MULTI- CRITERIA DECISION MAKING AND THE CHOICE OF UNIVERSITY IN EDUCATION

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ABSTRACT

University choice is one of the most important decisions for students. Although the entrance exams to the university may differ, students always make a decision based on the result of the exam. Since the number of people who graduated from university has increased in the recent years, the significance of choosing the right university has also increased. In this paper, first, multi criteria decision making (MCDM) is explained and then two MCDM methods, which are utilized in this study are described. Thereafter, the application of the MCDM is demonstrated with an example, which aims the right choice of the university. In this example, between the four universities selected in Istanbul, one university was decided adopting two different MCDM methods: Analytic Hierarchy Process (AHP) and Technique for Order Preference by Similarity to Ideal Solutions (TOPSIS). The criteria weights are determined by conducting a survey with participation of 100 university students of different universities. The main purpose of this study is to determine the optimum university utilizing the weights of the criteria which influence the choice of university, criteria and alternatives' relationships.

Keywords Multi Criteria Decision Making (MCDM), Analytic Hierarchy Process (AHP), Technique for Order Preference by Similarity to Ideal Solutions (TOPSIS)

Introduction

Every day, people encounter situations that they need to decide. They make decisions about many things which include personal decisions, educational decisions, medical choices, career decisions, financial decisions, etc. These are just few examples of decision types. However, the process of decision making is specific for the choices. While some choices are simple, another one can be complicated and can require multi steps to make the decision [1].

The decision making process involves two factors. The first factor is "criteria" which shapes the assessment of the person who makes decision. Second factor is "alternatives" to choose among others. We need more than one alternative to talk about the decision making process. If there is only one alternative, then, there is no decision making process [2].

Decision making is influenced by various important factors. Significant factors include past experiences, cognitive biases, an escalation of commitment and sunk outcomes, individual differences including age, sex and socioeconomic status, and a belief in personal relevance [2]. There are seven steps to guarantee an effective decision making: identifying decision, gathering information, defining alternatives, weighting the criteria, choosing among alternatives, taking action and reviewing the decision which is made.

1.1. Multi Criteria Decision Making

Multi criteria decision making (MDCM) has generated as a part of operations research, concerned with designing computational and mathematical tools for supporting the subjective evaluation of performance criteria by decision makers [3].

The MCDM procedure consists of generating alternatives, establishing and ranking criteria, assessing criteria weights, and application of the compromise ranking method [4].

MCDM might be considered as a complex and dynamic process including one managerial level and one engineering level [5]. The managerial level defines the goals, and chooses the final ‘‘optimal’’ alternative.

MCDM problems can be analyzed under three main titles. These are choice, sorting, and ranking problems. The purpose of choice problems is to determine the best alternative or to be compared with each other that many alternatives available is to make a good choice in a difficult group. While in sorting problems, alternatives are classified according to certain criteria and behavior; in ranking problems, alternatives can be classified from good to bad in measurable or identifiable manner [6].

Table 1 below categorizes MCDM into three and demonstrates methods utilized in each category.

Table 1 [7]
MCDM Methods

CHOICE PROBLEMS	SORTING PROBLEMS	RANKING PROBLEMS
AHP	AHP	AHP Sort
ANP	ANP	UTADIS
MAUT/UTA	MAUT/UTA	FlowSort
MACBETH	MACBETH	ELECTRETri
PROMETHEE	PROMETHEE	
ELECTRE I	ELECTRE III	
TOPSIS	TOPSIS	
GOAL PROGRAMMING		

1.1.1. Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP), introduced by Thomas Saaty (1980) [8], is an effective tool in dealing with complex decision making problems, and help the decision maker to set priorities and make the best decision. By reducing complex decisions to a series of pairwise comparisons, and then synthesizing the results, AHP helps to capture both subjective and objective aspects of a decision [8]. In addition, AHP integrates a useful technique for checking the consistency of the decision maker’s evaluations, thus reduces the bias in the decision making process. It is one of the most used method of MCDM methods. In literature, AHP is utilized for finance sector in banking [8-10], economics and economic integration [11-13], vendor selection [14,15], security assessment [16], health [17-19], other topics.

AHP generates a weight for each evaluation criteria according to decision maker’s pairwise comparisons about the criteria. The higher the weight is; the corresponding criteria is the more important. Next, for fixed criteria, AHP assigns a score to each option according to decision maker’s pairwise comparisons of the options based on that criterion. The higher the score is, the performance of the option with respect to the considered criterion is better. Finally, AHP combines the criteria weights and the options’ scores, thus determines a global score for each option, and a ranking, consequently. The global score for a given option is a weighted sum of the scores which is obtained with respect to all criteria [8].

