

## Site Selection of Firehouses based on Fuzzy Logic and Analytical Hierarchy Process (AHP) (Case Study: Region one of Bandar Abbas Municipality)

**Bahram Hosseinpour Koohshahi**

*MSc Student in Remote Sensing and Geographical Information System of Qeshm University Campus,  
University of Hormozgan , Bandar Abbas, Iran*

**Rasool Mahdavi Najafabadi <sup>1</sup>**

*Associate Professor in Natural Resources Engineering and Geomorphology, University of Hormozgan,  
Bandar Abbas, Iran*

**Arashk Holisaz**

*Assistant Professor in Watershed Engineering Management, University of Hormozgan, Bandar Abbas,  
Iran*

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### Extended Abstract

#### 1. Introduction

The deployment of every urban element in the position of the body - a particular area of the city - is subjected to certain principles, rules and procedures that, if followed, will ensure the success and effectiveness of that element in the same place, otherwise there will be many problems with the occurrence it does. Therefore, achieving equilibrium in the spatial distribution of resources and services is the main goal of the planners. Considering the importance of locating and its position in various projects, the importance of the location of the fire stations and the direct impact on its model and performance will be determined. Provision of fire station services requires their proper location in order to distribute them appropriately to minimize their financial losses. Locating fire stations and determining the number and location of stations guarantee the safety of citizens in the event of any incident. Today, with urban sprawl increasing, development is occurring at a rapid pace outside central city limits. Large commercial and business

districts (often with more office and retail space than the downtown area) quickly establish themselves in suburbia. The City of Bandar Abbas has not escaped this expansion. With current development activity expanding at the edge of existing city limits and large developments planned in the extraterritorial jurisdiction, the need for adequate fire and services increases. City of Bandar Abbas with a very dense urban structure and improper unavailable network is a typical example of such cities. Optimal location and distribution of fire stations for increased important and attentions have significant importance in to the safety in the city and provide arrangements to prevent and respond to fires and accidents. Urban planning standards and the relevant regulations can have made a significant contribution in reducing the loss of life and property and for the safety of citizens in the long run. The most important issue to service fire stations in Bandar Abbas city is insufficient number of stations and the limited range of available functional stations. This study intends to provide practical examples of the application of this tool to determine the appropriate locations of fire stations

1. Corresponding author, E- mail : ra\_mahdavi2000@hormozgan.ac.ir

according to the needs of People in Bandar Abbas's one st District. The Bandar Abbas city has a geographical location between 18 56 up to 22 56 east longitude and 08 27 to 15 27 north latitude; it is located in the eastern part of Bandar Abbas.

## 2. Review of Literature

The general objective of Multi-criteria Decision Making (MCDM) is to assist the decision-maker (DM) in selecting the “best” alternative from the number of feasible choice alternatives under the presence of multiple choice criteria and diverse criterion priorities. The multicriterion choice can be attributed to many spatial decision-making problems involving search and location/allocation of natural resources. These problems, often analysed in GIS, include location/ site selection for: service facilities, retail outlets, critical areas, hazardous waste disposal sites and emergency service locations. A site selection decision is structured according to the following steps: (1) determining the criteria that are used in evaluating the alternatives; (2) describing relevant criteria in decision making process; (3) developing the multi-criteria site selection alternatives; and (4) evaluating the alternatives and making the final site selection decision. Site selection is a typical MCDM problem in which preference among performance criteria plays a key role in the final decision. To assess the decision-maker's preference with a preference model, many efforts have been made to develop the theory and methodology for preference assessment. One of the most preferred approaches is Analytic Hierarchy Process (AHP) which has been developed by Saaty (1980). In AHP, a decision problem is first decomposed into a hierarchy of more easily comprehended sub-problems, each of which can be analysed independently. The elements of the hierarchy can relate to any aspect of the decision problem. Once the hierarchy is built, the decision makers systematically evaluate its various elements by comparing them to one another two at a time. Given a pairwise

comparison, the analysis involves three steps: (1) developing a comparison matrix at each level of the hierarchy starting from second level to the last level, (2) computing the relative weights for each element of the hierarchy, and (3) estimating the consistency ratio to check the consistency of the judgements. The AHP site selection solution process starts with the identification of the pertinent site selection factors. These factors are then structured into hierarchy descending from an overall objective to various criteria and sub-criteria in successive levels. The priority weights of structured site selection factors are then determined through pairwise comparisons to reflect the judgments and relative preferences of different stakeholders. The site selection decision ends when the decision makers provide their final recommendation for the most suitable site(s) with the analysis results. The site selection process involves making spatial decisions. GIS, with the capabilities of data acquisition, storage, retrieval, manipulation, analysis and visualization, has been used for supporting spatial decision-making. GIS and AHP were the first to combine GIS and AHP procedure to aid in site selection. The authors developed the spatial-AHP concept which uses selection criteria and area attributes recorded on GIS data maps to identify and rank potential landfill areas. In recent years, there have been a number of papers published about site selection using spatial information technologies and AHP

## 3. Method

Using traditional methods of fire station planning for services, means wasting paper and time, but today, GIS is served as a tool to create an efficient and efficient database. The selection of optimal locations for the establishment of fire stations requires identifying and analyzing various criteria and indicators. The indicators included in the research include eight physical and social parameters, each of which is related to the map placement in the GIS environment. Information layers have been created in

ArcGIS environment and the results of integration of information layers have introduced the best places for creating fire stations in Bandar Abbas municipality. Therefore, in this research, AHP method was used to estimate the relative importance of each of the parameters. By analyzing and overlapping of the fuzzy layers in the GIS environment, a final map of the location of the fire stations was prepared. Fuzzy operator AND, fuzzy gamma were used to prioritize the appropriate locations of the fire station.

#### 4. Results and Discussion

Thus, the qualitative and quantitative distribution of stations are examined through a scientific method. Indicators proposed in this study consist of eight physical and social parameters that are presented in a GIS environment in conjunction with each location on the map. In this study, the method of AHP was used to estimate the relative importance of each parameter. For this purpose, according to the experts, paired comparisons were made between the criteria.

Then the overall consistency of the pairwise comparison matrix was calculated. The

value of consistency ratio was 0.06. After assigning weights to each criteria, fuzzy layers were formed in GIS environment and by analyzing weighted fuzzy layers, final site selection was confirmed.

#### 5. Conclusion

The results indicated that the existing stations are located in the priority areas. Priority areas for the establishment of fire stations include parts of the eastern region of the earth, north-west as well as west and south of the studied area. Southern and northwestern parts of the existing stations are located within a radius of action, but the western and north-eastern areas are outside the station's performance. So the construction of two new stations in the mentioned areas seems totally necessary for covering the whole region. Finally, using Google Earth and the environmental field visits, a number of suitable locations in the north-east and west are introduced as the proposed location for the construction of a new station.

**Keywords:** fire station, GIS, fuzzy logic, AHP, A one Region of municipal Bandar Abass

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