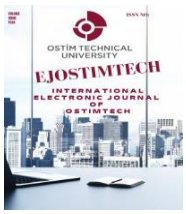

OSTİM TECHNICAL UNIVERSITY

EJOSTIMTECH International Electronic Journal of OSTIMTECH

EJOSTIMTECH, 2022; 1(1):51-61

CLASSIFICATION OF FOUNDATION UNIVERSITIES BY CLUSTER ANALYSIS ACCORDING TO ACADEMIC, FINANCIAL AND ADMINISTRATIVE INDICATORS

Serdar Çelik*

Abstract

The study's goal is to examine Turkey's 76 foundation universities using cluster analysis and classify them within the framework of selected variables based on academic, financial, and administrative indicators. Variables accepted as academic, financial, and administrative indicators were clustered in the study using Ward's method and the k-mean method. The most up-to-date data published on the Higher Education Institution (YÖK) website was used as the data source. 76 universities were grouped into six clusters according to the hierarchical clustering analysis using 13 academic, financial and administrative indicators. Then the k-means method was applied. The efficiency of the academic, financial and administrative variables of the universities in the formed clusters was determined by the results of ANOVA. While performing hierarchical clustering methods, standardization process was applied to the data. At the same time, it was determined which method would be applied depending on the observation data, variable data type and number. As a result of this study, in which two clustering methods were studied, different clustering structures were obtained for both methods.

Keywords: Cluster Analysis, Foundation University, Ward's Method, K-Means Method

Introduction

Universities are institutions where raw data is transformed into information and produced, vocational training is received, and new technologies are developed. These higher education institutions contribute directly to the economy and development of the cities, regions and countries in which they are located. Universities vary in terms of both their founding goals and their vision. It has become organizations that not only produce information, but also work in interaction with the environment they live in, transform their experience into marketable products and act for the benefit of society together with stakeholders. Higher education in Turkey has been a service provided by the state until thirty years ago. In recent years, the inability to meet the increase in demand has led to the establishment of foundation universities with some regulations. Foundation universities are established by non-profit foundations and their number is increasing every year. Due to this increase, foundation universities have become an important research area in terms of academic, financial and administrative criteria. University rankings are one of the most important goals of universities. Because universities have different outputs and objectives, rankings may be insufficient to describe a university's status. In addition to university rankings from a research standpoint, it is critical to evaluate universities using a variety of criteria that are applied equally to all universities. The metric system used to rank universities does not account for all aspects of university productivity (Raan & F. J., 2005; Pérez-Esparrells & Orduna-Malea, 2018). As a result, universities should not be evaluated solely on their overall score. As a result, universities should not make university ranking their primary goal. we must evaluate universities based on their respective objectives. Universities should be evaluated based on their own goals.

Literature Review

Classifying universities is an effective strategy for controlling institutional characteristics in academic research and developing internal policies. Academic, administrative and financial performance measures are the driving force for decision makers while developing these policies. Measuring institutional academic performance in an objective, accurate, honest and reliable way helps to allocate resources efficiently, prioritize research and development investments, to inform all stakeholders, to attract potential candidate students, and improve institution self-assessment. Classifying

* Res. Asst., Ostim Technical University, Ankara, Turkey, serdar.celik@ostimteknik.edu.tr, ORCID: 0000-0003-4530-9055