1.1.2. Technique for Order Preference by Similarity to Ideal Solution (TOPSIS)

TOPSIS method was first developed by Hwang and Yoon [20] and it ranks the alternatives according to their distances from the ideal solution and the negative ideal solution. The best alternative has simultaneously the shortest distance from the ideal solution and the farthest distance from the negative ideal solution. The ideal solution is identified with a hypothetical alternative that has the best values for all considered criteria whereas the negative ideal solution is identified with a hypothetical alternative that has the worst criteria values [21]. In literature, TOPSIS is utilized for personal selections [22, 23], supplier selections [24, 25], safety evaluation [26], education evaluation [27], health, safety and environment management [28], other topics.

Material and Methods

University choice has been one of the hardest decisions to be made by both students and families during the years. This choice consists lots of criteria, which affect decision. Weighting of these criteria can be different for each person/student. During this process, multi criteria decision making methods can be used for making the right

decision to determine the optimum university. In this study, we utilized AHP and TOPSIS methods for this decision.

The alternative set of universities are from Istanbul, the most metropolitan city in Turkey and are: Istanbul University, Yildiz Technical University, Koc University and Sabanci University. Alternative universities are the best and oldest universities in Istanbul and are the target universities of many students. Yildiz Technical University is 3rd oldest university of Turkey with its history dating back to 1911. Istanbul University was opened on 30 May 1453 by Mehmet the Conqueror under the name of Medaris-i Semaniye and Fatih Darüssiifasi. Both these universities are state universities. Koc University started education in 1993 in Istanbul and Sabanci University is founded in 1996. Both these two universities are private universities.

There are several criteria for university selection problem handled in this study. All criteria are determined and evaluated by brainstorming, thus through this technique we reduced the amount of criteria. After elimination, the six criteria for the selection of university are specified as: prestige, scholarship opportunity, social facilities, international expansion and connections, business opportunity and accessibility. We operated a survey to 100 students who are students from different universities with the aim of specifying the criteria weights. In Table 2 below, we display the alternatives and criteria which are identified and utilized in this study.

Table 2
Alternatives and Criteria that are Identified and Utilized in This Study

	UNIVERSITY	CRITERIAS	
A1	Istanbul University	Prestige	C1
A2	Yildiz Technical University	Scholarship opportunity	C2
A3	Koc University	Social facilities	C3
A4	Sabanci University	International expansion and connections	C4
		Business opportunity	C5
		Accessibility	C6

2.1. Solution with AHP

The most important step in AHP is the creation of the hierarchical structure of the problem. When the hierarchical structure is created, we can understand that what the problem we want to solve and how to do the pairwise comparisons. In Figure 1, we demonstrate the hierarchical structure of the handled problem.

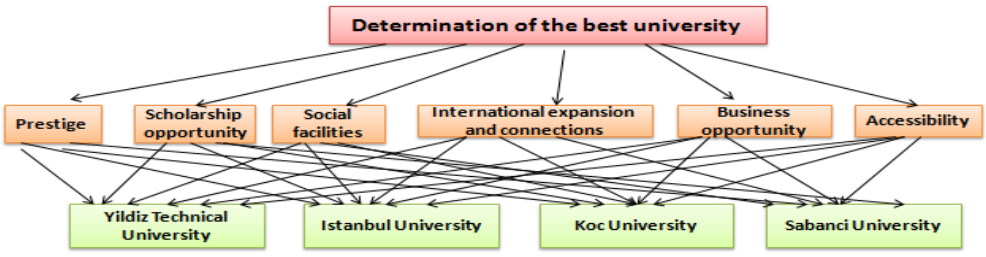

Figure 1
Hierarchical Structure of University Choice Problem

Once hierarchical structure is created, pairwise comparison matrix is constructed. Pairwise comparison is performed based on criteria. Pairwise comparison matrix and normalization matrix are presented by Table 3.

