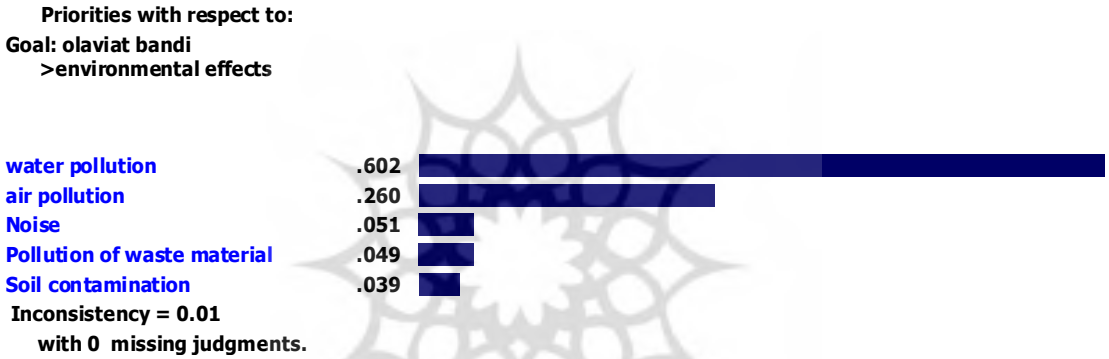

Diagram 4. Prioritization survey of environmental impacts sub-criterion (Source: Expert Choice output)

Table 9. Prioritization of environmental impacts sub-criterion

No.	Criteria	Weight	Priority
1	water pollution	0.602	1
2	Air pollution	0.260	2
3	Noise pollution	0.051	3
4	Pollution of waste material	0.049	4
5	Soil contamination	0.039	5

Table 10. Prioritization of destruction of natural environment sub-criteria

No.	Criteria	Weight	Priority
1	Effect on the physical and chemical environment	0.371	2
2	Effect on the biological environment	0.373	1
3	Effect on the whole natural environment	0.256	3

Prioritization of destruction of natural environment criterion towards the hazard of working with vinyl chloride

After modeling in Expert Choice and importing paired comparisons matrices, weights of the sub-criteria were obtained. Prioritization reasons of 3 sub-criteria of the destruction of natural environment criterion were reviewed by paired comparison using Expert Choice as shown in Diagram 5, and the priorities are shown in Diagram 6. As seen in Table 10, the relative weight of impacts on the biological environment (0.373) has the highest importance and highest priority towards the destruction of the natural environment hazards of working with vinyl chloride. The relative importance of impacts on the physical and chemical environment is the next priority.

Since the inconsistency ratio of paired comparisons was 0.03 (lower than 0.10) according to diagram 5, these comparisons were acceptable.

	Effect on p	Effect on b	Effect on th
Effect on physical and chemical environment		1.19	1.21
Effect on biological environment			1.74
Effect on the whole natural environment	Incon: 0.03		

Diagram 5. Paired comparison of the destruction of natural environment sub-criteria (Source: Expert Choice output)

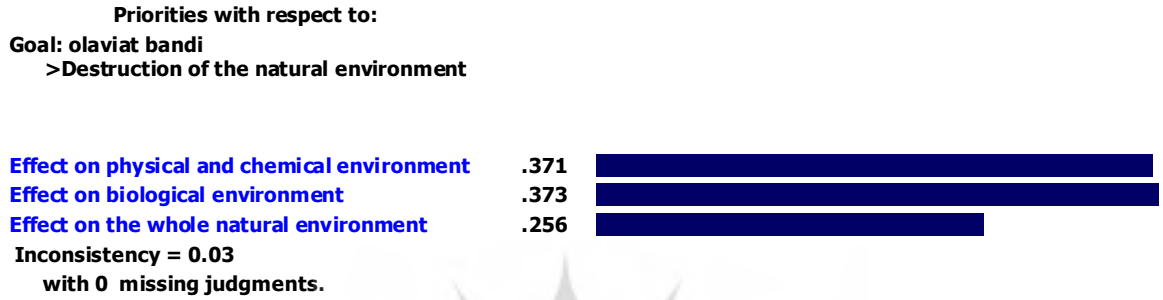

Diagram 6. Prioritization survey of the destruction of natural environment sub-criteria (Source: Expert Choice output)

Prioritization of impacts on individual health criterion towards the hazard of working with vinyl chloride

After modeling in Expert Choice and importing paired comparisons matrices, weights of the sub-criteria were obtained. Prioritization reasons of 5 sub-criteria of impacts on individual health criteria were reviewed by paired comparison using Expert Choice as shown in Diagram 7, and the priorities are shown in Diagram 8. As seen in Table 11, the relative weight of impacts on the respiratory system (0.417) has the highest importance and highest priority towards impacts on individual health due to working with vinyl chloride. Therefore, it had the greatest impacts among 5 sub-criteria. The relative weights of cancer and nervous system sub-criteria (0.215 and 0.158, respectively) are the next priorities. Inconsistency ratio of paired comparisons was 0.09 (lower than 0.10) indicating that these comparisons were acceptable.

