

# Urban Growth and Urban Need to Fair Distribution of Healthcare Service, Case Study: Shiraz Metropolitan

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## Research note

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# Abstract

**Objective:** 1) To analyze urbanization development pattern in Shiraz after the year 1977; 2) To analyze hospital development model in Shiraz after the year 1977; 3) To review and prioritize location allocation criteria for hospitals; and 4) To specify appropriate locations for the establishment of potential future hospitals in Shiraz based on selected criteria.

**Results:** Although a significant expansion is seen from different geographical directions (particularly northwest and southeast of the city) in the urbanization model after the year 1977, the construction of hospitals has been limited to the central parts of the city and the areas around the city lack any hospitals. The “open access path to the hospital during incidents and disasters and a light traffic” criterion has enjoyed the highest priority amongst the 24 selected hospital location allocation criteria. Appropriate locations for establishment of new hospitals in the future have been marked as colored maps. The present study has been able to determine and prioritize a comprehensive list of hospital location allocation criteria. Moreover, the achieved maps from this study can be used by policy makers to develop new hospitals.

## Introduction

According to World Health Organization (WHO) the world urban population is expected to grow approximately 1.63% per year between 2020 and 2025, and 1.44% per year between 2025 and 2030[1]. Rapid and often unplanned urbanization leads to conditions that affect human health in a negative way. Inequalities in health facilities distribution and in access to healthcare are a major concern for urban society. Therefore, it is necessary to have a precise plan to increase the number of these facilities concurrent with urban population growth. Determining the optimal number and location is one of the most important criteria for establishing new hospitals [3]. Evaluation of locations from different aspects using objective and subjective criteria is an important and strategic issue in the primary steps of location allocation [4]. Based on our knowledge, various studies have been conducted to select the optimal hospital location; nevertheless, different researchers have used different hospital location criteria in their studies [4–7].

By considering the importance of fair distribution of healthcare services, the present study aims are at the following: 1) To analyze urbanization development pattern in Shiraz after the year 1977; 2) To analyze hospital development trend in Shiraz after the year 1977; 3) To review and prioritize location allocation criteria for hospitals and 4) To specify appropriate locations for the establishment of potential future hospitals in Shiraz based on selected criteria.

## Methodology

This study used two type of data:

1. Shiraz region land-use maps of 1977, 1987, 2000, and 2016 extracted from Landsat image. To evaluate urban growth model, Landsat satellite with 30m and 60m resolution were used. The Shiraz land-use map was extracted by supervised classification method and the maximum likelihood algorithm in three classes of land-uses. Meanwhile, the land-use change maps in the city of Shiraz were prepared and the process of urban growth was achieved for Shiraz after the year 1977.
2. The hospitals data, based on land-use times, hospitals placed on land-use map by use of hospitals address. Thus, hospital development and urbanization development models were compared.

To select suitable area for new hospitals based on urban growth, hospital location indices mined of the Ministry of Health and Medical Education (MH&ME)[1] and other related studies. Then, primary checklist was provided as a questionnaire to experts. Experts were the administrative section of the hospital development, urban planner, social medicine and urban management that questionnaires were given to them. The characteristics of these individuals have been given in Table 1. 22 questionnaires were completed in interview with experts and investigated using the Delphi technique in two rounds. The criteria with agreement score higher than 75 percent were selected as effective criteria for location.

The achieved criteria from interview with experts were arranged in the form of a pairwise compare questionnaire. The aim of preparing this questionnaire, which was developed based in the Analytical hierarchical Process (AHP), determining the importance and priorities of the criteria's were based on one another. The AHP questionnaires were completed by experts who had completed the questionnaire in the previous stage. Then, the results of pairwise comparisons by experts were analyzed by Expert choice software. The inconsistency ratio of pairwise comparisons was calculated and questionnaires with a level of inconsistency of higher than 0.1 were returned to experts for revision and correction. Following the revision and corrections made by experts, the numbers resulting from paired comparisons were entered the software and the absolute weight was calculated. This way, the priority of all selective criteria was achieved using the calculated weights.

Then, Geodata base of criteria were created in Geographic Information System (GIS), and weight of criteria joined to related layers for spatial analysis to location for new hospitals. Based on the achieved result, the final raster layer was divided into inappropriate areas, moderate, high and very high potential areas for construction of a new hospital.

#### **Footnote:**

[1] AR-0201 guideline

## **Results**

With the growth in construction, bare lands in the city and surrounding areas have been allocated for the development of the city (Figure S1).

