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ASSESSING ENVIRONMENTAL EFFECTS OF AROMATIZING UNIT BY COMPARING LEOPOLD, MODIFIED LEOPOLD, AND ICOLD TECHNIQUES

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ABSTRACT

Oil and gas from the early days of their eruptions have served as a driving force to lead the society to progress and development. The scarcity of resources, the environment, and its protection are among the most important issues facing the human community and in particular developing countries such as Iran and the environmental protection is regarded as one of the most serious human problems. Supplying natural gas for industrial and service sectors as an inevitable task in moving toward sustainable development and making economic, socio cultural, and environmental progresses in Iran is a taken-for-granted fact.

Conducting studies to assess the possible effects of development on the environment to achieve basic management solutions in utilizing resources and environmental values with the aim of attaining the sustainable development that is currently taking into account throughout the world is considered as one of the main mechanisms to emancipate human from the current environmental problems. Currently, there are over 422 methods available to conduct environmental assessments. This study assessed the environmental effects of the establishment project of South Pars Aromatizing Unit using checklists, Leopold, modified Leopold, and ICOLD techniques.

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The results confirmed the establishment of this project by considering corrective and management practices.

Keywords: Biologic effects; physical effects; odorous substance; environment; socioeconomic effects.

1. INTRODUCTION

Environmental protection is one of the most important issues faced by the modern world and it is not possible to consider the economic growth without taking into account the environmental protection as stressed by Principle 50 of the Iranian Constitution under the inspiration of Islamic teachings (Abbas Pour, 1992). Oil and gas from the early days of their eruptions have served as a driving force to lead the society to progress and development (Naddaf, 2007). The scarcity of resources, the environment, and its protection are among the most important issues facing the human community and in particular developing countries such as Iran and the environmental protection is regarded as one of the most serious human problems (Qarachorlu, 2005). Development is the result of human activities and each development with whatever level of quality or quantity affects the environment. Although development in the industry brings about serous environmental outcomes, it provides human communities with tools needed to control the environment. Conducting studies to assess the possible effects of development on the environment to achieve basic management solutions in utilizing resources and environmental values with the aim of attaining the sustainable development that is currently taking into account throughout the world is considered as one of the main mechanisms to emancipate human from the current environmental problems. However, sustainable development can be achieved through protecting the environment and natural resources and the rational use of them (Ashraf Zadeh et al, 2009). Assessing environmental effects is one of the most efficient ways that by recognizing the environment and its significance analyzes the potential effects of different sectors and activities done in a project on the components of the environment and ultimately provides mechanisms for making more adjustment through its results (Canter, L. W. 4550). The excessive pollution of the air and environment in recent decades has forced most countries of the world to turn to the use of clean energies. At the turn of the twenty first century natural gas has been considered as the crème de la crème of fossil fuels due to its less pollution and its more advantages compared with other fossil fuels (Gholami et al., 2011). Supplying natural gas for

industrial and service sectors as an inevitable task in moving toward sustainable development and making economic, socio cultural, and environmental progresses in Iran is a taken-for-granted fact. Natural gas mainly contains methane which has no color or smell and it cannot be detected when there is a leakage. To prevent possible threats of natural gas leakage an odorous substance that is one of the sulfur organic compounds as a warning material must be added into it in very insignificant amounts. Therefore, the establishment of South Pars Aromatizing Unities aimed at producing an odorant substance that can be used to aromatize natural gas. Since different activities in construction and operation phases can be associated with destructive environmental outcomes, this study is going to assess the environmental effects of the establishment project of South Pars Aromatizing Unit using checklist, Leopold, modified Leopold, and ICOLD techniques.

2. METHODOLOGY

1. Project description: South Pars Gas Field with an area of 9700 km2 (3700 km2 of which is the Iran's share) contains 48% of the Iran's total gas reservoirs (8% of the world total gas reservoirs). The gas reservoirs of this part of the field are estimated to equal 14 trillion m3 and 18 billion condensate barrels (Petro Gas Co., 2013). Given that the initial feed of the project is sour gas, the place providing the feed must be located in the shortest distance from the project and since the gas produced in South Pars Gas Field contains sulfurous substances it is a suitable feed and thus the proposed place is the first refinery of South Pars Gas Complex Company located in Assaluyeh with a production capacity of 40 thousand condensate barrels, 25 million m^3 gas, and 200 tons sulfur per day (Mohammadi, 2004).