Gönderilme Tarihi: 24 Eylül 2022/ Kabul Tarihi: 10 Kasım 2022

universities is recognized as an effective strategy for internal policy development in higher education (Shin, 2009). This is because classification provides transparency for various internal policy approaches and collaboration among institutions (Bartelse & Vught, 2007). Early classifications for universities were categorized in terms of their similarities and differences. Recent classification studies have focused on research performance. A classification study should be closely related to its intended use. Local or global ranking lists attract the attention of the public and academia. The rankings provide easily understandable and interpretable information about the university. It also helps to encourage competition and make a difference among universities. States use rankings for allocating resources and for quality assessment. Employers consider rankings to recruit recent graduates. Students who want to get into universities with high reputations use rankings. However, rankings may be subject to criticism regarding the choice of indicators. Descriptive approaches are insufficient to make the complex structure of universities understandable (Raponi, Martella, & Maruotti, 2016). This is because ranking systems use quantifiable data and different calculation formulas rather than qualitative data. Therefore, as a way of comparing universities, cluster analysis techniques should be used rather than a simple ranking algorithm and focusing on their identified areas. In studies on clustering universities, researchers have been interested in classifying universities on an institutional basis. Bartelse and Vught (2007) examined the indicators of classification in five dimensions: education, innovation, R&D, staff characteristics, and institutional variables. Many factors, such as existing criteria and variables, must be taken into account to create a useful classification. Universities often avoid doing an entire institution analysis because they have strengths in one area. Therefore, typical academic research performance indicators include publication numbers, citation counts, journal impact factors, and reputation rankings. Higher education institutions in Turkey offering associate, bachelor's, master's and doctoral programs are designed as public universities and foundation universities under the supervision of YÖK. The operating revenues of state universities are provided by the state without any specific performance evaluation, while foundation universities are funded by their founders or co-founders, tuition fees and other revenues. While the revenues of foundation universities are provided by stakeholders, they are calculated by taking into account the institutional size and expenses of the university rather than performance. Küçükcan and Gür (2009) provide a comparative analysis of management systems in higher education, while Günay and Günay (2011) investigate quantitative developments. Using data from 2010 and 2013, Tosun (2015) analyzed the current state of public universities in six categories: educational income, educational structure, educational quality, publications, projects, and entrepreneurship-innovation. The lack of a classification scale for Turkish universities imposes limitations on academic research as well as global policymaking. In the absence of a classification scale for Turkish universities, researchers and policymakers are forced to work with an arbitrary comparable grouping. Such a practice may lead to inconsistent results. The purpose of this study is to investigate and analyze variables and indicators for classifying foundation higher education institutions in Turkey on the basis of academic, financial and administrative indicators and to classify foundation universities using a cluster method.

There are two research questions in this study:

1. What are the indicators that can be used to classify foundation universities in Turkey?

2. How can universities be classified with quantitative variables?

In the next section, the data used in the analysis and the clustering methodology are explained. Then the clustering findings are presented and discussed. The paper concludes with some conclusions and recommendations for decision makers.

Research Method

The main purpose of this study is to classify foundation universities in Turkey in terms of academic, financial and administrative variables. In cluster analysis, first of all, robust data sets are required. The data sets were created based on the literature. Ağıralioğlu (2012) outlined 13 requirements for a top university. Language, history, fundamental sciences, original school, department, institute, information and communication resources, financial resources, faculty, staff, and students, scientific publications, citations, and patents, publicity and outreach, university-society ties, and government ties are some of these criteria. According to academic standards such student enrollment, faculty and program enrollment, the number of master's and doctorate programs offered, faculty membership,

Gönderilme Tarihi: 24 Eylül 2022/ Kabul Tarihi: 10 Kasım 2022

publications, and projects, Gözükara (2015) analyzed 72 foundation universities. Elbawab (2022) conducted a clustering study that took into account variables such as academic reputation score, faculty student score, citation score per faculty, and international student score. The developed framework is constructed with the following variables:

x1: Total number of students

x2: Number of permanent lecturers

x3: Number of permanent faculty members

x4: Library area

x5: Number of printed books

x6: Number of E-Books

x7: Total covered area per student

x8: Full scholarship rate

x9: Current expense per student

x10: R&D and library expenditures total

x11: Contribution of student income to total income

x12: Advertising promotion expense

x13: Student societies

variables are considered.

In the second step, data were collected from YÖK statistics. According to the academic, financial and administrative indicator variables, the full data of 76 foundation universities were reached. Many algorithmic methods come to the fore for cluster analysis. These algorithms are grouped under two main topics (Ma, JN, & Tavares, 2009). The first is hierarchical clustering methods that generate dendrograms and non-hierarchical clustering methods. The common purpose of the methods is to maximize the differences between the clusters and the similarities within the clusters. Which method to use is generally related to the number of clusters, as well as it is useful to use both analysis methods together. Thus, it is possible to compare which one gives more appropriate results (Johnson, 2002).

