LOCATING OF SEMNAN GENERAL LOGISTICS PARK BY AHP METHOD AND GIS

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The existence of logistics centers in a country makes an appropriate basis for the development of domestic and international freight transportation. In Iran, logistics centers include logistics cities, logistics villages, general and agricultural logistics parks that their locations have been determined in the "preparation document of the country's logistics centers", which was provided by the Office of comprehensive Plan and Transportation Models of the Ministry of Roads and Urban Development of Iran, in November 2018. One of the parks among 12 general logistics parks have been located in Iran, is General Logistics Park of Semnan arena. In this paper, based on technical and specialized criteria related to the locating of logistics centers, especially of general logistics parks, and by Fuzzy Analytic Hierarchy Process (F-AHP) method and also Arc GIS software, the best location for the establishment of general logistics park in Semnan arena, is identified and proposed.

Keywords: F-AHP, Geospatial Information System (GIS), Logistics Centers, Locating of Logistics Park.

1. Introduction

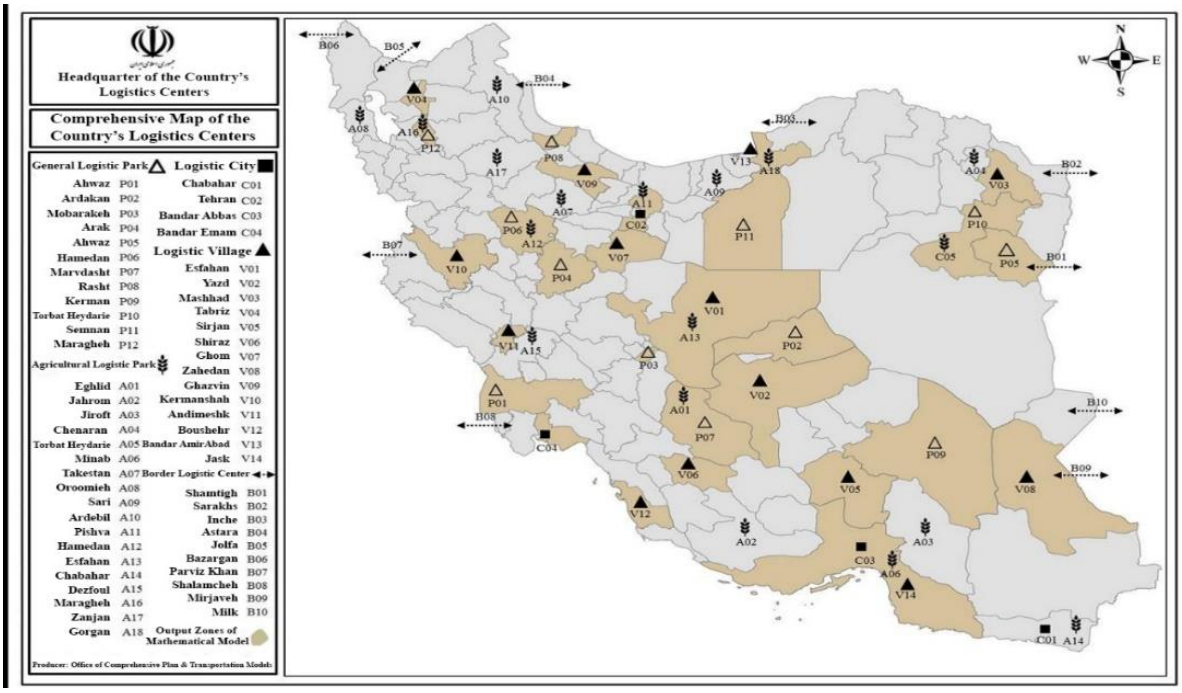
One of the indicators of the economic development of any country is its progress in freight transportation. One of the important infrastructures in the development and expansion of domestic and international freight transportation in each country is the existence of logistics centers such as logistics cities, logistics villages, and general, specialized and agricultural logistics parks. The most important operation of the logistics parks is to create a suitable basis for creating combined or multi-modal transportation

(with at least two modes of transport) to transport all kinds of goods, both domestically and internationally.

In the preparation document of the country's logistics centers, which was prepared by the office of the comprehensive plan and transportation models of the Ministry of Roads and Urban Development in 2018, logistics centers are located in different zones (Figure 1), but it is necessary to determine the accurate location of the logistics center in each zone.