Although a significant expansion was seen from different geographical directions (particularly in northwest and southeast region) in urban growth after the year 1977, the construction of hospitals has been limited to the central area. Trends of hospitals development since 1977 showed 12 hospitals were built before 1977 (Figure 1A), 5 hospitals between 1977 and 1987 (Figure 1B), 7 hospitals between 1987 and 2000 (Figure 1C), and 10 hospitals after the 2000. Although urban growth and population had rapid increase after 1990 but hospitals growth rate were less.

The main criteria for new hospital location based on the standards of the MH&ME and literature review. The primary checklist has been delivered in Table 1 (Sub-Criteria). It must be noted that 33 of these criteria's belonged to the MH&ME standards and 12 criteria's were achieved through review studies and suggestions by experts.

Following the application of Delphi technique on the primary list, 24 criteria achieved a score of 7.5 from 10. These 24 cases were classified as sub-criteria in 6 main criteria groups (as the main criteria for allocation of location for the hospital). The relative importance of each criterion and its sub-criteria has been given in Table 1.

### **Table 1. The main criteria and Sub Criteria of hospital location allocation and their importance**

Appropriate locations for establishment of hospitals in the future have been marked in Figure 2 with blue color (very high), green (high) and pink (moderate). The specified locations (A and B) have achieved the highest scores. Location A is in the south areas of the city and around municipal zone 2 and location B has a smaller area and located in municipal zone 10 in Shiraz.

## **Discussion**

Shiraz is the fifth metropolitan in Iran [8]. The results of study showed that since 1977, Shiraz had rapid growth in various geographical directions (particularly the northwest and southeast of the city) (Fig. 1). Movahed (2008) has confirmed that the city of Shiraz has concerned immigrants from smaller towns and villages around it because of its job opportunities, applicable facilities. Shiraz gardens and bare lands have decreased and replaced with urban built areas since 1921 to 2004[9]. Although hospitals have been built within the mentioned period but most of them have been intense on the central areas of the city. High demands for healthcare services from Shiraz within south provinces and the countries around the Persian Gulf from and the increasing growth in the number of immigrants, conduct to measures for optimal use of healthcare services, a careful planning is needed in the area of selection of hospital locations based on scientific criteria. It must be noted that hospitals in Shiraz have mostly been constructed on lands endowed by benevolent people. Therefore, in many cases, an appropriate location has not been selected for the construction of hospitals based on standard criteria. Now it is not economically cost-effective to transfer current hospitals to other locations. Since the process of allocation of location has a large effect on increasing accessibility, reducing costs and launching various activities, this process is considered as one of the most important and effective executive projects [10–11]. The total criteria of current study were revised, scored and prioritized by experts in the city of Shiraz.

These criteria as a comprehensive checklist of criteria for location allocation for hospital can be used by health related researchers and policy makers in Shiraz and other metropolitan and large cities in Iran.

There are many studies in the existing literature on use of AHP in hospital location. Chatterjee and Mukherjee (2013) used three criteria's of "geometric shape of the land", "population density" and "physical development opportunities" to hospital location in India rural area. Other criteria same as "land price", "land ownership", "distance from educational centers", and "distance from public transportation stations" identified as effective factors [4]. Sharmin and Neemaee (2013) selected the appropriate location for the construction of a hospital in Dhaka in Bangladesh by AHP. From among the criteria used for this selection, the four criteria of "distance from current hospitals", "network of passages", "industrial centers" and "water currents" were identical with the finalized criteria in the present study [12]. Zhoe and Wu (2008) selected an appropriate location for the establishment of a new hospital in Beijing, China. Criteria's same as "distance from current hospitals", "network of passages" and "distance from residential areas" were identical with the finalized criteria in the present study. Other criteria used in this study included "distance from the metro" and "distance from secondary streets". Although they were part of the primary criteria, but they did not receive the necessary score for the city of Shiraz by experts in this study. The study showed that "proximity to the metro" has the top priority among the criteria investigated [5]. Ibrahim et al (2012) selected an appropriate location for the establishment of a new hospital in the city of Benghazi in Libya. "Access to network of passages", "land size", "possibility of physical development", "distribution in various geographical regions", "proximity to the population" and "noise pollution" were important criteria that announced by experts in the city of Shiraz. The results of the said study showed that from among the criteria investigated, "access by patients to hospital during emergencies" had the top priority [6]. Wissem et al (2011) selected the appropriate location for the establishment of a new hospital from three locations suggested in Sfax. the criteria of "distance from network of passages", "population density", "possibility of providing urban services such as gas", "distance to other hospitals", and "air quality" were identical with the finalized criteria in the present study. Although the criteria of "distance to educational centers" and "proximity to public transportation systems" were rejected by experts views in research. The results of the study showed that "air quality" was the top priority in allocation of location for hospitals [7]. Lack of attention to these criteria in selecting a location with a particular land-use can have plenty of damages to financial resources, the environment, people and urban management [13].

