Journal of Turkish Operations Management

FACILITY LOCATION SELECTION PROBLEM: AN APPLICATION FOR STUDENT SELECTION AND PLACEMENT CENTERS

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ARTICLE INFO

Article History:
Recived: 02.12.2017
Revised: 15.12.2017
Accepted: 27.12.2017

Research Article

Keywords:
Stent selection, Multi-Criteria Decision Making, Analytical Hierarchy Process (AHP), Decision Support Systems.

ABSTRACT

In this study, a two-phase stent selection decision support system (DSS) is developed to help the physicians in their stent selection decisions. Firstly, a questionnaire was conducted to developed decision support system. Questions are randomly applied to cardiology department physicians in the province of Ankara, which is selected as pilot area, to get the results to be statistically valid. The results were evaluated by means of MINITAB14 program. In development of DSS, an independent set of criteria is obtained first and arranged in the Analytical Hierarchy Process (FAHP) decision hierarchy. In the first elimination phase of the DSS, the physician obtains the feasible set of stents by providing limited values for the 13 requirements. DSS, then, uses AHP decision hierarchy to rank the feasible stents in the second phase.

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Introduction

The most essential matter in facility location selection problem is to select the most suitable geographical region. The top level managers deal with these problems in order to satisfy the needs. These managers also tackle with to make decisions in a proper way. If the decision suits with the current situations but not with the long term goals, it does not mean that this is the best choice. For this purpose, the management department must take responsibility to deal with long term goals.

Since the importance of the subject, the facility location selection problem must be handled by not only a single person, but also the whole perspective of the institution. The collaborative effort of the institutions also makes the decisions that are thought widely. Thanks to the nature of the collaborative work, brain storming and mutual exchange of experience are essential matters which bring the broad view of aspects to the issue. In this study, instead of making the decision individual, AHP group decision making is used. By looking at the problem with a broad view of point, answers that are given by collaborative effort are getting more precise and more realistic. Since AHP group decision making problem allows pairwise comparison, it is also getting more beneficial results with getting different answers from different people with the help of the created survey.

This study is done for the Student Selection and Placement Centers in Turkey. All examinations are done by the taking the answers from the one of the institution of Student Selection and Placement Center named as ÖSYM in Turkey. Since the institution is regarding almost everyone who wants to the education in Turkey, the problem is more essential for this reason.

The main aim of the study is to handle the most appropriate examination center. In order to decide the examination center, a survey is created according to the light of views of managers and personnel of the institution. With the help of the views, all main criteria and sub criteria has been obtained. All relevant pairwise comparison has done for main criteria and sub criteria as Physical Situation of the Examination Hall, Transportation to the Examination Building, Properties of the Examination Building and Environment of the Examination Building. As a result of this study, 4 main criteria and 22 sub criteria has been obtained as a research structure of the model.

Since the criticality of the facility location selection problem, data collection is done in 69 different existing centers in ÖSYM and answers are handled. Surveys are send to 69 different existing centers in ÖSYM that are demonstrates in Table 1. Answers are getting with light of views of managers and personnel of the institution. With the help of the answers of survey, the most appropriate selection criteria are examined. The collected data has been analyzed by Microsoft Excel software package program.

Table 1: Exam Center Coordinatorships which are answered surveys in ÖSYM

Name of Exam Center Coordinatorships which are answered surveys in ÖSYM		
1. Aksaray	24. Hatay	47. Muğla
2. Akşehir	25. Iğdır	48. Mustafakemalpaşa
3. Amasya	26. İstanbul 1	49. Muş
4. Artvin Hopa	27. İstanbul 4	50. Nazilli
5. Balıkesir	28. İzmir Güney	51. Niğde
6 Batman	29. İzmir Kuzey	52. Niksar
7. Bayburt	30. İzmit	53. Osmaniye
8. Beypazarı	31. Kahramanmaraş	54. Ödemiş
9. Biga	32. Karabük	55. Sivas