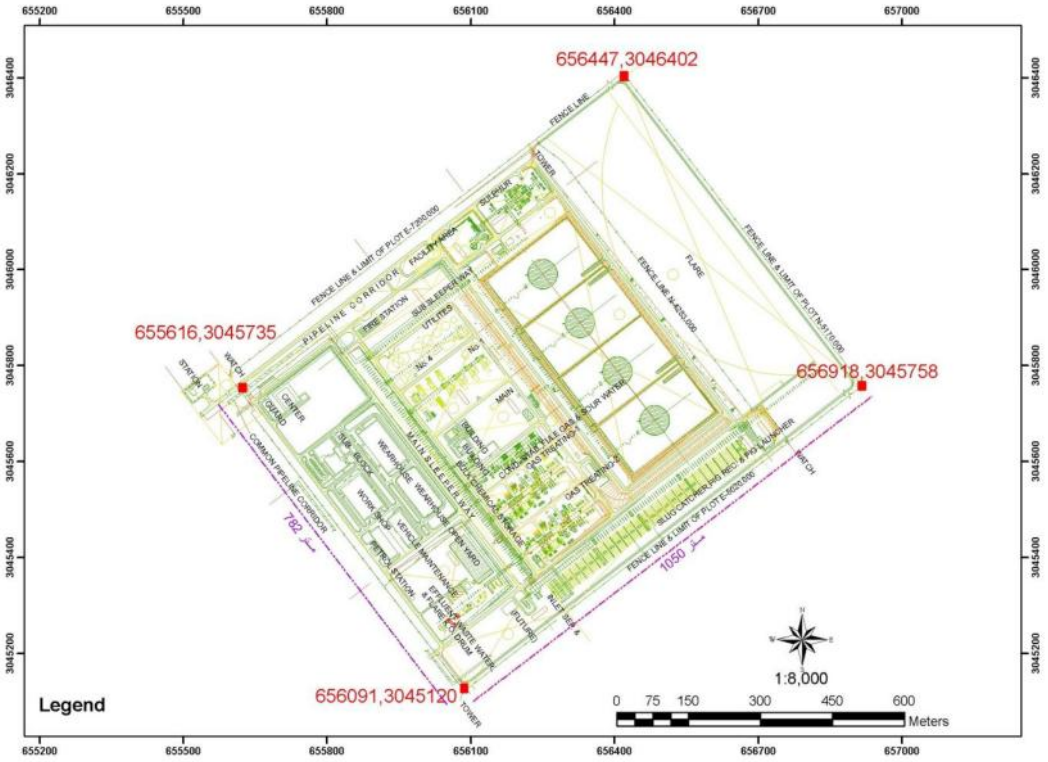


Fig.1. South Pars Gas Field

2. Region under study: Assaluyeh is a huge industrial region located in the east of Bushehr Province near Persian Gulf, 300 km far from Bousheh and 570 km far from the west of Bandar Abbas. It is neighboring Fars Province in the north and Hormozgan Province in the east. The region under study is 100 km far from South Pars Gas Field which is located in Persian Gulf (Qatar's north dome field sequence). The geographical position of Pars Energy Special Economic Zone has considerable advantages such as having the least distance with South Pars Gas Field, the existence of an international airport, direct access to sea water, the existence of infrastructural establishments for trans-regional communication channels, the existence of potential labor in nearby cities and villages, lush nature, and beautiful natural landscapes.

2.1 Physical conditions

2.1.1 Slope

Slope in the region under study is directed southwest. In some parts, the slope of the land is directed to the northwest, southeast and northwest. It should be noted that the dominant slope of the proposed place for the establishment of aromatizing unit is 1 to 3 degrees directed to

southwest so that the place has a slightly greater height in the northern, eastern and northeastern parts.

2.1.2 Water resources

Water is supplied from three resources, i.e. running waters, groundwater, and the Persian Gulf water zone. The running water comes from permanent and seasonal rivers and the only perennial rivers of the province are Mand, Shappo, and Dalaki. The groundwater includes both saline and fresh water. In fact, most of springs in the province are sulfurous and some also have fresh water.

2.1.3 Climate

The region under study is located at tropical (hot and dry) climate. The huge water resources of Persian Gulf waters affect adjacent areas in Bushehr Province and create a balance in temperature and humidity variations. The impact caused the huge differences between the minimum and maximum air temperature in these areas and generally there are no excessive fluctuations of temperature in areas affected by Persian Gulf. The temperature in summer in dry conditions reaches a maximum of 45 centigrade degrees and in humid conditions it reaches 41.5 centigrade degrees. The temperature in winter in dry and humid conditions is 7-8 centigrade degrees. The relative humidity of the region during the whole year is 100%. In addition, as there is a permanent wind blow in coastal areas under the influence of land and sea breezes, they have a constant temperature and moisture exchange.

2.2 Natural conditions

Bushehr Province is characterized by limited plant growth due to its particular climate, inadequate rainfall, and poor soils. Only the plants with the ability of storing water can survive. However, in winters when there is some rainfall, deserts and plains are covered with green meadows and interesting sceneries of wild flowers. Trees in the region are mostly tropical trees with small spiny leaves and deep roots sometimes as long as a dozen meter. Assaluyeh is located at latitude of 27 degrees and a longitude of 52 degrees with average scattered vegetation. Some areas are covered with dense palm and mangrove trees.

2.3 Social conditions

Assaluyeh with large installations of the South Pars has the two towns and 21 villages. However, despite the influx of immigrants and migrant workers these towns and villages do not occupied by immigrants and they have preserved their own indigenous identity due to their cultural

context. Side installations of South Pars as managed by Pars Energy Special Economic Zone are located in the vicinity of 13 villages in Assaluyeh.

3. STEPS FOR PRODUCING AROMATIZING SUBSTANCE

A. The feed is prepared and it is undergo per- alkalization to separate hydrogen sulfide and carbon dioxide.
B. Extracting mercaptan from the feed using 10% WT solution
C. Separating aromatizing substances form C1-C2 solutions with a low boiling point by distillation
D. Drying through absorption
E. Preparing alkaline and catalyst solution
F. Treatment of consumed caustic materials
G. Waste neutralization

4. WAYS TO ASSESS THE ENVIRONMENTAL IMPACT OF THE PROJECT

Over 422 techniques have been invested so far to assess environmental effects. In fact, before choosing a given alternative, a thorough analysis of environmental outcomes of all alternatives is required so that to choose the one with the minimal environmental consequences and optimal technical and economic advantages (Farashi&Farashi, 2008). Environmental effects are changed made through different human activities in physical, biological, economic, social, and cultural environments. These effects that may occur in different time periods are assessed in terms of construction and operation aspects. To identify significant environmental effects, environmental factors that must be taken into account in studies on environmental aspects of projects are physical-chemical, biological, and social economic factors. It should be noted that different parameters are considered for each of the above cases. In order to deal with environmental affects in a logical and organized way and make appropriate decisions, environmental effects of different projects are classified and are used in environmental analyses. The present study used 10 main process including screening, setting boundaries, determining techniques, collecting data, public participation, data analysis, choosing alternatives, compensatory measures, controlling and monitoring, and reporting the results (Phillips, 2001). Environmental components were also divided into three general biological, physical, and economic, social, and cultural categories. The

study was conducted through field visits and the data were collected through different sources. In order to assess the positive and negative effects of different methods, the following matrixes were used:

1. Leopold
2. Modified Leopold
3. ICOLD

4.1Leopold matrix

Among the methods used in Iran, matrix is one of the popular methods used very frequently and its efficiency has been proved in many research projects. This mated was developed in the late 1960s by Leopold as a technique that considers all environmental outcomes of a given projects and it was approved by the US Environment Act (Piri, 2011). One of the advantages of this matrix is that is sums up positive and negative consequences of a project. In this study, the severity and scope of physical, biological, and socioeconomic effects in two constructional and operational phases were assessed using Leopold method.

