

The Optimized Location of Hospital Using an Integrated Approach GIS and Analytic Hierarchy Process: A Case Study of Kohdasht City

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Abstract

Background and purpose: Access to health service centers is one of the essential principles in a city, which involved in health care community diverse of individuals. It is imperative essential and important for convenient and fast access to such centers in a short time. The present study was performed to determine the hospital optimal location in the Kuhdasht city.

Materials and methods: Have been selected on the basis of criteria of utility, performance, safety, population density, proximity, and adaptability for hospital Optimal Positioning. Information was collected about the need for measures by means of field survey, interviews and questionnaires. Then used to achieve the best location of model compounds "Analytic Hierarchy Process" (AHP). Computing and spatial is made establishing criteria using Arc GIS software and Excel.

Results: Based on the results obtained, the final map, the result of review of the all criteria relevant to the location of hospitals in the Kuhdasht city, Maps optimum show the study area into zones with priority given to very poor, poor, average, suitable and very suitable, And they determined the implementation of the proposed sites.

Conclusion: The results show, can be identified and selected optimal locations using GIS software and Hierarchical AHP.

Keywords: Geographic information systems; Location of hospitals; Analytical hierarchy process (AHP)

Introduction

Health centers are centers that directly contribute to the health of the individuals and communities. Quick, timely and inexpensive access, to these centers is very important for any community, especially in urban communities [1]. Determining the precise location of health-care services is essential because of the vital importance of these centers [2]. In most cities, lack of proper space allocation and optimal location of the city's services with facilities, especially health services (hospitals and clinics), have led to an ascending increase in urban and citizen problems.

This shows that decision makers and city managers are often faced with difficult decisions involvement with complex situations. This complexity is mainly due to a large number of decision-making criteria which must consider and it is sometimes difficult to understand the interrelationships between these different criteria [3]. However, with urbanization, planning actions are also becoming more difficult day by day. One of the key solutions is using of GIS, which, in addition to providing faster access to information, has both spatial and non-spatial analyzes [4]. In a specific city, due to centrality and other factors, which; attracts different patients from remote locations, medical facilities based on necessary forecasts, for the future could include medical equipment, medical care, nurses with hospital beds [5].

Hospital is a medical unit that focuses on diagnostic and prognostic care, healthcare surveillance, therapeutic actions, educational and research facilities to provide effective healthcare beside, comfort and safety recovery for both inpatients and outpatients [6]. In recent years, it has been shown that using GIS with effective data is the most prominent method of providing a new life, in modeling urbanization theory in programming. Using this program helps to sanitize the urban environment which lead to optimal location [7]. In addition, selecting optimal choice of hospital location, kind of brand strategy,

marketing method, differentiation of human resources based on their performance, could led to increases in competition [8].

To determine the best place for healthcare centers, five important principles and indicators should be considered:

- **Access Principle:** An important criterion in locating these centers is easy access.
- **Distance principle:** The study of the distance factor in the location of the centers is based on the demographic threshold.
- **Neighborhood principle (compatibility):** The existence of some inappropriate uses such as industrial centers and pollutants in the vicinity and adjacent therapeutic centers in case of patient comfort reduces their efficiency.
- **Radius of service:** The coverage distance of each health center to other health centers.
- **Population Criterion:** This indicator is one of the most important criterions for the construction or expansion of health centers. Capacity of these centers is related to the population size and their distribution.

It seems that a standards combination of structural, process and

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outcome will be the best choice for controlling the quality of care and facilities for health care services [9,10].

Proximity to firefighting centers, land prices, distance from other hospitals, distance from educational centers, gradient of land, population density, distance from warerooms and tool houses, vicinity to the parks, distance from urban center, distance from industrial places, network access, communication requirements, the condition of the strategic demand, the competitiveness of the company and, finally, the supporting and related industries, are the main criteria for building hospitals and health centers [11]. Also, quantitative and qualitative evaluations according to compatibility matrix, utility matrix, capacity matrix and dependency matrix, are the location analyzing optimal methods in construction of health care centers.

