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A location model for industrial and mining factories Case study: Dolomitic lime in north of Khuzestan Province

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ABSTRACT

Location as a spatial analysis helps effectively to reduce the expenses. Development of geographic information system and its combination with multiple-criteria decision analysis led to more accurate and effective location processes. In the present work, it was tried to identify all factors affecting location procedure of a dolomitic lime processing factory, form the associated hierarchy (with 6 criteria and 21 sub-criteria) and apply the analytical hierarchy process as well as classification of the factors using some expert ideas. Then, providing a database that included sub-criteria surface features, area-weighted average method was used in ArcMap software to categorize data layers into five groups (improper to very proper).

1. INTRODUCTION

Mining procedure consists of three major units: exploration, extraction and mineral processing. At processing phase, location of the processing factory is considered as an important decision in mining projects. Since the factory is to be used during the lifetime of the mine, having it constructed on a suitable land may guarantee success of the whole project. Location depends on many factors so that it may be considered as a multiple-criteria decision-making problem. Analytical hierarchy process is a powerful framework in multiple-criteria decision-making which was developed by Thomas L. Saaty in 1980. This process employs paired comparison of the decision-making criteria.

AHP was paid much more attention among other multiple-criteria decision-making techniques so that Saaty researches have been cited by 1000 scientific works in fifteen years. Besides, using GIS is considered as beneficial because of the capability to add and combine various numerical data. Expert Choice software could be used to apply analytical hierarchy process.

2. The studied area

The dolomitic mine area is located in Lali County and has been exploited recently. With proved reserves of 31 Mt, its longitude is from 48° 34' to 49° 21' E and longitude is from 32° 4' to 32° 27' N.

In location of a mineral processing factory, it is necessary to take every requirement and into account and make sure that they are all met. Accordingly, it was tried to take benefit of operation regulations and specific instructions as well as checking on other processing and mineralization facilities to obtain their strength and blind spots in order to provide a complete set of effective factors in location of the dolomitic lime processing factory.

3.1. Financial factors

Construction of any factory has to be studied in advance from a financial point of view. The processing factory was assumed as an essential need for the region; then, it is vital to realize that whether the possible places are financially suitable or not.

Some major features that affect the future of the project are: land clearing costs, infrastructural facilities costs, product final costs, return on investment maximum, the shortest return on investment time period, economic lifetime of the factory, etc.

3.2. Trading factors

The last level in mining is called concentration in which minerals are made applicable for other industries. It is vivid that every mineral processing factory has to be able to compete with other manufacturers. Such ability is explained by quality and price of products. Quality is totally dependent on technical factors and equipment inside the facility. However, price highly depends on the distance between the factory and mine or affiliated industries.

3.3. Technical factors

Depending on the mineral type, every factory may need various land areas for their equipment and facilities. In addition, such factory produces wastewater and other hazardous wastes which have to be dumped in a proper place (known as a tailings dam).

3.4. Environmental, geographical, social and cultural factors

Huge changes in ecology and environment of plants and animals may be considered as adverse effects of mining. Toxic fumes are indeed hazardous for human. Factories near cultural heritage may bring about destructive results.

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3.5. Geological factors

Subsidence and landslide have to be taken in consideration when it comes to location of a factory. Construction on weak points (from geological and geotechnical points of view) requires more investments and exposes the project to hazard. Faults locations (specifically active ones) and earthquake history of the area influence location of factory.

3.6. Juridical factors

Investigation on ownership state of nearby lands (natural and legal) and construction on owned lands are necessary to avoid any loss by investors or fraud. Moreover, civil law has explicitly provided some mandatory codes to determine the territory of wells, canals, etc.

3.7. Infrastructural factors

Supply of water (drinking and industrial), electricity, fuel, telecommunications as well as providing roads, railways and airports are placed into this group.

3.8. Mineral factors

Processing factories are usually constructed near mines and minerals; hence, it is not unlikely that they are located on probable reserves. Alteration mapping and detailed exploration results may come highly useful to predict mineralization trends and avoid any problems.

