Factors affecting the selection of appropriate area for health care center in operational zones

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Abstract
Aims: This study was conducted in order to determine the key factors in selecting an appropriate location for war field health care center and selecting the most proper location for building a field hospital.

Methods: The study is of mathematical modeling type. Brain storming, multi-voting and nominal group techniques were used for extracting key factors and Analytic Hierarchy Process technique was used for selecting the most appropriate location in the case scenario.

Results: The most influential factors and their relative values from experts’ view were the possibility of performing insider/enemy operations (stability of battlefield), number of possible injured and wounded people in area, land status and the geography of region, condition of roads and connecting passageway and finally field hospital distance from frontlines of battlefield. By placing these weights in decision making model and with the hierarchical analysis for the given scenario and completing the model using responders, the location B was selected as the best point for construction of field hospital.

Conclusion: Regarding the logical stability in thinking analysis model, one can make coherent integrated relations between subjects and different phenomena and ultimately making decision that would follow the most benefits.

Keywords: Health Care Center, Operational Fields, Analytic Hierarchy Process

Introduction
In all natural, security, political and military crises, there is the possibility of the occurrence of events that cause injuries to human. A country that is ready to appropriately react at the time of crisis, can take appropriate course of actions to prevent the spread of crisis and losses while reducing the human casualties. One of the measures commonly taken by the public and private relief organizations and finally military organizations is establishing relief and medical centers. The most important problem for establishing these centers is to choose a place for establishing the health care centers regarding available resources and facilities and also regional characteristics and the volume of injured and wounded people, in a way that can cover a wide area, the way of transporting the injured victims would be easy and simple with no waste of funds; Also, crises and disasters should expose the minimum damage to it and it should have proper distance with place of injury and crisis occurrence.

During the Iran-Iraq war, the experience of the construction of hospital and medical field centers began since 1981. Site selection was done based on group decision-making and experiences, as most of organizational decisions have group origin [1]. During the war, these centers had been constructed in the form of CONEX, metal and concrete gable bents or ridge bents construction and were delivering health services to thousands of injured people and more than 20 thousand surgeries were performed within them that surely many of them led to save the lives of warriors. One of the subjects that have been discussed during that time and also after the end of war was whether the selection of locations during the war had been proper or not? All responses presented so far, have been based on the personal experiences and diffuse inferences. It is necessary that the impartial scientific methods be designed and conducted to investigate the above issue.

Relief and medical centers in the operational zone are defined classified into five categories of "relief post", "field emergency ", "field hospital", "urban hospital" and "clinic". "Relief post" is the first point of group relief to wounded and injured people. After individual relief, the rest of cares for wounded and injured veterans is done as outpatient and in the front line in this station. It has limited and defined medical facilities and is set up at the level of combat battalions. "Field emergency" is the second point of caring wounded and injured soldiers in operational zones and is designed and constructed for the two groups of chemical wounded and injured victims. In terms of equipment, it is equipped with medical facilities and personnel at the level of medical emergencies, and is
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set for brigades. "Field hospital" is the third center to care the wounded and injured soldiers in operational zones. It is considered as the most equipped and complete medical center located in the frontline and has various treatment sections with clinical and paraclinical facilities and also a medical ward and a support ward. Organizationally, a field hospital is constructed at the level of main operating base for every one to three of the division's rear guards. The major trend of hospital is emergency measures and emergency surgical operations. "Urban hospital" is considered as the fourth therapeutic level in terms of triage, evacuation, care and attendance. These centers are located in the cities that provide services both for non-military patients and in the battle conditions, to the wounded people. The last classification is "clinic" that has a large treatment space that widely operates at two sections of outpatient wounded individuals and chemical patients.

Decision-making means judging and selecting and is one of the most important characteristics of human beings. The necessity of a strong technique that can help human in this area is quite tangible. For the complicated decision makings, usually mathematical models are employed for simplification and summarizing of real world's issues. Using mathematical models has many advantages such as simplifying of the problems' analysis and determining a very clear purpose for the question or problem and also allowing the proper and comfort comparative calculation. This method of decision making is called Analytic Hierarchy Process [2, 3].

Analytic Hierarchy Process (AHP) technique is a method of decision-making that gives the decision-maker(s) the power to shape the intended issue or question and on the basis of the obtained structure; one could do comparisons for determining the priority of decision options. AHP process requires the paired comparison, and then determination and evaluation are performed. In this method, the option that would obtain the highest weighting value will be selected as the best option. Among the most important advantages of this method is its use in decision making with qualitative criteria. Another advantage of this method is to give structure to the given decision making issue through the hierarchy formation. Classification of criteria from the tree's top to the bottom causes the complex issues to be evaluated systematically by AHP. At the present time, application of AHP is more in decision making of socio-economical systems such as resource allocation, performance evaluation, work sequencing etc. [4].

AHP process is described by the following methods: "drawing and describing the hierarchical tree", "Determination of criteria, sub-criteria and alternatives (including detection, identification and classification; standardization; credit rating or calculation of validity and preparing the table of criteria, sub-criteria and final standardized alternatives)", "data collection", "data calculation operation", "geometric mean calculation", "extraction of priorities (including normalization and extraction of well-balanced average)" and "determining the final weight of alternatives or options" [5, 6]. The purpose of this study was to investigate factors affecting the appropriate site selection in operational fields and choosing the most proper area for constructing the field hospital.

