Environmental Impact Assessment management strategies with complex outcomes: Fuzzy AHP-GIS evaluation of Iran oil refineries using an integrated agent-based model of a Tehran oil refinery

Mohammad Rezaie Narimisa*
Iranian Social Security Organization, Azadi St, No 345, , PO.BOX; 1457965595

Manouchehr Rezaie Narimisa
Oil Industries Engineering and Construction Company (OIEC)-Iran, Kamranieh, Pasha Zahri, Pirooz Alley, No 2, PO.BOX; 1937956751

Abstract

The problems that studied in this project are for EIA of oil refineries in Iran same as Tehran oil refinery and geographical area around it, villages and towns. The problems in details studied in the EIA frame work are environmental protection from damages, ensure there is sufficient information for decision makers, environmental information are considered in decisions, coordinate environmental policy, public involvement in all phases, promote popular participation in government decisions, economic performance. In this paper, an analytical hierarchy process (AHP)-fuzzy and Geographic Information System (GIS) have been considered to evaluation approach to Tehran oil refinery multi-criteria decision making for final EIA of oil refineries in Iran as sample. The Environmental Impact Assessment of oil refineries in Iran is based on the evaluation of environmental impacts reports, field study assessments, environmental monitoring and decision-making process. In final process of EIA for case study 1024 maps were provided and final maps for four years between 2008 to 2011 EIA studies in two phases as construction and operation in four separated parameters of such as; economical, environmental, land use and social. Then all layers collected and put on together to provide final EIA map of the case study as a sample for all oil refineries in Iran.