In the study, Ward's method, which is frequently used among hierarchical clustering analysis methods, and k-means method from non-hierarchical clustering methods were used. Although Clustering Analysis is classified in many ways in the literature, it is commonly seen that it is evaluated in two major groups: hierarchical and non-hierarchical clustering methods. When evaluating hierarchical methods in the context of clustering units, they involve a series of n-1 clustering decisions that transform units into a hierarchy or a tree structure, where n is the number of units. Hierarchical clustering is classified into two types: combinatorial and divisive. Combining methods begin with each observation forming a cluster on its own. It then merges the two most similar clusters at the same time, bringing the clusters together until a single cluster is formed. Single linkage, full linkage, average linkage, Ward, median centralisation, and centroid methods are examples of combining methods. Divisive methods begin with a single cluster that contains all of the units and progress through successive divisions, first into two clusters, then three clusters, and so on, until each is a single-member cluster. Non-hierarchical methods, in contrast to hierarchical methods, do not use stepwise processes. Instead, after determining the number of clusters, observations are assigned to them. Non-hierarchical methods that are widely used include k-means, medoid, fuzzy, and stacked clustering. Due to a lack of a certain number of clusters, it was decided to use the hierarchical clustering method in the study. One of the hierarchical clustering methods is the Ward method, which is used to cluster units with different variance structures within a cluster. It was chosen because it clusters the clusters in a way that reduces variability. In addition, the k-means method, a non-hierarchical method, was used to compare the clustering results. The Ward and k-means methods are explained in the sections that follow.

Gönderilme Tarihi: 24 Eylül 2022/ Kabul Tarihi: 10 Kasım 2022

Hierarchical Cluster Analysis

Hierarchical methods are used to form the cluster tree in hierarchical clustering analysis. The results of hierarchical methods are displayed in tree diagrams known as dendrograms (Hubert, 1974). Grouping (agglomerative) and partitioning (divisive) clustering algorithms are two types of hierarchical methods. Grouping clustering algorithms assume each point in the initial database to be a cluster and form new clusters by merging these clusters. Partition clustering algorithms take all of the points in the initial database and form k clusters by discarding points that are different from each other. According to Figure 1, agglomerative methods move from left to right, while divisive methods move from right to left. As illustrated in the figure, divisive clustering methods perform reverse clustering, so computer package programs used in cluster analysis applications avoid divisive methods in favor of agglomerative methods. The procedure for repeatedly applying hierarchical agglomerative methods begins with accepting each observation as a cluster, i.e. the number of observations equals the number of clusters. Using the similarity measure, the number of clusters is reduced by merging the most similar clusters. The process is then repeated at each step, merging the two most similar clusters into a new cluster, until all observations are found in a single cluster (total n-1 times) (Hair, Black, Babin, & Anderson, 2014).

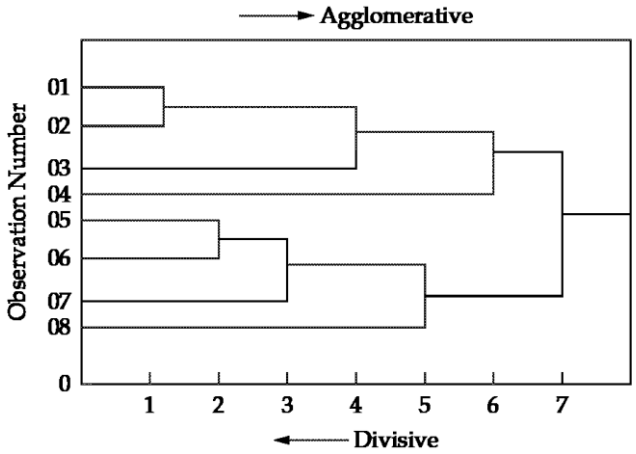

Figure 1. Dendrogram for the hierarchical clustering procedure (Hair, Black, Babin, & Anderson, 2014)

Ward's Method

Ward's method, which is one of the hierarchical clustering methods, is widely regarded as the most effective (Hands & Everitt, 1987). This method, among agglomerative clustering methods, can provide cluster formation by minimizing intragroup dispersion in each pairwise merger using the classical sum of squares criterion. Ward's method, as a result, has a more complex structure than other hierarchical methods. The goal of this method is to reduce the variance between objects by grouping them together. As a result, it considers the average distance between observations in a cluster's center and observations in the same cluster (Tekin & Gümüş, 2017).