Figure 1:

Comprehensive map of the country's logistics centers in Iran



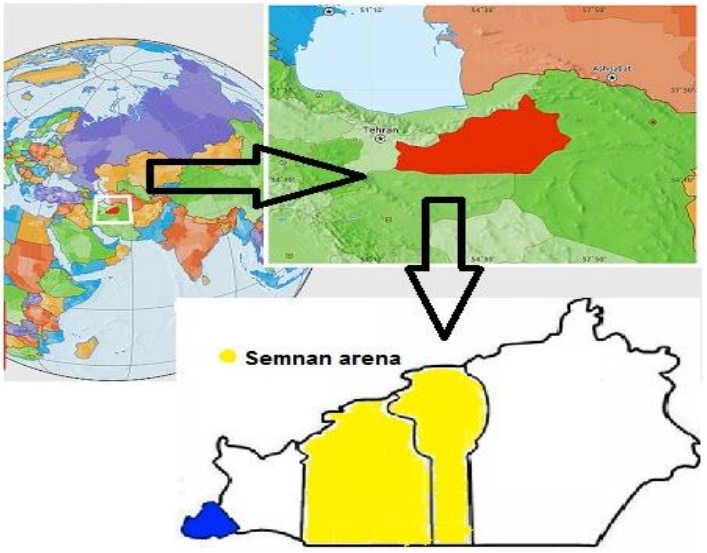
Since Semnan province is located at the crossroads of the north-south and east-west routes in Iran for freight transportation and because of the importance of movement of all kinds of goods in the shortest time and at the lowest possible cost, and the important position of the province Semnan as one of the production-industrial hubs of the country, in this article, we intend to locate one of the logistics centers of the country, namely the general logistics park of Semnan arena (P11 in Figure 1). Semnan arena (including the cities of Semnan and Damghan), with an area of 35,845 Km^2, which is located at the north of the Kavir plain and south of the Alborz Mountain ranges is shown in figure 2. Since in the mentioned preparation document, a general logistics park has been foreseen in the Semnan arena which is one of the 12 general logistics parks in the country, based on technical and specialized criteria related to the locating of logistics centers, especially of general logistics parks, and by Fuzzy Analytic Hierarchy Process (F-AHP) method and Arc GIS software, the best location for the establishment of general logistics park in Semnan arena, is identified and proposed.

1.1 Definition of the logistics center

Logistics centers include the logistics city, logistics village, border logistics center, general and agricultural logistics parks, which must be established in designated places for the development and prosperity of domestic or international freight transportation. To learn more about one of the types of logistics centers, namely general logistics park, we refer to the definition of general logistics park mentioned in "the preparation document of the country's logistics centers":

General Logistics Park: These logistics centers play a centralizing role in logistics services related to domestic cargo. The cargo processed in these centers generally has a domestic origin and destination and belongs to all categories of goods and practically aims to reduce domestic logistics costs, improve combined transport and improve the logistics efficiency of the country by providing a wide range of added-value services. This type of logistics centers have a national scope of activity, have a multi-modal terminal, which provides logistics services to different types of goods groups, including composition, distribution, unloading, loading, storage, legal inspections related to the movement of goods and added-value services [1].

Figure 2.
Location of Semnan arena in Iran



2. Methodology

Its exact location will suggested based on technical and specialized criteria related to the locating of logistics centers, especially of general logistics parks by Fuzzy Analytic Hierarchy Process method (F-AHP) as well as Arc GIS software.

For this purpose, we first consider the main and most important criteria for locating a general logistics park and then seek the opinions of experts and specialists about the prioritization of criteria through the AHP questionnaire. Then we evaluate the reliability of the results obtained from the questionnaires. If the reliability of their opinions is confirmed,

according to their opinions and by the Expert Choice software, each criterion is weighted. Corresponding to each criterion, a layer is defined and uploaded in the GIS software. After we obtain distance layer and fuzzy them, related weights are multiplied in the fuzzy layers and then we combine and overlay the weighted layers in the software to identify a suitable area or areas for the establishment of the logistics park. Finally, the selected areas are compared in terms of area, environmental principles, and proximity to or distance from the city, and the best option is selected.

3. Data analysis

3.1. Introducing criteria for spatial locating

To find the best location for any unit, including commercial, service, etc., many and various criteria are considered, depending on its type of use. Likewise, relevant technical and specialized criteria should be considered to find the best place for the establishment of a general logistics park. In the literature of researches related to the locating of logistics centers and logistics parks, various and different criteria have been presented and proposed.