Table 1. Leopold matrix

Scope			**Severity**					
Statement	Value	Range	Statement	Value	Range	Statement	Value	Range
Excellent	+5	+5 to +1.4	Excellent	+5	+5 to +1.4	Stressed	1	0 to -1
Good	+4	+4 to +1.3	Good	+4	+4 to +1.3	Disorganized	2	-1.1 to -2
Moderate	+3	+3 to +1.2	Moderate	+3	+3 to +1.2	Confused	3	-2.1 to -3
Acceptable	2+	+2 to +1.1	Acceptable	+2	+2 to +1.1	Wasted	4	-3.1 to -4
Insignificant	+1	+1 to 0	Insignificant	+1	+1 to 0	Failed	5	-4.1 to -5

4.2ModifiedLeopold

Modified Leopold matrix or the Iranian matrix is used as an alternative to assess the environmental effects. The original version of the matrix failed to assess the effects of development in Iran. To match the adjectives in Persian, the valuation scale of the matrix was modified (Makhdum, 2009). Structural simplicity and multi-criterion assessment applicability is among advantages of the matrix. In order to distinguish undesirable effects, positive and negative signs can be used with assessment values. Through the interaction of activities and the components of the environment, the matrix diameters were drawn and the intensity of positive and negative effects was written in each matrix cell. Finally, the number of positive values, the ration of positive values to the algebraic sum of values, and the rating means were calculated. The positive values reduce the negative values in the matrix. All influential activities and affected environment factors were scored. Finally, the rating means of columns and rows was used as a basis for judgment and decision making. The factors were rated using a scale of -5 to +5 in the modified matrix. In fact, the modified Leopold matrix was used to assess the environment effects of the project under study in constructional and operational phases as this matrix can describe the position of the region and the project under study. The following five cases were tested to confirm or reject the project:

1. There is no rating means less than -3.1 in the matrix columns and rows.
2. If the number of rating means is less than -3.1 either in columns or rows is greater than 50% the project is rejected.
3. There is no rating mean less than -3.1 in each column and if there are some rating means less than -3.1 but their number id less than 50%, then the project is confirmed by implementing optimization plans for those environmental factors whose rating means are less than -3.1.
4. There is no rating mean less than -3.1 in each row. However, if there are some rating means less than -3.1, then the project is confirmed by implementing optimization plans for those environmental factors whose rating means are less than -3.1.
5. There are some rating means less than -3.1 in some columns and rows. In this case, the project is confirmed by implementing optimization plans and taking corrective measures.

4.2 ICOLD matrix

This matrix is one of the methods that can be used to express the qualitative results of environmental assessment of the project in quantitative terms (Falahatgar et al., 3010). The matrix assess the effects of the project activities on environmental factors in the area under study in construction and operation phases in physical, biological, and socioeconomic environments and the magnitude of the effect is scored using a scale of -3 to +3. The matrix contains several columns and rows. The columns contain micro-environmental factors identified in the previous stage and the rows represent micro-activities done in the project (Karimi et al., 2008).

Effect types: Positive and negative signs (+ and -) shows the favorable and unfavorable effects of the project.

Effect consistency: The effects that occur at a given time period and are not consistent are temporary effects and are shown by T. in contrast, the effects that exist permanently or periodically in the long term are permanent effects and are shown by P.

Occurrence time: All effects occurring as a result of implementing a project do not happen simultaneously. Some may occur immediately or after a short time when an activity is started while some may occur in loner terms. In ICOLD matrix *I*, *M*, and *L* are used to refer to immediate, mid-term, and long-term effects, respectively.

5. RESULTS

1. Assessment by Leopold

The results through the assessment made by the following checklist on physical, biological, and socioeconomic environments in the construction and operation phases are presented as follows:

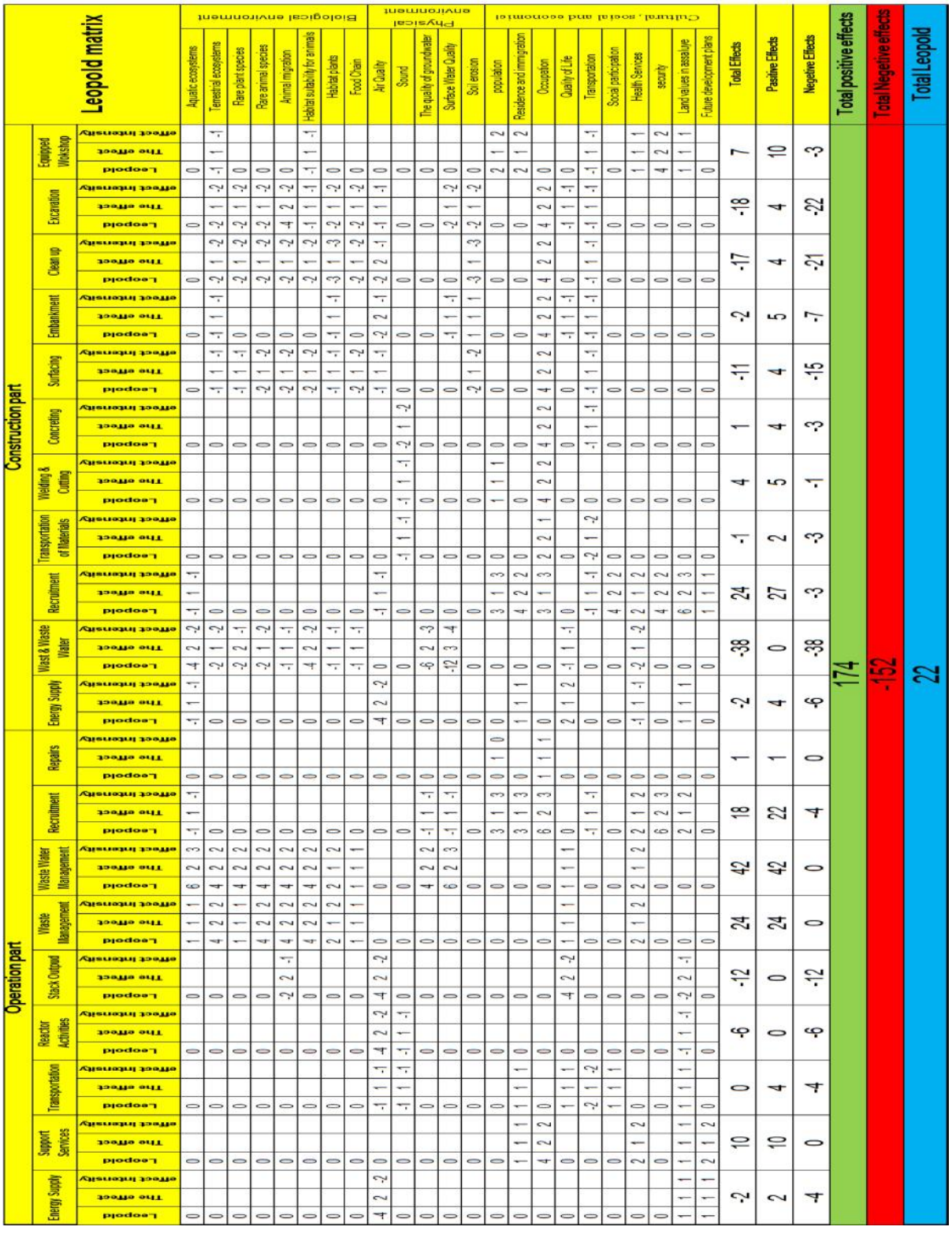


Fig.2. Assessment checklist

2. Assessment by modified Leopold

The results through the assessment made by the following checklist on physical, biological, and socioeconomic environments in the construction and operation phases are presented as follows:

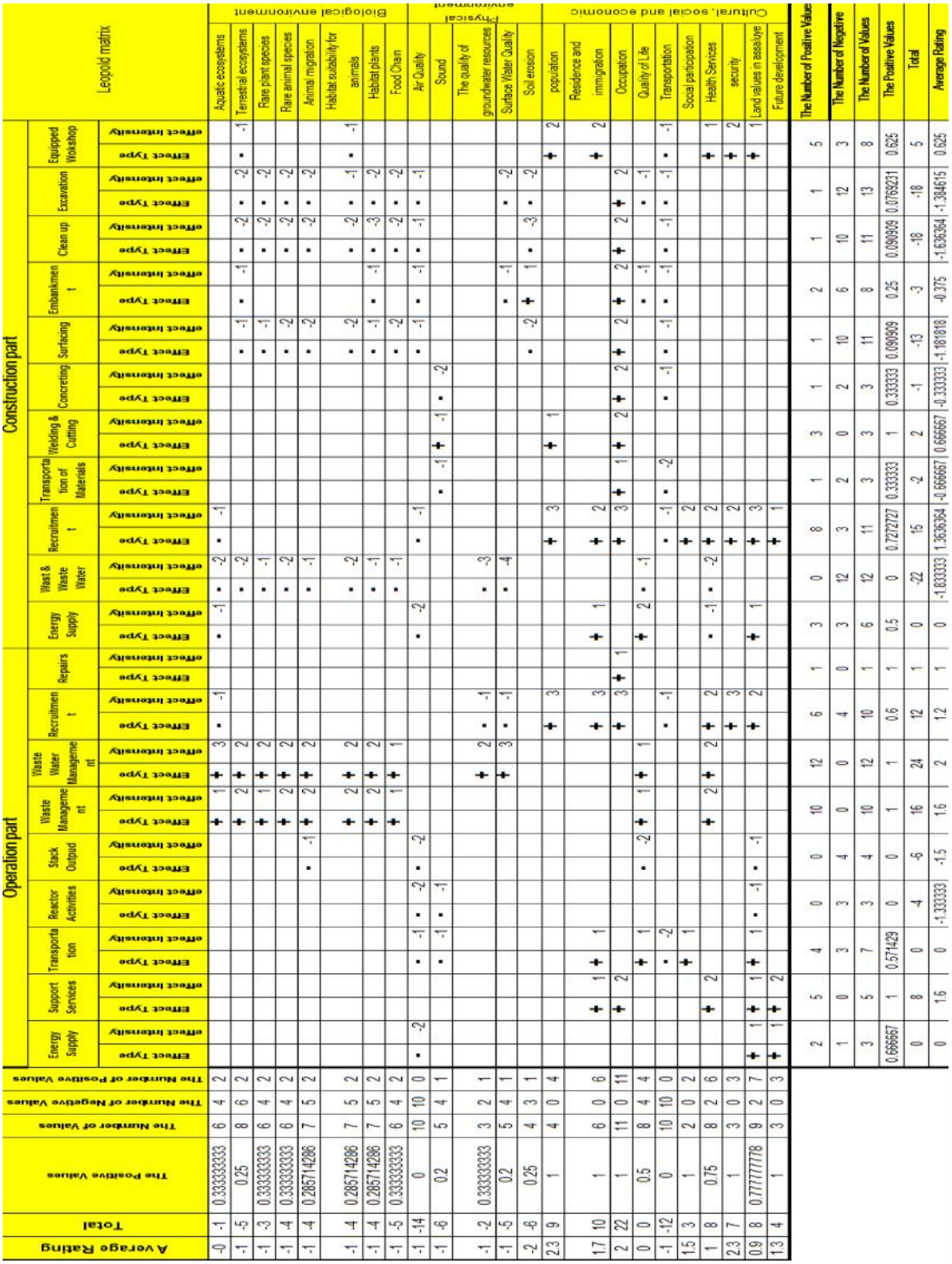


Fig.3. Assessment checklist

2. Assessment by ICOLD matrix

The results through the assessment made by the following checklist on physical, biological, and socioeconomic environments in the construction and operation phases are presented as follows