Non-Hierarchical Cluster Analysis

Non-hierarchical clustering methods are used when the number of clusters is fixed. When the number of units is large, non-hierarchical clustering methods are faster and more meaningful than hierarchical techniques. The k-means method is the most commonly used method in non-hierarchical clustering analysis. Non-hierarchical methods, unlike hierarchical methods, do not have a tree-like structure. Instead, the researcher determines the number of clusters and then assigns units/objects to clusters. Non-hierarchical methods are becoming increasingly popular today. Non-hierarchical methods are thought to have several advantages over hierarchical techniques because the clustering process is dependent on the researcher making decisions based on objective or theoretical assumptions. The results, for example, are less sensitive to data outliers, the distance measure used, and the inclusion of irrelevant or inappropriate variables. Furthermore, because non-hierarchical methods do not require the calculation of similarity matrices across all observations, but rather only the similarity of each observation to the cluster centers, they can be used to analyze extremely large datasets. Although non-hierarchical

Gönderilme Tarihi: 24 Eylül 2022/ Kabul Tarihi: 10 Kasım 2022

approaches have numerous notable advantages, they also have limitations. Non-hierarchical approaches are not efficient for analysing a large number of potential cluster solutions. Unlike hierarchical techniques that provide all feasible cluster solutions in a single analysis, each cluster solution is a separate analysis. Therefore, non-hierarchical procedures are not thought to be well suited for investigating a large range of possibilities.

K-Means

MacQueen (1967) described the traditional k-means algorithm, which is now one of the most widely used clustering algorithms. Every to cluster numerical data where the cluster has a center called the mean designed. The number of clusters in a non-hierarchical clustering analysis should be known in advance by the researcher. When the number of clusters is known in advance, the k-means method can generate at least two clusters and as many as the number of observations. This method minimizes differences between data in the same cluster while increasing differences between data in different clusters (Al Kindhi, Sardjono, Purnomo, & Verkerke, 2019). In multidimensional space, x_1, x_2, …, x_n are observation vectors of p variables each, and a_{1n}, a_{2n}, …, $a_k n$ are cluster centers for each group of individuals in the same space.

$$W_n = \frac{1}{n}\sum_{i=1}^{n} min_{i\leq j\leq k} \left\|x_i - a_{jn}\right\|^2$$

Individuals or objects are assigned to the nearest cluster according to the rule (Gürsakal, 2019).

Data and Findings

Universities not only produce knowledge, but also play an important role in working in interaction with the environment they are in and transforming the experience gained into marketable products and providing various benefits to society together with the stakeholders. The descriptive statistics of the variables related to the academic, financial and administrative indicators used in the study are shown in Table 1.

Table 1. Descriptive statistics of academic, financial and administrative indicators

Variables	N	Min	Max	Average	Standard deviation
x1 (Total number of students)	76	378	39392	8502.41	8571.788
x2 (Number of permanent lecturers)	76	24	1634	370.14	292.950
x3(Number of permanent faculty members)	76	1	878	212.03	168.546
x4 (Library area)	76	250	12500	3440.41	3152.778
x5 (Number of printed books)	76	1428	513060	62068.71	85207.814
x6 (Number of E-books)	73	21	7771598	428769.62	1012258.682
x7 (Total indoor space per student)	76	3	92	17.43	15.689
x8 (Full scholarship rate)	74	15	100	19.30	11.467
x9 (Current expense per student)	71	3175	124358	23362.13	22265.356
x10(Total R&D and library expenditures)	71	16174	129085193	11866488.20	23440579.46
x11(Contribution of student income to total income)	71	2	99	72.20	25.243
x12 (Advertising promotion expense)	71	34158	9877054	1748122.75	2083971.891
x13 (Student societies)	76	6	114	44.62	26.449

Ward's method was applied to the data used in the study. Ward's method has been preferred because it gives more accurate and best results in clustering small amounts of data. The square Euclidean distance was preferred in the calculation of the distance values between the data values in Ward's method. However, since the incremental clustering methods, which include distance calculations, are very sensitive to the differences between the variables, it was deemed appropriate to standardize the data. For this reason, z values were found by standardizing the data and analysis was applied.