Table 11. Prioritization of impacts on individual health sub-criteria

No.	Criteria	Weight	Priority
1	Breathing system	0.417	1
2	Hearing system	0.142	4
3	Nervous system	0.158	3
4	Cancer	0.215	2
5	Skin	0.068	5

	breathing s	Hearing sys	nervous sy	Cancer	Skin
breathing system		4.55	4.14	1.19	4.08
Hearing system			1.19	1.12	1.51
nervous system				1.37	2.6
Cancer					5.2
Skin	Incon: 0.09				

Diagram 7. Paired comparison of the impact on individual health sub-criteria (Source: Expert Choice output)

Diagram 8. Prioritization reasons of impact on individual health sub-criteria (Source: Expert Choice output)

Sensitivity analysis results

Sensitivity analysis for selecting assessment methods with several goals is another result of this research. For this purpose, while weights of the other criteria remain constant, the weight of the desirable criterion gradually can be increased or decreased based on the assessment goal to select an ideal assessment method. As seen in diagrams 9-11, in dynamic-based sensitivity analysis compared to the general goal, the highest sensitivities are concerned with water pollution, air pollution, impact on the biological environment, impact on physical and chemical environments, and so on. As observed in diagrams of sensitivity analysis, priority stability of the alternatives was reviewed when percent weight varied between the criteria. For example, when the percent weight of environmental impacts varies, water pollution sub-criteria have a higher priority compared to that of air pollution, and so on, which no variations occur in the rating and only the values increase. Some variations may also happen in sub-criteria values with a change in percent weight of other criteria, but the rating does not change.

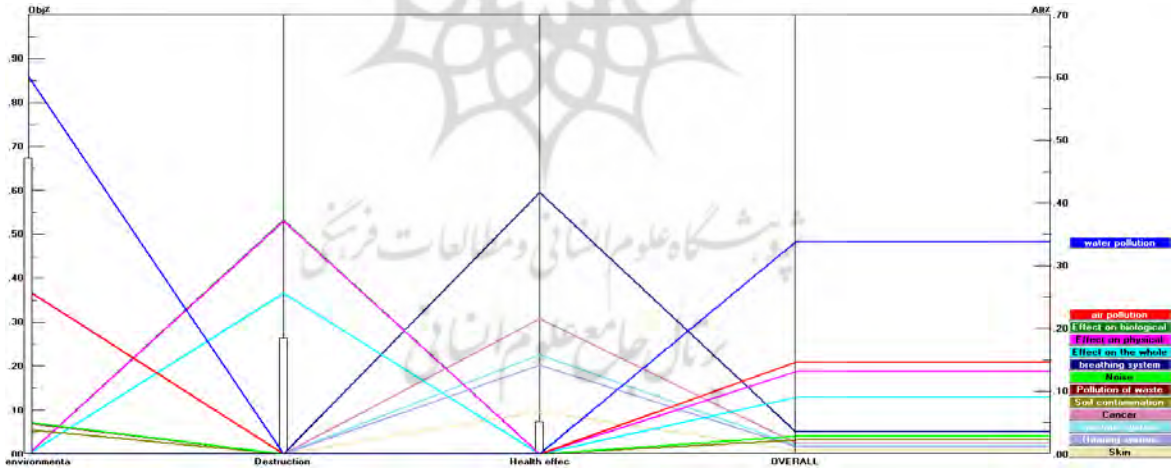

Diagram 9. Sensitivity analysis based on efficiency compared to the main goal

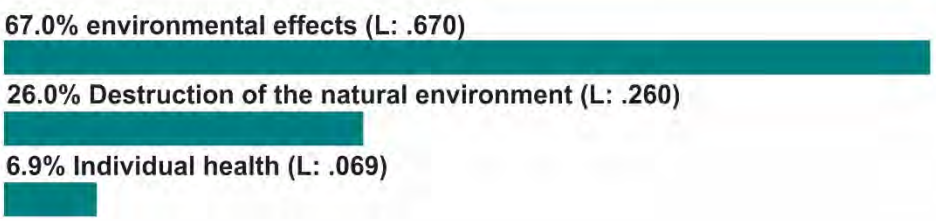

Diagram 10. Sensitivity analysis of criteria based on efficiency compared to the main goal

