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Plant establishment location along with case study

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Abstract

One of the most important factors influencing market development and competitiveness is determining the appropriate location for the construction and start-up of companies and plants. So far, various models have been presented by researchers in the field of industrial centers location that have considered criteria such as time, cost, transportation and market as the main criteria for decision making. The present paper provides a good guidance for industrial centers location at national level. This guidance provides a variety of multi criteria decision making methods. A case study is examined in the present research to locate Alumina plant. It is tried in the present paper to determine the decision making criteria based on the requirements of the plant, the opinions of experts and managers, the location problems implications and the specific policies of industries location in the country. The provided guidance can be a suitable practice for solving the industrial centers and plants location problems at national level.

Keywords: location model, multi criteria decision making methods, industrial centers, national level, Alumina plant

1-INTRODUCTION

The centers location is to select a place for one or more centers in a way that a given purpose such as transportation costs, fair customer service, capturing the largest market etc. is achieved [1].
Location means choosing a place for new centers that minimize the cost of producing and distributing goods or services to potential customers. The final decision is always based on the evaluation of the objective (quantitative) and subjective (qualitative) factors of each of the raised places [2].
The centers location means finding the right place for the new or current centers, considering the existing centers and the constraints that exist, so that the project would be exploited in the most economical place and its competitiveness is considered as one of the key objectives. This decision must be consistent with the specific policies of the investors and the government and would largely meet the plant requirements and the environmental conditions [4-5].
The centers location problem challenges geometric and mixed problems. Study on the centers location requires conducting studies on many research areas, such as research on operations/management of science, engineering, geography (geology and climate), economics, computer science, math, marketing, electronics engineering, urban design, and related fields [6].

1.1 The Importance of Location Studies

Plant Location is one of the key steps in establishing a plant; since the results of this decision represents itself in the long run and have significant effects on the economic, environmental, social, and other aspects. One of the aspects from inter-organizational perspective is the direct impact on the plant Profitability and from the intra-organizational perspective, is that the construction of large factories in one region can affect various economic, social, cultural, environmental and other conditions. The plant location is economically important in terms of initial investment when establishing the plant. Also, this decision has a key impact on the price of the goods / services when operating the project [14].
Conducting location studies allows the government to establish macro-policy of industrial growth around rational principles and avoid excessive accumulation of industries around large cities and capitals [15]. It should be noted that the decision to locate large plants is a complex process and its complexity is due to the fact that this process depends on significant factors as follows:

1. Access to skilled worker and specialist
2. Access to the required services of the plant such as electricity, fuel, telephone, gas, etc.
3. Employees' higher level of welfare
4. Access to sales markets
5. Access to vehicles
6. Etc.

However, criteria such as the environment are heavily opposed to the fact that the polluting plants (such as the Alumina production plant) are close to large cities [3].
In general, the best location for a plant is a place that can, in part, meet the needs of the plant and the environmental conditions and minimize the total cost of production and distribution. Also, it should be conformed to and coordinate with the specific policies of the employer and the government. Such a definition of location reflects the fact that although location is one of the tasks of industrial engineers, however, an industrial engineer alone cannot do this, and it is necessary to obtain the best result taking advantage of geographers related to geographic factors, sociologists related to human factors and economists due to the

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economic considerations[16]. In fact, location needs a cross-functional team of process specialists, industry engineers, geographers, sociologists, and economists to collect the necessary data and ultimately, consolidate them by industrial engineers and determine the desired location.

A suitable location can have a positive impact on the company's competitiveness. These effects include the following:

- Increase in production capacity
- Additional benefits
- Increase the speed of goods and services turnover
- Business Development
- Better customer service
- Increase shareholders' equity
- Reducing prices
- Reducing the cost of business affairs
- Reducing production waiting times

The present paper is organized as mentioned in the second part of the research model. This section includes a hierarchical multi-criteria decision making approach [17]. In the third section, methodology is presented along with the results of implementing each method. The fourth part of this paper also presents and summarizes the results [10].