Considering the quality of service and attracting clients (patients) in hospitals and health care centers is important, so that, many authors stated the items related to the customer and society among the most criteria, such as; consumer satisfaction of Service providers, identifying vulnerable parts of the community, paying attention to cost effectiveness, creating a rational reimbursement structure, hospital service quality and safety, and internal and external vulnerability.

What distinguish GIS from other types of information systems is their locational analytic functions. GIS analytic functions, apply locational data and descriptive non-locational data for answering the required questions. GIS can quickly retrieve and provide information about the hospital location, number of hospital parts, number of beds, number of patients in the departments, required staff information, number of doctors, and distribution of health centers among all the health care provision places.

Joghadaie et al. in their study, have investigated a two-component linear mathematical programming model and considering simultaneously combination of both service locating and services allocation, and they found that this model allows decision makers to consider precisely cost of services, locating and allocating provisions and quality of service. Lee et al. conducted a research "Choosing best place to build a hospital in Taiwan by AHP method," where the famous "diamond model" introduced at Porter's Competitive of Nations.

Considering the criteria in this study are different from the others studies, and considering that the infrastructure and location of each location will not accept all the fixed and rigid criteria, on the other hand, Kohdasht is the priorities that create and build an optimally locational hospital is the first priority. So that, this research is aimed to optimize the hospital location by GIS integrated approach and hierarchical analytic process in Kohdasht city in 2015.

Methods and Materials

This research is a descriptive-cross-sectional studies which. The statistical population consists of all policymakers, planners and managers of the health sector and managers of the urban area of Lorestan province, which using convenience sampling in this study, in to select 25 health managers, policymakers and urban area who they have the predetermined condition and then the questionnaire distributed. The tool of collecting data is library and field research, including the identification and comparison of the optimal location of considered hospital based on library studies and interview with urban experts. Also, to compare and analysis data in addition, map information conducted a researcher-made questionnaire which its validity and reliability have been confirmed. In order to determine and identify the optimal location of the hospital in the city of Kohdasht,

researcher after determining the criteria and sub criteria, designed a questionnaire which determined the importance of criteria and sub criteria based on their score. Also, by using the paired comparison table; which shows the impact of each criterion on other criteria and by using decision-making group through language phrases, comparing of both criteria according to the study goals ; "lowest, less, less than average," have been conducted.

After collecting data, the first level criteria put in a table with two vertical and horizontal columns, and the questioner will determine the weight of each of the criteria relative to the other, based on the comparison scale. Then sub-criteria of the first-level criterion will be compared. In sum, using the innovative time-based method, each criteria and sub-criteria weight calculated. Then total score of each proposed factors are calculated and their mean will be obtained and eventually the data are prepared for the AHP method.

The AHP is a method that should first be categorized according to the purpose of the project, as well as the quantitative or qualitative sub-criteria and alternatives, and then according to proportion to the number of sub-criteria or alternatives in each class, allocated a suitable several of the respondents to each class. Finally, among individuals with good knowledge about the sub-criteria, they filled specific quota of each class.

Results

Initially, a map of topography, a detailed map of the plan and city map of the city were prepared from the municipality. Then by adding the latitude and longitude in the Arc GIS, data were ready to add status information (Figure 1).

Based on compatibility in this study, 46 sample points in the map have been identified. Thus, according their importance they have given specific rate. And by GIS, an interpolation operation was performed and finally, the map of compatibility for the entire county of Kohdasht was prepared. Based on the intervals of the graph, if intervals is closer to incompatible activities, receives less score, and the more distance of the intervals, the score is higher, the degree of compatibility significance region is shown by white color. The maps below show the compatibility of incompatible activities at definite intervals (Figure 2).

Based on the intervals in Figure 3, the more the population density, the more they receive score, and the lower the intervals have density, the fewer score they receive. The importance of populated areas is shown in white color. The map below shows areas with population density

Figure 4 shows the importance of suitable neighborhoods which is shown in white. The higher the neighborhood and closer to the other centers, it gets the higher score, and if the intervals are inappropriate in neighborhood, they will get fewer score.

