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# Study of locating Fire stations using ELECTRE method: (case study: Maku city)

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**ABSTRACT**

It could be stated that using GIS and linear assignment for analyzing position data and choosing optimized location, has unique performance, so it is suggested that fire fighting organizations use these software applications to create database. It is suggested that fire fighting organization and safety services, create reasonable relationship with urban service centers to enhance their performance, and equip these centers to safety tools before the incident. The purpose of this study is Study of locating Fire stations using ELECTRE method. ELECTRE method is one of the Multi criteria decision making which can compound the quantitative and qualitative criteria, weight each criterion based on its importance and help decision makers to select the best option at the same time. Electrical method is one of the available methods in compensatory methods. In this method, all options are analyzed and evaluated by non-ranked comparisons. Whole stages of this method are based on coordinated and uncoordinated sets and thus it is called ‘‘coordination analysis’’. The results and findings show that zone (3) dominated (5) times and defeated (1) time, so it is located in the first rank with (4) points and is the most suitable zone for Fire stations. In contrast, zone (4) defeated (5) time and dominated (1) time, therefore it is located in the last rank with (-5) points and is not the most suitable zone for Fire stations. And, zones (2, 5, 1) dominated (4, 3, 2) times and defeated (2, 3, 4) and located in other ranks with (2, 0, -2) points respectively. Also, zones (4,1) should be omitted because their defeated times are more than dominated times.



## Introduction

Today, excess density of population in city and it is increasing growth in bulk is led to demand and attention to urban development [Roy. 1991]. Demand for urban development is one of the most important issues against human in future. Therefore, to solve this problem and obstacles, safety system of city should be developed along this to cover whole city. The most important problem about the services of fire stations is the inappropriate distribution of stations and restricted function area of present stations. So, qualities and quantities distribution of stations is investigated scientifically and professionally. Pay attention to the public transportation, cycling and Pedestrian oriented development (POD) and car-free streets can increase the quality of urban spaces and create more secure pedestrians with Psychological comfort for human. Old urban fabric with hidden physical, historical, and cultural values has been the best evidence of urban identity and meanwhile, the life and growth of this fabric has prevented the internal erosion of the city and has limited its unlimited expansion. The city communication network plays its lifeline role and it is considered as one of the important fundamental and determinant lines in urban development plans. The importance of networks in urban design is such that they cannot be considered separated from each other, because all of the activities of the inhabitants of a city including commercial, cultural and administrative activities depend on communication networks [Gharib. 2003]. On the other hand, the formation of a city fabric is directly related to the city’s street network so that each of these fabric types is affected by the formation of the streets within the city. Star (radial), annular (circular), raster, and linear fabrics are of this type. What are important from the perspective of transportation and traffic in various fabrics, are the characteristics of movement, access and efficiency of various transportation systems, safety, and costs associated with these systems [Amoud rah, 1997]. Locating, including spatial analysis, which is abundant in the impact of reducing the cost of creating and setting up various activities. That's why one of the most important stages of the project and the Executive transition effects. one of the anxieties of urban planners in urban spaces and service spaces located design appropriate and desirable. the equipment and facilities of the Foundation of urban informal settlements and lack of defects formed they cause problems for citizens. Validity and importance of each city, depending on the services and facilities. As providing this service will be better lives in the more comfortable and the cost of living for citizens will be less. If this is the appropriate location services and is enough of aqtasdi costs and reduce appreciably when residents will be able to settle this matter from another expert and scientific research that should be carried out by the various support organizations and organs. Today, find the appropriate location or locations to create a specific geographic area of activity is an important component of project steps, particularly in the macro level and national Executive is considered. The final locations have all required terms and conditions and the lack of gratification check these terms and conditions prior to the implementation of such projects will be looking for plenty of

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undesirable results. One of the basic tasks of urban management or in a very clear and significant city, organized a comprehensive service management system (Hwang et al, 1971). Hence the most important tasks of the city are significant to the topic assigned services. In order to achieve the efficient management and how to assign a user category has always been urban space can be raised to different user until the late Renaissance period and the beginning of the industrial world's population growth and ataqlab to the city and population trend of late urbanization has been the result of solving the problems of the city and planning has been easy for them. with the beginning of the industrial revolution and the migration of villagers to the cities city population cities faster Copyright problems and has been to the cities has increased( Howerton. 2006). The city's population, according to United Nations estimates these world of 2.3 billion in 1990 to 4.7 billion in 2020 will increase that 90 percent of the growth in developing countries will happen (UN, 1993, Table A. 2). Unfortunately, a third world country on a low income and who are not entitled to the growth and development of preparation necessary for dealing with the issues arising from the accelerating urban growth are not administrators and dastnderkaran cities in relation to the provision of services to citizens and classified with a serious face and have a problem (Poor Eskandari. 1992).