10. Bingöl	33. Karadeniz Ereğli	56. Siverek
11. Bismil	34. Karaman	57. Sorgun
12. Bitlis	35. Kastamonu	58. Söke
13.Bursa	36. Kayseri	59. Şereflikoçhisar
14. Çan	37. Kırıkhan	60. Şırnak
15. Denizli	38. Konya	61. Tarsus
16. Elazığ	39. Konya Ereğli	62. Tavşanlı
17. Ergani	40. Konya Seydişehir	63. Tokat Zile
18. Gaziantep	41. Malatya	64. Tunceli
19. Giresun	42. Manisa	65. Turgutlu
20. Gölbaşı	43. Manisa Salihli	66. Uşak
21. Gölcük	44. Mardin	67. Van Erciş
22. Gölhisar	45. Menemen	68.Yozgat
23. Gümüşhane	46. Merzifon	69. Zonguldak

Literature Study

Analytic Hierarchy Process is developed by Thomas L. Saaty in 1971. In 1977, Saaty transformed the AHP into a model facilitating the solution of decision making problems (Rençber, 2010: 34.). The main objective of creating AHP is to contribute the solution of the multi criteria decision making problem. The Analytical Hierarchy Process (AHP) is a method or model to get not only a magical solution of multi-criteria decision making problem, but also a way of helping to the decision makers to find the "the best" answer (Forman, Selly, 2002: 14).

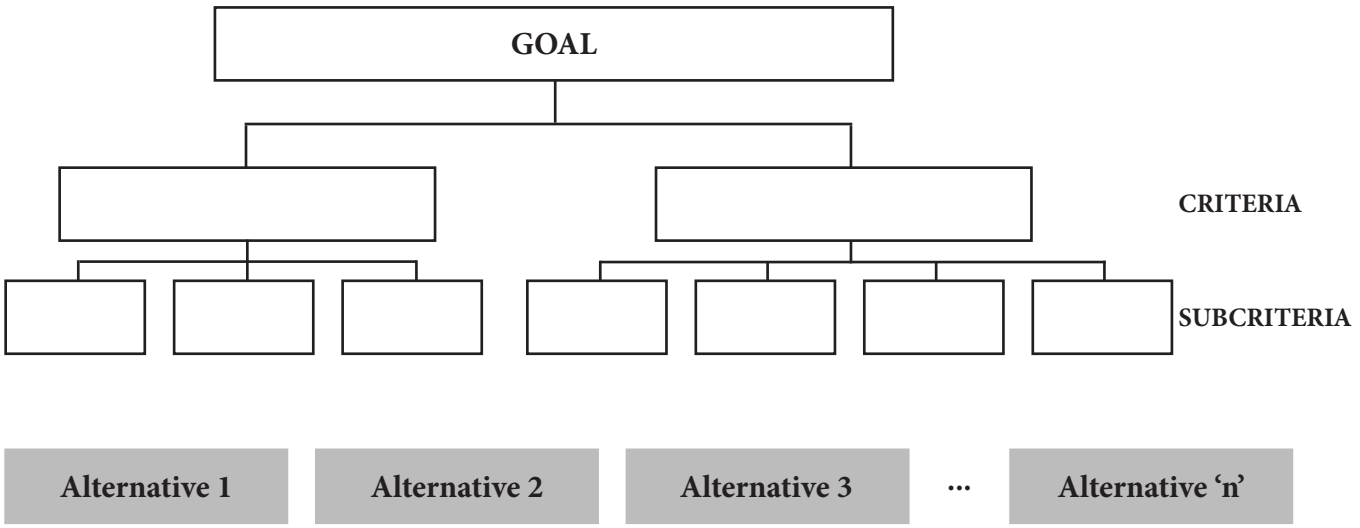
AHP is a strong and consistent method that helps the decision maker in order to combine both qualitative and quantitative factors in the decision-making process for groups and individuals (Saaty, 1990: 10). The AHP method is also used for decision making problems which include one or more decision-makers with different alternatives in environments which involves certainty or also uncertainty. It is said that the method is easy to use and also giving an opportunity to make a decision as a group and individual, allowing to include the decision makers intuition and instincts to the solution process (Doğan, 2004: 9). One of the most essential functions of the AHP is to include different factors in a hierarchy can be synthesized .