Ismail Onden et al. Consider spatial criteria including proximity to railways, main roads, seaports, and airports, and some other criteria, such as population, to be important for a suitable location for a logistics center [2]. Kirrilov and Tselin propose the following general criteria for assessing the target area: business climate, financial attractiveness (general and logistics costs), the environmental conditions, consumer market proximity, presence of a competitive environment, logistics infrastructure, availability of professionally trained personnel, market suppliers, political risks and competitive advantages [3]. According to Mironyuk, the main criteria for the placement of logistics centers at the regional level are: the intersection of traffic flow of one or more modes of transport; availability of transport, warehousing, and logistics infrastructure for the processing of traffic and customer service; ability to handle multiple types of transport; urban areas should have high population density; placements should relate to regional development goals [4]. Uysal and Yavuz used the following criteria to analyze the study area: proximity to seaports and airports, distance to residential areas, availability of labor, security of the environment, availability of highways and roads, traffic density [5]. Rao et al. Point to some other criteria such as the price of the leased land, the impact on the environment, the natural conditions, the impact of the logistics center on nearby residents and traffic congestion, etc. [6]. Zak and Weglinski pay attention to the criteria of proximity to the airport, construction cost in urban areas, air pollution, etc. [7]. Rikalović et al. Consider some other criteria for locating a logistics center, such as spatial position, inter-modal connections (road, water, air and, rail transport), the size of the available location, topography, environment, ecological aspect of the location, constraints in the area, etc. [8]. In the technical report prepared for the Asian Development Bank, the connection and intersection of the road, rail and, air modes of transportation in the logistics center have been considered as important criteria [9]. In a research project conducted by Isfahan Management and Planning Organization, regarding the locating of logistics centers in Isfahan province in 2019, these criteria have been considered: distance from environmentally protected areas, land cover constraints, land slope, fault risk areas, distance from flood plains, the environmental limit of cities, Proximity

to airports and customs, proximity to special commercial areas, proximity to industrial areas and industrial towns, agricultural and mining areas, urban and rural settlements, distance from freight entry/exit points of the province, distance from main roads, distance from Railways, distance from electricity, gas and telecommunications infrastructures [10].

From all the proposed criteria mentioned above, and taking into account the economic, environmental, social and, geographical conditions of the study area (i.e. Semnan Arena (including the cities of Semnan and Damghan)), some important criteria that are effective in locating the general logistics park were considered: 1- Low slope regions, 2- Distance from faults and earthquake centers, 3- Distance from rivers, waterways and, floodways, 4- Proximity to production-industrial towns and mines, 5- Proximity to the main roads 6- Proximity to the railway, 7- Proximity to the airport, which are considered as the main geographical or spatial criteria in this article, and the environmental criteria of the region, the area of the selected region, distance from the city or proximity to it, are additional criteria that will be discussed later.

3.2. Opinions of specialists and experts according to AHP questionnaire

After identifying the criteria that are effective and important in locating the general logistics park, it then should be examined which criterion and to what extent is more important than another one. For this purpose, a questionnaire was prepared and the opinions of some experts in the fields of transportation and also urban planning were gathered. In this questionnaire, the criteria affecting the location of the logistics park were compared in pairs. If two criteria were in equal importance for the expert, the number 1, was assigned to it, and if one of the criteria was more important than the other, in expert's opinion, a number from range 2-9 (based on its importance) was assigned to it. For example, if the criterion of "proximity to the main road" is 7 times more important than the criterion of "distance from rivers, waterways and floodways", the number "7", which is close to the criterion of "proximity to the main road", is chosen by the expert.

Figure 3.

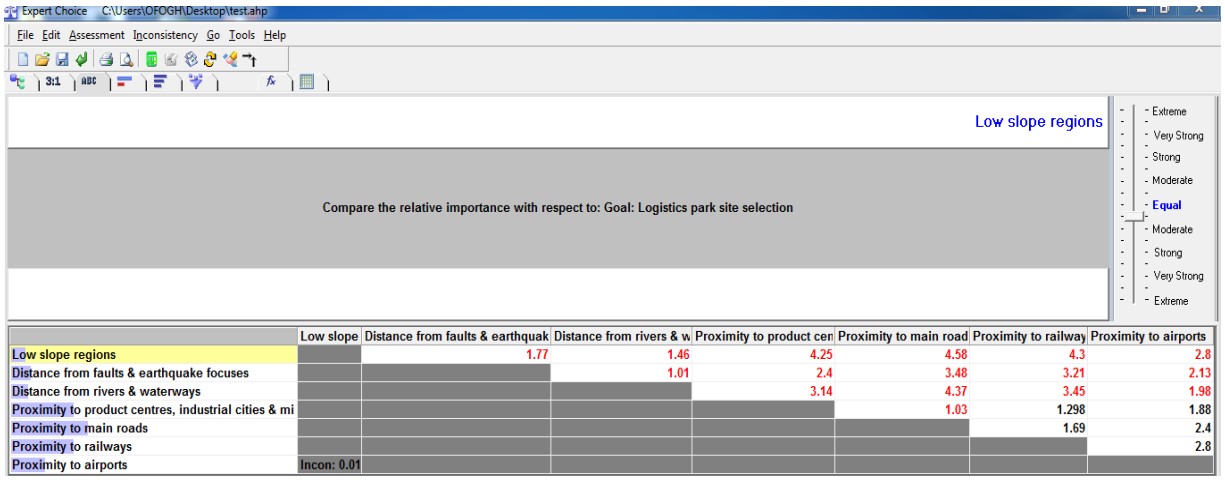
One of the questionnaire tables completed by one of the experts

Criterion j	Priorities																	Criterion i
Proximity to production –industrial towns and mines	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Distance from rivers, waterways and floodways
Proximity to the main roads	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Distance from rivers, waterways and floodways
Proximity to the railway	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Distance from rivers, waterways and floodways
Proximity to the airport	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Distance from rivers, waterways and floodways

To aggregate and average all the opinions of the respondent experts, a geometric mean was taken from their responses to each of the pairwise criteria comparisons. Then the results obtained from the geometric mean were entered in Expert Choice software as a criteria comparison matrix.