There are many examples of applications of Multi Criteria Decision Making in literature (For instance: The evaluation of service quality[Tsuar et al, 2002]; Inter company comparison [Deng et al, 2000]; The applications inaggregate production planning [Wang et al, 2004], Facility location selection [Chu et al. 2002] and large scale nonlinear programming [Abo-Sina et al, 2004]. The modifications proposed in this paper can be implemented in all real world applications of Fuzzy TOPSIS.., Krishnamurthy et.al (1995, 1996) used RS and GIS techniques to find a suitable position for artificial recharge of ground water in India. Also, they investigated the effects of geomorphologic and geological factors on the behavior of ground water and stated that there is a special unevenness in each area for recharge of ground water[Krishnamurthy et al, 1996]. parhizkar and Choudhury (1998) used remote sensing capabilities in extracting different layers like land usage, geomorphology, vegetation, and their integration in GIS environment to determine the most suitable area for artificial recharge of ground water[Parhizkar. 1994]. Mahdavi (1997, 16) investigated water management and artificial recharge of ground water in Jourm city and indicated that controlling usage and recharge of water tables by the watershed management is the main management technique[GIS for Fire Station Locations and Response Protocol, 2007]. In this study, we tried to locate optimized fire station in Maku city using ELECTRE method.

**Methods and materials**

**Mathematical situation of studied area:**

Maku city Being situated in the north part of Western Azarbayezan province, Maku city is bounded by 39º, 00' latitude to 18º, 00' north latitude and 44º, 31' longitude. Globally, Maku is located at 2560 meter height above sea level .distance from city to center of provence is 280km and distance from city to Tehran is 850km.

**Research Methodology**

In this study we used following methods to collect data:

1. Library and software method and using locating instructions from scientific papers and studies.
2. Interview with fire fighting expert of Maku city.
3. Field study to evaluate present stations and collecting data which were questionable.

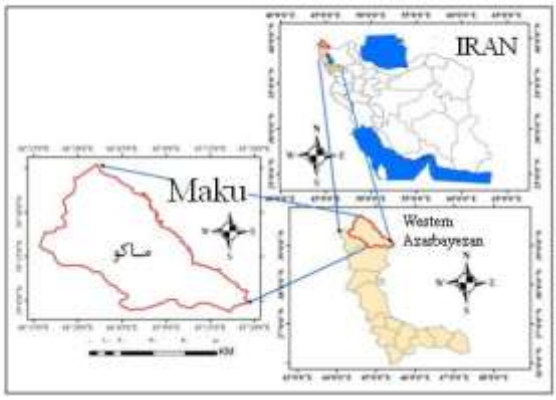


**Figure 1: Mathematical situation of studied area**

In present study we used linear assignment to locate fire station in Maku city, and with field study and using present maps, numeral data as Shape file and providing distance map, weighting these data using ELECTRE method has been done and finally using software Arc GIS 9.3 these data incorporated using index overlay method and presented as fit places for locating fire stations in Maku city.

**Theoretical principles of ELECTRE method .**

In recent decades, several researchers attempt to use Multi Criteria Decision Making (MCDM) in complex and complicated decisions. These decision methods divide into two parts;

1. MODM = Multi Objective Decision Making
2. MADM = Multi Attribute Decision Making

Multi Criteria Models use to select the best options. Evaluative Models for MADM classify into two models;

1) Compensatory Model
2) Non- Compensatory Model

Non-compensatory model includes methods which don`t need to achieve data from DM and lead to objective answer. Exchanging between indictors is permitted in Compensatory model. It means that for example, a weakness in a indicator may be compensated by option of other indicator. Electrical Method is a type of available methods in Compensatory Models. In this method whole options evaluate by non-ranked comparisons. All stages of this method are established based on coordinated and uncoordinated sets and thus this method is known as ''Coordination Analysis''. Banayoun established the Electrical Method and Delft, Nijkamp, Roy and their colleagues developed it. In Electrical method, the concept of domination uses implicitly. In this method, options are compared in pairs, then dominant and weak (dominant and defeated) options determined and weak or defeated options omitted (Roy, 1991; 49-73).