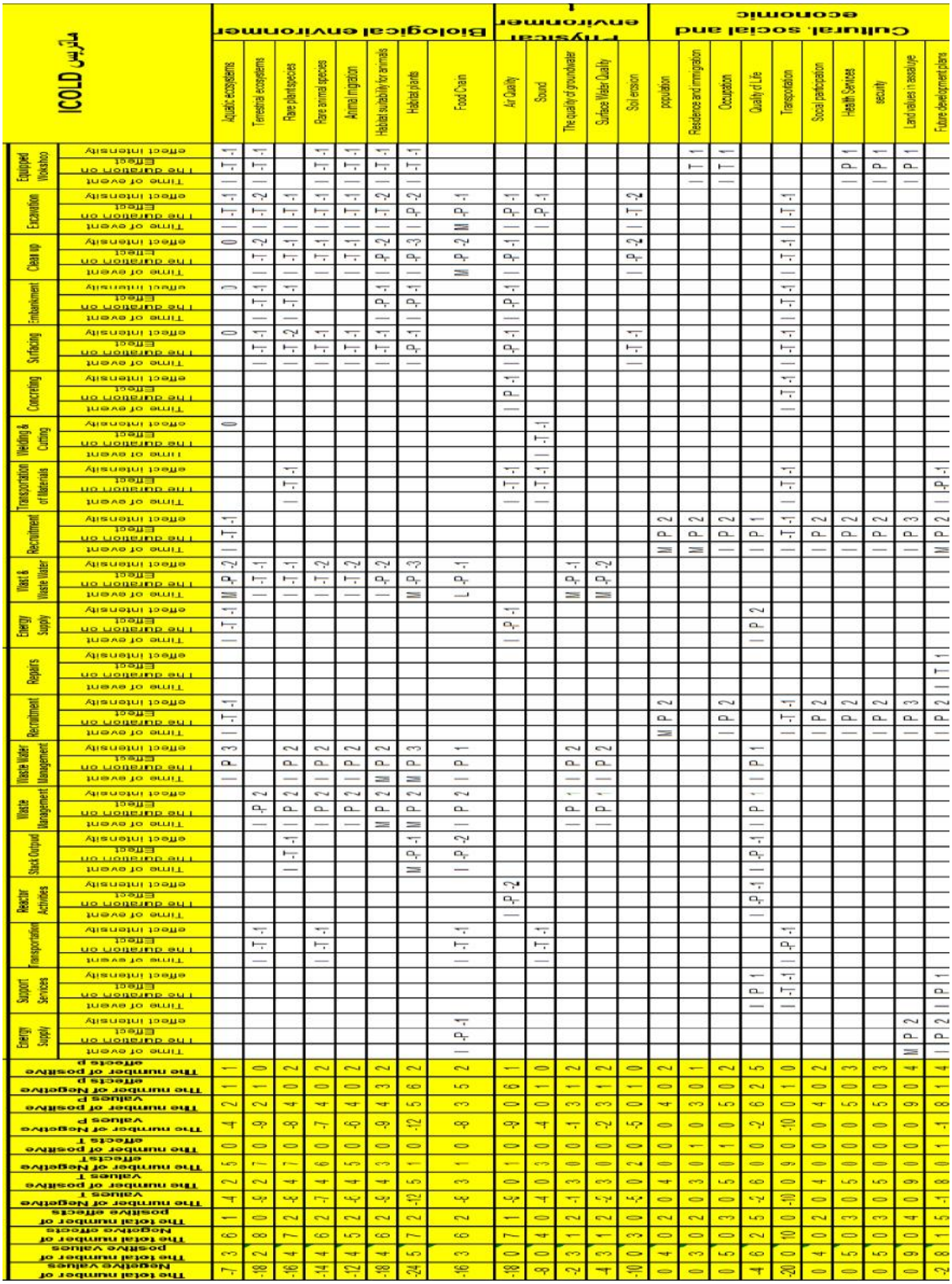


Fig.3'. Assessment checklist

6. CONCLUSION

1. Assessing results through Leopold

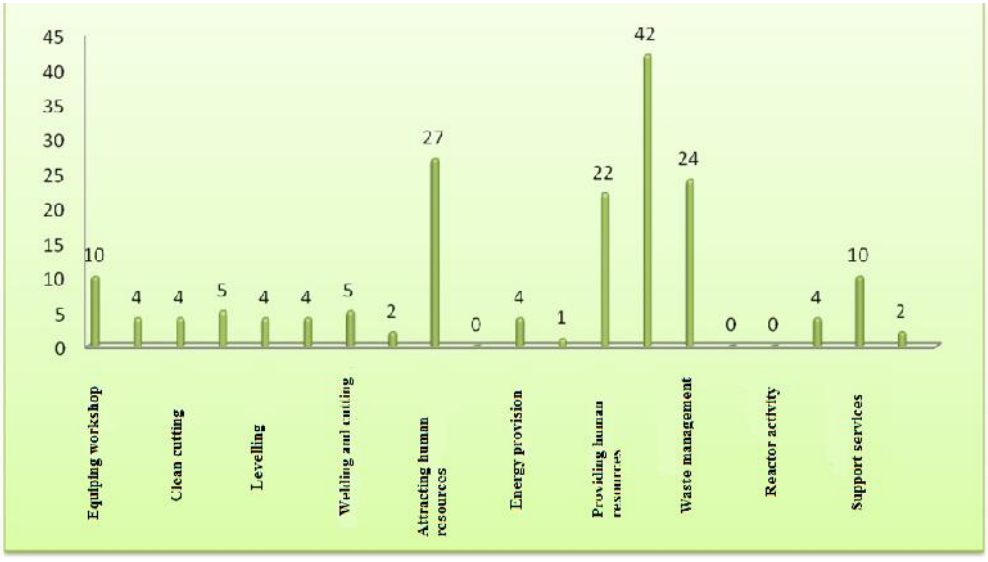


Fig.4. Positive effects

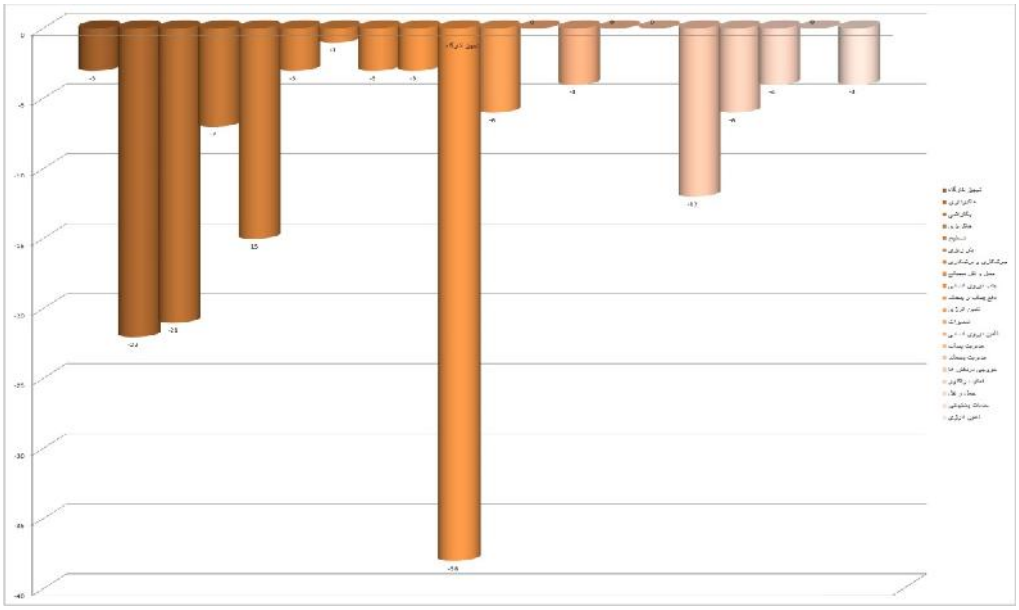


Fig.5. Negative effects

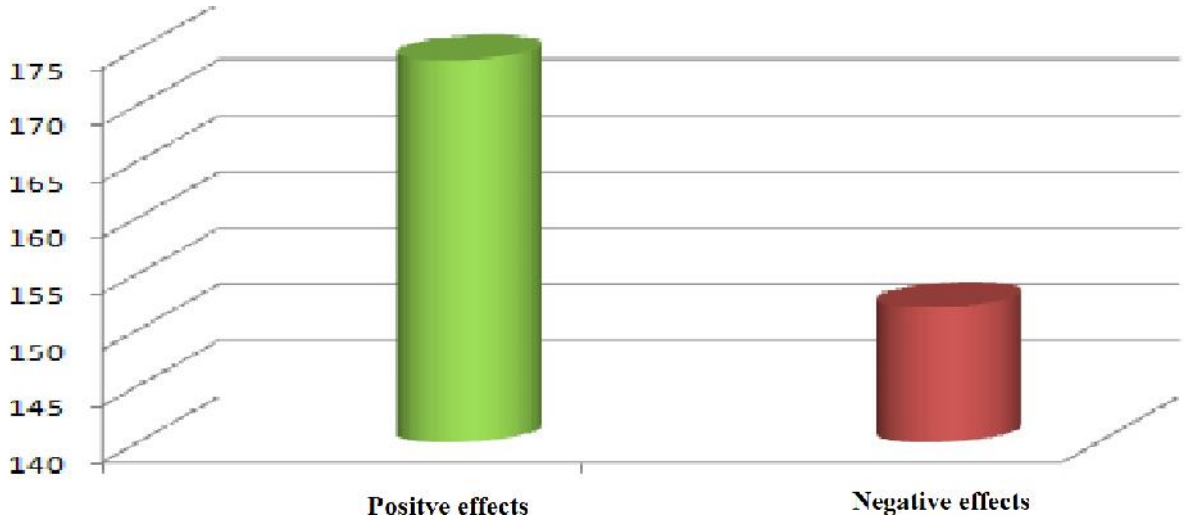


Fig.6. Final results