Figure 4.

Recording the opinions of experts as a comparison matrix in Expert Choice software



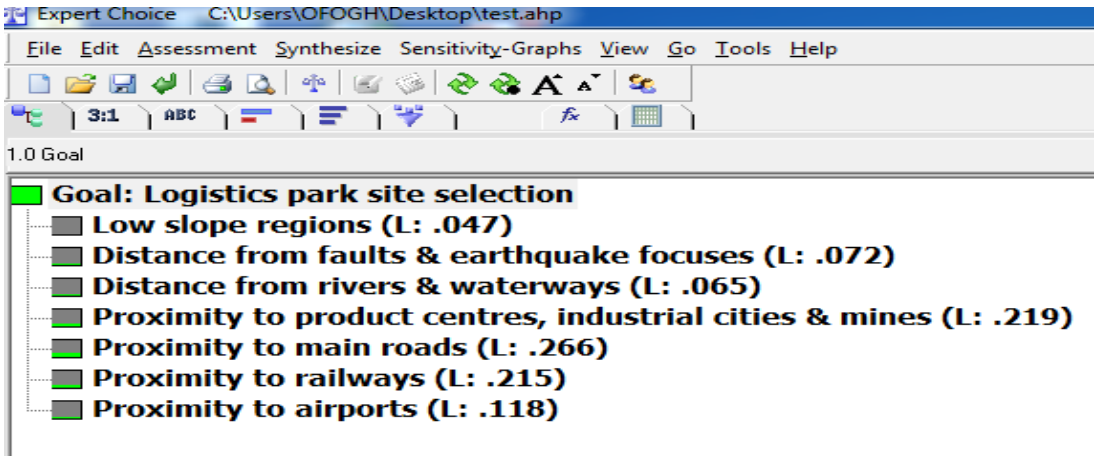
	Low slope	Distance from faults & earthquak	Distance from rivers & w	Proximity to product cen	Proximity to main road	Proximity to railway	Proximity to airports
Low slope regions		1.77	1.46	4.25	4.58	4.3	2.8
Distance from faults & earthquake focuses			1.01	2.4	3.48	3.21	2.13
Distance from rivers & waterways				3.14	4.37	3.45	1.98
Proximity to product centres, industrial cities & mi					1.03	1.298	1.88
Proximity to main roads						1.69	2.4
Proximity to railways							2.8
Proximity to airports	Incon: 0.01						

To control the reliability of the information collected from the questionnaires, we do this: If the inconsistency rate is less than 0.1, the answers and opinions of experts are reliable. As can be seen in Figure 4, the incompatibility rate is 0.01, which (0.1> 0.01) indicates that the average of the answers and opinions of the experts has a good reliability.

After completing the criteria comparison matrix, the weight of each criterion was resulted from Expert Choice software that is shown in Figure 5.

Figure 5.

Weights of criteria resulted from Expert Choice software



The weights of the main criteria is summarized in the following table:

Table 1.
Weights of the main criteria

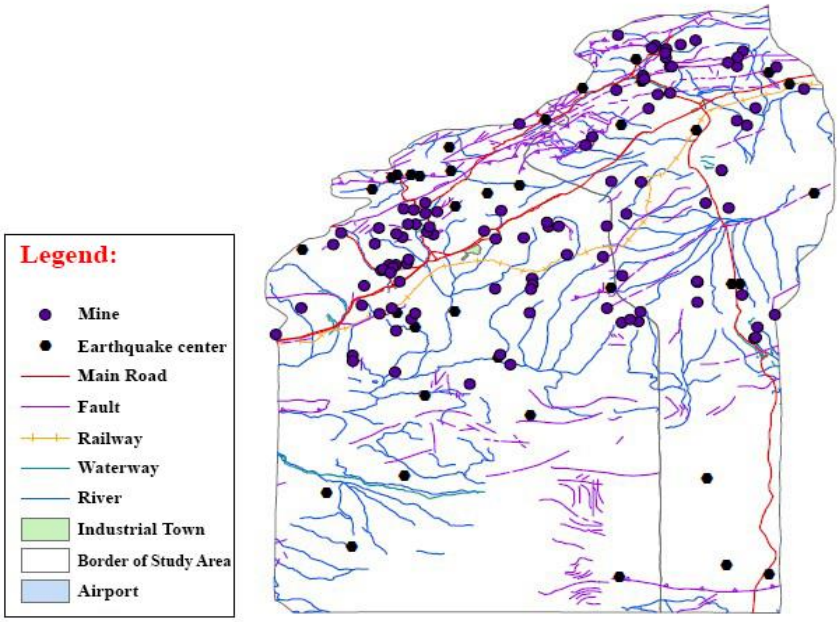
	Regions with low slope	Distance from faults and earthquake centers	Distance from rivers, waterways and, floodways	Proximity to production-industrial towns and mines	Proximity to the main roads	Proximity to the railway	Proximity to the airport
Weights resulted from Expert Choice	0.047	0.072	0.065	0.219	0.266	0.215	0.118