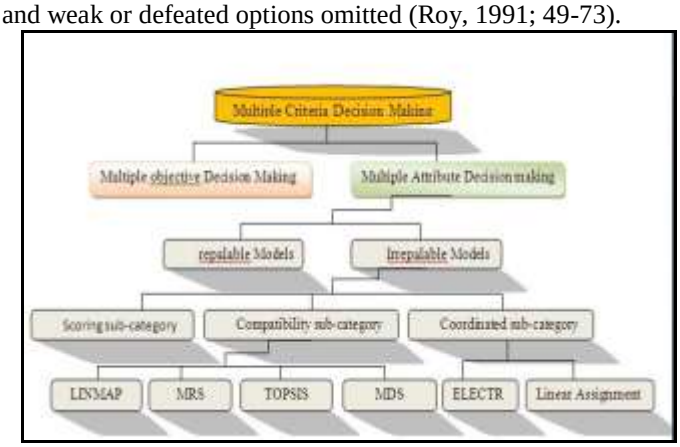


**Figure 2: Situation of ELECTRE among the other Multi Criteria Decision Making.**

**Problem-Solving process in ELECTRE method**

**Establishing Decision Making Matrix:**

According to the criteria and numbers of options and evaluation of whole options for the different criteria, Decision Making Matrix develops as follow;

$$X = \begin{bmatrix} x_{11} & \dots & x_{1n} \\ \mathrm{M} & \dots & \dots. \\ x_{1m} & \dots & x_{mn} \end{bmatrix}$$

In which the Function of Xij (i = 1,2, ... ...., M) is in relation to the criteria I j (j = 1,2,3, ... ..., n).

**Scale down the Decision Making Matrix:**

In this stage, all criteria with different dimensions is changed into the dimensionless criteria and matrix R defined as follows. There are several methods to scale down, but generally the following equation used in electrical method (Tille: 2003, 19-21).

$$R = \begin{bmatrix} r_{11} & \dots & r_{1n} \\ \mathrm{M} & \dots. & \dots \\ r_{m1} & \dots & r_{mn} \end{bmatrix} \quad r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \qquad (1)$$

**Determining Weighted Matrix of criteria:**

$$W = \begin{bmatrix} w_1 & \dots & 0 \\ \mathrm{M} & w_2 & \dots \\ 0 & \dots & w_n \end{bmatrix}$$

As you can see, Weighted Matrix (W) is diagonal matrix in which the elements on main diameter are not zero and amount of these elements equal to importance coefficient of the related vector.

**Determining Weighted Normalized Decision Matrix:**

Weighted Normalized Decision Matrix is obtained by multiplying Scale down Decision Making Matrix into the Weighted Matrix of criteria.

$$V = R \times W = \begin{bmatrix} v_{11} & \dots & v_{1n} \\ \mathrm{M} & \dots & \dots \\ v_{m1} & \dots & v_{mn} \end{bmatrix}$$

**Establishing agree and disagree criteria set**

The criteria set J = (1, 2... m) divides into two subsets; agree and disagree for each pair of options e, k (k, e = 1,2, ...., M, k # e) . Agree Set ($S_{Ke}$) is a set of criteria in which option K is preferred to option e. and its complementary set is the opposite set ($I_{Ke}$) in mathematical language;

$$S_{ke} = \left\{ j \middle| v_{kj} \geq v_{ej} \right\} \qquad (2)$$

$$I_{ke} = \left\{ j \middle| v_{kj} \ \pi \ v_{ej} \right\} \qquad (3)$$

**Establishing Agree Matrix:**

To establish agree matrix, its elements, agree indicators, should be calculated. Agree indicator is sum of weight of criteria in agree set. Thus, indicator $C_{ke}$ is between option k and option e equals to (Roy, 1991, 49-73):

$$c_{ke} = \frac{\sum_{j \in s_{ke}} W_j}{\sum_{j=1} W_j} \qquad (4)$$

For total normalized weights $\sum_{j \in 1} W_j$ equals 1 so:

$$c_{ke} = \sum_{j \in s_{ke}} W_j \qquad (5)$$

Agreement represents the superiority of options k on option e which its amount changes in the range of zero to one (0-1). After calculating agree indicator for all options, matrix which is a m * m matrix is defined as follows. Generally, this matrix is not symmetrical.