The hospital should be located in the city where the best efficiency, has in the other word, in locating hospital, we should consider its economics and prosperity. Based on the intervals defined in Figure 5, the longer the intervals are set to perform better than other centers, they get higher scores, and the shorter the intervals are less, and they get less scores.

Hospital safety and utility are important factors that should be consider when building a hospitals. Based on the intervals indicated in the chart, the longer the intervals are given, the better the immune system than the other centers is, and the high score they receive and if the safety is low they receive low score (Figure 6).



Figure 1: Topography and geographic situation.

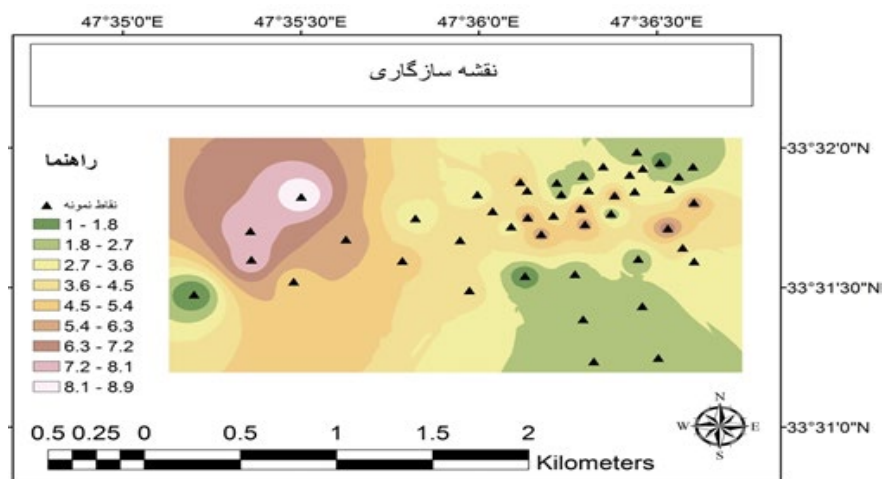


Figure 2: Compatibility map of Kohdasht city.

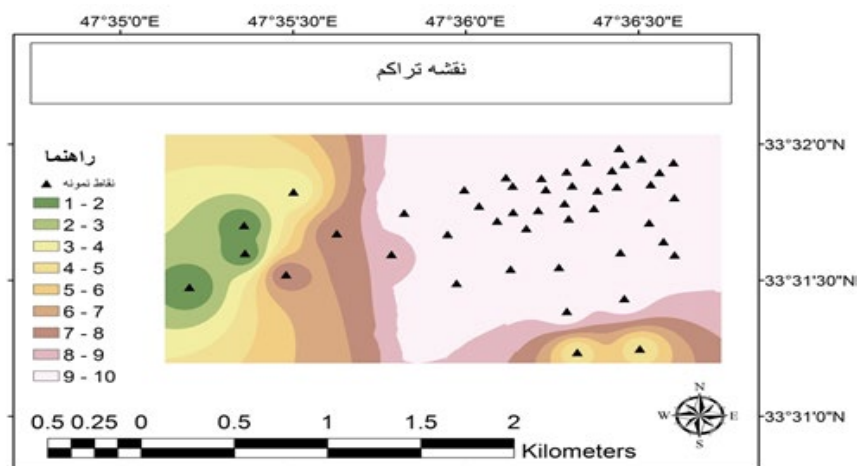


Figure 3: Density map of population in Kohdasht city.