After the observation data were standardized, Ward's method was used with square Euclidean distance. According to the square Euclidean distance, in the pairwise comparison of the academic, financial and administrative variables of the universities, the lowest distance value was found to be 0.391643 between TED University and Istanbul Gedik University. This is followed by Istanbul Rumeli

Gönderilme Tarihi: 24 Eylül 2022/ Kabul Tarihi: 10 Kasım 2022

University - Eurasia University with a distance measure of 0.59064; Lokman Hekim University – Piri Reis University is followed by 0.641876. When looking at the highest distance values; It is seen that there is too much distance between İhsan Doğramacı Bilkent University and Ibn Haldun University and other universities.

When dendrogram showing the hierarchical clustering results of the universities is examined, the universities that are most similar to each other in terms of academic, financial and administrative indicators form clusters at a distance of 1 unit, while the universities that are the least similar to each other are gathered at a distance of 25 units. While the academic, financial and administrative variables of some universities are very similar to each other, they form a group at a distance of one unit, while some universities seem to be a single group at first due to their unique variables. When there is a distance of 25 units in the dendrogram, all universities form a single cluster. As a result of dendrogram, it was decided that the optimum number of clusters is 6 in the range of 1-14 units. Dendrogram results are given in Table 2 and Figure 2.

Table 2. Ward's Method Results (Universities in Clusters)

Cluster-1	Cluster-2	Cluster-3	Cluster-4	Cluster-5	Cluster-6
İstanbul Gedik	KTO Karatay	OSTİM Teknik	İstanbul Bilgi	Beykent	Koç
TED	Özyeğin	İstanbul 29 Mayıs	İstanbul Kültür	İstanbul Gelişim	Sabancı
Yüksek	Altınbaş	İstanbul Ticaret	Nişantaşı	Bahçeşehir	İhsan Doğramacı
Beykoz	Biruni	Fenerbahçe	Üsküdar	Yeditepe	Bilkent
MEF	İzmir Ekonomi	Konya Gıda ve Tarım	Atılım	İstanbul Aydın	İbn Haldun
Avrasya	Haliç		İstinye	İstanbul Medipol	
İstanbul Rumeli	İstanbul YeniYüzyıl		İstanbul Okan	Başkent	
Kapadokya	İstanbul Arel		İstanbul Sabahattin Zaim	Maltepe	
İstanbul Kent	Işık		Doğuş		
İzmir Kavram	Kadir Has				
Alanya Akev	Nuh Naci Yazgan				
Lokman Hekim	Hasan Kalyoncu				
Piri Reis	İstanbul Esenyurt				
Demiroğlu Bilim	Ufuk				
Sanko	Acıbadem Mehmet Ali Aydınlar				
Toros	Bezm-i Alem Vakıf				
Türk Hava Kurumu	TOBB Ekonomi ve Teknoloji				
Kocaeli Sağlık ve Teknoloji	Çağ				
	Antalya Bilim				
	İstanbul Ayvansaray				
	Fatih Sultan Mehmet Vakıf				
	Çankaya				

In the agglomerative table, the universities with the most similarity to each other are matched according to the coefficients depending on the academic, financial and administrative indicator variables. In the agglomerative table stage, there are n-1 stages. According to this statement, there are 76-1=75 stages for universities. With the table, it can be seen at which stage the universities come together with which university. While the closest, that is, the most similar universities, form a cluster in the first place, a new university or a new cluster formed by other universities is added to the cluster. The two institutions that appear to be closest to one another, based on this methodology, are TED University in cluster 2 and Istanbul Gedik University in cluster 1. These two universities took the Yüksek İhtisas University between them in the 8th stage. In other words; The universities that are closest to each other in terms of academic, financial and administrative indicators are TED University and Istanbul Gedik University. Later, Eurasia University and Istanbul Rumeli University were found close. The farthest universities from each other are Acıbadem Mehmet Ali Aydınlar University-Atılım University and Atılım University-İbn Haldun University. As can be understood from the coefficients, universities that are closest to each other according to academic, financial and administrative variables are in the first

Gönderilme Tarihi: 24 Eylül 2022/ Kabul Tarihi: 10 Kasım 2022

place. Universities that are less similar to each other are in the next rank. The data of this table is given in Table 3.