Keywords: Iran, Environmental Impact Assessment (EIA), Tehran oil refinery, Analytical Hierarchy Process (AHP), Geographic Information System (GIS).
Introduction
The development and implementation of a three-stage EIA process involving: (1) preliminary screening of proposed undertakings; (2) environmental assessment of those proposed developments deemed to have potentially significant effects during the initial screening stage; and (3) environmental impacts review in those circumstances in which large-scale public consultation and detailed technical reviews are required to determine impacts and project suitability (Armitage 2005). The concept of defensive expenditures could be used to assess social responses to adverse changes in environmental and resource conditions, as a means to distinguish stages in which local sectors respond individually from qualitatively different stages in which intersectoral events are more noticeable (Escofet & Bravo-Pena 2007). Generally speaking, decision-making divides broadly into three levels: policy, plan/program, and project. The EIA was supposed to be a tool for both preventing damage to the environment and the early integration of environmental considerations into decision-making (Feldmann 1998). The increasing awareness of the findings of policy and decision making theory in the environmental assessment community has recently led to an intensifying debate on the theoretical foundations and the appropriate practical use of strategic environmental assessment (the SEA) (Fischer T.B., 2003). This means that the future Environmental Impacts Assessment (the EIA) procedures applied to each specific road and railway project in this infrastructure plan, in the areas indicated as ‘critical’ in the screening, have a high probability of obtaining a negative EIA declaration from the independent environmental bodies, which will compromise the legal feasibility of these particular projects (García-Montero et al. 2010). However, in order to assess the global impact of these plans, the SEA must analyze other aspects related to the future use of the infrastructure network, including the overall impact on energy resources, contamination and climate, changes in demographic distribution, and the alteration of the socio-economic balance of the territory under question (Garcia-Montero et al. 2008). The potentials of environmental assessment as a sustainability instrument has long been recognized, but the criteria against which the development proposals traditionally are judged are not necessarily the criteria for sustainable development (George 1999). Moreover, the EIA system under the EU Directive is undergoing review by the European Community, and there may well be some major amendments to the directive as a result of this review. These different factors will make the next 10 years of the EIA practice in Ireland not only interesting but very challenging (Geraghty 1996). Environmental impacts assessment and strategic environmental assessments are essential instruments used in physical planning to address such problems (Gontier et al. 2006). Furthermore, it would be beneficial to carry out research on what kinds of buildings are assessed, and compare the quality of assessed buildings to the existing building stock (Haapio & Viitaniemi 2008). Traditionally, environmental problems have been most focused at large point sources, e.g. industrial plants, power plants, mining areas etc (Hanssen 1998). Scoping is a crucial yet less-researched-on stage of environmental impacts assessment, in which practicality falls well behind conceptual ideals. We argue that such implementation deficits reflect dilemmas between two key rationales for scoping—environmental precaution and decision-making efficiency—and between technical and participatory conceptions of the decision-making process (Snell & Cowell 2006). The role of the EIA authority is central to the EIA process and to the permit-granting processes. A developer must take into account all the aspects addressed in the authority’s statement (Soderman T., 2006). Through the EIA system, it was hoped to expand the provision of green fields in land development, to minimize topographical changes due to construction, and to allocate additional
protected areas in large scale tourist developments (Song & Glasson 2010). In conclusion, the development and application of such a multi-criteria methodology forms a sound scientific base for an overall and more integrated socio-environmental planning in relation to population, urban structure, green and infrastructure network of shrinking cities (Schetke & Haase 2008). The results of an EIA can help an organization to diagnose the occurrence and seriousness of various environmental impacts that may determine its performance (Pun et al. 2003). The EIA research agenda must evolve and mature if this globally significant decision tool is to fulfill its potentials (Cashmore 2004). The ideas reflected in the proposed model also forms the basis for the assessment criteria consolidated in a Review Protocol and an Evaluation Package which can be used as a tool and a benchmark for assessing the practice of incorporating the RA into the EIAs of high profile projects (Demidova & Cherp 2005). Such learning may conceivably prove to be of equal significance as environmental assessment’s more direct contributions to transforming development plans (Cashmore et al. 2008). The reason for examining documents other than just the EIS was to get a better picture of the EIA process as a whole, rather than just what was reported in the EIS (Cooper & Sheate 2002). These methods usually display extensive databases and fragile qualification instruments to support stakeholders’ decisions (De Siqueira & De Mello 2006). In recent years, the above-said department under the new name of “the Deputy Office for Human Environment” has been re-established. This department is in charge of executing supervisory regulations related to environmental impacts assessments of plans and projects (Dabirie 1994). Boilers and turbines also release particles that are directly proportionate to the quality of fuels used (Roshanzamir 1991). Refineries produce a lot of solid waste materials (Aghaie, 1986). One of the ecological problems of refineries that are in coastal areas is their adverse impacts on marine ecosystems (Bahoush 1991). In different processes of production done in coking and catalyst units’ sour water containing phenol, ammonia and hydrocarbons are produced (Golestan, 1985). The main pollutants are sulphur oxide, nitrogen oxide, carbon monoxide, aldehydes, ammonia, particles and hydrocarbons (Jaafarzadeh, 2001). Another source of pollution can be releasing water used for cooling purposes, water used for washing purposes, leakage of substances from tanks, pipelines and loading places (Ghanizadeh, 2001). Hydrocarbons emitted from refineries are the main cause of pollution. They are emitted either from chimneys or from reserve tanks. Some hydrocarbon emissions are the result of evaporation (Sarfehnia 1993). The existing EIA system focuses primarily on the treatment of pollutants after their generation, rather than on the prevention of pollutants before they are created, it encourages enterprises to continue their reliance on the EOP treatment (Chen et al. 1999). Finding financial sources, experts and institutional capacities for this will be only one of the helpful tasks (Branis & Christopoulos 2005). This is an aspect of both impacts assessment and effectiveness evaluation theory that is critically under-developed (Cashmore et al. 2010). Environmental assessments (the EAs) refer to preliminary studies conducted within the environmental impacts assessment (the EIA) process in the United States; such studies are used to determine the significance of anticipated impacts of proposed actions (Burris R. K., & Canter L. W., 1997). Environmental impact assessments (the EIA) are considered as important tools for the assessment of the impacts of human activities (Cartalis et al. 2000). Seen this way the IA is primarily used to gather knowledge that supports the outcomes of the continuous negotiations of the Commission’s proposals (Backlund 2009). Environmental impacts assessment can be defined as the process of predicting and evaluating the effects of an action or series of actions on the environment (Baratto et al. 2005). Natural resources are in general considered the “inputs” to
impacts assessment studies (Bare & Gloria 2008). The Guidelines include a standardized approach to evaluating social impacts that might occur throughout the 4-phase life cycle of a typical industrial or dangerous facility, including: (1) planning/policy development, (2) construction implementation, (3) operation/maintenance, and (4) decommissioning/abandonment (Bass 1998). Human activity has an inevitable impact on the environment and this impact is generally negative. It is unquestionable that society is increasingly aware of the state of the surrounding environment, since it forms the basis for all human activities (Blanco Moron et al. 2009). Process industries involve handling of hazardous substances which on release may potentially cause catastrophic consequences in terms of assets lost, human fatalities or injuries and loss of public confidence in the company (Kalantarnia et al. 2010). Hydrocarbons are among the most important air pollutants that are emitted by petroleum refineries, since they are involved in almost every refinery process (Kalabokas et al. 2001). Environmental impacts assessment (the EIA) is a procedure for assessing the environmental implication of a decision to enact legislation, to implement policies and plans, or to initiate development projects. It has become a widely accepted tool for environmental management (Ramanathan 2001). This would increase the weight of the EIA related arguments in the national appellate procedures and contribute, in some cases significantly, to the substantive influence of the EIA in decision-making (Polonen 2006).