The AHP is a measurement theory which compares the alternatives according to common criteria. AHP provide major assistance guidance to the decision maker in reaching the conclusion of multi-criteria and multi-choice problem. The problem of AHP consists of a hierarchical structure which comes from multiple levels. It is used the criteria, the purpose and a hierarchical structure consisting of possible sub-criterion levels and alternatives for every problem in the Analytic Hierarchy Process (Saaty, 1990: 9-11). It is an overall method of complicated, difficult to understand or unstructured problems. It constructed three basic principles as the determination of the advantages, the construction of the hierarchy and the logical and numerical consistency (Güner, Yücel, 2007: 74).

In AHP, the problem is constituted in a hierarchical way in AHP problem. Figure 1 demonstrates the three-level hierarchical structure. At the top of the hierarchy, goal is constructed. At the bottom of this goal, the criteria (if there is exists, sub criteria are constructed) and alternatives are constructed respectively (Felek, Yuluğkural, Aladağ, 2007: 7.).

Ali Emrouznejad and Marianna Marra analyze AHP in order to provide some basic statistics on AHP journals and researchers. They also review the main topics and applications of integrated AHPs and

provide direction for future research by highlighting some open questions during the three periods 1979–1990, 1991–2001 and 2002–2017.



Source: Saaty T.L. and, Vargas L.G., (2001), Models, Methods, Concepts & Applications of The Analytic Hierarchy Process, Springer, s. 3.

Figure 1: Three-Level Hierarchical Structure

Implementation

The study is done in ÖSYM and it is a unique study for the Student Selection and Placement Centers. In this study, it has been attempted to show the scientific view with AHP method by comparing both subjective and objective components for the problem of facility location selection problem. The main scope of the study is to handle the most appropriate examination center. Within the scope of the implementation, a selection proposal has been represented with multiple criteria approach in the light of the managers and personnel of ÖSYM in order to open new examination center in Turkey.

Since the reason that the institution is regarding almost everyone who wants to the education in Turkey, the problem is more essential for this reason. The profile of the institution of ÖSYM has been to make examinations and serving for almost everyone in Turkey. The vision and the mission of the institution are described as:

- Being a transparent institution that conducts examinations according to the measure of right and justice and measure in the light of scientific methods and evaluation studies,
- Being 100% secure and reliable both in domestic and abroad, working with crypto and e-signature, completing the process from the examination preparation stage to the evaluation stage, automation, international information security standards for the applicant who does the appropriate and qualified examination, a high reputation in society.

The scope and objective of study

The scope of the study includes multi criteria decision making problem for the selection of examination center location. The criticality of facility location selection has been mentioned in the earlier parts of this study. It has also been highlighted that of the vital importance of this selection for the successful operation of ÖSYM.

The main objective of the study is to utilize the AHP technique for the most suitable facility location selection for Student Selection and Placement Centers. For this reason, it is essential to obtain and

evaluate the most appropriate alternative examination centers that are settled on an agreement by the top managers of the institution. The decision of the opening an alternative examination center is a critical subject for not only the top managers but also the people who will have examinations in these mentioned alternative examination centers. Because of this reason, it is essential to have the most proper result because of the importance of the scope of the study.

Nevertheless the AHP technique which can be used in the implementation in nearly most cases today, seem not to provide a decisive result, it rather helps to top level managers in a broad extent. Thanks to AHP, a comparison is done for the selection of the most convenient examination center locations. Thanks to this comparison, it can be easier to handle the both subjective and objective point of view when selecting among the proposed defined alternative ones.

All in all, AHP method gives an opportunity to look at subjective criteria in pairwise comparison, decision makers mostly tend to prefer AHP method. AHP method provides not only to handle overall view of the different criteria in the situation but also to help the decision maker evaluate whether the issues in each level are of the same order of magnitude, when dealing with the subjective criteria. Thanks to AHP method, the decision maker compares lots of different elements that are called criteria or sub criteria in a right way.

Methodology

According to the type of the case study and with the help of AHP method which utilizes the both qualitative and quantitative research methods concurrently, a case study has been implemented. The implementation has done in institution that named as Student Selection and Placement Centre (ÖSYM) in Turkey.