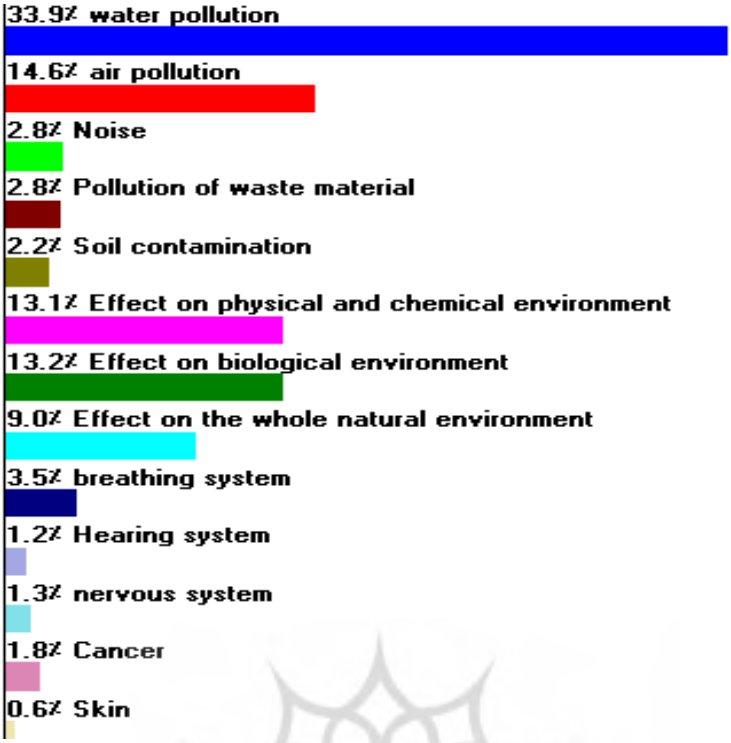

Diagram 11. Sensitivity analysis of sub-criteria based on efficiency compared to the main goal

Discussion and conclusion

The old idea that man has always been ruling nature is gradually fading to a real understanding of mutual relationships between industry and the environment. The expansion of industrial activities is also a major indicator of economic development. However, this development should be executed in the frame of sustainable development (Zenuz, 2003). Environmental crises in Iran are one of the most extreme ones in the world (Meiboudi, 2013). The majority of existing environmental problems are rooted in a lack of required awareness and cultural weaknesses regarding the relationship between man and the environment, which is a cultural dilemma. Hence, a national and international determination is needed to strengthen the culture of environmental protection among all community groups (Shobeiri &Meiboudi, 2013). The type and amount of pollution in Gas and petro-chemical industries as one of the greatest sources of pollution based on inputs, procedures, and outputs are varied. Various processes in any country including exploration, extraction, oil processing, and downstream industries, and operation of refineries and utilization of petro-chemistry pose numerous and different impacts to the environment (soil, air, water whether surface water or groundwater, organisms, plants, trees, and even humans). It is also followed by other environmental concerns such as global warming, ozone depletion, water pollution, and extinction. Because oil, gas, and petro-chemistry reserves are critical infrastructure and owing to abundant and comprehensive hazards for the environment, this industry has always been focused by safety and environment specialists and experts. Moreover, petrochemical processes are considered a polluting source due to the consumption of various water sources and producing wastewaters, dealing with gaseous materials as a feed, intermediate materials or products, energy-consuming processes prepared by combustion of fossil fuels and