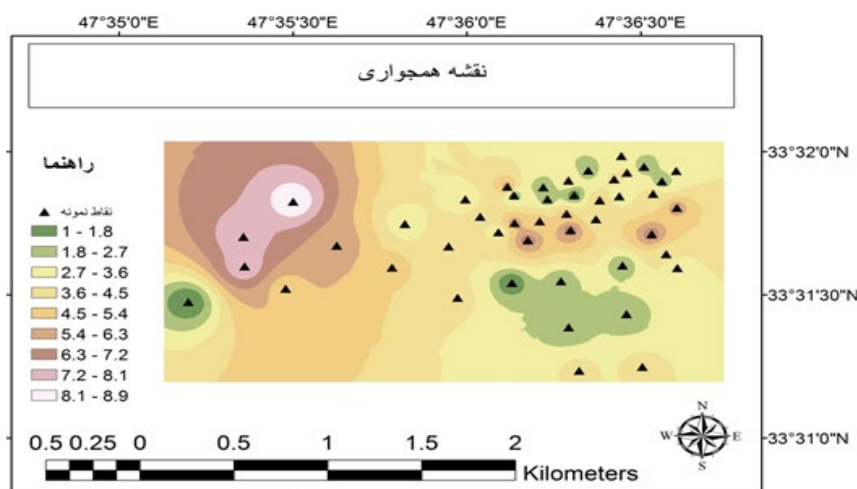


Figure 4: Map of the neighborhood of Kohdasht city for the construction of a hospital.

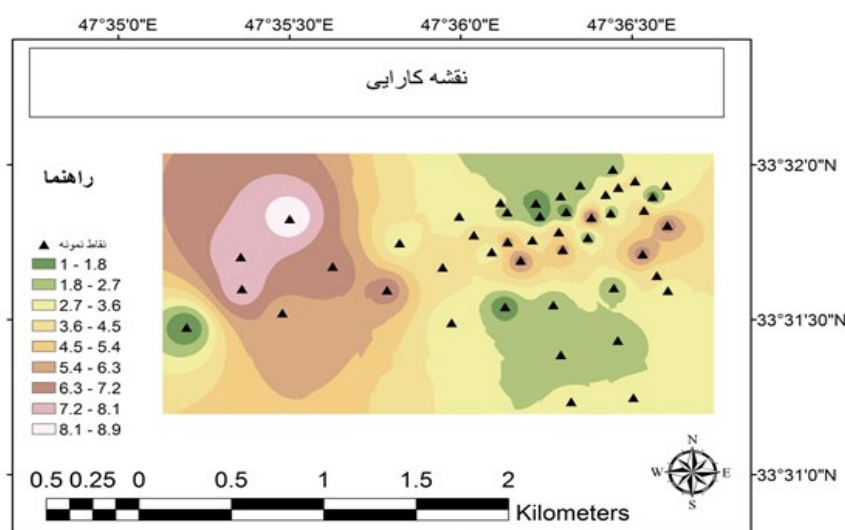


Figure 5: Map of the efficiency of the city of Kohdasht.

In order to measure the utility of the site, there should be a suitable location including: the size of the land, the location, slope, physical characteristics, access, facilities and equipment and pollution. By comparing these factors with current cases, the utility rate is determined. Based on the intervals set in the graph, if the location is more favorable than other centers, it will get higher score, and vice versa (Figure 7).

Roads links different urban facilities and, so that, their significance is critical in urban areas. Hospitals should be built alongside the main roads. Of course, attention should be paid to noise pollution and other factors, and roads should be constructed with a relatively good distance from the main roads. After the identification and entry of the main arteries to the GIS environment, according to the chart each point which have an appropriate place they are marked with yellow, and each where are not appropriate have been shown in blue (Figure 8).

Final map

Based on the results of the evaluation of the criteria, we can judge the optimum location of the hospital. In the previous steps, the combined layers of each criterion were derived from the integration of the layers. At this stage, by mapping the layers of the main criteria together, the priority mapping of the places is specified. Based on the previous criteria, 46 sampling points in the map have been identified for the optimal places in the city of Kohdasht. These places are defined as “very inappropriate, inappropriate, moderate, appropriate, perfectly suitable” in their graph. The following chart of the final plot mapping shows the effect of weights on selecting the appropriate location (Figure 9).