Table 2: Fundamental Scale for Pairwise Comparisons

The Foundamental scale for Pairwise Comparisons		
Intensity of Importance	**Definition**	**Explanation**
1	**Equal importance**	**Two elements contribute equally to the objective**
3	**Moderate importance**	**Experience and judgment slightly favor one element over another**
5	**Strong importance**	**Experience and judgment strongly favor one element over another**
7	**Very strong importance**	**One element is favored very strong over another, its dominance is demonstrated in practice**
9	**Extreme importance**	**The evidence favoring one element over another is of the highest possible order of affirmation**
Intensities of 2, 4, 6, and 8 can be used to express intermediate values. Intensities 1.1, 1.2, 1.3, etc. can be used for elements that are very close in importance.		

Source: Thomas L. Saaty, "The Analytic Hierarchy and Analytic Network Measurement Processes: Applications to Decisions Under Risk", European Journal of Pure and Applied Mathematics, Vol 1, No 1, 2008, s. 125.

In AHP, the facility selection problem which is the subject of decision making problem is divided into its components organized in the hierarchical structure. By looking at the problem, it is obvious that pairwise comparisons in AHP method are the basic building blocks. The fundamental scale for pairwise comparisons suggested by Saaty from 1 to 9 pairwise comparison scale is used, while making pairwise comparisons between criteria. After the hierarchy is created, pairwise comparisons of criteria are calculated. The decision maker makes the decision in order to handle relative importance criteria according to the 1-9 scale. (Saaty, 2008: 257).

In this method, the target or goal to be reached is determined in AHP. Then, criteria and, if applicable, sub criteria are determined. At the lowest level, these criteria alternatives are available. In this phase, survey study is consulted, in order to determine all the criteria or the opinions of experts in the matter. In this study, survey study has been chosen.

When doing all these determinations, the decision hierarchy is constructed. Then, the pairwise comparison matrices are created. Surveys send to different existing coordinatorships in ÖSYM. Exam Center Coordinatorships that are answered to the surveys in ÖSYM are demonstrated in Table 1. Answers are handled with light of views of managers and personnel of these institutions. With the help of the answers of survey, the most appropriate selection criteria are examined. The collected data has been analyzed by Microsoft Excel software package program.

Since the decision maker makes comparisons according to his /her own opinion, consistency ratio is calculated first. This ratio is calculated whether the survey is consistent or not. If not, decision maker reviews the decision about the comparisons and provide new consistent decisions.

Pairwise comparisons are recorded in diagonal cells, when the eigenvector values are calculated in the AHP method. Each diagonal value is recorded as 1. When a cell demonstrated as xij, diagonal value is calculated as xij = (1 / xij). When the comparison matrices are generated, the comparison the column values for each column in the matrix divided by the sum of the normalized matrix values are obtained. By calculating the average of the line values in the normalized matrix eigenvector values (averages) are found. After all, degree of importance of the criteria are handled.

Certain examinations are done by ÖSYM in scheduled days and there are many people that entering these examinations in every year. The institution also has examination centers in several provinces of Turkey. Because of this reason, there is a requirement to manage all these examinations and also examination centers. It must be constructed the alternative locations first in order to manage and decide whether opening a new facility or not. All in all, because of the most suitable way to get answers from all examination centers is considered as sending survey, the survey is created, send with the upon the request of the top manager of ÖSYM and got answers from 69 of Exam Center Coordinatorships of ÖSYM.

Research Model

With doing relevant studies in the literature about the problem, a generic AHP method is has been used for the facility location selection problem. Since the study is done for real implementation, it is important to define main criteria and sub criteria for the case. For this reason, not only main criteria but also sub criteria are defined. All in all, hierarchy structure is obtained for a real implementation facility location selection in the institution of ÖSYM.

As the review of aforementioned model, the main goal has defined as examination building selection. Examination building selection is also called as aim or goal, as mentioned before. The main target is divided into 4 criteria as Physical Situation of the Examination Hall, Transportation to the Examination Building, Properties of the Examination Building and Environment of the Examination Building.

These criteria are also divided into sub criteria in their integrity. By this way, Physical Situation of the Examination Hall consist of Light Receiving Condition of the Examination Hall (Ph1), Ventilation System of the Examination Hall (Ph2), Distance Between Desks (Ph3) and Heating and Cooling System of the Examination Hall (Ph4), Physical Situation of the Desks (Ph5) and Noise Level of the Examination Hall (Ph6).