production of combustive gases, and varieties of industrial residues. The highest levels of precision should be taken into consideration due to the increasing reduction of available environmental resources in designing and operationalizing production processes so that recovering and recycling the resources maximizes their availability and minimize the pollution. Any plans for controlling and managing environmental pollutants require thorough identification of pollution sources. Hence, full analysis of production processes in petrochemical units in terms of emissions is the first step in controlling and managing the pollutants. The petrochemical units are primarily intended to produce petrochemical and chemical products, oil byproducts, oil derivatives, and natural gas (Sobhan Ardakani, et al 2018) .Polyvinyl chloride is made of vinyl chloride monomer, a plastic construction material widely used throughout the world, which covers a wide range of products as packing, pipes, car parts, construction materials, and furniture. This compound is also used for manufacturing plastic pipes, coats of cable and wires, flooring, photography films, and automobile electronic industry. Plastic making industries are the main sources of releasing vinyl chloride in the environment (Ranjbar, Jafarzadeh, and Haghighyfard, 2005). Plastic goods are often made of artificial polymerized materials, and they create severe pollutions in the environment because they are very durable after a short useful life, which is not easily possible to get rid of. Consumption of plastics has largely expanded by the development of processing and forming technologies in a variety of industries including packaging, home appliances, farming, automotive industries, aerospace industries, marine industries, etc. Although nearly%10 of the weight of solid wastes are plastics, in terms of density and volume they are%25 to%30 of entire solid wastes (Karimi Pour Zarei, 2013).

As human activities and their impacts are increasing, the resulting hazards are also increasing. Since the intensity and importance of threats to earth resources, natural ecosystems, and the global population are increasing and manifesting, comprehensive and multilateral education on the responsibility against the environment is further needed. Since environmental education is a process to help promote information on the impacts of human activities on the environment, which encourages the personnel to protect the environment and improve the quality of life during interactions between human needs and the environment. Personnel training particularly managers and experts along with precise planning can increase efficiency and effectiveness in any organization. Today, by using various tools and media applied to education, the range of the audience has widened. The ultimate result of environmental education is to enhance environmental awareness of personal behavior toward environmental protection. Since a systematic and pre-designed education is to provide opportunities to facilitate and accelerate learning within an education system, the selection of a method adaptable to conditions and facilities plays an important role in achieving the desired goal. Any organization tries to meet the needs of learning and organizational success by setting systematic strategies and considering criteria such as duration of the courses, costs, resources, and facilities. Thus, in some cases, a proper education evaluated according to research and scientific principles can have desirable results due to convergence or divergence of the indexes and presence of diverse participants including employees, managers, and organizers of the courses on the decision-making process. A measure or index is needed for evaluating every subject, but it becomes complicated when several indexes are

considered, and complexity rises when multiple criteria conflict or of different textures. Here, the assessment and comparison are no longer a simple analysis performed by mental power, and scientific analysis instruments will be needed (Ghaemi et al, 2016). This research was conducted to reach this goal, and it tries to assess EIA methods towards environmental education using AHP, which is a widely used multi-criteria decision-making tool as well as the synchronized application of some measurement criteria. Because petrochemical industries consist of vinyl chloride and its derivatives, they potentially affect individual health and destroy the environment. Environmental education and Expert Choice were used simultaneously to assess the environmental impacts of this compound about local and international developments of petrochemical industries and hazards resulting from their activity. Total results of the present research toward the environmental impacts of vinyl chloride using Expert Choice and AHP are shown in Table 8, and with a relative weight of 0.670, it had the greatest importance. Destruction of natural environment and impacts on health criteria (relative weights of 0.069 and 0.260, respectively) are the next priorities. Inconsistency ratio of paired comparisons (0.09) that is lower than 0.10, is an acceptable consistency. It seemed that the respondents who were working in the area were severely affected and witnessed it has been destroying the environment so that the largest value was given to this criterion, which occurs in the economic, social and cultural environments, and it is influenced by spreading sewage of the complex to the surrounding environment, maintenance operation of dry and wet wastes as well as lack of suitable stop leaks or fences. Undoubtedly, it has negative sometimes irreversible effects including water pollution, soil contamination, and air pollution, the disappearance of plant and animal species, and upset the ecosystem equilibrium. Therefore, by presenting appropriate solutions, following environmental problems, and applying state-of-the-art scientific and technologic environmentally friendly instruments, not only the impacts will be mitigated or eliminated, but they accelerate the trend of sustainable development when positive impacts increase. Water pollution sub-criterion (relative weight=0.602) had the greatest importance towards hazards of working with vinyl chloride, and the greatest impact among environmental impacts (5 sub-criteria). That is also why this sub-criterion is affected by activities in the cooling unit, laboratory, and temporary maintenance of wastes. The petro-chemistry industry is very water demanding and it produces a large volume of effluents, in which the existing pollutants complicate the problem. Discharge of petrochemical effluents considering their combinations causes removal of a notable part of biotic elements that gradually disappears plant and animal species directly or indirectly, and it enters human communities through the utilization of water resources and threatens their health. For this reason, water recycling and effluent dilution should be taken seriously. Air and noise pollution sub-criteria (relative weight=0.26 and 0.051, respectively) are the next priority. Inconsistency ratio of paired comparisons was 0.01, which was lower than 0.10 indicating that the consistency of the comparisons was acceptable. It is noteworthy that air pollution sub-criteria exist in a physicochemical environment, which is affected by feeding operation from ethylene dichloride line, exhaust gases, catalyst preparation, polymerization, and the steam unit. Such risks can be greatly prevented by using air pollution control equipment and by continuous monitoring. Air is the most valuable source for living organisms to survive, and its pollution is a major challenge