3.3. Input information in Arc map software

Geospatial information System (GIS) is a powerful tool that can be used to locate places with different uses in a variety of specialized fields, including transportation.

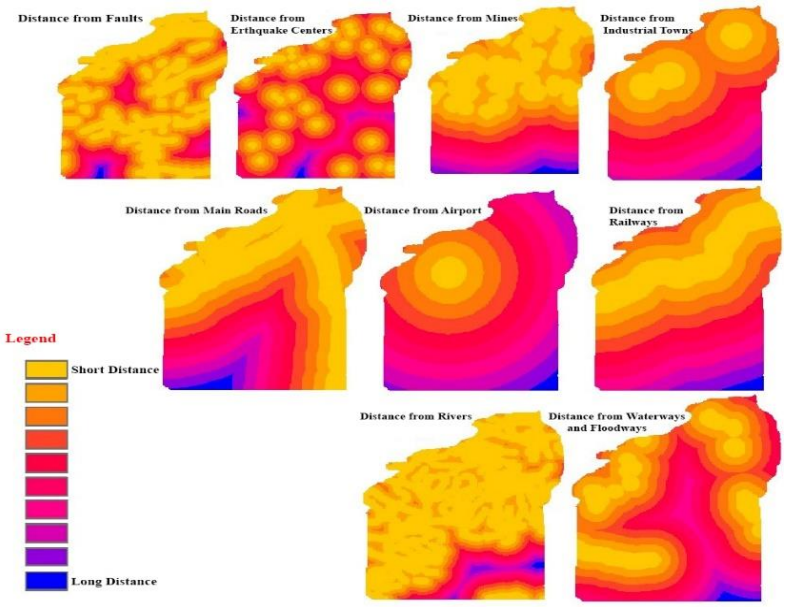
In this study, we used Arc map software version 10.4.1 to upload data and locate the general logistics park. First, we entered the layers of main roads, railways, airport location, slope layer, industrial towns, mines, faults, earthquake centers, rivers and, waterways of the study area in the software environment, which can be seen in Figure 6.

Figure 6.
Study area



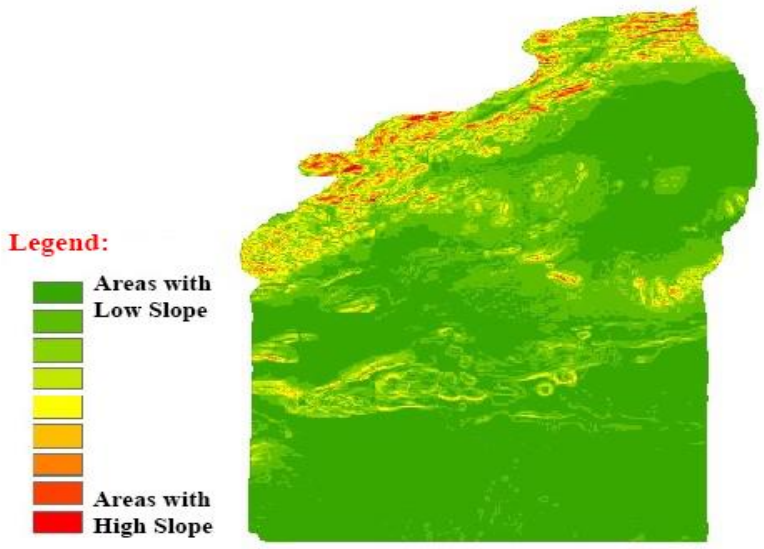
Since to identify the best place to establish a general logistics park, more or less distance from the mentioned 7 items is important and decisive, in the next step, we made the distance layer from each of the mentioned layers by the software that is shown in Figure 7.

Figure 7.
Distance layer of natural features, centers, etc.



Remarkably, the slope layer was made from the DEM layer of the arena that is shown in Figure 8.