The association of the EIA with other environmental management tools, such as environmental management systems or environmental performance evaluation, and sustainable development initiatives will be a priority challenge for all who are engaged in this domain (Ramos et al. 2008). Looking to experience in planning, then, might help in providing insights into some of the conceptual problems faced in environmental assessments (Richardson 2005). Once the objectives are set, there should be a systematic screening of options on purely environmental factors in the EIA process involving land use planning, where wetlands were threatened by settlement sprawl, for example (Ruddy & Hilty 2008). This constitutes the evaluation process that involves the aggregation of the individual assessments to a total assessment on the basis of a logical decision or process (Sankoh 1996a). African countries and the majority of developing countries in the world have not been able to adopt or have never considered adopting a formal EIA (Sankoh 1996b). These limiting indicators can then be used to define exploitation limitations and carrying capacity constraints to define economic development strategies that are environmentally sustainable and economically viable (Schultink G., 2000). In community-based approaches to the EA, a participatory forum facilitates a process of communal dialogue and collective decision making that includes: the development of goals, the sharing of knowledge, negotiation and compromise, problem-posing and problem solving, the evaluation of needs, the definition of goals; and research and discussion usually around questions of justice and equity (Sinclair et al. 2009). Industrial ecosystem is an important approach for sustainable development (Singh et al. 2007). The findings from this study and future research will be important as practitioners consider opportunities for implementing environmental review alleviation and varying approaches to integrating planning and environmental review processes (Slotterback 2008).

-Tehran oil refinery
Oil refinery and environment interactions were studied given the size of the job and environmental features in the framework of different units of an oil refinery (executive, constructional, operational and processing) and different environmental (physical, biological,
socio-economical and cultural) parameters. The major environmental impacts and consequences of oil refineries include gas emissions, effluents, solid wastes, noise, odor and negative visual and aesthetic impacts (Ardalanie, 1989).

The following are the details of the oil refinery facility of the case study:

Name: Tehran Oil refining Co.
Date of establishment: 1965-1968
Date of operating: 1969 (South refinery)-1973 (North refinery)
Nominal capacity: 220,000 barrels per day
Operational capacity: 240,000 barrels per day
Feed: Light crude oil of Ahvaz–Asmari oil field, crude oil of Maroon/Shadgan, Middle Asia
Production units: Crude oil distillation, viscosity control unit, liquid gas recovery, gasoline hydrogenated refining and gasoline conversion, hydrocracker, Hydrogen, Nitrogen, Sulfur recovery, Amine gas treatment (Khosravanie, 2001).

Table 1. Tehran oil refinery productions

<table>
<thead>
<tr>
<th>Product</th>
<th>Capacity (1000 liter per day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid gas</td>
<td>1259</td>
</tr>
<tr>
<td>Gasoline</td>
<td>1700</td>
</tr>
<tr>
<td>Jet fuel</td>
<td>6989</td>
</tr>
<tr>
<td>Light Naphta</td>
<td>383</td>
</tr>
<tr>
<td>Kerosene</td>
<td>3442</td>
</tr>
<tr>
<td>Gas oil</td>
<td>12872</td>
</tr>
<tr>
<td>Furnace oil</td>
<td>7549</td>
</tr>
<tr>
<td>Crude engine oil</td>
<td>1878</td>
</tr>
<tr>
<td>Bitumen production feed</td>
<td>2160</td>
</tr>
</tbody>
</table>

Source: Iranian petroleum ministry

Material and methods

1. Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a multi-criteria decision making tool for dealing with unstructured, complex and multiple-criteria discrete decisions (Partovi, 2007). AHP has been successfully applied to a diverse array of problems (Chang et al., 2009). The use of AHP is suggested to solve the problem of independence among alternative or criteria (Dagdeviren et al., 2008). The basic theory of AHP is the condition of functional independence of the upper part, of the unidirectional hierarchy, from all its lower parts, and from the criteria or sub-criteria in each level (Dagdeviren et al., 2008). AHP is easy to use but it is strong, such that it can handle the complexities of real-world problems.

AHP is a technique that decomposes a problem into several levels of components in such a way that they form a hierarchy. The top element of the hierarchy is the goal for the decision making (Erdogmus et al., 2006). The elements affecting the decision are called criteria, and the criteria can be subdivided into sub-criteria. The lowest level comprises the alternatives as shown in Figure 3.6 (Partovi, 2007). Decision making begins the prioritization procedure to determine the relative importance of the elements in each level. Elements in each level are compared pair-wise with respect to their importance to an element in the next higher level in a hierarchical structure. Starting at the top of the hierarchy and working down, a number of square matrices (preference matrices), are created in the process of comparing elements at a given level (Partovi, 2007).
Furthermore, this approach assists the user to appraise the importance of each criterion in relation to the others in a hierarchical structure (Li & Li 2009; Levary & Wan 1999). After forming the preference matrices, the composite weights of the decision alternatives are determined by aggregating the weights throughout the hierarchy. Aggregation is done by following a path from the top of the hierarchy to each alternative at the lowest level and multiplying the weights along each segment of the path. The outcome of this aggregation is an overall weight for each alternative (Partovi, 2007). In this research for EIA-AHP of Tehran oil refinery the executive items were came into four general parameters.