Urbanization model in Shiraz is being expanded from different directions. Therefore, it is necessary to make the necessary plans for eliminating the healthcare problems of people living in newly-developed areas concurrent with the expansion of the city from different directions. However, most hospitals in Shiraz are concentrated in the central parts of the city and the areas around the city lack any hospitals (Fig. 1). Locations selected for construction of a new hospital based on the criteria of the present study as appropriate locations (with average to very high potential) are mainly located around the city (Fig. 2). Therefore, the map achieved from this study can be used properly in planning made by policymakers in the field of health.

## Conclusion

Today's hospital and healthcare centers are important urban infrastructure. Current study extract the criteria's for hospital location from MH&ME the standards and related studies, then scored and prioritized as comprehensive list of criteria for location allocation of hospitals by related experts and AHP. Open access path to the hospital during incidents and disasters and a light traffic has enjoyed the highest priority for the construction of a hospital. Policy makers in the field of health and researchers active in this area can use these criteria as useful scientific tools for selecting the most appropriate locations and investigating the location of existing hospitals. The achieved maps from this study, which have been created based on determined criteria, can be used by policy makers to locate new hospitals.

## Limitations

Limitation on access to noise pollution, air pollution data and traffic data on incidents and disasters occurrence time, and the pathogenic conditions of the areas were the main Limitations. Also data about location of communication and telecommunication towers were not provided for the researchers because of their confidentiality.

## List Of Abbreviations

World Health Organization (WHO)

Ministry of Health and Medical Education (MH&ME)

Analytical hierarchical Process (AHP)

Geographic Information System (GIS)

## Declarations

**Ethics approval and consent to participate:** This manuscript was extracted from the second author's M.Sc. thesis in Medical Informatics (Project No. 94-01-07-10074) and was ethically approved by Shiraz University of Medical Sciences.

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**Consent for publication:** Not applicable.

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**Author's contributions:** All the authors had substantial contributions to design of the work, the acquisition, analysis or interpretation of data; And, all the authors also had substantial contributions to drafting the work or revising it critically for important intellectual content and final approval of the version to be published.

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## Tables

Table 1  
The main hospital location allocation criteria and their relative importance

Main criteria	Weight	Sub-Criteria	Weight	Synthetic weight A	Synthetic weight B	Priority
<b>Population</b>	<b>0.1139</b>	Population density	<b>0.3346</b>	<b>0.0381</b>	<b>0.0225</b>	<b>21</b>
		Proximity to the major urban population	<b>0.3915</b>	<b>0.0446</b>	<b>0.0282</b>	<b>19</b>
		pathogenic conditions of the areas	<b>0.2909</b>	<b>0.0331</b>	<b>0.0347</b>	<b>13</b>
<b>Location characteristics</b>	<b>0.1002</b>	Being located in urban areas	<b>0.1723</b>	<b>0.0173</b>	<b>0.0120</b>	<b>24</b>
		Fair distribution all over the city	<b>0.3747</b>	<b>0.0376</b>	<b>0.0301</b>	<b>17</b>
		Fast and easy accessibility	<b>0.4516</b>	<b>0.0453</b>	<b>0.0323</b>	<b>14</b>
<b>Accessibility</b>	<b>0.1977</b>	Proximity to the main streets	<b>0.1858</b>	<b>0.0367</b>	<b>0.0253</b>	<b>20</b>
		Not having heavy traffic in emergency conditions	<b>0.5911</b>	<b>0.1169</b>	<b>0.0863</b>	<b>1</b>
		The possibility of separating the hospital's main entrance from its emergency entrance	<b>0.2214</b>	<b>0.0438</b>	<b>0.0308</b>	<b>16</b>
<b>Compatibility</b>	<b>0.1696</b>	Being far from airport	<b>0.0799</b>	<b>0.0136</b>	<b>0.0188</b>	<b>23</b>
		Being far from radio, television, and telecommunication masts	<b>0.0813</b>	<b>0.0138</b>	<b>0.0189</b>	<b>22</b>
		Being far from hills, valleys, and faults	<b>0.1721</b>	<b>0.0292</b>	<b>0.0409</b>	<b>10</b>
		Not being located on the river, landslide, or avalanche path	<b>0.2323</b>	<b>0.0394</b>	<b>0.0557</b>	<b>7</b>
		Being far from industrial centers	<b>0.1158</b>	<b>0.0196</b>	<b>0.0288</b>	<b>18</b>
		Establishment of hospitals in the areas with lower air pollution	<b>0.1591</b>	<b>0.0270</b>	<b>0.0318</b>	<b>15</b>