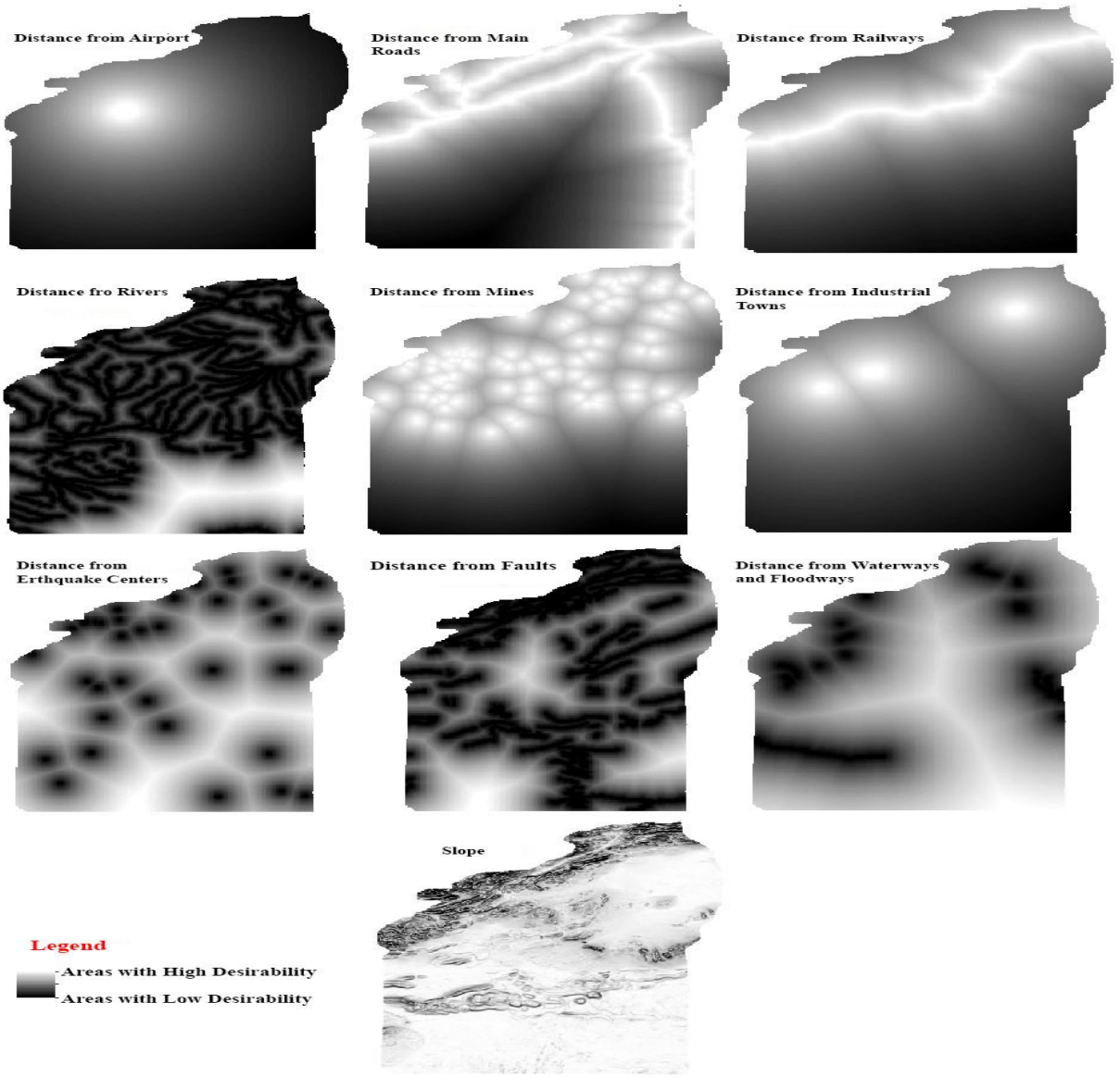
Figure 8.
Layer of the slope of the region



Then, the distance raster made in the previous step, were converted into fuzzy raster by functions or operators like large, small, etc., and then we multiplied the resulting raster