Transportation to the Examination Building consists of Public Transportation (T1), The distance Between City Centers and Examination Building (T2), Private Transportation (T3) and Adequate Guidance Signboard (T4).

Properties of the Examination Building has been assessed with regard to Sufficiency of Parking Space (P1), Cleanliness of the Examination Hall (P2), Sufficiency of Toilet Number (P3), Sufficiency of First-aid Equipment in the building (P4), Alternative Evacuation Area in Danger (P5), Sufficiency of Entrust Area and Responsible in Charge (P6) and Having Sense of Mission About Rules (For Responsible Head Teacher and Servants) (P7). Finally, the main criteria which is called as Environment of the Examination Building has been divided into 4 sub criteria as Sufficiency of Social Opportunities (For Consumption) (E1), Safety in the Area of Examination Building (E2), Unpleasant smell in and near the Examination Building (E3), Noise around the Examination Building (E4) and Closeness to the Health Centers in Case of Emergency (E5).

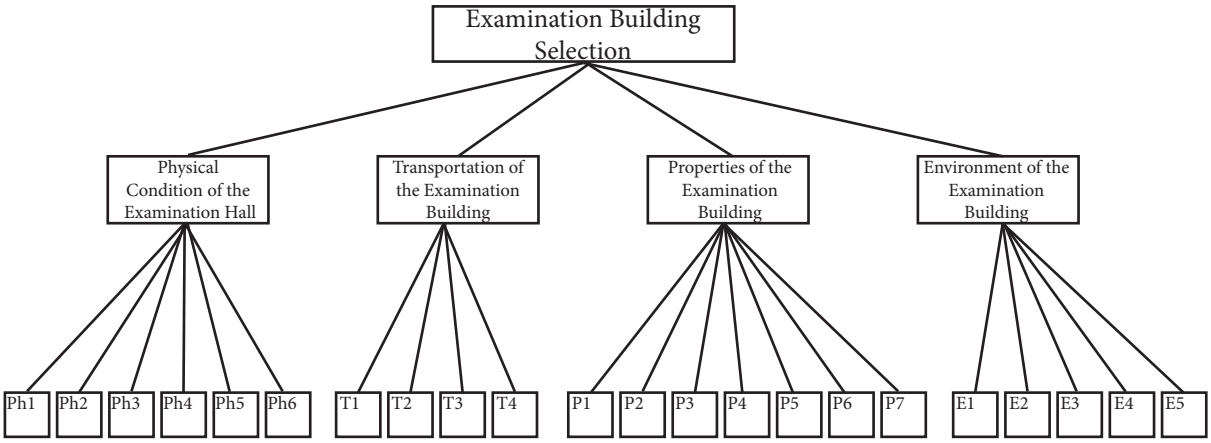


Figure 2: Hierarchical Structure

In this study, it is aimed to evaluate the most appropriate facility location selection problem under four main criteria and 22 sub criteria. The main aim of the study is also to have maximum customer satisfaction of people that enter examinations and to obtain maximum profitability for ÖSYM.

Analysis and Findings

In the location selection problem, it is possible to make comparisons and calculations of AHP by forming hierarchy for critical main criteria and sub criteria for ÖSYM as seen previous figures. First, it is formed a hierarchical structure thanks to the nature of AHP. After forming, main criteria and sub criteria that take part in the hierarchy, has been compared with each other in sequential order.

Main criteria that are Physical Situation of the Examination Hall, Transportation to the Examination Building, Properties of the Examination Building and Environment of the Examination Building are compared with each other. As mentioned before, calculations are done according to the answers of 69 surveys that include pairwise comparison in them. The calculations are done with the help of 'Microsoft Excel' package software program. The comparisons and results that have been obtained are given in tables below.