Discussion and Conclusion

Available records indicate that important issues in the construction

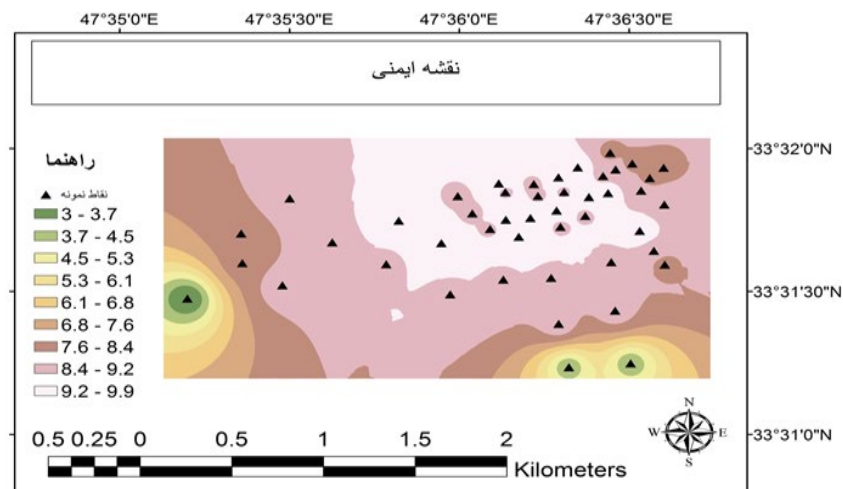


Figure 6: Safety map of Kohdasht city for the construction of a hospital.

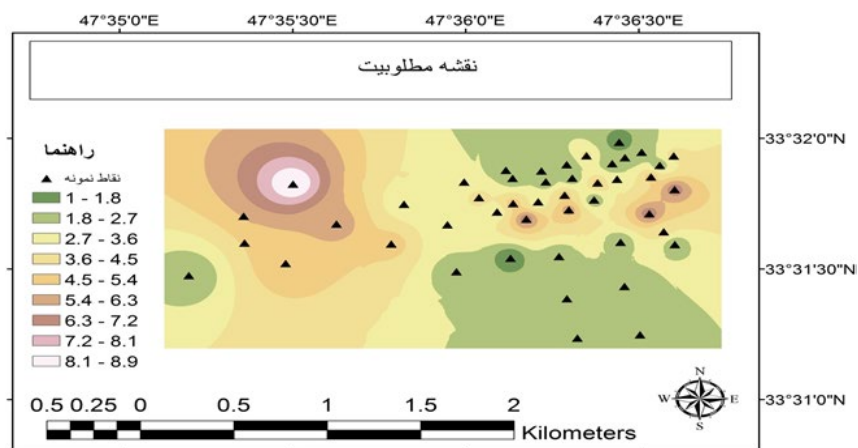


Figure 7: Map utility Kohdasht city for hospitals.

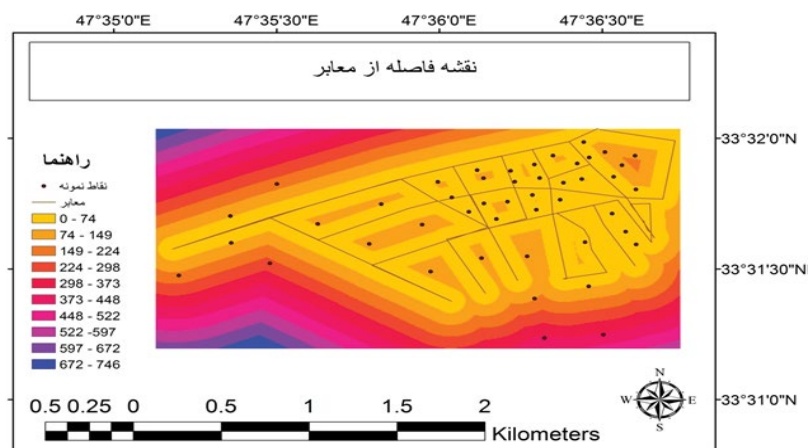


Figure 8: Road maps of Kohdasht city for the construction of a hospital.