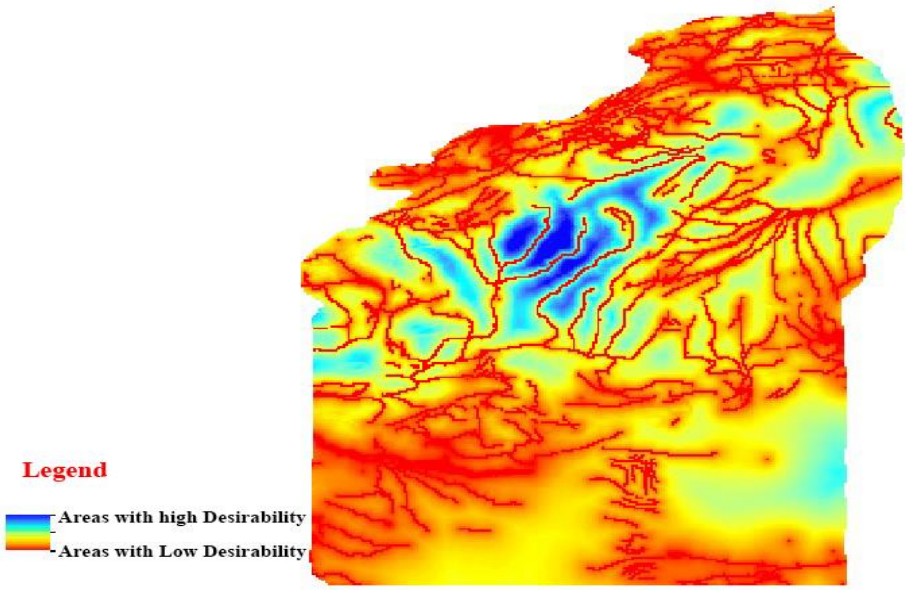
in their weights, which were acquired according to experts' opinions and were summarized in Table 1. So, we multiplied the weight of each criterion into the fuzzy raster and weighed them. For example, to fuzzy the distance raster of the fault, since the greater the distance from the fault is more desirable, we used the function "large", or to fuzzy the raster of "distance from the main road", since the shorter the distance from the main road, the more favorable the region to establish the logistics park, we used function "small". We then weighed all the fuzzy raster that are shown in Figure 9.

Figure 9.
Fuzzy raster that has been weighted



Then we overlay the weighted raster in the software environment using the function "gamma"(with factor 0.7), and finally, the following map was acquired.

Figure 10.
The final result acquired from the software



According to the final map (Figure 10), the dark blue spots indicate the areas that are most desirable for the establishment of a general logistics park, which is totally about 20,000 hectares.

4.Discussion and Findings

Since the distance from the city boundary line, for the establishment of the transportation terminal (unit of class 3) should be at least 250 meters [11] so as not to have environmental hazards for the city, and whereas the blue areas are outside the city limits, so the establishment of a logistics park in the mentioned area is environmentally safe.

Of course, an important issue here is whether the distance from the city is desirable or not. The proximity of the logistics park to urban areas and population centers is desirable because it reduces the cost of moving laborers and park personnel to the logistics park, and proximity to the final consumer or consumption market is a strong point for the logistics park. On the other hand, the proximity to the city leads to environmental and noise pollution for the residents of the city and also is effective in increasing urban traffic. Therefore, to determine distance from the city, the most optimal place should be considered by indigenous experts.

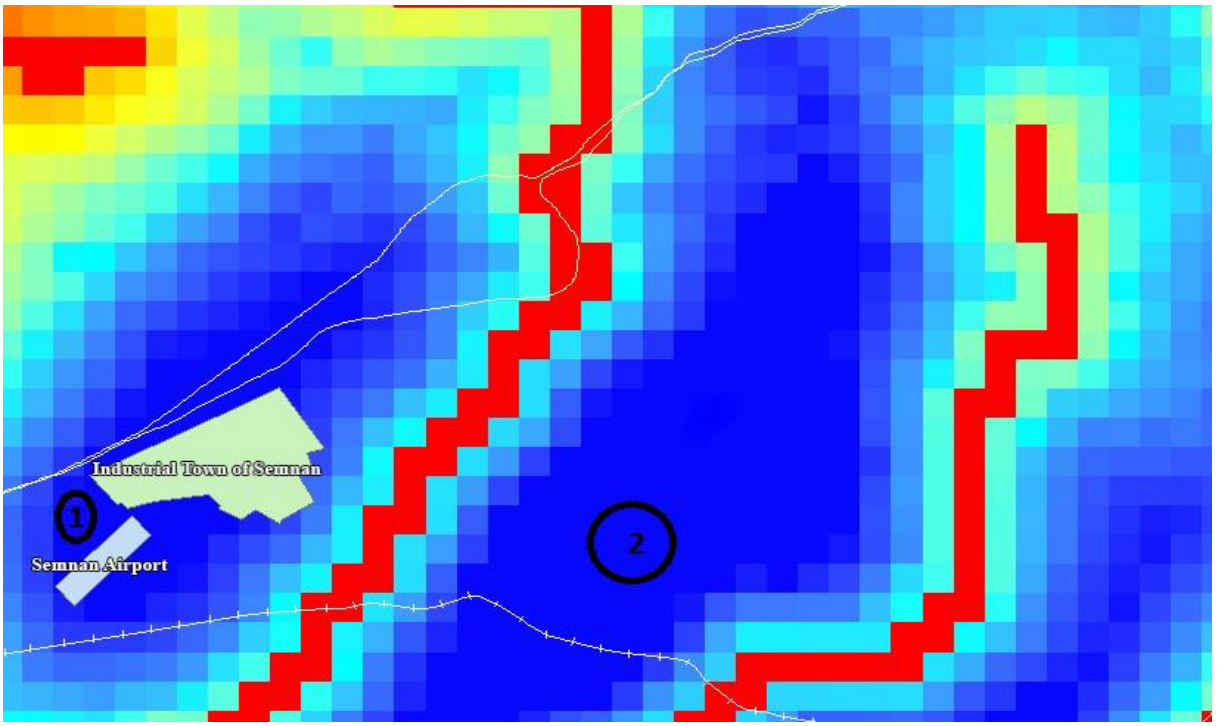
Considering that the desired area for the establishment of a logistics center outside the cities, is at least about 1 square kilometer [12], so to establish a general logistics park, it is necessary to consider an acceptable area.