that not only jeopardizes human health, but it leaves highly unpleasant impacts on the environmental factors (plants, animals, and objects). For this reason, qualitative and quantitative assessment studies should be conducted to eliminate air pollution from the petro-chemistry industry, and necessary actions should be taken. As observed in Table 10, impacts on the biological environment sub-criterion (relative weight=0.373) had the greatest importance towards the destruction of the natural environment resulting from work with vinyl chloride. It has the highest priority among the 3 aforementioned parameters, which is because of Shadegan International Wetland, Persian Gulf, and firths as local biological environments, and since this is an environmental study, higher weights were given in comparison to other items. Physical and chemical environments altogether are equal to biological environments and in a natural environment, one third is biological while the rest are the other two environments. Therefore, the impacts of physical and chemical environments (relative weight=0.371) are the next priorities. Since the inconsistency ratio of paired comparisons, according to Diagram 5 was 0.03, which is lower than 0.10, the consistency is acceptable. Respiratory system (relative weight=0.417) has the highest importance towards impacts on individual health as a result of work with vinyl chloride. Among 5 sub-criteria, it had the greatest impacts. Cancer and nervous system sub-criteria (relative weights= 0.215 and 0.158, respectively) are the next priorities. The inconsistency ratio of paired comparisons (0.09) was lower than 0.10, and the consistency was acceptable.

Sensitivity analysis for selecting assessment methods with several goals is another result of this research (Diag.9-11). In a dynamic-based sensitivity analysis compared to the general goal, the highest sensitivities are concerned with water pollution, air pollution, impact on the biological environment, impact on physical and chemical environments, and so on. As observed in diagrams of sensitivity analysis, priority stability of the alternatives was reviewed when percent weight varied between the criteria. For example, when the percent weight of environmental impacts varies, water pollution sub-criteria have a higher priority compared to that of air pollution, and so on, which no variations occur in the rating and only the values increase. Some variations may also happen in sub-criteria values with a change in percent weight of other criteria, but the rating does not change.

There are numerous papers on how to use AHP, some of which are noted in the form of a literature review. Indexing environmental quality of three industries based on socioeconomic problems including the construction of an aluminum factory, a 6-million-ton oil refinery, and expansion of existing local industries was performed by this method. The final results suggested that the expansion of existing local industries with the lowest environmental impacts was selected (Jafarian Moghadam et al, 2011). Records of petro-chemistry projects showed that they were mostly executed without environmental considerations and they resulted in various pollutions and destruction of a majority of natural resources)Petrochemical Special Economic Zone Organization.2001, Shale Amayesh Consulting Engineers.1995 National Petrochemical Company, Material Safety Data Sheet of National Petrochemical Company 2006).

A case study in Arvand Petrochemical Complex using AHP showed that TSS and COD, as the most important water pollutants were 0.325 and 0.237, respectively. In terms of pollution quantity and adverse effects on aquatic habitats and air pollution, emissions of SOx and NOx were the most important air pollutants. The results of this study confirm

that based on the properties of pollutants in petrochemical complexes in the area, a variety of fish species and benthic organisms were facing negative effects of Arvand Petrochemical Complex (Jozi et al, 2010). Another case study on environmental pollutants in the city of Isfahan revealed that environmental crises, haze, air pollution, visual pollution, non-potable water pollution, soil contamination, noise pollution, and light pollution were the greatest environmental impacts in Isfahan. The results of using AHP suggested that light pollution, visual pollution, and soil contamination were priorities 1 to 3, respectively, which is different from the mixed-method used in the present paper and it is technically unreliable (Javadi, Saghaei, 2018). In Shazand Petrochemical Complex, risk analysis showed that the risk of air pollution in physicochemical environment (3.738), in biological environment risk of reduced security of habitats (2.776) and social, economic and cultural environment, the risk of jeopardizing public health (4.684) are the most important risks (Samadi Khadem et al., 2012).in environmental impacts of petrochemical industries in Mahshahr Special Economic Zone, water pollution (final weight=0.299) was the most important pollution and air pollution (final weight=0.468) was the next priority (Jafarian Moghadam et al. 2011). In Ahvaz, the AHP method showed that the most important of environmental unsustainability is air pollution (final weight= 0.28) (Mohammadi Deh Cheshmeh et al, 2015). Research Institute of Petroleum Industry (RIPI) used the AHP method for assessing and weighting criteria and sub-criteria based on expert opinion by brainstorming. The major criteria in this research were time, environment, technology, independence, and relevant sub-criteria. The result of the final assessment in Expert Choice indicated that rotating MBR is the most ideal option for sewage treatment in RIPR. Constant MBR, SBR, and extensively aerated activated sludge are the next priorities (Tarkian et al, 2013).