Given that positive effects are in sum greater than the negative effects, the project is acceptable and applicable according to Leopold matrix.

2. Assessing results through modified Leopold

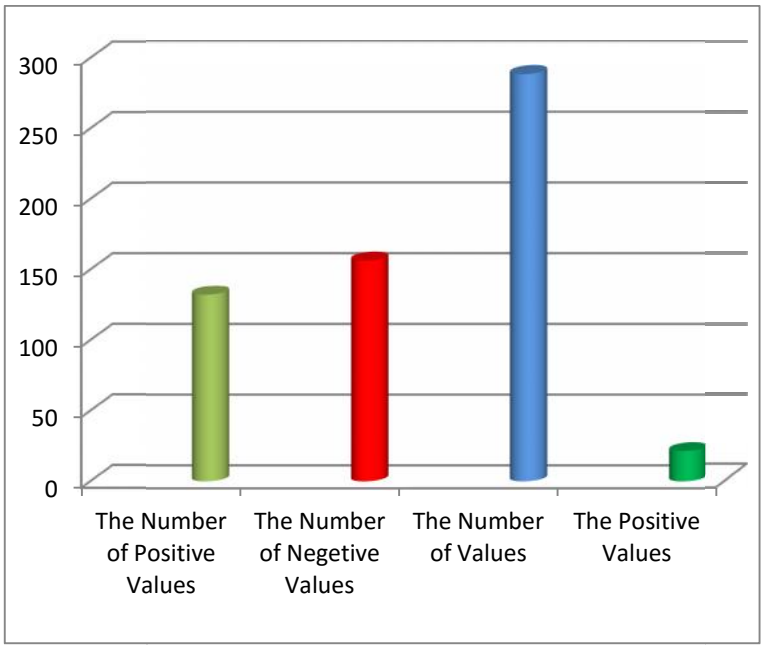


Fig.7. Values

Considering that there is no rating mean less than -3.1 in all columns and rows, the project is acceptable and applicable according to modified Leopold matrix.