<sup>1</sup> Before calculating CR

<sup>2</sup> After calculating CR

Main criteria	Weight	Sub-Criteria	Weight	Synthetic weight A	Synthetic weight B	Priority
		Establishment of hospitals in the areas with lower noise pollution	0.1480	0.0251	0.0360	12
Infrastructure	0.2521	Proximity to urban services, such as fire station	0.2451	0.0618	0.0571	6
		Availability of information technology and telecommunication infrastructures	0.1794	0.0452	0.0392	11
		The possibility of establishing facilities, such as parking	0.1847	0.0466	0.0445	8
		Availability of urban infrastructures, such as gas, water, and telephone	0.3908	0.0985	0.0859	2
Land specifications	0.2193	Having adequate area according to HM's standards	0.2540	0.0557	0.0647	4
		Having standard geometrical shape	0.1546	0.0339	0.0443	9
		Adapting the land dimensions with HM's standards	0.2682	0.0588	0.0635	5
		Adapting the width of the roads directed to the hospital with standards	0.3234	0.0709	0.0761	3
<sup>1</sup> Before calculating CR						
<sup>2</sup> After calculating CR						

## Figures

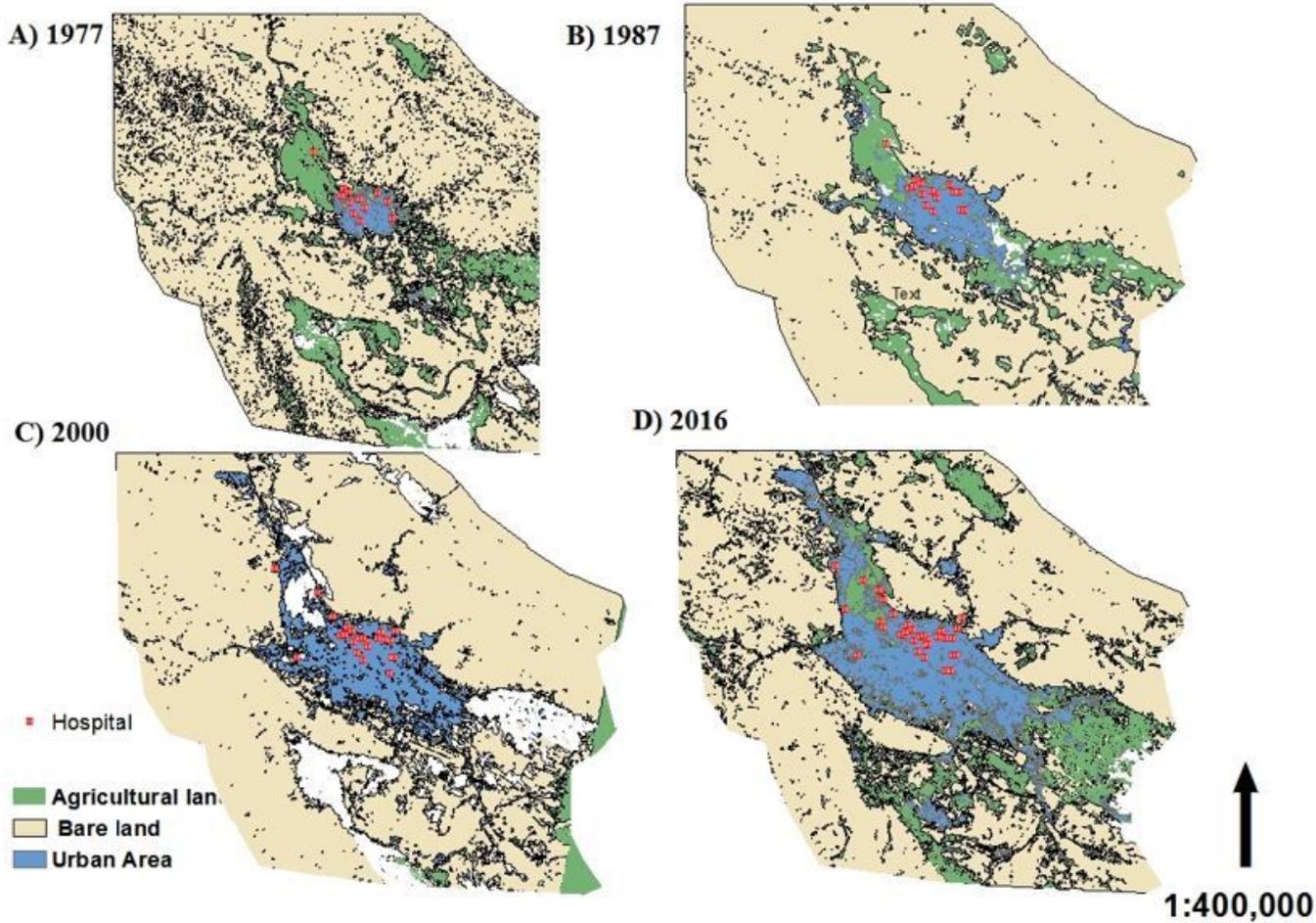
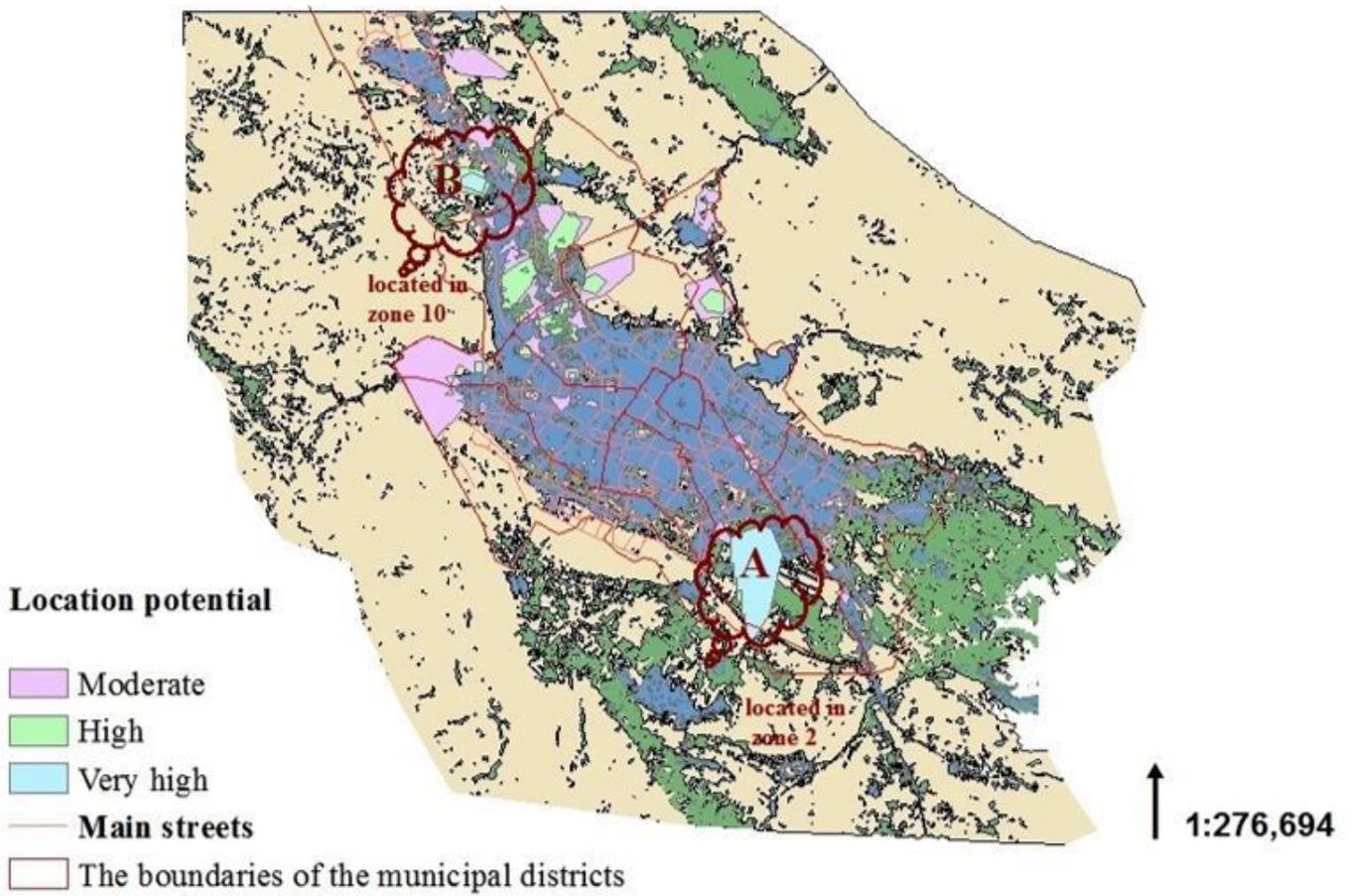


Figure 1

The hospital location allocation criteria and their relative importance



**Figure 2**

Appropriate locations for establishment of hospitals in the future