In Table 3, comparison matrix for main criteria and relevant weights which are called as degree of importance are found in the following matrix;

Table 3: Comparison Matrix for Main Criteria, Degree of Importance and Compatibility Rates

Comparison Matrix for Main Criteria, Degree of Importance and Compatibility Rates					
Examination Building Selection (Main Criteria)	Physical Condition of the Examination Hall	Transportation to the Examination Building	Properties of the Examination Building	Environment of the Examination Building	Degree of Importance
Physical Condition of the Examination Hall	1,000	1,028	0,414	1,550	0,208
Transportation to the Examination Building		1,000	0,434	1,438	0,203
Properties of the Examination Building			1,000	2,457	0,439
Environment of the Examination Building				1,000	0,151
					1,000

With analyzing the table above, the most essential criteria for selecting a new examination building for ÖSYM is rated in following sequential order; %43,9 Properties of the Examination Building, %20,8 Physical Condition of the Examination Hall, %20,3 Transportation to the Examination Building and finally %15,1 Environment of the Examination Building.
Each sub criteria group is examined in pairwise comparison, after comparing the main criteria pairwise. The degree of importance of each sub criteria which are Physical Situation of the Examination Hall, Transportation to the Examination Building, Properties of the Examination Building and Environment of the Examination Building are given tables below.

Table 4: Comparison Matrix for Sub Criteria for ''Physical Situation of the Examination Hall' main criteria, degree of importance and compatibility rates

Comparison Matrix for Sub Criteria for 'Physical Situation of the Examination Hall' Main Criteria, Degree of Importance and Compatibility Rates							
Physical Situation of the Examination Hall	Light Receiving Condition of the Examination Hall	Ventilation System of the Examination Hall	Distance Between Desks	Heating and Cooling System of the Examination Hall	Physical Situation of the Desks	Noise Level of the Examination Hall	Degree of Importance
Light Receiving Condition of the Examination Hall	1,000	1,040	1,071	0,961	0,951	0,884	0,164
Ventilation System of the Examination Hall		1,000	0,832	0,832	0,815	0,838	0,147
Distance Between Desks			1,000	0,938	0,942	0,942	0,166
Heating and Cooling System of the Examination Hall				1,000	1,000	0,942	0,173
Physical Situation of the Desks					1,000	0,927	0,174
Noise Level of the Examination Hall						1,000	0,176
							1,000

In Table 4, the sub criteria 'Physical Situation of the Examination Hall' is examined in Microsoft Excel software program. With the help of this software program, the most essential sub criteria for Physical Situation of the Examination Hall is given in sequential order as %17,6 Noise Level of the Examination Hall, %17,4 Physical Situation of the Desks, %17 Heating and Cooling System of the Examination Hall,

%16,6 Distance Between Desks, %16,4 Light Receiving Condition of the Examination Hall and %14,7 Ventilation System of the Examination Hall.

Table 5: Comparison Matrix for Sub Criteria for 'Transportation to the Examination Building' main criteria, degree of importance and compatibility rates

Comparison Matrix for Sub Criteria for 'Transportation to the Examination Building' Main Criteria, Degree of Importance and Compatibility Rates					
Transportation to the Examination Building	Public Transportation	The distance Between City Centers and Examination Building	Private Transportation	Adequate Guidance Signboard	Degree of Importance
Public Transportation	1,000	0,895	0,361	0,385	0,146
The distance Between City Centers and Examination Building		1,000	0,385	1,083	0,197
Private Transportation			1,000	2,036	
Adequate Guidance Signboard				1,000	0,197
					1,000

In Table 5, the sub criteria 'Transportation to the Examination Building' are examined in Microsoft Excel software program. Thanks to this software program, the most essential sub criteria for Physical Situation of the Examination Hall is given as %46 Private Transportation. All other criteria considered as minor importance levels.

Table 6: Comparison Matrix for Sub Criteria for 'Properties of the Examination Building' main criteria, degree of importance and compatibility rates