**Calculate the index weights based on judgment and decision making paired comparisons**

To use this method, the matrix of paired comparisons is formed as indicators of the relationship.

\[
D = \begin{bmatrix}
    a_{11} & \cdots & a_{1n} \\
    \vdots & \ddots & \vdots \\
    a_{n1} & \cdots & a_{nm}
\end{bmatrix} = \begin{bmatrix}
    W_1 & \cdots & W_1 \\
    W_1 & \cdots & W_n \\
    \vdots & \ddots & \vdots \\
    W_n & \cdots & W_n
\end{bmatrix}
\]

In this matrix \( a_{ij} \rightarrow \forall i, j = 1, 2, \ldots, n \) represents the personal judgment of the decision maker about the comparison between the pair of indices \( i, j \) index is \( i \). In other words, a decision maker can be with respect to the index \( i, j \) indices have different importance and priorities. For example, it can have the same importance, or rather is much more to use it, it is first preferences to the table 1 and then used a little.

**Table 2 Scale to quantify the qualitative criteria**

<table>
<thead>
<tr>
<th>Explanation</th>
<th>Definition</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element ( i ) to element ( j ) are equally important</td>
<td>Equally Preferred</td>
<td>( a_{ij} = 1 )</td>
</tr>
<tr>
<td>Element is a rather ( i ) to element ( j )</td>
<td>Moderately Preferred</td>
<td>( a_{ij} = 3 )</td>
</tr>
<tr>
<td>Element ( i ) is much prefer the element ( j )</td>
<td>Strongly Preferred</td>
<td>( a_{ij} = 5 )</td>
</tr>
<tr>
<td>Element ( i ) is very much prefer the element ( j )</td>
<td>Very Strongly Preferred</td>
<td>( a_{ij} = 7 )</td>
</tr>
<tr>
<td>Element ( i ) is very much prefer the element ( j )</td>
<td>Extremely Preferred</td>
<td>( a_{ij} = 9 )</td>
</tr>
<tr>
<td>Intermediate values Preferred</td>
<td></td>
<td>( a_{ij} = 2, 4, 6, 8 )</td>
</tr>
</tbody>
</table>

On the other hand \( \frac{W_i}{W_j} \) is representative of the actual weight index \( i \) to index \( j \) that the values are unknown and must be determined. With little attention is given:

\[ \forall i = j \rightarrow a_{ij} = 1 \]

The formula is expressed as a ratio to its significance is the same. On the other hand:

\[ a_{ji} = \frac{1}{a_{ij}} \]
If the index value index i to index j form decision maker is equal with \( a_{ji} \) then the value of index I to index j will be reverse of it and it means \( \frac{1}{a_{ij}} \).

For a paired comparison matrix non measurement scaling in this method, each component of the overall decision-making matrix is divided into components corresponding column. This is the mathematical form of the case.

\[
(j=1, 2, ..., n) \quad \text{and} \quad n_{ij} = \frac{x_{ij}}{\sum_{i=1}^{m} x_{ij}}
\]

In this formula \( n_{ij} \) is representing the normalized value of index i to index j.

**Consistency of judgments**

One of the preferences of analytic hierarchy process is the possible consideration of consistency of judgments compatibility in for determine the criteria’s and sub criteria’s. On the other hand in twin criteria matrix how much, consistency of judgments was observance. When the importance of criteria’s estimated as compared with each other, it is probable the imperfect in judgments. It means if \( A_i \) is more important than \( A_j \) and \( A_j \) is more important than \( A_k \) as a rule it should be \( A_i \) is more important than \( A_k \). But in spite of all efforts preferences and feelings of decision makers most of the time are imperfect and innumerous. Then it should be finding the index that visible the amount imperfect judgments. The mechanism that considered for imperfect in judgments is the calculation of coefficient named incompatibility coefficient (IR) that obtain from divided incompatibility index (II) to collision index (RI). If this coefficient is equal or less than 0/1 compatibility in judgments is acceptable otherwise it should be revise again. On the other hand comparison twin criteria matrix should set again:

\[
\text{Compatibility index}= \frac{\lambda_{\text{max}} - n}{n - 1}
\]

Collision index with concern to number of criteria’s (n) can take from this table:

**Table 3** collision index with consideration of number of indexes

<table>
<thead>
<tr>
<th>N</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.I.</td>
<td>0</td>
<td>0/58</td>
<td>0/9</td>
<td>1/12</td>
<td>1/24</td>
<td>1/32</td>
<td>1/41</td>
<td>1/45</td>
<td>1/49</td>
<td>1/51</td>
<td>1/48</td>
<td>1/56</td>
<td>1/57</td>
<td>1/59</td>
</tr>
</tbody>
</table>