The point is the results of the recommended method for decision making may not be perfectly accurate and error-free because AHP has a hierarchical structure and there is a linear and one-sided correlation between goal, criteria, and attributes. In this model, the criteria are compared two by two and this comparison is not carried out in a network structure. Opinions of experienced individuals are asked, which associate the results to their opinions and judgments. However, the use of the recommended model as a backup system would be very helpful and the accuracy of made decisions would be ensured. Finally, about the results found about environmental impacts of vinyl chloride, application of Expert Choice and AHP technique in the present paper, it can be concluded that using on-the-job training presented by this team, healthy environment, healthy lifestyle and being protected from exposure to environmental impacts of chemicals is possible to take effective steps toward achieving sustainable development. It should be noted that the environmental impacts of a certain activity would be prioritized thanks to environmental education and applying the aforementioned method and software.

Solutions and recommendations

There different methods for removing, mitigating, or controlling environmental impacts to minimize undesirable environmental impacts. For air pollution, the use of hydrogen-rich carbon-based fuels or non-fossil fuels if possible reduces combustion emissions. Checking flare and incinerator for likely reduced efficiency is performed daily, and monitoring exhaust emissions are periodical. The energy of the stack gases is used for preheating

mechanisms. Holding various courses aiming at scientific and applied enhancement, instructing environmental behavior to deal with health, safety, and environmental challenges are essential at various levels. Such courses should be
suited to occupational duties, public knowledge, and educational level. For air pollution control, identification, and analysis of pollutants, a compilation of monitoring, control, mitigation, and removal of the pollutants in sources of pollution, purchase, and installation of air pollution control equipment, and improvement of the process are the most important recommendations. For variations of water quality, dry cleaning methods such as vacuum instead of water, which changes to effluent can be used. Parts of sewage collection and transmission systems such as lagoons, pipes, and canals should be continuously inspected to make sure there is no leakage or they should be repaired timely in case of leakage. Quality and quantity parameters and variations of all created effluents should be determined and groundwater should be regularly monitored. For impacts on economic, social, and cultural environments, a recommendation could be holding conventional and updated courses on HSE and promote employees' awareness about the existing hazards. Optimal operation of sewage treatment facilities, water recycling plans, building canals, and ponds for keeping treated sewage for irrigation of green fields are recommended. Wise planning and management of plantations and the creation of green fields around Petro-chemistry complexes can reduce local pollutions and rehabilitate soil and wildlife habitats. Wet wastes including those made by the restaurant and pantry as well as greenfield residues could be used for making fertilizer of good quality (Sobhan Ardakani, 2018). The following list is periodic educational and applied courses that are recommended for various levels of staff on the environmental impact criteria:

- Sampling and experiments on air and water pollutants
- Sampling and experiments on hazardous wastes
- Sewage treatment management
- Management of storage, collection, transportation, and disposal of hazardous wastes
- Promotion of scientific networks, cooperation, and participation, revision of existing courses, procedures, and approaches to the environmental education
- Compilation of inter and transdisciplinary schemes in the frame of expanding sustainable education
- Sampling and experiments on aquatic sources receiving process wastewaters, the dryer, leaching, and sanitation units twice a week
- Monthly visit of the fleet of hazardous waste transmission
- Monthly visit of reserves and depots of other wastes

The following courses are recommended for protecting and promoting individual health criteria:

- HSE management courses
- Occupational health courses
- ISO standards such as ISO 14007, as soon as the project begins

The following courses are recommended for meeting desirable goals about the destruction of the natural environment:

- Environmental Impact Assessment (EIA)
- Strategic Environmental Assessments (SEA)
- Ecological Impact Assessment
- Ecological Risk Assessment
- Health, Safety, Environment (HSE)

Environmental management

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