2. RESEARCH MODEL

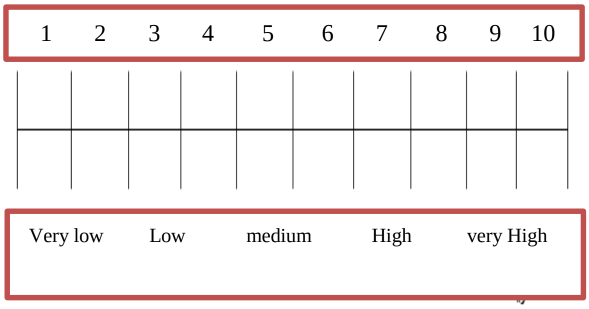
1-2 reviewing the Hierarchical Multi-Attribute Decision Making Method.

It is tried in this chapter to explain the application of a hierarchical multi- Attribute decision-making methodology for location issues. Of course, the method does not include all the available methods and there are several methods; however, it is tried to explain the most practical method. In the following, firstly, we present how we convert the qualitative into quantitative criteria in location studies in the second part. In Section 3, we describe unscaling location criteria to make different measurement criteria comparable. How to determine the weight of location criteria using entropy and vector-based methods are presented in the next section. In the next section, the multi-attribute decision-making process, including Analytical Hierarchy Process (AHP), will be examined in detail. Finally, summary and conclusions are presented [13].

2.2 Conversion of qualitative into quantitative criteria in location studies

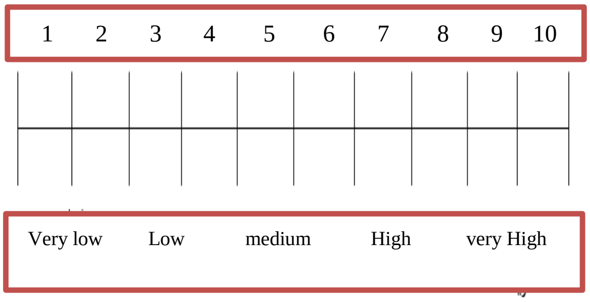
As stated above, various criteria are effective in selecting a place. However, it should be noted that some of these criteria are quantitative (price, cost, distance,) and others are qualitative (social image, security, weather conditions, government laws and regulations, and required manpower). It is needed to convert qualitative criteria to quantitative ones in location studies so that they can be compared and weighted.

Different methods can be used to convert qualitative criteria to quantitative criteria; however, the best methods are those that use interval and ordinal scales with bipolar scale. A general approach to measuring a qualitative measure with interval scale is to use a bipolr scale as follows:



This measurement is based on an 11-point scale where zero, is the lowest value, and 10, is the highest value. This measurement is for positive measures such as income. The higher the income, the more favorable it will be. We show these criteria as C_i^+.

This type of measurement is also applied to criteria with negative aspects, except that this 11-point scale changes as follows:



These criteria are shown as C_i^-. It should be noted that the values like 6, 8, 4, 2 are intermediate values between two other values, and values of zero and ten are less used.

Three points should be considered in making qualitative statements, quantitative. These three points convert the ordinal scale to interval scale.

1- The distance between qualitative terms should be the same. For example, the distance between the very low and the low, is equal to the distance between the low and the middle, middle and high as well as high and very high.
2- It is assumed that the score of 9 is three times greater than the score of 3.
3- The combination of values (summation, subtraction, multiplication, and division) is allowed for different criteria, because the difference between the two values is the same for each given criterion [8&9].

2-3. Unscaling location criteria

Another point about the criteria for a decision matrix is the existence of positive and negative criteria all in a matrix. Meanwhile, the quantitative criteria have a specific unit, such as Rials, kilograms, meters, etc. To make different measurement scales comparable, it is necessary to use unscaling methods, by which the values of different criteria will be dimensionless and additive. It is worth noting that unscaling is also applicable to multi-criteria decision-making methods in mathematical models. There are several ways for unscaling, some of which include:

1- unscaling using a norm (Vector unscaling)
2- Linear unscaling
3- Fuzzy unscaling
4- Saaty's unscaling method
5- Logarithmic unscaling [7]