At last rate of incompatibility matrixes are coming for this formula:

\[
\text{Incompatibility rate matrixes}= \frac{I.I.}{R.I.}
\]

1. **Relative weight criteria’s (indexes) in construction phase for Tehran oil refinery**

With use of geometrical average twin comparisons matrix were calculated. In this method, after provide the twin comparisons matrix, first geometrical average of each line of matrix is calculate, second the column matrix obtained will divided of each indexes to sum of all existing indexes will normalized for correct result. The new column matrix obtained is weighted matrix of concern indexes. The calculation method is here.
In this research four main indexes determined in order to priority for main indexes of environmental impact assessment of Tehran oil refinery. The decision maker twin criteria matrix is in the table 3.

**Table 4 Twin criteria matrix of main indexes of this research**

<table>
<thead>
<tr>
<th>The main elements of the environmental impact assessment</th>
<th>Economical</th>
<th>Land Use</th>
<th>Environmental</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>1</td>
<td>1.4</td>
<td>2.9</td>
<td>3</td>
</tr>
<tr>
<td>Land Use</td>
<td>0.71</td>
<td>1</td>
<td>4.9</td>
<td>2</td>
</tr>
<tr>
<td>Environmental</td>
<td>0.34</td>
<td>0.2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Social</td>
<td>0.33</td>
<td>0.5</td>
<td>0.5</td>
<td>1</td>
</tr>
</tbody>
</table>

Step one: Preparing the data
First choice of high-performance functions for linguistic variables defined above, and input and output data sets in each stage, the preparation is a process that input and output functions related to participation. I therefore prepared a set of diagrams that show different levels in the decision. Each value in the decision making level in a series of 100 percent 1 to 0% for 0 to join the membership will change. This means that only one of the absolute value is true is false and all other values, a set Decision making that values it at all values of It is true that from 100% to 0% change. The logic toolbox decision-making software, input and input variable is always on the enamel a numeric value.

Step two: Applying the logical operator
After preparation of the variable input and output functions using decision rules, which can output to a number is obtained higher or lower than the input number.

Step three: Inference rules for decision-making
Control systems are inference rules of decision and rule base, which is a set of rules and decisions are relating to the collection, input and output values. Before applying the inference method, the weights for the (grade 0 to 1) are defined by any law. According to the rules of weight is specified at a minimum level. For example, weight one, to maximum has no effect on output, to exert influence in the relationship between the rules should give the number except one.

Step Four: Merge all outputs and results summarized
Since the decision is with regard to all laws, rules must be in total output are merged, at this stage, the results were not applied for any law to be performed in parallel.

Step Five: TOPSIS (Technique for Order Preference by Similarity to the Ideal Solution)
• In this method two artificial alternatives are hypothesized.
• Ideal alternative: the one which has the best level for all attributes considered.
• Negative ideal alternative: the one which has the worst attribute values.
• TOPSIS selects the alternative that is the closest to the ideal solution and farthest from negative ideal alternative.

Input to TOPSIS
• TOPSIS assumes that we have m alternatives (option) and n attributes / criteria and we have the score of each option with respect to each criterion.
• Let xij score of option I with respect to criterion j we have a matrix X=(xij) m*n matrix.
• Let J be the set of benefit attributes or criteria (more is better)
• Let J’ be the set of negative attributes or criteria (less is better)

Steps of TOPSIS
• Step 1: Construct normalized decision matrix.
  This step transforms various attribute dimensions into non-dimensional attributes, which allows comparisons across criteria.
  • Normalize scores or data.

\[ r_{ij} = \frac{x_{ij}}{\sqrt{\sum x_{ij}^2}} \text{ for } i = 1,\ldots,m; j = 1,\ldots,n \]

Other steps of TOPSIS were out of the studies so they did not use.

Environmental impact assessment of oil refinery in Iran is one of the most important parts for the environmental protection. So the scope of this project can contain all the oil refineries in Iran because all of the oil refineries have similar action and their products are the same. So the scope for this project can cover all the oil refineries in Iran for environmental impacts assessment and knowledge of environmental management for oil refineries to help protect the environmental.

Table 1 shows the activities of operation phase of Tehran oil refinery. The operational phase is under test and the productions and materials need to quality control as technical programming and flow sheet of major unit operations and material balance flow is under revise for till getting better results of productions.