Comparison Matrix for Sub Criteria for 'Properties of the Examination Building' Main Criteria, Degree of Importance and Compatibility Rates								
Properties of the Examination Building	Sufficiency of Parking Space	Cleanliness of the Examination Hall	Sufficiency of Toilet Number	Sufficiency of First-aid Equipment in the building	Alternative Evacuation Area in Danger	Sufficiency of Entrust Area and Responsible in Charge	Having Sense of Mission About Rules (For Responsible Head Teacher and Servants)	Degree of Importance
Sufficiency of Parking Space	1,000	0,717	0,719	0,725	0,725	0,697	0,654	0,105
Cleanliness of the Examination Hall		1,000	1,000	0,818	1,053	1,000	0,958	0,145
Sufficiency of Toilet Number			1,000	1,041	1,020	1,000	0,958	0,149
Sufficiency of First-aid Equipment in the building				1,000	1,031	0,990	0,956	0,152
Alternative Evacuation Area in Danger					1,000	0,980	0,958	0,145
Sufficiency of Entrust Area and Responsible in Charge						1,000	0,929	0,148
Having Sense of Mission About Rules (For Responsible Head Teacher and Servants)							1,000	0,156
								1,000

In Table 6, the sub criteria 'Properties of the Examination Building' are examined in Microsoft Excel

software program. Thanks to this software program, the most essential sub criteria for Physical Situation of the Examination Hall is given in sequential order as %15,6 Having Sense of Mission About Rules (For Responsible Head Teacher and Servants), %14,9 Sufficiency of Toilet Number, %14,8 Sufficiency of Entrust Area and Responsible in Charge, %14,5 Cleanliness of the Examination Hall, %14,5 Alternative Evacuation Area in Danger and %10,5 Sufficiency of Parking Space.

Table 7: Comparison Matrix for Sub Criteria for 'Properties of the Examination Building' main criteria, degree of importance and compatibility rates

Comparison Matrix for Sub Criteria for 'Environment of the Examination Building' Main Criteria, Degree of Importance and Compatibility Rates						
Environment of the Examination Building	Sufficiency of Social Opportunities (For Consumption)	Safety in the Area of Examination Building	Unpleasant smell in and near the Examination Building	Noise around the Examination Building	Closeness to the Health Centers in Case of Emergency	Degree of Importance
Sufficiency of Social Opportunities (For Consumption)	1,000	0,304	0,293	0,263	0,307	0,068
Safety in the Area of Examination Building		1,000	1,067	0,992	1,347	0,245
Unpleasant smell in and near the Examination Building			1,000	0,917	1,379	0,243
Noise around the Examination Building				1,000	1,561	0,261
Closeness to the Health Centers in Case of Emergency					1,000	0,182
						1,000

In Table 7, the sub criteria 'Environment of the Examination Building' are examined in Microsoft Excel software program. Thanks to this software program, the most essential sub criteria for Physical Situation of the Examination Hall is given in sequential order as %26,1 Noise around the Examination Building, %24,5 Safety in the Area of Examination Building, %24,3 Unpleasant smell in and near the Examination Building, %18,2 Closeness to the Health Centers in Case of Emergency and %6,8 Sufficiency of Social Opportunities (For Consumption).

Results and Comments

In location selection problem, one of the most important matters which have to be taken by top level managers is to select the most appropriate geographical area in order to meet the needs successfully. Thus, the problem is not only essential for the management of the institution, but also for making decisions concerning for the long term goals. Because of the importance of the subject, facility location selection problems cannot be handled by a single person. With a broad view point to AHP group decision making problem is handled in this study instead of individual decision making. With getting various answers from different people, beneficial and precise results are achieved thanks to the constructed survey.

This study is a unique study that is implemented in Student Selection and Placement Centre (ÖSYM) in Turkey. The institution is making examinations and provides service nearly everyone that wants to take education in Turkey. The problem is even more critical for this reason.

The aim of the study is to have the most convenient examination center. Because of the importance of facility location selection problem, data collection is done by survey in the light of views of managers and personnel of the institution of ÖSYM. Thanks to answers of survey, the most appropriate selection criteria are examined. The collected data has been analyzed by Microsoft Excel software package program.

All relevant pairwise comparison is done for main criteria and sub criteria as Physical Situation of the Examination Hall, Transportation to the Examination Building, Properties of the Examination Building and Environment of the Examination Building. 4 main criteria and 22 sub criteria has been obtained as a research model structure as a result of this study.

It has been also aimed to serve for the institutions or various sectors which look for giving the right decision for selecting the most convenient facility locations among other alternatives with lots of criteria. All in all, thanks to conclude a decision with a right facility location, there have been always right services on the right locations.

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