2.4 Determine the weight of the location criteria

As noted in the previous sections, any problem, facing the decision maker, may have several criteria. Therefore, "knowing the relative importance of the criteria" is necessary. Hence, each criterion is achieved a weight, so that the total weight of the criteria is equal one. These weights indicate the relative importance (degree of preference) of each criterion to others, in order to make the intended decision. There are several methods to assess the weights of the criteria, some of which are:

A. entropy
B. The LINMAP method
C. The weighted least squares method
D. Eigenvector method (AHP) [7]

2.5 Analytical Hierarchy Process

Analytical Hierarchy Process (AHP) is proposed based on human analysis for complex problems. The method, which is proposed by a researcher called Thomas L Saati in the late 1970s, has been utilized in a variety of areas, as well as a useful method for location methods [12]. Also, this method helps decision makers to better understand the problem by dividing the problem to several levels and reduce its complexities. This method also helps to classify inconsistent variables for decision making. AHP is a multi-criteria decision-making method that uses a hierarchical structure or network structure to represent a decision problem, and then prioritizes alternatives based on decision maker judgment throughout the system and can be used to evaluate qualitative and quantitative criteria.

Since the method organizes decision variables at successive levels of importance, it is named as hierarchical analysis. This structure is used to evaluate interconnection between sectors.

AHP and its application are based on the following three principles:

A. forming a hierarchical structure for the problem
B. Calculating preferences through paired comparisons (in the form of the final substitution rate)
C. logical consistency between comparisons

Understanding phenomena and complicated problems can be problematic for the human mind. Hence, the decomposition of a large problem into its partial elements (using a hierarchical structure) can help to understand. The relationship between each element and other elements must be specified in a hierarchical structure and at different levels, and the relationship between the problems goals and the lowest class of hierarchy is precisely clarified.

The reliability of the hierarchical structure and its related calculations is reviewed using a method entitled as hierarchical volume weighting.

The hierarchical weighting method, including the criteria and sub-criteria for effective decision making, can be shown hierarchically and at different levels, so that each level includes sub-criteria influenced by a variable or variables existing on the immediate previous level [11]

2.1.5 The Analytical Hierarchy Process Implementation stages

The use of AHP to solve a decision problem includes the following four steps:

Step 1: Create the decision tree by breaking down the decision-making problem to several levels of the interdependent decision elements. (Developing decision tree)

Step 2: Collect input data using paired comparison of decision elements. (Firstly, comparison of decision criteria together and, second, comparisons of alternatives together relative to each criterion)

Step 3: Use the eigenvector method to estimate the weight of decision elements.

Step 4: Aggregate the weight of the decision elements to reach the final ranking of decision alternatives [12].

3-RESEARCH METHODOLOGY

3.1 Research scope

The present research aimed to locate alumina in southern provinces of the country. These provinces include Hormozgan and Bushehr. The reason of choosing these provinces is that most of the raw materials used in the Alumina plant are imported from abroad by sea shipping, first by ship to the port and, then discharging and loading to the plant. Alumina is as the primary material in the production of aluminum, and the main purpose of producing alumina in this plant is to meet the domestic demand and then, export surplus production. Hence, on the one hand, it is imperative to include target sales markets in order to minimize the cost of transferring the product in plant location; on the other hand, the proximity to sea is essential to import raw materials and export products. The following regions are considered as the sites for the construction of the plant in the preliminary studies that required further studies to select as the final sites.

Table 1- REGION NAME

City	Region name
Bandar abbas	Persian Gulf industrial town
	Special Economic Zone of Mines and Metals
Gavbandi	Ziarat
	Kooshkenar
Bandar Lenge	Between Bavardan and Hoseinieh
	Moghuyeh
	Berkeh-ye Soflin
	Tauneh
	Mahtabi
	Saye khosh
	Kenj
Minab	Bandzark
Jask	Koohmobarak
	Hoozhdan
	Gabrik
	Khoorkarti

2-3 Research Goals and Questions

The main goal of the research is to select the appropriate location to construct the Alumina plant that has the lowest cost of construction, production and sale of the product. This goal in turn is divided into the infrastructure and costs goals, each with its own criteria. The main research questions include the proper place to construct the mentioned plant and the research secondary questions are as follows: 1) what is the most appropriate decision-making framework to select a plant location that covers all the research objectives?
What are the secondary and satisfying criteria that lead us to the main goal of the research?
These criteria should be consistent with scientific and practical criteria in the native conditions of Iran and the specific requirements of the industry and location problems.