**Table 5** Paired comparison matrix non measurement scaling and relative weight in construction phase of Tehran oil refinery

<table>
<thead>
<tr>
<th>The main elements of the environmental impact assessment</th>
<th>Prioritize</th>
<th>relative weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>3</td>
<td>0.15</td>
</tr>
<tr>
<td>Land Use</td>
<td>4</td>
<td>0.11</td>
</tr>
<tr>
<td>Environmental</td>
<td>2</td>
<td>0.45</td>
</tr>
<tr>
<td>Social</td>
<td>1</td>
<td>0.29</td>
</tr>
</tbody>
</table>

**Table 6** The non measurement scaling and the relative weights of the main criteria in the operation phase for Tehran oil refinery

<table>
<thead>
<tr>
<th>The main elements of the environmental impact assessment</th>
<th>Prioritize</th>
<th>relative weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economical</td>
<td>3</td>
<td>0.184</td>
</tr>
<tr>
<td>Land Use</td>
<td>4</td>
<td>0.110</td>
</tr>
</tbody>
</table>
Environmental | 1 | 0.377
Social | 2 | 0.329

2. Geographical information system

For long time, people have studied the world using models such as globes and maps. In the last thirty years, it has become possible to put these models inside computers; more sophisticated models into smaller computers. These computer models, along with the tools for analyzing them, make up a Geographic Information System (GIS) (Ormsby et al., 2004). GIS is a computer system for collecting, checking, analyzing, and integrating information related to the earth surface (Krpo, 2004). This system is able to collect and use data related to different location of earth (Navaie Toranie & Adeli Nia, 2004). In fact GIS helps the managers, programmers, engineers, and everybody implementing data as a type of system for management, analyzing, and show data and results (Saadi Mesgari & Ghods, 2005). Therefore, it is a useful tool for integrating data and information, and assisting in decision-making (Liu et al., 2007) that means the purpose of GIS is to provide an objective support for decision making based on spatial data (Taboada et al., 2006). GIS is a powerful software technology that allows unlimited amount of information to be linked to a geographic location. Coupled with a digital map, GIS allows users to see locations, features, events, and environmental changes with unprecedented clarity. In addition it displays layer upon layer of information such as environmental trends, pesticide use, soil stability, hazardous waste generators, dust source points, migration corridors, Lake Remediation efforts, and at-risk water wells. Effective environmental practice considers the whole spectrum of the environment. GIS is used in the entire world. Use of GIS in Europe started for registration of properties documents and preparing of environmental data base. In England the biggest user of GIS is services work such as telephone, water, electricity, gas, and preparing the geographical data base. Users usually implement GIS for monitoring and modeling regarding environmental changes such as in Japan and China. In addition nowadays GIS is used in environmental monitoring, environmental pollution, and protection of water resources for the entire world (Navaie Toranie & Adeli Nia, 2004).

In this research GIS-EIA system modified and designed for Environmental Impact Assessment of oil refinery in Iran as Tehran oil refinery has been selected for EIA. In this part of research for two case studies as Tehran oil refinery in four parts of economical, environmental, land use and social items have been considered to provide complete environmental impact assessment results for them. Base on the researches in the part of economical three items have been considered as; workshops, industrial equipments & material shops and economical knowledge. In part of environment; local environmental changes have been considered for better results. In the part of land use; changing the usage of natural resources and use the lands around the oil refinery for site preparation and effect of oil refinery on the land use changing have been considered to complete the land use part in the field of EIA of oil refinery. In the part of social; cultural effects, Environmental knowledge and historical problems have been considered for effects of these oil refineries on the population parameters and results of them in the field of EIA oil refineries. All of these researches based on the EIA Tehran oil refinery in two parts: construction and operation. For each refinery 100 effective maps provided for Tehran refinery in two phases as construction and operation in four general classification as; economical, environmental, land use and social parameters. As specified in each study area, the latitude and longitude of each point of the area
was recorded by using a GPS. By using the software Arc GIS 9.3 point data were converted to the regional data. Using the interpolation method, the parameters of the raster maps were prepared. The produced maps were combined together and with respect to the software classification model, different maps were drawn. For better results maps based on geographic location and characteristics of the nature of the information or forms built on land boundaries are identified in the study, were drawn. Also raster for map drawing has been considered as information which distinctive visual elements (multiple layers) are displayed (pixels). Then for complete the EIA study data integrity done as, data integrity means that using one or multiple databases, multiple tables with multiple layers of information, the information can be viewed on a map. In the next step maps were drawn as, view single physical forms part of the surface which is graphically displayed on a flat surface. Drawings signs, symptoms, and spatial relationships between the forms show. All maps provided with zooming capability in order to view details parts of geographic information big and bigger. For better analysis in EIA-GIS system in the maps data integration has been considered as, data integration means using one or multiple databases and multiple tables and data layer, the information can be seen on a map. In the next phase polygon of the maps for EIA results provided as, a polygon shows that the area on the map and the form of the curve that it can be defined with it.

**Result and discussion**

Results are coming in two parts AHP and put the AHP in GIS software.