3. Assessing results through modified ICOLD

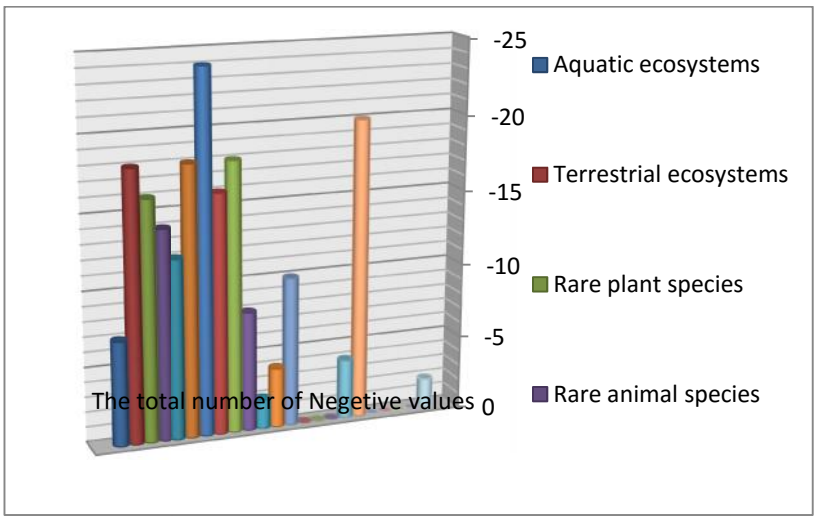


Fig.8. Negative effects

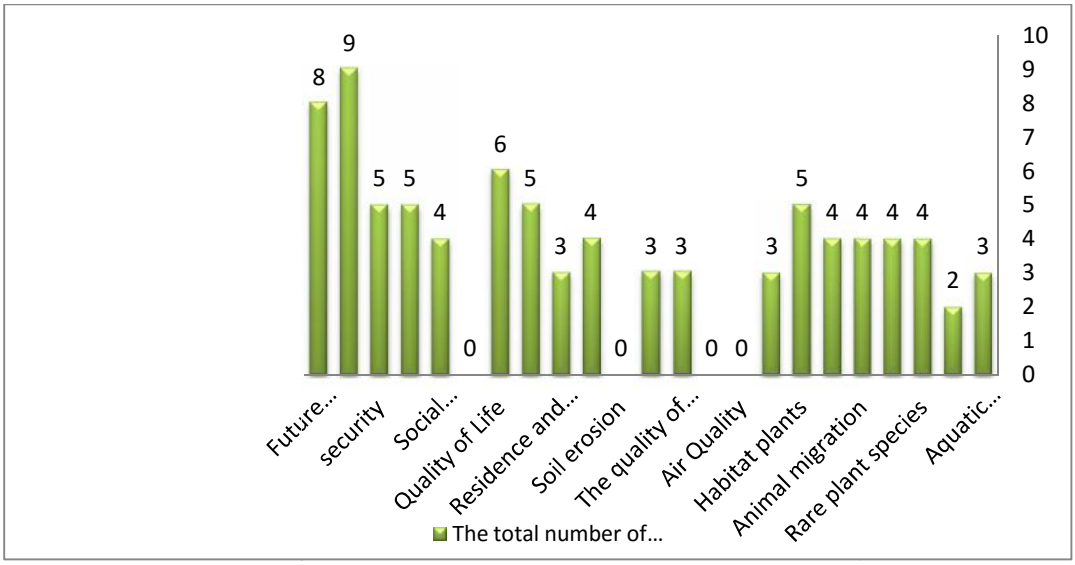
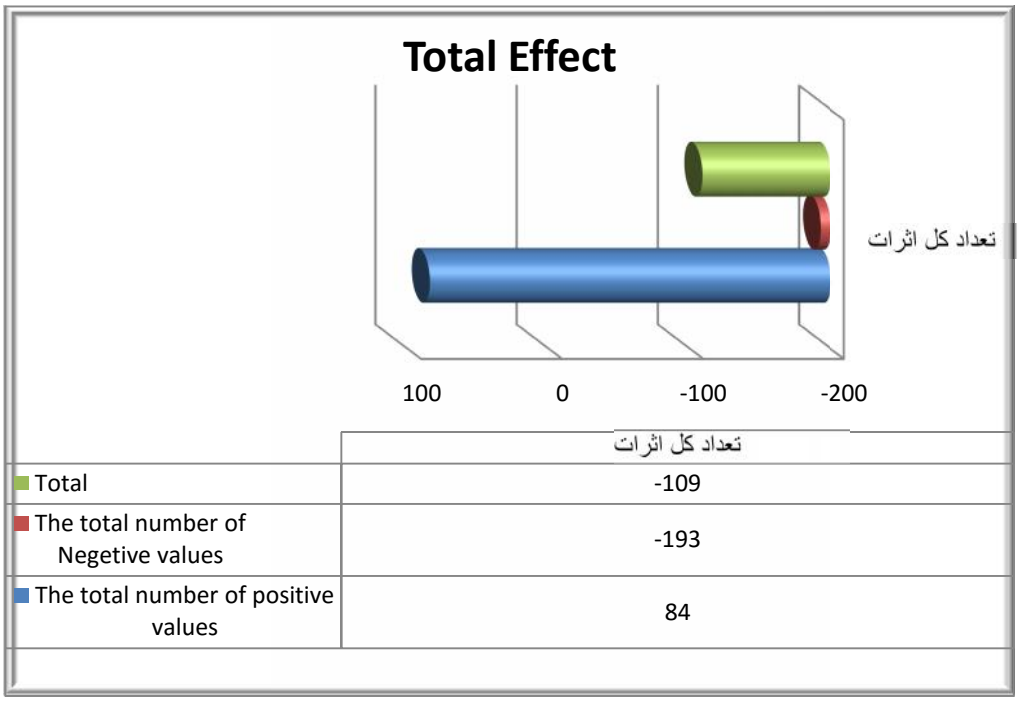
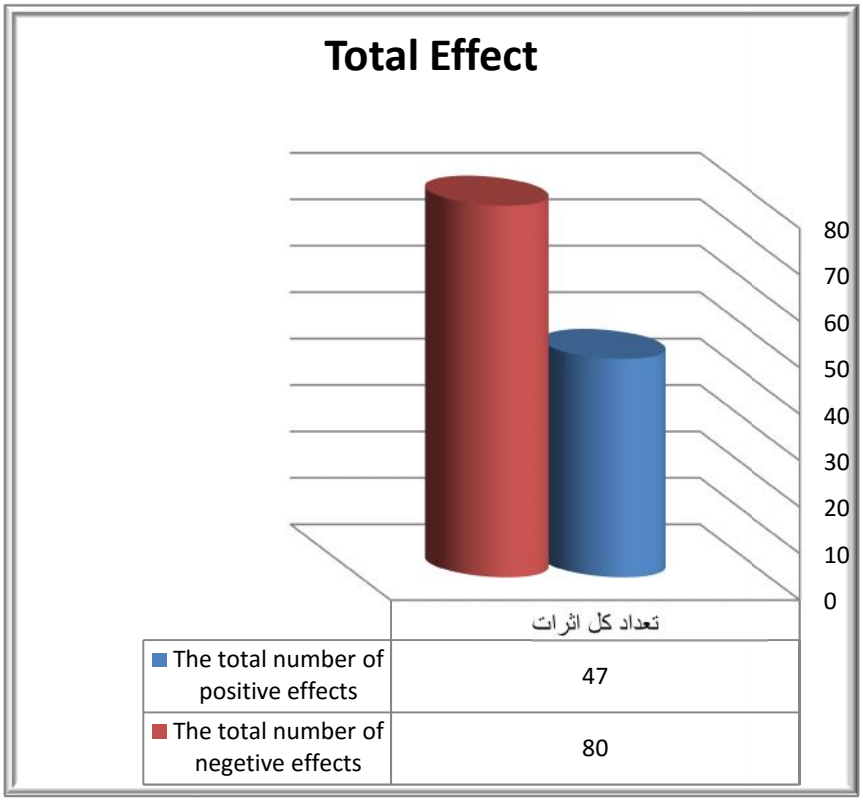


Fig.9. Positive effects



	تعداد کل اثرات
Total	-109
The total number of Negetive values	-193
The total number of positive values	84

Fig.9. Total effects



	تعداد کل اثرات
The total number of positive effects	47
The total number of negetive effects	80