3.3 Identifying Decision Criteria

The most important goal of plant location is to select the place to maximize satisfaction. Maximum satisfaction in locating industrial centers is to reduce the direct and indirect costs of the industrial unit during construction, commissioning and operation (i.e. the costs of the industrial unit at that point relative to other areas to produce and distribute the product or service). The goals, identified in obtaining maximum satisfaction include: 1. Infrastructure goals 2. Cost goals.
In infrastructure goals, all relevant infrastructures, effective in selecting a location, are considered. This goal set has more physical and hardware aspects and associates the location of the establishment with geotechnical conditions and proximity to human resources. Location criteria from the infrastructure dimension include:

1- Seismicity of the project site
2- Soil Liquefaction of the project site
3- The weather of the project site
4- Proximity to the airport
5- Proximity to the main ways of the country
6- Proximity to railroad
7- Proximity to Population concentration areas

Direct project costs reduction is intended in the cost criteria, and in this regards, calculations, prioritization and data collection are relied on quantitative data collection and indicates the objective cost reduction. The location criteria in terms of cost perspective include:

1- Raw material transportation cost
2- transportation cost to target sales markets
3- The cost of power transmission to the project site
4- The cost of gas transmission to the project site
5- Water supply cost
6- The cost of leveling and retrofitting the land
7- The cost of making breakwaters
8- The cost of access to appropriate drinking depth

It is worth noting that a series of criteria have been used as elimination criteria in solving the location problem. An elimination criterion is an indicator that, in case of non-fulfillment, it is impossible to establish the project in that area. These criteria in the plant location problem include:
1- Access to at least 14 meters drinking depth in case of water shortage
2- At least 15 hectares land around the port
3- Possibility to prepare the land to establish plant with a maximum distance of 5 km from the desired docks
4-Legal constraints

4.3 Research Method, Data Collection and Problem Solving Steps

The research method in the proposal of the Alumina plant site was descriptive survey. In this project, all discrete multi-criteria decision-making methods were examined according to the type of problem and decision conditions and a comprehensive model was developed for location. Then, the comparison indicators and location analysis were determined according to the conditions and requirements of the Alumina industry and the mentioned plant, as well as the managerial and expert considerations. The data collection in this project has been performed through interview channels with experts and scholars, library studies, study documents and related reports, and the Internet. It is worth noting that visiting all of the candidate areas was one of the key measures in solving the location problem, so that valuable information obtained in this way. In overall, questionnaire, observation, interviews and field studies (library and internet) have been different ways of data collecting in this research project. The large number of alternatives greatly increases the size of the next calculation at firstplace. Therefore, the number of these alternatives has been reduced using several elimination methods.

5.3 The Comprehensive Satisfaction Method

According to the defined criteria, we found that cities must satisfy certain factors including:

1- Access to at least 14 meters drinking depth in case of water shortage

Eleven regions among the selected regions are excluded using this method because of the lack of fulfillment of the initial conditions of the plant construction.

Table 2- plant construction

PROPOSED REGION	Possibility to provide land for the construction of plant	At least 10 hectares land around the port	Access to drinking depth at least 14 meters and maximum advance of 2000 meters	Legal constraints
Special Economic Zone of Mines and Metals - Bandar Abbas	0	1	1	1
Persian Gulf industrial town- Bandar Abbas	1	1	1	1
Moghuyeh- Bandar Lenge	0	0	1	1
Berkeh-ye Soflin Bandar Lenge-	1	1	0	1
Bandar-e Tauneh- Bandar Lenge	1	1	1	1
Mahtabi-Bandar Lenge	1	1	0	1
Saye khosh- Bandar Lenge	1	1	0	1
Between Bavardan and Hoseinieh-Bandar Lenge	1	1	1	1
Kenkh-Bandar Lenge	0	0	1	1
Kooshkenar-Gavbandi	1	1	1	1
Ziarat-Gavbandi	1	1	1	1
Khoorkarti-Jask	1	1	1	1
Hoozhdan-Jask	1	1	1	1
Gabrik-Jask	1	1	1	1
Koohmobarak-Jask	1	1	1	1
Bandzark-Minab	1	1	1	1
Booshehr	1	1	1	0
Dayer	1	1	1	0
Kangan	1	1	1	0
Tangestan	1	1	0	0
Deylam	1	1	1	0