4. Analytic hierarchy process

Selection of the best option among others according to every effective criterion there is, may be considered as an important task for decision-making managers. Priority of each option towards others may also become interesting as well. For instance, in selecting a contractor for a construction project, some criteria such as charges, construction duration, job background, etc. seem to be of great importance for decision-making. In such case, each option is defined and evaluated according to the known criteria and comparison points, respectively. Straight point determination is not a simple matter and may deflect final results; therefore, AHP may be used as a beneficial solution for rating. In 1970, Thomas L. Saaty designed such process which is concisely described in the following.

Decision-making procedure is divided into two groups: continuous and discrete. Discrete mode itself consists of single-criterion and multiple-criteria groups. Criteria may be qualitative, quantitative or mixed. AHP provides the feasibility to make decisions correctly with considering all types of criteria. Analytic hierarchy process may be implemented in three phases:

- Building the hierarchy
- Paired comparing
- Weight calculations

The effective factors in location of the dolomitic lime processing factories were weighted according to ideas of five experts in mining (exploration, extraction, processing, rock mechanics and mine management) which were obtained by means of paired comparison questionnaires.

Table 1: Results of Analytical Hierarchy Process

Weight	The following criteria	Row
0.13545	Distance from the centre feed	1
0.09364	Distance from the path	2
0.08353	Distance from the village	3
0.08314	The effect of writing (topography)	4
0.08199	The possible	5
0.07684	Distance from faults	6
0.05560	Seismic status	7
0.05377	Distance from areas of tourism and cultural heritage	8
0.05309	Strength of the stone floor	9
0.04115	Distance from communication ways	10
0.03719	Supply electricity	11
0.04690	Distance from areas with vegetation	12
0.04633	Distance from rivers	13
0.04056	Distance from fields	14
0.03934	Distance from the nomadic camps	15
0.01873	Distance from fields	16
0.01830	Distance from the target centers (client)	17
0.01693	Distance from water wells	18
0.01071	Providing telecommunication requirements	19
0.01000	Distance from the abandoned villages	20
0.00700	Distance from healthcare centres	21

Developing information layers

In case of using GIS, each criterion has to be given to software in form of a numerical information layer. It may be done by satellite photographs with high location accuracy and 1:25000 maps. For instance, high voltage transmission towers map was used to provide electricity supply information layer and 1:25000 maps were used to provide nomadic camps information layer. Region faults were extracted from geological 1:100000 maps. After that all layers are prepared, they have to be fuzzificated. Fuzzification is to separate the study area to subareas with different desirability values. For example, regarding plenty of explosions in mine areas which cause rocks to be thrown around or earth-shakes, unsafe territory of the mine must be identified using related equations and be given a zero point. Short-distant areas are given 1 point and as distance increases the given point would decrease. All layers were fuzzificated in a similar way and .By using statistical method (very proper, proper, average, improper and very improper), the below map was obtained.

According to the results, it may be concluded that the mineral processing factory has to be constructed on blue subarea.

Conclusion and suggestions

Location process method may be successfully used to weight sub-criteria in AHP. It may be observed that distance factor is definitely introduced by this method as the most important one. Considering the fact that every processing factory needs a place to dump wastewaters and gangues, it reveals to be necessary to carry out a separate study on location of tailings dam for the factory. Results of both researches may be combined to reach some areas in which the factory could be constructed. The ideal place may be chosen through other decision-making methods such as maximum likelihood.

Since the present work was carried out in an extended area and it was clearly impossible to consider some of the effective factors, it is suggested that one take the following options into account in more accurate researches on improper areas:

Stability level of the region

Wind conditions

Subsidence and landslide conditions

It is also recommended to perform another research using other methods such as FAHP for weighting of criteria which is supposed to remove some of AHP disadvantages.