$$C = \begin{bmatrix} - & c_{12} & \dots & c_{1m} \\ c_{21} & - & \dots & c_{2m} \\ \mathrm{M} & \mathrm{M} & - & \mathrm{M} \\ c_{m1} & \dots & c_{m(m-1)} & - \end{bmatrix}$$

**Determining Opposite Matrix**

Disagreement indicator (opposite) is described as follows (Roy: 1991, 49-73):

$$d_{ke} = \frac{\max_{j \in I_{ke}} \left| v_{kj} - v_{ej} \right|}{\max_{j \in J} \left| v_{kj} - v_{ej} \right|} \qquad (6)$$

The amount of disagreement indicator changes from zero to one. After calculating disagree indicator for all options, matrix which is a m * m matrix is defined as follows. Generally, this matrix is not symmetrical.

$$D = \begin{bmatrix} - & d_{12} & \dots & d_{1m} \\ d_{21} & - & \dots & d_{2m} \\ \mathrm{M} & \mathrm{M} & - & \mathrm{M} \\ d_{m1} & \dots & d_{m(m-1)} & - \end{bmatrix}$$

It noticed that the data including in agreement matrix, are different from data in opposite matrix and in fact these data are completed each other. The difference between the weight is developed through agreement matrixes, while the difference between determined values is obtained through opposition matrix.

**Establishing agree dominant matrix:**

In the sixth step, it indicated how to calculate agreement indicator $C_{ke}$. Now there is a determined amount for agreement indicator in this step which is called agreement threshold $\bar{c}$. If $C_{ke}$ is larger $\bar{c}$, option k is preferred on option e, otherwise it is not. Agreed threshold is calculated by the following equation (Roy, 1991, 49-73):

$$\bar{c} = \sum_{\substack{k=1 \\ k \neq e}}^{m} \sum_{\substack{e=1 \\ e \neq k}}^{m} \frac{c_{ke}}{m(m-1)} \qquad (7)$$

Agree Dominated Matrix (F) is developed based on the amount of agreement threshold and its elements determined in the equation bellow (Vami, 1992).

$$f_{ke} = \begin{cases} 0 & c_{ke} \geq \bar{c} \\ 1 & c_{ke} < \bar{c} \end{cases} \qquad (8)$$

**Establishing Opposed Dominance Matrix :**

Opposed Dominance Matrix (G) is established the same as Agree Dominated Matrix. First, decision makers should express opposite threshold $\bar{d}$ which is for example the mean of opposite indicators (disagreement) (Roy, 1991, 49) -73):

$$\bar{d} = \sum_{\substack{k=1 \\ k \neq e}}^{m} \sum_{\substack{e=1 \\ e \neq k}}^{m} \frac{d_{ke}}{m(m-1)} \qquad (9)$$

Similar to seventh step, it is better that the amount of opposite indicator ($d_{ke}$) become less, because opposite amount (disagreement) expresses superiorities dimension of option k on option is acceptable. In contrast, if ($d_{ke}$) were larger than $\bar{d}$, opposite amount would be very great and it would not be ignored. Thus, Opposed Dominance Matrix is defined as follows (1991, 49-73):

$$g_{ke} = \begin{cases} 0 & d_{ke} \geq \bar{d} \\ 1 & d_{ke} < \bar{d} \end{cases} \qquad (10)$$

Each element in the matrix (G) shows the dominant relationship between options.

**Establishing Final Dominant Matrix:**

Final Dominant Matrix (H) is developed after multiplying each element in Agree Dominated Matrix (F) into elements in Opposed Dominance Matrix (G) (Roy, 1991, 49-73).

$$h_{ke} = f_{ke}.g_{ke} \quad (11)$$

**Removing less satisfaction options and selecting the best option:**

Final Dominant Matrix (H) indicates detail preferences of options. For example, when amount of $h_{ke}$ equals 1, it means that option k is preferred on option e in both agree and disagree situation (it means its preference is larger than the agree threshold and its opposite or weakness is less than disagree threshold), but option k may be dominated by other options yet. The options should be ranked in a way that the more dominated options are selected than the more defeated one.

Determining the importance coefficient of options than the other, criteria are compared in pair by time suggested method.