6.3 Analytical Hierarchy Process (AHP)

The Analytical Hierarchy Process, as a multi-criteria decision making technique, was developed by Saaty (1980) [1]. So far, AHP has been utilized in a variety of areas, including planning, resource assessment, performance measurement, resource allocation, selection of the best policy among a number of alternatives and prioritization in order to solve complex decision problems. AHP is also considered as one of the most commonly used location methods. Tzeng et al. (2002) used this method to locate a restaurant in Taipei [14] and evaluated various alternatives using AHP. In their study, 4 alternatives were evaluated according to 11 criteria. Alfonse (1997) in a study entitled "using AHP in agriculture in developing countries", used AHP to find the location of agricultural products stores [3]. Akash et al. (1999)

2- At least 15 hectares land around the port

3- Possibility to provide land to establish the plant

4- Legal constraints

Used this method to find a site for the construction of power plant [4]. They used a profit hierarchy with 5 criteria and a cost hierarchy with 6 criteria in this study. Aras (2004) utilized the AHP method to determine the location of the wind power plant in Turkey. The steps of this method in the present are presented study in figure (2).

6.3.1 Developing the hierarchical structure

The following three basic steps should be taken to solve any problem using the analytical hierarchy process technique.

- forming hierarchy
- Calculating weights
- Calculating the compatibility rate

As mentioned above, all the factors affecting the maximum satisfaction of the plant establishment

Location can be categorized into two groups of infrastructure and costs goals. All factors affecting these criteria in the hierarchical structure are shown in figure (3).

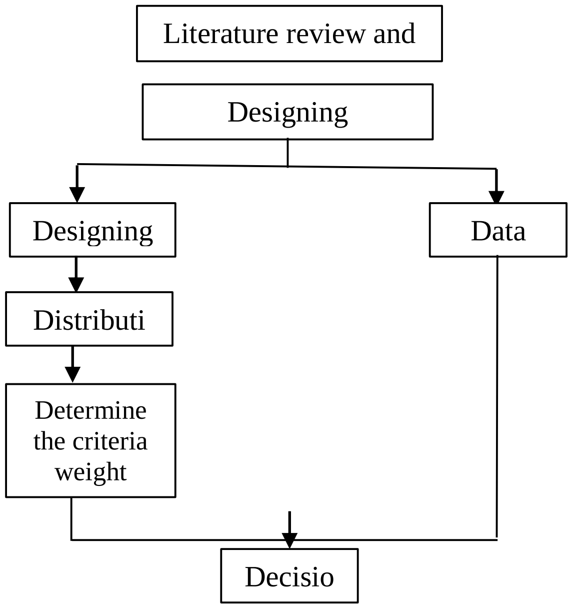


Figure 1) AHP steps in the Alumina plant location study

3.6.2 Hierarchical structure

The hierarchy considered for the Alumina production plant location problem is as follows, and according to the survey, the hierarchy, considered for the different project prioritization criteria, is summarized in two levels.

Table 3- Main Category

The main category	Criterion title
Infrastructure goals	Seismicity of the project site
	Soil Liquefaction of the project site
	The weather of the project site
	Proximity to the airport
	Proximity to the main ways of the country
	Proximity to railroad
	Proximity to Population concentration areas
Cost goals	Raw material transportation cost
	transportation cost to target sales markets
	The cost of power transmission to the project site
	The cost of gas transmission to the project site
	Water supply cost
	The cost of leveling and retrofitting the land
	The cost of making breakwaters
	The cost of access to appropriate drinking depth

3.6.3 Designing and distributing questionnaires

Questionnaires are designed according to the fuzzy hierarchical process concept. In this way, the effective factors were broken down from one level to another, and the factors of each level do not have any dependence to each other and then they are prioritized by the pair matrix Degrees of importance are very weak, weak, moderate, good and excellent as the Fuzzy numbers expressing these values confirmed by the experts.
The questionnaires were filled by project consultants, industrial experts and academic professors.