**The results for AHP-EIA Tehran oil refinery**

After modeling in Expert choice 11 and login the paired comparisons matrices, weight criteria’s and sub-criteria in the method as follow was obtained. In the figure 1 the main priority of Environmental impact assessment in Tehran oil refinery in the construction phase with Expert choice 11 software. As can be seen in Table 4 environmental criteria with relative weight 0.45 is the most important criteria. Thus the environmental criterion is the main elements of the environmental impact assessment of the oil refinery are most effective. A social criterion with relative weight 0.29 is in the next priority. Rate comparison incompatible pair obtained as 0/05 that because it is less than 0/1 compatibility of these comparisons is acceptable.

**Figure 1** Prioritization of major criteria environmental impact assessment of Tehran oil refinery construction phase in Iran with expert choice 11 software

After modeling in Expert choice 11 and login paired comparisons matrices, weight criteria and sub-criteria were obtained in figure 2. The main priority of Environmental impact assessment in Tehran oil refinery in operation phase can be seen with Expert choice 11. As in table 6 can be seen an environmental criterion with relative weight 0/38 is the most important, thus the main elements of the environmental impact assessment of the oil refinery is most effective. A social
criterion with relative weight 0/33 is in the next priority. Rate of comparison incompatible pair is 0/007 that because is less than 0/1 this comparison is reasonable consistency.

**Figure 5** Prioritization of environmental impact assessment of Tehran oil refinery operation phase with Expert choice 11 software.

The results for GIS-EIA Tehran oil refinery

![Graph showing prioritization of environmental impact assessment](image)

Obviously, the implementation of GIS in any organization is its complexity. As studied in this project for Tehran oil refinery the successful result of study is coming for final action plan of GIS-EIA. However, for the successful implementation of a system for GIS-EIA, the following actions should be taken as follow;
- Requirements Analysis of EIA oil refinery.
- Implementation of a pilot project (Pilot) for more accurate identification of needs and problems, in this case Tehran oil refinery.
- Conceptual design, logical and physical database.
- Maps, drawings and specifications needed to produce guidelines.
- Produce a map and descriptive information collection requirements.
- Design and implementation of GIS-EIA of oil refinery.
- Providing hardware and software requirements, and training of personnel.
- Development of the database is designed to cover specific applications for the system.
- Application development and data analysis functions.
- Development of information exchange standards and processes.
- Development the GIS-EIA and the development and maintenance of information processing of EIA.
- Full implementation of GIS-EIA as integrated systems in other operational units and dependent organizations same as workshops, material shops and personnel.
- Full implementation of GIS-EIA as Environmental and Social Action Plan (ESAP) as effects of oil refineries in social parameters same as; historical, environmental knowledge, cultural problems.
- Development of GIS-EIA as land use parameters and its effects on population and environment.
- Design and implementation of GIS-EIA as economical parameters such as workshops, material industrial equipments & material shops.
- Development of GIS-EIA as environmental parameters base on the lab tests and their effects on the located area on the maps.

In this project GIS-EIA of Tehran oil refinery and effects on located areas around it (Azim abad, Bagher city, Dorsoun abad, Esmaeil abad-e-moein) different parameters (economical, environmental, land use and social) have been considered to provide the maps based on data
collections, expert system decision-makers and GIS information. All these areas pointed on the maps and sat-images of their area on the GIS-EIA study of each oil refinery. **Table 7** Different parameters maps of Tehran oil refinery and located area around it during the project implementation (2008-2011)

<table>
<thead>
<tr>
<th>Location</th>
<th>Parameters</th>
<th>Economical</th>
<th>Environmental</th>
<th>Land use</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azim abad</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Bagher city</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Dorsoun abad</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Esmaeil abad-e-moein</td>
<td>36</td>
<td>28</td>
<td>28</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td></td>
<td>144</td>
<td>112</td>
<td>112</td>
<td>144</td>
<td></td>
</tr>
<tr>
<td>Total maps</td>
<td></td>
<td></td>
<td></td>
<td>512</td>
<td></td>
</tr>
</tbody>
</table>

All maps designed and implementation of four parts of GIS-EIA of oil refineries as case studies, Tehran oil refinery. Total maps of this project are 1024 maps for two case studies in four years by developing of four parameters effects on their locations. **Table 8** Different kinds of GIS maps provided for each case study during the project implementation-Tehran oil refinery (2008-2011)

<table>
<thead>
<tr>
<th>Special Geographical GIS maps</th>
<th>Numbers of maps of Tehran oil refinery</th>
<th>Azim abad</th>
<th>Bagher city</th>
<th>Dorsoun abad</th>
<th>Esmaeil abad-e-moein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hill shade</td>
<td>Azim abad</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Layers</td>
<td>Azim abad</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Land use</td>
<td>Azim abad</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Sat-image</td>
<td>Azim abad</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Slope</td>
<td>Azim abad</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Tin</td>
<td>Azim abad</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Zoning</td>
<td>Azim abad</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
</tr>
<tr>
<td>Total maps</td>
<td>112</td>
<td>112</td>
<td>112</td>
<td>112</td>
<td></td>
</tr>
</tbody>
</table>