**Table 1. Weighting the factors based on preference in paired comparison (Ghodsi Poor, 2009, 14)**

| Numerical values | Preferences (judging verbal) |
|---|---|
| 9 | Extremely preferred |
| 7 | Very strongly preferred |
| 5 | Strongly preferred |
| 3 | Moderately referred |
| 1 | Equally preferred |
| 2.4.6.8 | Intervals between strong preferences |

After the formation of paired comparison matrix, relative weights of criteria can be calculated. There are different methods to calculate the relative weight based on paired comparison matrix. The most important ones are the "least squares method, least squares logarithmic method, special vector method and approximate method. The special vector method is the most accurate one. In this method, Wi is determine in the equation12:

$A \times W = \lambda max W \quad (12)$

In this equation, λ and W are special amount and special vector of paired matrix respectively. If dimensions of matrix were larger, calculation would be too time consuming. So, to calculate λ, the amount of Dtrmynal λIA-matrix will be equaled to zero. Considering the greatest value of λ in equation (13), the amount of wi is calculated. (Saaty, 2001: 315).

$A - \lambda_{max}.I = 0 \quad (13)$

**Discussion:**

In this study, for the correct locating of fire stations, firstly, effective criteria were determined and classified.

Stage one: preparing position data layers:

In this stage, the 1:2000 map of detailed plan in Maku city which was provided in 1385 by housing and urban development organization, , was entered into GIS software and converted to Shape File.

Stage two: digitizing position data layers Digitizing effective layers in locating fire stations are performed in 3 ways:

1. Spot complications: hydrants, Mosques, oil and gas stations.
2. Polygonal complications: residential centers, educational centers, medical centers, administrative centers, industrial and workshop centers, storage centers and ….
3. Linear complications: passage network, strap business centers.

Stage three: providing distance map

In this stage, the distance map was created using spatial analyst for each criterion of position data.

Stage four: reclassifying maps on the basis of suitable areas and rating

In this stage, each map was classified into some classes according to the importance of each class, values between 1(the worst value) to 5 (the best value) was allocatedto them.

"Fire stations should be near residential, business and administrative complications, main streets, storage centers, industrial centers, hydrants, gas station, and dense population places, and should be far from educational, medical and religious centers, and then reclassification will be done on the basis of suitable places into 5 classes.

Stage five: analysis of data in ELECTRE.

The results of ELECTRE to locating Fire stations are showed in tables (1-7) and figures (2-11)

**Table 2: Decision Matrix (X)**

| Regions | available | trade | industrial | habitate | area | educational | official |
|---|---|---|---|---|---|---|---|
| 1 | 9 | 15889 | 6150 | 438418 | 1221221 | 236110 | 31800 |
| 2 | 5 | 37600 | 1800 | 297315 | 962319 | 47976 | 43708 |
| 3 | 13 | 20340 | 3890 | 565835 | 1475081 | 47974 | 4900 |
| 4 | 23 | 6227 | 950 | 345449 | 762035 | 19865 | 9470 |
| 5 | 26 | 2951 | 126 | 414707 | 804172 | 257214 | 21432 |

**Table 3: Scale down Decision Matrix (R)**

| Regions | available | Trade | industrial | habitate | area | educational | official |
|---|---|---|---|---|---|---|---|
| 1 | 0.2332 | 0.3445 | 0.8138 | 0.4642 | 0.5062 | 0.6628 | 0.5379 |
| 2 | 0.1295 | 0.8152 | 0.2382 | 0.3148 | 0.3989 | 0.1347 | 0.7393 |
| 3 | 0.3368 | 0.4410 | 0.5147 | 0.5991 | 0.6114 | 0.1347 | 0.0829 |
| 4 | 0.5958 | 0.1350 | 0.1257 | 0.3657 | 0.3159 | 0.0558 | 0.1602 |
| 5 | 0.6736 | 0.0640 | 0.0167 | 0.4391 | 0.3333 | 0.7220 | 0.3625 |

**Table 4: Paired Comparison Matrix of different criteria (S)**

| Criteria | available | industrial | habitate | educational | trade | habitate | official | Wij |
|---|---|---|---|---|---|---|---|---|
| available | 1 | 3 | 5 | 5 | 7 | 7 | 9 | 5.285714 |
| industrial | 0.33 | 1 | 3 | 5 | 5 | 7 | 7 | 4.047143 |
| habitate | 0.2 | 0.33 | 1 | 3 | 5 | 7 | 7 | 3.361429 |
| educational | 0.2 | 0.2 | 0.33 | 1 | 3 | 5 | 7 | 2.39 |
| trade | 0.14 | 0.2 | 0.2 | 0.33 | 1 | 3 | 5 | 1.41 |
| habitate | 0.14 | 0.14 | 0.14 | 0.2 | 0.33 | 1 | 3 | 0.707143 |
| official | 0.11 | 0.14 | 0.14 | 0.14 | 0.2 | 0.33 | 1 | 0.294286 |
| Inconsistency rate: 0/0252 (due to being less than 0/1 compatibility matrix indices are acceptable) | | | | | | | | |