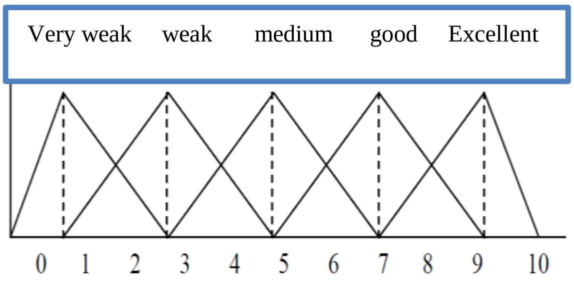


Figure2. Fuzzy numbers to compare the criteria

4.6.3 Determination of the criteria weight

- How to determine the criteria weight in the main category

Considering that the criteria are divided into two groups in the first level and in the main category, the main category only needs a single paired comparison. The estimated weight from the comparison of the two groups of infrastructure and cost criteria, given the experts' views in the two sections of employer and executor were summarized in Table 4-28, respectively.

goals	Weight
Infrastructure	.167
cost	.883
total	1

- How to determine the criteria weight in infrastructure goals

The comparative matrix of the infrastructure goals was prepared in Table 4-29 to determine the weight of the infrastructure criteria, and was implemented in two sections of employer and the executor.

	Seismicity	Soil Liquefaction	weather	Proximity to the airport	Proximity to the main ways of the country	Proximity to railroad	Proximity to Population concentration areas
Seismicity							
Soil Liquefaction							
weather							
Proximity to the airport							
Proximity to the main ways of the country							
Proximity to railroad							
Proximity to Population concentration areas							

Table 4- Comparative matrix of infrastructure goals

The paired-comparison of criteria will be conducted depending on the relative preference and importance of each criterion in comparison to the other criterion in five different levels.

score	Description
1	Both criteria are of equal importance.
2	The first criterion is relatively more important than the second one.
3	The first criterion is more important than the second criterion.
4	The first criterion is much more important than the second one.
5	The first criterion is extremely more important than the second one.

Since all criteria are of equal importance compared to themselves, no value is allocated in the main diameter of the matrix.

- How to determine the criteria weight in the cost goals

Considering that all the desired criteria in the cost goals can be computed with the same unit (Rials), the costs obtained for each criterion in each of the regions and cities specifies their weight

Main category	Criteria	Criterion weight
Infrastructure goals (.167)	Seismicity of the project site	.036
	Soil Liquefaction of the project site	.054
	The weather of the project site	.107
	Proximity to the airport	.270
	Proximity to the main ways of the country	.214
	Proximity to railroad	.151
	Proximity to Population concentration areas	.169
Cost goals (.833)	Caustic Soda transportation cost	.030
	Limestone transportation cost	.070
	Alumina transportation cost	.159
	The cost of power transmission to the project site	.094
	The cost of gas transmission to the project site	.159
	The cost of leveling and retrofitting the land	.011
	The cost of making breakwaters	.109
	The cost of access to appropriate drinking depth	.368

Table 5: The results of hierarchical model implementation in determining the weight of infrastructure criteria

10. CONSLUSION

The present paper proposed a general framework for deciding on the location of industrial centers at the national level. The model is also implemented through a case study of the construction of an Alumina plant in southern Iran. For this purpose, discrete multi criteria decision-making methods have been investigated and Proper methods have been identified and applied. First, the Comprehensive removal techniques were used; then, the fuzzy AHP method was used to consider the uncertainties in the data. Finally, a cost analysis has been applied to assess the cost of the implementation results. Calculating the zones' priority in terms of Infrastructure goals

