

## ***Using fuzzy Analysis Network Process (Fuzzy ANP) in Recognizing Optimum Place of Transfer Stations for Solid Waste in Esfahan***

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### **Abstract**

Collecting, transferring, and excretion of urban garbage have sanitary and socio-economic importance. The plethora of waste generation cause many acute problems, which are considered as environmental crisis in many countries. Based on necessity and facilities, garbage collecting and transferring is carried out by many ways. The most common way is to use the garbage transferring stations. Transfer station efficiently increases collecting waste matters and decreases transportation costs, pollution, energy, trucks transportation, and road exhaustion. The sites for these stations should be selected considering financial and technical facilities. Considering the goals of this research, at first, effective factors and criteria in site selections were recognized by a review of previous studies and former researches. For recognizing internal relations between criteria, DEMATEL technique was employed. Weight of each criterion was determined after completion of pairwise comparison questionnaire using fuzzy analysis network process model. It was combined with a sum function in ArcGIS software. This process runs for recognizing optimum places in Esfahan. This research helps urban managers and programmers to recognize and choose establishment places for garbage transferring stations by recognizing effective factors in determining the garbage transferring stations site selection.

### **Introduction**

Collecting, transferring, and excretion of urban garbage have sanitary and socio-economic importance. The plethora of waste generation leads to many acute problems, which are considered as environmental crisis in many countries. Based on necessity and facilities, garbage collecting and transferring is carried out in many ways. The most common way is to use the garbage transferring stations. The main purpose of building transfer stations is to collect the waste by great quantity of small vehicles and carry them to the transfer stations. In the transfer station if the station sites are selected properly, the waste would be transferred from the small vehicles to big vehicles until they are carried to the burial site. Because of the population growth and village-to-city migration, the burial sites are designed for a long period. They must be away from the city and the future development path. Henceforth, their distance to the city area would be far. In such cases, transfer stations are helpful. In addition, wastes produced by sub-urban factories and uncovered areas would be carried to the transfer station. Therefore, study of transfer stations is very important from sanitary and economic aspect. Nowadays, collection and transference of wastes in many cities of Iran are being done non-sanitarily and in many cases some obsolete methods are used. In fact, transfer stations are the optimized form of temporary waste stations in city of Esfahan. Their difference is that the sanitary protocols are of the primary rules of transfer stations- unlike the temporary waste stations. Transfer station efficiently increases collecting waste matters and decreases transportation costs, pollution, energy, trucks transportation, and road exhaustion. The sites for these stations should be selected considering financial and technical facilities.

### **Materials & Methods**

Considering the goals of this research, at first, effective factors and criteria in site selections were recognized according to previous studies and former researches. For recognizing internal relations between criteria, DEMATEL technique was employed. Weight of each criterion were determined after completion of pairwise comparison questionnaire using fuzzy analysis network process model and combined with a sum function in

ArcGIS software. In this research, MATLAB software was used to implement DEMATEL and Fuzzy ANP techniques. ArcGIS was used for spatial modeling and zoning. This process runs for recognizing optimum places in Esfahan. This county is one of the counties of Isfahan Province located in center of Iran which its center, the city of Isfahan, is in the third rank of population and produces 900 tons of wastes per day. The mentioned county has 9 cities with 6 districts. The new location for waste dumping of the city and the adjacent towns is located in the east of Isfahan in Segzi region, Km 2 of Isfahan- Naeen road, at 32° 37'36" Northern Latitude and 52° 1'36" Eastern Longitude.

### Discussion of Results

In the first step, the criteria effective in selecting the waste transfer stations were distinguished. These are distance from waterway, soil, geology, distance from main passages, slope, and distance from faults. Then, the interactions and inter-relations between the criteria were investigated using the DEMATEL technique. DEMATEL is a technique of decision making methods based on pairwise comparative, and expert judgments. The table 1 shows the final weights of the effective criteria in selecting the suitable sites for installation of transfer stations using Fuzzy Analytical Network Process (Fuzzy ANP).

**Table 1. Final weights for each criteria and sub-criteria using Fuzzy ANP**

Criteria	Physiographic		Technical, Environmental			Economic, Social	
Sub-criteria	Distance from Fault	Slope	Geology	Soil	Distance From River	Distance from Residential Area	Distance from Highway
Weight	0.1148	0.1583	0.1168	0.1055	0.1529	0.1812	0.1705

In order to make a zonation of the region, the amount of fuzzy membership for each criterion was determined and the fuzzy map for each one was designed in ArcGIS. In the final step, the obtained weights in analytical hierarchy process were multiplied to their fuzzy- derived maps and all weighted maps were combined together using the SUM function (related to the raster layers models) in ArcGIS. In order to identify and evaluate the potentials of the region for the installation of waste transfer station, the final map were classified into 7 classes based on standard deviation.

Class 1 was recognized as the most proper due to the highest potential of installation of transfer stations and other classes are respectively of a lower importance. The results indicate that only 0.727 percent of the region, equal to 114.172 square kilometers, is determined as class 1. Class 2 has a percent of 6.686. The proportions of classes 3, 4, 5, 6 and 7 are, respectively, 20.982, 41.376, 23.627, 6.157, and 0.262 percent. In addition, with respect to the location of cities of this county and the location of current waste dump, some points were suggested for installing new transfer stations. To reach out to this point, the least distance to the location of sites with class 1 priority were considered as a site for installing new transfer stations. Furthermore, by adding the land use layer of the county, the new sites were suggested to be located in deserted land use or in the land uses with no vegetation cover so that the cultivated lands are prevented from any harm. The table 2 describes some additional information about the suggested points.

**Table 2. The situation of suggested points for waste transfer station**

Suggested transfer stations	The city under cover	Distance to the city (Km)	Current land use	Class condition	Field assessment
Station 1	Koohpayeh	6.5	Deserted area	1	Very Proper
Station 2	Harand	7	Deserted area	1	Very Proper
	Azhieh	13.5			
Station 3	Varzaneh	6.5	Deserted area	1	Very Proper
Station 4	Hasan Abad	7.6	Deserted area	1	Very Proper
Station 5	Nik Abad	11.1	Rangeland	1	Very Proper
	Mohammad Abad	6.4			
Station 6	Rahna	12.5	Cultivation lands	2	Proper (the only obstacle is being located in cultivated areas)
	Isfahan	7.6			
	Khoorasgan	7.2			

**Conclusions**

The rapid development of urban and population growth accompanied with whole amount of urban wastes requires attention for management of these wastes. The process of selecting proper sites for transferring of the waste as an alternative requires various parameters. Attention to each of these parameters and selecting a proper site increases the efficiency of waste collection and decreases the transportation costs, air pollution, energy consumption, truck traffic and road exhaustion.

This research helps urban managers and programmers recognize and choose establishment places for garbage transferring stations by recognizing effective factors in determining the garbage transferring stations site selection. An important issue is precision in determination of the weight for each criterion, which plays a great role in the results. The more these weights are calculated, the more reliable the results will be.

Fuzzy Analytical Network Process technique plays a great role in making the results closer to reality by considering relationships among criteria and by being close in comparing criteria to human thinking. This reliability can only be achieved when the experts correctly determine the relations among the criteria. Furthermore, combination of effective criteria is another point to be considered in order to have more accurate results. The technique used in this article is one of the simplest techniques in combining criteria that has shown a significant accuracy due to the evaluations. In order to achieve better results, it is necessary to evaluate this research with other combination methods and compare the results, so that a better decision making for this important economic issue could be obtained.

**Keywords:** DEMATEL technique, Esfahan, fuzzy analysis network process (fuzzy ANP), garbage transit station.

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