Methods

In this research some techniques including interviewing and the study of texts and documents and brainstorming were used for preparing the list of factors affecting the site selection of field hospitals and then multi-voting techniques, nominal groups (through responding to questions), and completing tables of paired matrix or binary [two by two] matrix were used to find the most effective factors in selecting the best location and relative value of each factor, and the hierarchical classification was employed for prioritizing and selecting the best location for the field hospital in a defined scenario. The study population was 15 subjects, from whom the 14 questionnaires were collected (return rate of 94%). Following steps were taken to accomplish the study:

1- Brainstorming implementation and preparing the list of affecting factors and achieving the common list and shortening of the list using multiple multi-voting technique
2- Carrying out group thinking and choosing the most important factors (5 prioritized agents)
3- Obtaining a binary [two by two] matrix for each factor and the distribution between responders and completing the binary matrix by each responder (70 paired matrixes were obtained at this stage which were in 5 groups of 14)
4- Obtaining the geometric mean of the above matrix, normalizing the matrixes, obtaining the arithmetic mean of the normalized matrix and finally determining the weight of each factor (or criteria), the relative value of each given location was calculated based on each factor based on the opinions of 14 respondents.
5- Developing the scenarios from the given operational field and determining the four points to build treatment center in one of them
6- Preparing the agent-location matrix and obtaining the weight of each place considering all factors using all responder's comments and carrying out the calculations according to paragraphs 3 and 4.

8- Selection of the best location given the weight obtained.

Scenario: It is arranged that in a war zone by dimensions of 35×120 (length × depth) km, a concrete field hospital be designed and constructed with the operating volume of three standby surgery rooms and admission of 150 injured patients per hour. Among the four points of A, B, C and D located at different distances from the frontline, which are the best places to build the hospital?

Results

The main ten points and the obtained scores for each in the poll taken from the samples are presented in the Table 1.

Table 1- 10 main factors in the optimum site selection for construction of the field hospital

<table>
<thead>
<tr>
<th>Row</th>
<th>Affecting factor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Field hospital distance from the rear supporting cities</td>
<td>52</td>
</tr>
<tr>
<td>2</td>
<td>Field hospital distance from the frontline</td>
<td>84</td>
</tr>
<tr>
<td>3</td>
<td>Field hospital type (fixed, mobile, etc.)</td>
<td>62</td>
</tr>
<tr>
<td>4</td>
<td>Land status and geography</td>
<td>75</td>
</tr>
<tr>
<td>5</td>
<td>The possibility of insider/enemy operation (stability of the battlefield)</td>
<td>71</td>
</tr>
<tr>
<td>6</td>
<td>Regional health status</td>
<td>21</td>
</tr>
<tr>
<td>7</td>
<td>The status of roads and connecting passageways of the region</td>
<td>69</td>
</tr>
<tr>
<td>8</td>
<td>Number of the probable wounded and injured individuals</td>
<td>80</td>
</tr>
<tr>
<td>9</td>
<td>Types of vehicle and transportation of wounded</td>
<td>38</td>
</tr>
<tr>
<td>10</td>
<td>The extension or size of battlefield covered by the field hospital</td>
<td>60</td>
</tr>
</tbody>
</table>

Using paired comparison, the relative weight of abovementioned factors In the determination of the location of the hospital are presented in Table 2.

According the results, location B was selected as the best point (Table 3).

Table 3- Ratings of four centers in terms of pentad criteria

<table>
<thead>
<tr>
<th>Criteria Center</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>C5</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Discussion

Location A had the highest score in terms of the three factors of 1, 2 and 5, had the second rank in terms of factor 4, and was in the fourth rank in terms of the third factor. Therefore, it seems that the first selection had been the location A. Location B was in the first rank only in terms of the factor 4; in terms of the third and fifth factors was in the second rank and in terms of the factor 1 and 2 was respectively in the third and fourth rank. Location C had the best status in terms of the factor 3 (geographical situation of the region), but in terms of factors 1, 4 and 5 was in the last priority. Location D was in the third rank in terms of the factors 3, 4 and 5 and in the second place in terms of the factors 1 and 2.

Considering the relative value and weight of each factor and their relative importance, one can expect that the final ranking of the centers undergo the change. Location A, in spite of having the minimum distance from the frontline of the battlefield and the highest number of wounded and the most convenient connecting ways of the region, had been in the second priority due to the fact that in terms of stability of the battlefield, i.e., the probability of insider operation with the enemy had been in the second pace. The relative importance of the factors (relative value or weight) has a very bold role in determining priorities. As evident, to solve problems through logical explicit analysis, the three principles including "the principle of hierarchy construction", "the principle of setting priorities" and "the principle of logical consistency" can be diagnosed. Natural principles of analytical thinking will strengthen and consolidate the analytic hierarchy process or AHP. As Saati sets forth in his book named decision making for managers, "Humans are capable of recognizing the relations between issues that they observe, comparing the similar issues' pair in contrast with a certain criteria and they can recognize the both members of the single pair by evaluating the rate of their preference, for one over the other, then combine their judgments through the new logical process and tenure or AHP to better understand the entire system".

Logical consistency which is presented in the analysis...
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Thinking model shows that human can establish coherent and stable relationships between various topics or phenomena.

Conclusion

Considering the logical consistency presented in the analysis thinking model, one can establish coherent and stable relationships between various topics or phenomena, and ultimately adopt a decision that will bring the maximum benefits.

References