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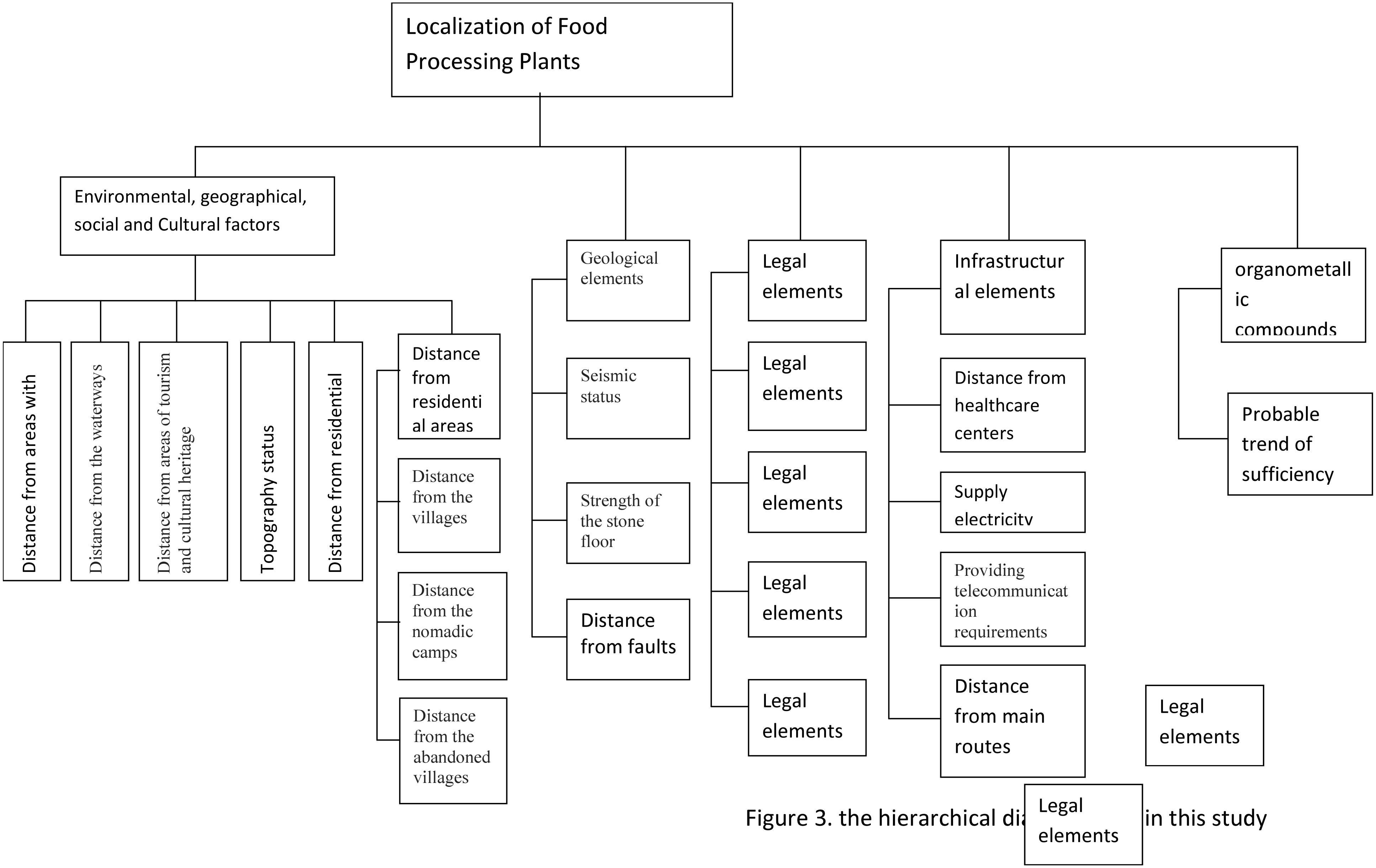