Table 3
Pairwise Comparison Matrix and Normalization Matrix

PRESTIGE

	YTU	IU	KOC	SABANCI
YTU	1.00	3.00	0.25	0.25
IU	0.33	1.00	0.17	0.17
KOC	4.00	6.00	1.00	3.00
SABANCI	4.00	6.00	0.33	1.00

NORMALIZATION TABLES

	YTU	IU	KOC	SABANCI	WEIGHT
YTU	0.107	0.188	0.143	0.057	0.124
IU	0.036	0.063	0.095	0.038	0.058
KOC	0.429	0.375	0.571	0.679	0.514
SABANCI	0.429	0.375	0.190	0.226	0.305

SCHOLARSHIP OPPORTUNITY

	YTU	IU	KOC	SABANCI
YTU	1.00	0.33	0.50	0.50
IU	3.00	1.00	3.00	3.00
KOC	2.00	0.33	1.00	0.50
SABANCI	2.00	0.33	2.00	1.00

	YTU	IU	KOC	SABANCI	WEIGHT
YTU	0.125	0.167	0.077	0.100	0.117
IU	0.375	0.500	0.462	0.600	0.484
KOC	0.250	0.167	0.154	0.100	0.168
SABANCI	0.250	0.167	0.308	0.200	0.231

SOCIAL FACILITY

	YTU	IU	KOC	SABANCI
YTU	1.00	0.14	0.20	0.20
IU	7.00	1.00	3.00	3.00
KOC	5.00	0.33	1.00	1.00
SABANCI	5.00	0.33	1.00	1.00

	YTU	IU	KOC	SABANCI	WEIGHT
YTU	0.056	0.079	0.038	0.038	0.053
IU	0.389	0.553	0.577	0.577	0.524
KOC	0.278	0.184	0.192	0.192	0.212
SABANCI	0.278	0.184	0.192	0.192	0.212

INTERNATIONAL EXPANSION AND CONNECTIONS

	YTU	IU	KOC	SABANCI
YTU	1.00	5.00	0.33	0.33
IU	0.20	1.00	0.20	0.20
KOC	3.00	5.00	1.00	0.33
SABANCI	3.00	5.00	3.00	1.00

	YTU	IU	KOC	SABANCI	WEIGHT
YTU	0.139	0.313	0.074	0.179	0.176
IU	0.028	0.063	0.044	0.107	0.060
KOC	0.417	0.313	0.221	0.179	0.282
SABANCI	0.417	0.313	0.662	0.536	0.482

BUSINESS OPPORTUNITY

	YTU	IU	KOC	SABANCI
YTU	1.00	7.00	5.00	5.00
IU	0.14	1.00	0.14	0.14
KOC	0.20	7.00	1.00	1.00
SABANCI	0.20	7.00	1.00	1.00

	YTU	IU	KOC	SABANCI	WEIGHT
YTU	0.648	0.318	0.700	0.700	0.592
IU	0.093	0.045	0.020	0.020	0.045
KOC	0.130	0.318	0.140	0.140	0.182
SABANCI	0.130	0.318	0.140	0.140	0.182

ACCESSIBILTY

	YTU	IU	KOC	SABANCI
YTU	1.00	3.00	7.00	9.00
IU	0.33	1.00	5.00	7.00
KOC	0.14	0.20	1.00	4.00
SABANCI	0.11	0.14	0.25	1.00

	YTU	IU	KOC	SABANCI	WEIGHT
YTU	0.630	0.691	0.528	0.429	0.569
IU	0.210	0.230	0.377	0.333	0.288
KOC	0.090	0.046	0.075	0.190	0.101
SABANCI	0.070	0.033	0.019	0.048	0.042

After pairwise comparison matrix, consistency of judgment is checked. It has been observed that the comparisons made in the calculation guarantee consistency.

At the final stage, university choice rankings are obtained by the multiplication of the criterial weight and weight of the criteria based on alternative universities. This process is demonstrated with Table 4 below.

Table 4
Determination of Weighting of Alternatives

Criterias / Alternatives	PRESTIGE	SCHOLARSHIP OPPORTUNITY	SOCIAL FACILITY	INTERNATIONAL EXPANSION AND CONNECTIONS	BUSINESS OPPORTUNITY	ACCESSIBILTY			
YTU	0.124	0.117	0.053	0.176	0.592	0.569		0.176	0.287
IU	0.058	0.484	0.524	0.060	0.045	0.288	x	0.143	= 0.218
KOC	0.514	0.168	0.212	0.282	0.182	0.101		0.144	0.248
SABANCI	0.305	0.231	0.212	0.482	0.182	0.042		0.178	0.248
								0.211	
								0.148	

As a result of calculations made by the AHP method, the final ranking of universities is obtained as follows (Table 4):

1. Yildiz Technical University
2. Koc University
3. Sabanci University
4. Istanbul University

2.2. Solution with TOPSIS

First, decision matrix is formed as a result of evaluations. 1-9 scale is utilized for this evaluation. The scores of the alternatives are normalized and then weighted normalization is obtained by multiplying the criterion weights by the normalization values. Decision matrix, normalized matrix and weighted normalized matrix are displayed by Table 5.