Criteria ->	**Seismicity**	**Liquefaction**	**weather**	**Proximity to the airport**	**Proximity to the main ways of the country**	**Proximity to railroad**	**Proximity to Population concentration areas**	**Total score**
Persian Gulf industrial town-Bandar Abbas	0/02	0/669	0/809	1/000	1/000	1/000	1/000	**0/169**
Bandzark-Jask	0/998	1/000	1/000	0/749	0/961	0/120	0/180	**0/119**
Ziarat-Gavbandi	0/999	0/668	0/866	0/749	1/000	0/120	0/263	**0/118**
Between Bavardan and Hoseinieh-Bandar Lenge	1/000	0/668	0/867	0/750	0/855	0/120	0/263	**0/113**
Koohmobarak-Jask	0/998	0/667	0/808	0/749	0/961	0/120	0/113	**0/110**
Hoozhdan-Jask	0/999	0/667	0/808	0/749	0/769	0/120	0/113	**0/103**
Gabrik-Jask	0/999	0/667	0/808	0/749	0/576	0/120	0/113	**0/095**
Kooshkenar-Gavbandi	1/000	0/668	0/866	0/750	0/385	0/120	0/263	**0/94**
Khoorkarti-Jask	0/999	0/667	0/808	0/749	0/038	0/120	0/113	**0/079**

After scoring and prioritizing different regions in terms of infrastructure goals, the Persian Gulf industrial town in Bandar Abbas, Bandzark in Minab and Ziarat in Gavbandi, won the highest scores for infrastructure goals with the score of .169, .119 and .118, respectively. Also, Khoorkarti in Jask won the lowest rank with the score of 079. Calculation of zones priorities in terms of cost goals

Title	**raw materials Transportation cost (Limestone)**	**Raw material transportation cost (Caustic Soda)**	**transportation cost to target sales markets**	**The cost of power transmission to the project site**	**The cost of gas transmission to the project site**	**Access to appropriate drinking depth**	**The cost of leveling and retrofitting the land**	**The cost of making breakwaters**	**Score**
Persian Gulf industrial town-Bandar Abbas	1/000	0/573	0/995	0/740	0/537	1/000	0/883	1/000	0/194
Ziarat-Gavbandi	0/583	0/925	0/702	0/763	0/947	0/999	0/500	0/001	0/181
Kooshkenar-Gavbandi	0/675	1/000	0/609	0/764	1/000	0/999	0/001	0/001	0/168
Between Bavardan and Hoseinieh-Bandar Lenge	0/902	0/797	0/920	0/591	0/786	0/615	0/833	0/001	0/142
Bandzark-Jask	0/001	0/001	0/001	0/001	0/001	0/999	1/000	1/000	0/083
Hoozhdan-Jask	0/723	0/362	1/000	0/847	0/367	0/008	1/000	0/001	0/081
Khoorkarti-Jask	0/375	0/218	0/543	1/000	0/199	0/307	1/000	0/001	0/081
Koohmobarak-Jask	0/375	0/218	0/543	1/000	0/199	0/008	1/000	0/001	0/057
Gabrik-Jask	0/161	0/080	0/200	0/374	0/073	0/008	1/000	0/001	0/023

As can be seen, the Persian Gulf industrial zone in Bandar Abbas as well as Ziarat and Kooshkenar in Gavbandi are the best alternatives in terms of cost and Hoozhdan, Koohmobarak and Gabrik are the worst alternatives with the score of 0.194, 0.171 and 0.168, respectively.

4.1 Final Prioritization

Considering the effect of designated weights in Table 28-9 on different points (based on cost and infrastructure criteria), the prioritization of the studied zones is as follows according to the following formula:

Final score = (.167 × the zone score in infrastructure criteria) + (.833 × the zone score in cost criteria)

Row	Studied Zone	Final Score
1	Persian Gulf industrial town-Bandar Abbas	.190
2	Ziarat-Gavbandi	.162
3	Kooshkenar-Gavbandi	.156
4	Between Bavardan and Hoseinieh-Bandar Lenge	.137
5	Bandzark-Jask	.087
6	Hoozhdan-Jask	.085
7	Khoorkarti-Jask	.082
8	Koohmobarak-Jask	.066
9	Gabrik-Jask	.035

As it is observed, the Persian Gulf Industrial Town in Bandar Abbas has the highest rank in the location studies of the Alumina plant in the proposed and investigated areas with the with the score of 190.

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AUTHORS CONTRIBUTION
This work was carried out in collaboration among all authors.

CONFLICT OF INTEREST
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