**Table 5: Weighted Normalized Decision Matrix (V)**

| Regions | available | trade | industrial | habitate | area | educational | official |
|---|---|---|---|---|---|---|---|
| 1 | 0.0900 | 0.0809 | 0.1289 | 0.0477 | 0.0306 | 0.0236 | 0.0116 |
| 2 | 0.0500 | 0.1915 | 0.0377 | 0.0324 | 0.0241 | 0.0048 | 0.0159 |
| 3 | 0.1301 | 0.1036 | 0.0815 | 0.0616 | 0.0370 | 0.0048 | 0.0018 |
| 4 | 0.2301 | 0.0317 | 0.0199 | 0.0376 | 0.0191 | 0.0020 | 0.0034 |
| 5 | 0.2601 | 0.0150 | 0.0026 | 0.0451 | 0.0202 | 0.0257 | 0.0078 |

**Table 6: Agreement Matrix (C)**

| Regions | available | trade | industrial | habitate | area | educational | official |
|---|---|---|---|---|---|---|---|
| 1 | 0.0000 | 0.7435 | 0.2155 | 0.6137 | 0.5781 | 0.9999 | 0.9999 |
| 2 | 0.2564 | 0.0000 | 0.2920 | 0.5109 | 0.4753 | 0.9999 | 0.9999 |
| 3 | 0.7844 | 0.7079 | 0.0000 | 0.5922 | 0.5566 | 0.9999 | 0.9999 |
| 4 | 0.3862 | 0.4890 | 0.4077 | 0.0000 | 0.3933 | 0.9999 | 0.9999 |
| 5 | 0.4218 | 0.5246 | 0.4433 | 0.6066 | 0.0000 | 0.9999 | 0.9999 |

**Table 7: Opposite Matrix (D)**

| Regions | available | trade | industrial | habitate | area | educational | official |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 0.844875 | 1 | 1 | 0 | 0 |
| 2 | 0.824595 | 0 | 0.910586 | 1 | 1 | 0 | 0 |
| 3 | 1 | 1 | 0 | 1 | 1 | 0 | 0 |
| 4 | 0.778099 | 0.88718 | 0.718369 | 0 | 1 | 0 | 0 |
| 5 | 0.742327 | 0.839846 | 0.680862 | 0.575394 | 0 | 0 | 0 |

**Table 8: Agree Dominated Matrix (F)**

| Regions | available | trade | industrial | habitate | area | educational | official |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 |
| 2 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| 3 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 5 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |

**Table 9: Opposite Dominated Matrix (G)**

| Regions | available | trade | industrial | habitate | area | educational | official |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 5 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |

**Table 10: Final Dominated Matrix (H)**

| Regions | available | trade | industrial | habitate | area | educational | official |
|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 4 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 5 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |

**Table 11: Number of dominant and recessive of each selected areas**

| Regions | Number being defeated | Rule number | Difference |
|---|---|---|---|
| 1 | 2 | 4 | -2 |
| 2 | 4 | 2 | 2 |
| 3 | 5 | 1 | 4 |
| 4 | 1 | 5 | -4 |
| 5 | 3 | 3 | 0 |

**Conclusion**

It could be stated that using GIS and linear assignment for analyzing position data and choosing optimized location, has unique performance, so it is suggested that fire fighting organizations use these software applications to create database. It is suggested that fire fighting organization and safety services, create reasonable relationship with urban service centers to enhance their performance, and equip these centers to safety tools before the incident. It is suggested that fire fighting organization and safety services, promote in teaching citizens about how to use fire extinction tools. The three existing stations in Maku city are suitable regarding the population of the city and that one station per 30000 persons is necessary, but because of the vastness of city, these three stations can't service optimally to whole city. It is suggested that 2 additional medium stations to be located in city area, , and because Maku city has one central station and three secondary (small) stations, and this city doesn't have medium station.

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