Table 5

a) Decision Matrix, b) Normalized Matrix and c) Weighted Normalized Matrix

a) Decision Matrix

	PRESTIGE	SCHOLARSHIP OPPORTUNITY	SOCIAL FACILITY	INTERNATIONAL EXPANSION AND CONNECTIONS	BUSINESS OPPORTUNITY	ACCESSIBILTY
YTU	6	4	4	7	7	9
IU	4	5	6	4	5	7
KOC	7	5	6	6	6	5
SABANCI	8	6	6	7	6	3

b) Normalized Matrix

	PRESTIGE	SCHOLARSHIP OPPORTUNITY	SOCIAL FACILITY	INTERNATIONAL EXPANSION AND CONNECTIONS	BUSINESS OPPORTUNITY	ACCESSIBILTY
YTU	0.0364	0.0392	0.0323	0.0467	0.0479	0.0549
IU	0.0242	0.0490	0.0484	0.0267	0.0342	0.0427
KOC	0.0424	0.0490	0.0484	0.0400	0.0411	0.0305
SABANCI	0.0485	0.0588	0.0484	0.0467	0.0411	0.0183

c) Weighted Normalized Matrix

	PRESTIGE	SCHOLARSHIP OPPORTUNITY	SOCIAL FACILITY	INTERNATIONAL EXPANSION AND CONNECTIONS	BUSINESS OPPORTUNITY	ACCESSIBILTY
YTU	0.0064	0.0069	0.0057	0.0082	0.0084	0.0097
IU	0.0043	0.0086	0.0085	0.0047	0.0060	0.0075
KOC	0.0075	0.0086	0.0085	0.0070	0.0072	0.0054
SABANCI	0.0085	0.0104	0.0085	0.0082	0.0072	0.0032

Ideal and negative ideal solution values are determined for all criteria. When ideal and negative ideal solution values are determined, ideal and negative ideal solution distances are calculated. Lastly, relative closeness to the ideal solution is calculated. These stages are presented by Table 6 and 7 below, respectively.

Table 7

Ideal and Negative Ideal Solution Distance

PRESTIGE	SCHOLARSHIP OPPORTUNITY	SOCIAL FACILITY	INTERNATIONAL EXPANSION AND CONNECTIONS	BUSINESS OPPORTUNITY	ACCESSIBILTY	⇨ Ideal Solution Value
0.0085333	0.0104	0.0085	0.0082	0.0084	0.0097	
PRESTIGE	SCHOLARSHIP OPPORTUNITY	SOCIAL FACILITY	INTERNATIONAL EXPANSION AND CONNECTIONS	BUSINESS OPPORTUNITY	ACCESSIBILTY	⇨ Negative Ideal Solution Value
0.0042667	0.0069	0.0057	0.0047	0.0060	0.0032	

Table 8

The Relative Closeness to the Ideal Solution

	Si*	Si-	Ci*
YTU	0.005	0.120	0.961
IU	0.007	0.094	0.934
KOC	0.005	0.116	0.958
SABANCI	0.007	0.124	0.950

As a result of calculations made by TOPSIS method, the final ranking of universities is obtained as follows:

1. Yildiz Technical University
2. Koc University
3. Sabanci University
4. Istanbul Universit

RESULTS AND DISCUSSION

Together with the current education system in Turkey, students are obliged to enter the exam which is designated and prepared by Student Selection and Placement Center (OSYM) in order to be able to enroll in a university. Students are being prepared during their high school life. They get a score through the answers that are revealed from the questions marked with the correct and the wrong answers. It is very important to make the right choices after the results of the exam are explained and this problem is a multi-criteria decision making problem in real life. There are many alternatives and many criteria which will affect the determination of right choice.

In this study two MCDM methods (AHP and TOPSIS) are described and employed for university choice in education system. In this study, most significant criteria that affect the university selection process are taken into consideration. The criteria's importance level enables to identify the criteria's weight. They are calculated by conducting a survey with participation of 100 students. Alternative universities are selected from the biggest city in Turkey: Istanbul.

According to AHP and TOPSIS method, Yildiz Technical University is found the most appropriate alternative for both methods. Evaluation of these two methods indicates similarities. In order to obtain more successful results, survey can be used to determine criteria that will be taken into consideration.

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