# Identifying Areas outside the Response Range of Fire Stations Services Using Network Analysis (Case Study: Fire Stations in Tabriz)

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## 1. INTRODUCTION

Relief and rescue activities such as fire stations due to the sensitive nature of their work are of special significance among other urban services. Identifying areas outside the scope of fire stations can help urban planners find the optimal location for the provision of their services. On the other hand, the general policy underlying the development of fire stations creation in Iran has not been based on any specific plans, with fire stations being mainly established in vacant lands or lands without ownership. It has exerted an impact on the location of fire stations in cities. Certainly, timely service of fire stations more than anything depends on proper positioning of a station.

Following the rapid population growth, the dramatic and unreasonable expansion of cities, increasing demands for public services and the domination of neoclassical economics in which the competition for higher profits reduces the share of public land use (safety, emergency, etc.) in favor of increasing the share of residential and commercial land uses, optimized distribution of land uses and service centers has been the main concern of urban planners. The rapid growth of population and physical expansion of cities have given rise to a host of problems like land shortage and improper spatial distribution of land.

Among the urban services available in cities, the optimal distribution of fire stations due to the growing attention to safety issues in cities and adoption of preventive measures to fight fires and disasters have gained importance.

Emergency services such as fire stations, given the critical nature of their activities, are more important than other urban services. Identifying the areas outside the scope of fire stations services can help urban planners find proper sites for the establishment of fundamental urban services. This paper seeks to identify areas outside the reach of fire stations in Tabriz metropolis based on the standard response time (3 to 4 minutes).

## 2. THEORETICAL FRAMEWORK

One of the most useful applications of GIS is network analysis program. It has various applications in different natural and urban fields. One of the urban applications of this program is finding the shortest and best route for timely response in emergencies. International standards recommend 5-km

radius for fire stations as well as 3-5 min response time for reacting to fires. To achieve this standard, the response radius of each station should be reduced. It is essential to establish stations in a distance in which the first fire engine can reach the site of incident in a maximum of 5 min (the recommended time is 3 min). The response radius of fire stations is 4 min on average, meaning that the period between the fire engine leaving the station and reaching the fire site should not be more than 4 min. A fire engine can travel a maximum of 2.9 km in 5 min in a straight line.

## 3. METHODOLOGY

This is an applied research in which the research data were obtained through documentary analysis and field observations. To this purpose, the road network database of Tabriz city was fully studied. Then, using Network Analysis Program in GIS software, the response area of each station was calculated separately. Finally, after analyzing 19 fire stations across the city, the areas outside response radius were determined.

## 4. DISCUSSION & CONCLUSION

A study of the areas within the response radius of each fire station and its comparison with standard areas shows that of 19 fire stations in Tabriz, only three stations, i.e., Stations 11, 18 and 19, cover an area greater than the scope recommended in the standard time. In general, all stations without exception have to cover areas outside their response radius in the standard time.

The study of three scenarios discussed in this study indicate that in light traffic, about 30.04% of Tabriz city lies outside the coverage of fire stations within 4-min standard time . This figure rises to 46.48% in heavy traffics. However, it is only reasonable to consider the actual traffic situation which is the middle ground between light and heavy traffic. Under these conditions, the analysis conducted on the third scenario suggests that about 37.75% of Tabriz city lies outside the fire stations response area, especially the west part of the city.

The results suggest that in normal traffic, 40.14% of the urban area based on the 3-min standard and 62.25% based on 4-min standard are covered by fire stations. Also, the systematic analysis of all fire stations indicates that the entire urban area of Tabriz can be covered by fire station services in 11 min.

**Keywords:** Tabriz Network Analysis, Fire stations, Response Area.

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