The criteria used to determine the score and weight maps for each of the criteria and sub-criteria classification in Expert choice 11 the achieved weight in preparation software. After the raster with Raster calculator in Arc GIS 9.3 they have been overlapped. Figure 6 Map of weighting.
factors for each of the above shows. Figure 7 to 10 Final plans zoning EIA-Tehran oil refinery as digital displays for construction phase and figure 11 to 14 final plans zoning EIA-Tehran oil refinery as digital displays for operation phase. The map of the objectives are in the study and use of software EIA and effective points in the region with four exciting classification, low, moderate, high, extremely high.

**Figure 6** Economical parameter (2008-2011)  
**Figure 7** Land use (2008-2011)

**Figure 8** Environmental parameter (2008-2011)  
**Figure 9** Social parameter (2008-2011)
Figure 11 EIA Tehran oil refinery final weightings map in construction phase during (2008-2011)

Figure 10 EIA Tehran oil refinery final weightings map in operation phase during (2008-2011)

Conclusion

Environmental Protection in Petroleum Industry

The Ministry of Petroleum of Iran and HSE (Health, Safety and Environment) companies and other related industries have created an optimal management system, especially with regard to the environment, yet a long way is ahead before we can reach required standards in this field. It also requires strong determination and strategic planning. To meet these ends the following conditions should be provided for:

Try to provide a way for understanding the problem’s between Oil Ministry, people and Environmental Protection Organization. People all agree on the necessity to create an effective mechanism of interaction between the strategic and effective institutions in this area. Agreements are on the necessity for environmental strategies in oil and gas industries. Decision makers are determining the environmental strategies as prerequisites for oil and gas industries. Decision makers are the emphasis on creating strong and active centers for research and intellectual backgrounds for senior experts and managers. Try for scientific supervision and legal authority
necessary for organizational and continuous monitoring of environmental strategies of oil and gas industries. Due to geographical studies and layouts: Iranian Environmental Protection Agency acts only through the raw data and global standards. So that they can act proportionate to conditions of each region. 16. Risk assessment of industrial activities, petroleum and its cost: We should assess precisely the risk and costs of oil industries, this way we can determine the extent of impacts of each industry on the environment and making clear that should be responsible in case anything goes wrong. Training courses: holding training courses for managers run by Environmental Protection Agency or HSE University can inform them and make them responsive to environmental issues. Environmental crisis management: Environmental laws with regard to preventing pollutions and contamination in the processes of waste disposal of plants, factories or refineries are useless when an accident occurs. These laws can do nothing in case such accidents happen. Adjustment measures necessary for old units: Some oil refineries and their parts were built in old times when environmental concerns and laws as we know today did not exist. These oil refineries are main sources of pollution now. It is not easy to stop their operation now due to economic issues. On the other hand we cannot ignore their polluting the environment on the grounds that these oil refineries are old. So it is needed to introduce measures to deal with the pollutants emitted by these old refineries. Decision and policy making centers: Considering the many challenges in the field of oil industry, the quality and efficiency of management in these fields is important. So there should be an information bank or thought bank for managers in these fields. In fact an improved management method supplements other scientific and strategic studies done by universities or research centers. In order for planning and making decisions in oil industries not to be only of short-term nature, we need more parties and organizations involved, such as Environmental Protection Agency, Ministry of Petroleum, Ministry of Agriculture, Ministry of Health, Ministry of Roads and Transportation (Ports and Shipping Organization and Meteorological Organization), the Islamic Consultative Assembly, Interior Ministry and research and study centers. This strategy, if carefully designed and implemented together with determination can be the master key to solve environmental problems in oil and gas industries and its side industries. It can even become a model and pattern for other industries. Use of special software for environmental impacts assessment of oil refineries is less prone to error that usually occurs when the job is done with paper and hand. All the personnel involved in oil refineries’ projects or processes and operations should be properly trained because the quality of their work or their sense of responsibility contributes to the better materialization of environmental protection measures. Always use the EIA software to achieve the correct results without errors.

Acknowledgment
At this stage multi-year program is developed for the organization. The basis for planning is the fourth stage results. Application priority ranking system, based on several years of activities, budget and development plan placed calculations. Implementation of each activity system analysis of detailed information needs to shape its needs. The results of analysis of the above required information for the development of a conceptual diagram provide enterprise. The environmental impact assessments of oil refinery programs are clear but not all of them have special software because the preparation of the software and work with that needs complete programming and it is a cause of concern for providers.
References