Figure 3. the hierarchical di in this study

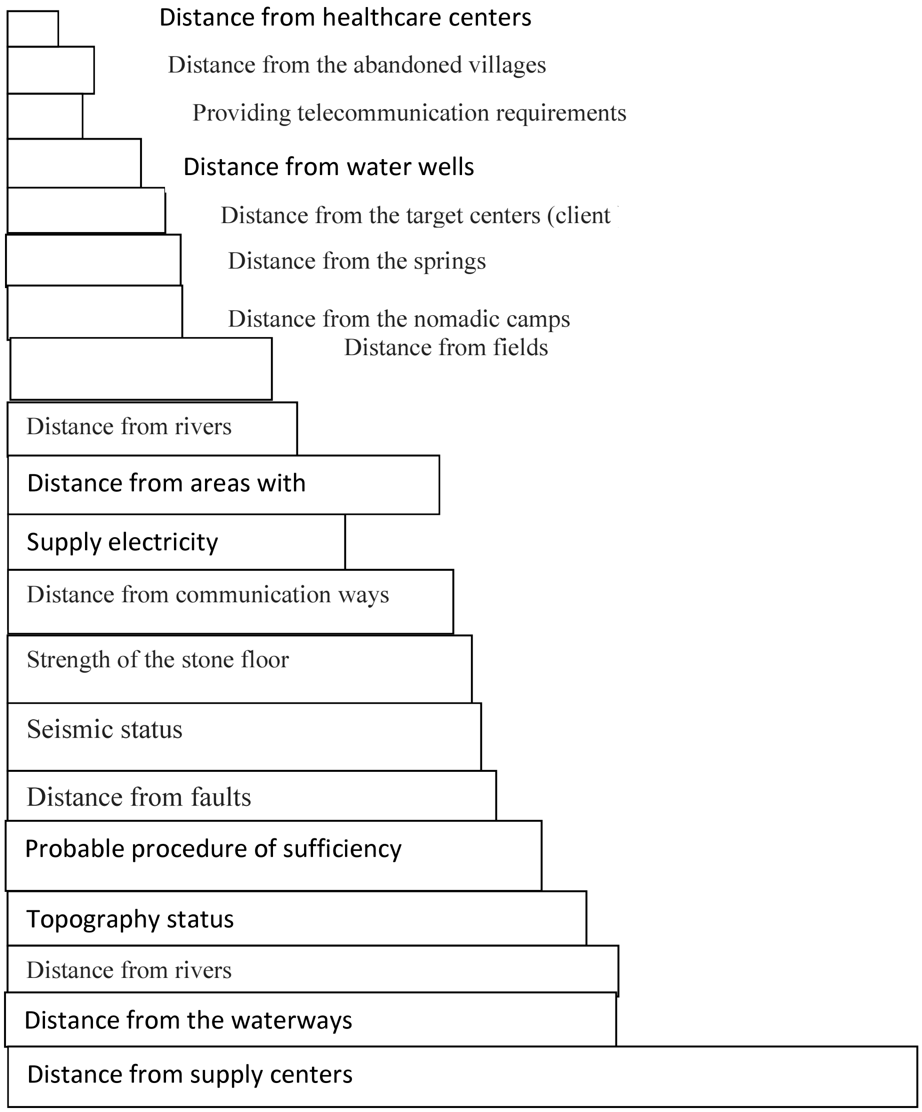

Figure 3. display of the result of hierarchal analysis method in a graphical form

Table 2. Privacy zones and distances considered for fuzzification of outcomes

Explanations	**Outcomes**
Distance from this mineral area is 945 meter	Turquoise mine
privacy zone is 200 meter	Faults
privacy zone is 500 meter	electrical transmission lines
privacy zone is 500 meter	communication masts
privacy zone is 500 meter	Cultural and national heritage
privacy zone is 400 meter	Residential areas in villages
privacy zone is 200 meter	Residential areas in nomadic camps
privacy zone is 70 meter	Residential areas in abandoned villages
privacy zone is 150 meter	Routes
privacy zone is 520 meter	Fields
privacy zone is 100 meter	wells
privacy zone is 520 meter	Springs
privacy zone is 150 meter	Rivers
privacy zone is 30 meter	Waterways
privacy zone is 500 meter	healthcare centres
Use of Normalized Difference Vegetation Index in satellite images and determination of the points with vegetation	Farmlands, gardens and vegetations