Fig.10. Number of effects

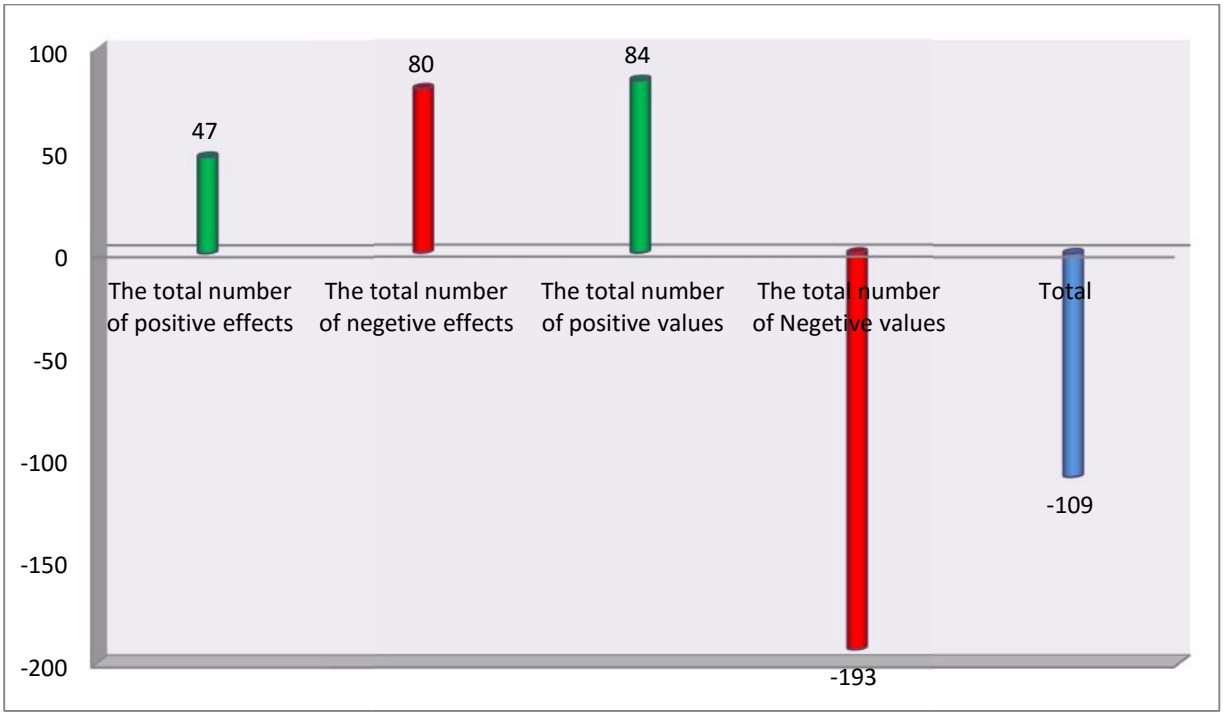


Fig.11. Final results

Since the results of assessment by ICOLD is -109 and is greater than -500, the project is considered acceptable and applicable.

4. Assessment of the effects and the affected environment

Following tables shows the effects imposed on the environment

Table 2. Effects and the affected environment

No.	Environment influenced by negative effects	Possible causes
1	Water ecosystems	Wastewater discharge
2	Terrestrial ecosystems	Wastewater discharges, spills, and gas release
3	Food chain	Wastewater discharges, spills, and gas release
4	Air quality	Gas spills and release
5	Surface water quality	Wastewater discharge

4. Necessary measures to prevent, reduce, and control wastewater discharges and gas spills and release

Table 3. Actions required

Measures taken by officials		Measures taken by employees
Management measures	Technical/engineering measuring	Compliance
Training employees	Selecting type of equipment	Reporting problems
Preparing correct regulations	Using appropriate storage tanks and their accessories	Keeping places clean and without pollution
Preparing work safety	Selecting proper pumps and mercaptan filters	Not entering dangerous places
Preparing crisis management plan	Selecting appropriate pipes and fittings	The availability of leakage disposal equipment
Installing SOS phone systems	Installation of proper ventilation systems	
Monitoring and maintenance	Determination of pipeline boundaries	
Installing online wastewater monitoring systems	Installing alarm systems for gas leaks	
Development of green space by 15%	Installing alarm and fire extinguish systems	
How to report and select those who receive monitoring results	Cathodic protection in accordance with standards	
	Designing cutout systems	
Creating a central control room	Procurement of all equipment needed for emergencies	
	The use of signs and warning signs	

Table 4. Actions required for wastewater and gas leakage

Measures taken by officials	Measures taken by employees
Blocking the leakage channel when it is possible without creating a danger	People who are exposed to direct liquids must use appropriate glasses and other protective equipment to protect their eyes and use impenetrable plastic gloves to protect the skin of their hands.
Transferring unnecessary people until the pollution is removed.	
Covering leaking area with closed-cell foams in order to mitigate the leakage effects	
The use of liquid adhesive materials, such as diatomaceous soil and collecting mercaptan residuals from the ground	
Using a 5% disinfectant solution (sodium hypochlorite) in a solution diluted with a ratio of 50% in the event of a large leak	
If there is a leak in the system, the leakage place should be blocked immediately.	If there is a leak, non-expert persons must immediately leave the scene.
If the leak is small, the stench should be removed by 5% disinfection solution. Spray the products (solutions) on the emission site. Then the place should be washed with water.	In case of contact with mercaptan steam, your hands should immediately be washed with soap and water for 10 minutes.
The use of the enzymatic or bacterial deodorants	

5. The proposed general project management plan

General environmental reports are considered as very important connection channels among industries, owners of production, service, and development activities and the community as a whole. The project executors and operators are required to prepared and publish such reports to independent environmental management systems and for increasing the responsibility of the affected people by the project toward the protection of the environment. The main actions proposed for the environmental management of the project under study are as follows:

- Establishing the environment office, selecting personnel, and assigning tasks in aromatizing unit.

- Preparing self-inspection programs, understanding all aspects and details of each section of the project by its practitioners, knowing the optimum conditions, compliance with standards, and creating the best organizational conditions
- Providing special and general trainings related to public health and safety and environmental requirements (In addition to providing training and general awareness raising programs as the responsibility of those who are in charge of the project, people employed in the project should take the responsibility of reducing and controlling pollutions from the source and implementation operations as a permanent principle before starting their tasks and when doing them. Providing training on how to perform tasks in a sympathetic and organized way brings about positive results for the project executors and results in the social satisfaction in terms of reduced environmental accidents).
- Develop green spaces and promenades can result in the increased public satisfaction.
- Providing support resources (such as basic, high, and low consumption commodities) from the local markets will lead to the economic boost and the formation of economic businesses in the region.
- Attracting expert labor with 50% priority given to local residents must be taken into account.
- Service employees must be only recruited from local residents.
- Capacity building, holding elementary, basic, and advanced workshops to train employees and increase their knowledge in different sections such as safety workshops, impact assessment workshops, environmental and professional health workshops, and providing specialized trainings for selected employees must be taken into account.
- Determining stations and equipment used and designing a reward system
- The most important environmental concerns of the aromatizing unit are propyl mercaptan and butyl mercaptan,environmental monitoring program will be devised accordingly.

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