Considering the mentioned criteria and points, in the area that has the most desirability and was marked in blue, naturally, regions are more desirable that meet the above 7 criteria as much as possible and also meet all the environmental criteria, the acceptable area and the optimal distance from the city mentioned above. It is worth mentioning that to complete the results acquired from the software, it is necessary to conduct a field visit from selected areas to approve the 7 criteria that were controlled by the

software, and also to determine the appropriate location in terms of operational and Executive items, on the ground.

From all the points mentioned, in our opinion, a point in the blue area that has suitable access to the rail and the main road and is proximate to the industrial town and the airport and meets other criteria, is our first suggested option that has been shown by number 1 in Figure 11. In the second priority and if the operational conditions for the implementation of the first option are not met, the second proposed alternative, which is identified by number 2, is another suggestion for the establishment of Semnan General Logistics Park.

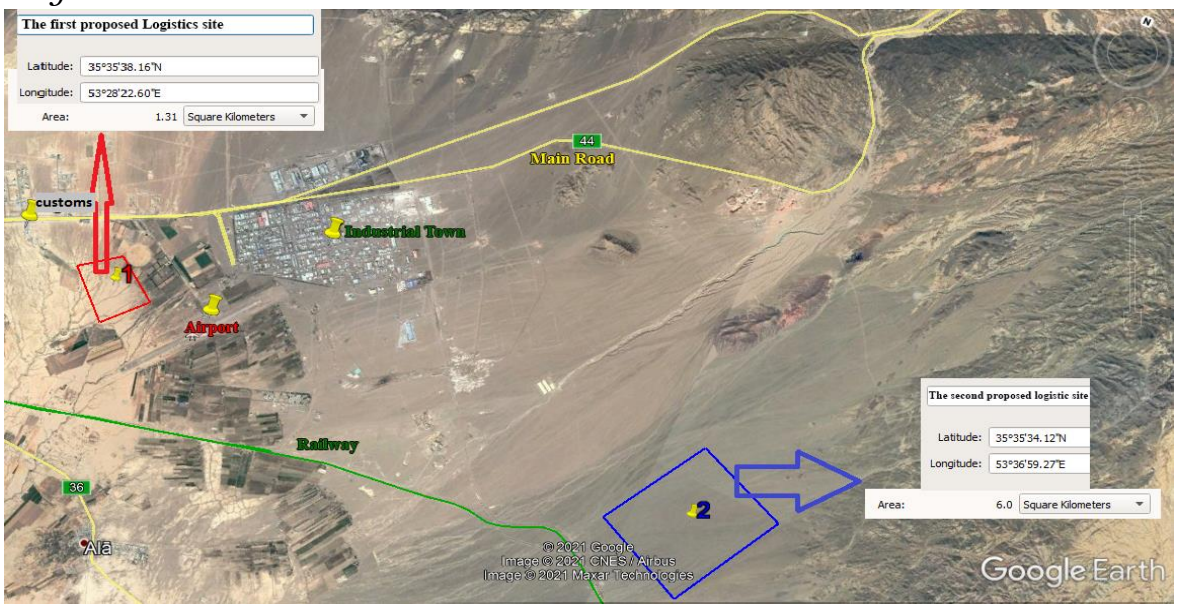
Figure 11.
Suggested alternatives



To clear the geographical characteristics of the two suggested alternatives, by matching the mentioned areas in the Google Earth software, the longitude and latitude of the center of alternatives 1 and 2 are acquired, which their specifications are shown in Figure 12.

Figure 12.

Display of suggested alternatives in Google Earth software by their latitude and longitude



Conclusion

For the establishment of any unit, it is suitable at first to simulate target areas in a computer space according to the criteria, before executing and operating it on the ground, so that either decision making becomes easier for managers or budgets and capitals are spent properly. In this article, we used the AHP method as well as the powerful tool of Geospatial information System (GIS software) to locate the Semnan General Logistics Park so that the best locations for the establishment of the park were introduced in the software environment. Of course, it is necessary to look at the region from a real and operational perspective, by conducting field visits from desired areas resulted from the software to choose the best region or regions.

It is hoped that by the increase in quantity and quality of rail transport infrastructure in the country and hence improving its performance, the desire of goods owners and freight carriers to use rail transport will increase and the natural need for the formation of logistics centers in the country will create and increase day by day.

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