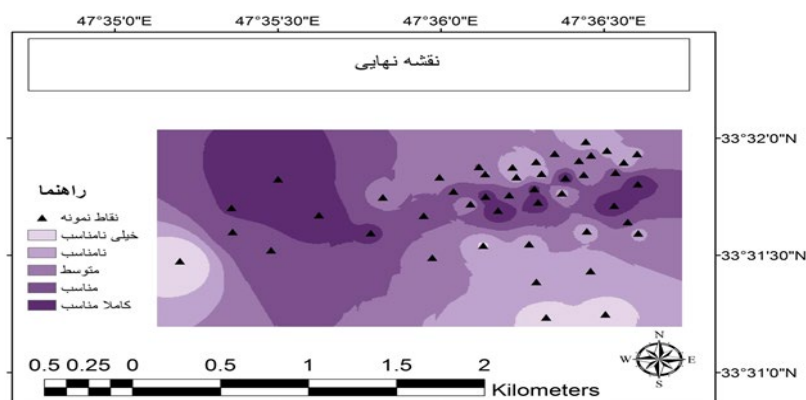


Figure 9: Ultimate map of Kohdasht city for the construction of a hospital.

of the hospital that have caused many problems in most cities, including the lack of clarity of criteria and criteria for locating health centers. Considering the many factors involved in choosing the right place, it is difficult to achieve this by manual and traditional methods. As outlined in the results of the research in Chapter 4, in the optimal location hospital the priority is with points: 44, 45 and. 39. Because there is no hospital in this area, based on the results obtained, it can be argued that there is an optimal location for the establishment of a hospital in the city of Kohdasht using GIS and the hierarchical process.

By comparing the areas that have the proper conditions for building a hospital, we conclude where points 39, 44 and 45 are the most important places. Because in these places, communication with the western ways of the country and the south is more suitable. There is also no hospital in these places. Point 44 of Farhangian, Phase 2, where has been under construction recently and will have a large population and a lot of people will live in the area in the future.

Point 45 is behind the Police Station (Police Station 12) where is in a good situation, also the population density is good. Point 39 is located next to the Firefighting department and near the Red Cross org, finally the price of land and, is reasonable there in terms of population density, the vast majority of citizens can easily access the hospital it this area.

Due to the lack of health care centers in the edge part of the city, and due to the small number of hospitals in the city of Kohdasht, it is suggested that, in order to access small clinics (Clinics or Healthcare Center).especially in areas of lacking healthcare centers and with high population density, healthcare centers established. Also, considering that financial resources and basic infrastructure are one of the most important factors in the development of the city, it is necessary to identify and preserve the resources needed to allocate. And with the growth rate of population the public service network is also need to being developed throughout the city. Investigations and case studies

show that the use of AHP technique is very useful for optimal hospital locating and can be used in other services such as emergency cares.

References

1. Witlox F, Antrop M, Bogaert P, De Maeyer P, Derudder B, et al. (2009) Introducing functional classification theory to land use planning by means of decision tables. *Decision Support Systems* 46: 875-881.
2. Wu J, Zhou L (2012) GIS-Based Multi-Criteria Analysis for Hospital site Selection in Haidian District of Beijing.
3. Turnbull J, Martin D, Lattimer V, Pope C, Culliford D (2008) Does distance matter? Geographical variation in GP out-of-hours service use: an observational study. *Br J Gen Pract* 58: 471-477.
4. Yagwobi M, Aghaharimi Z, Karimi S, Javadi M (2011) Factors affecting patients' preferences in choosing a hospital based on the mix marketing components in Isfahan. *Mirror of heritage* 14: 106-114.
5. Rahmanpour AA (2009) Locate the schools and the evaluation of it. *Journal of Geography Education* 24: 9-11.
6. Pourmohammadi MR (2003) Urban land use planning. Tehran: Publication of the side.
7. Azizi M (1383) Application of Geographic Information System in Location, Spatial Distribution and Network Analysis, Health Centers, Case Study: Mahabad. Master thesis, Tabriz University.
8. Shi'a I (1386) Urban Planning Workshop. Tehran University of Science and Technology.
9. Cole R, Cyrus (1378) City Health Network (2ndedn), United Nations Children's Fund (UNICEF).
10. Khanka, Hamid, Dehgar (1391) Hospital Preparedness for Disasters, National Program for the Center for Management of Accidents and Emergencies, Disaster Rehabilitation Research Center. Tehran University of Social Welfare and Rehabilitation Sciences.
11. Lin CT, Wu CR, Chen HC (2008) The study of construct key success factors for the Taiwanese hospitals of location selection by using the fuzzy AHP and sensitivity analysis. *International journal of information and management sciences* 19: 175-200.