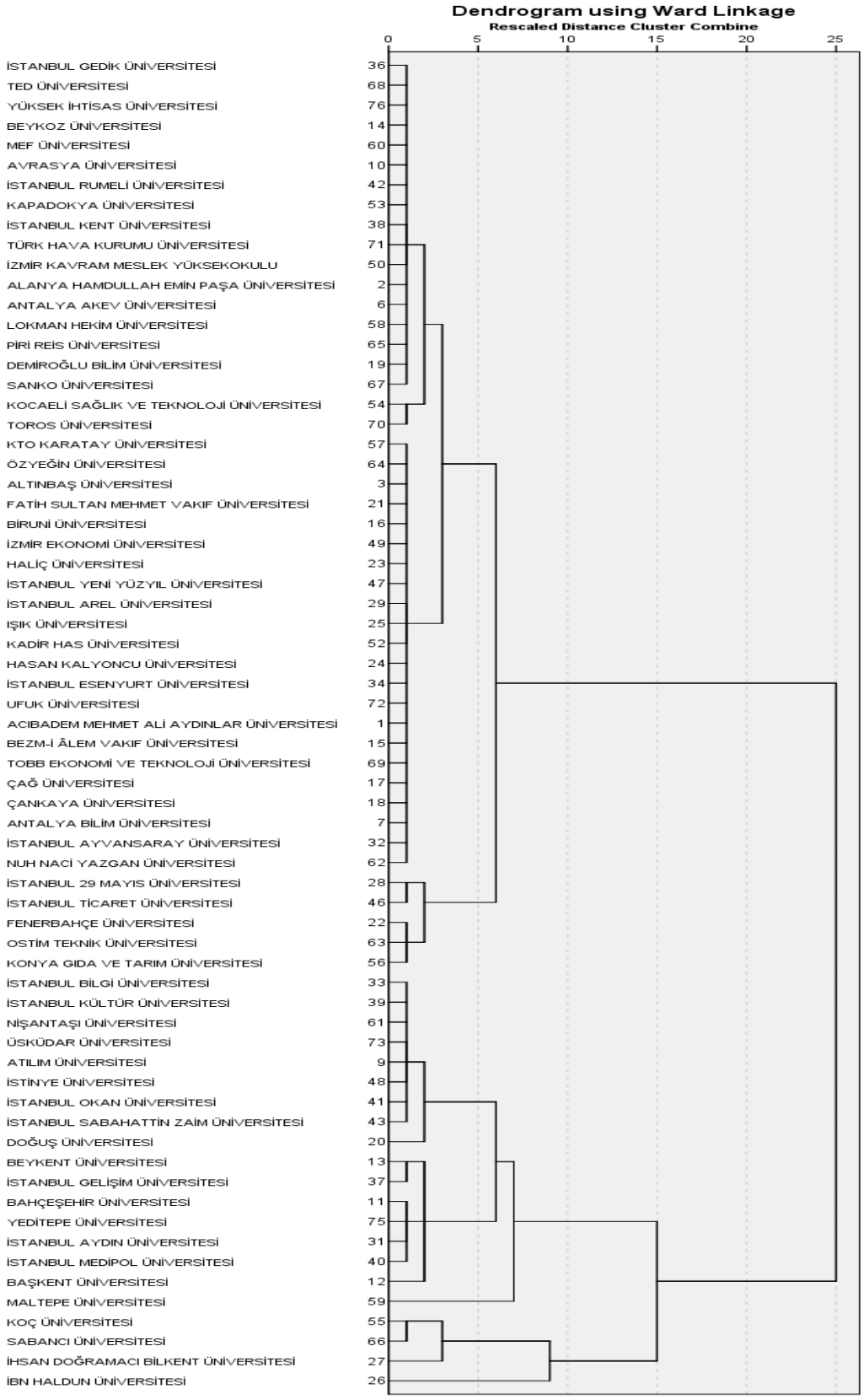

Figure 2. Dendrogram using Ward's method for clustering universities by parameters of academic, financial, and administrative indicators

Gönderilme Tarihi: 24 Eylül 2022/ Kabul Tarihi: 10 Kasım 2022

Table 3. Formation of Clusters Agglomerative Table

Stage	Merged Clusters		Coefficients	Stages of Clustering for The First Time		Next Stages
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	İstanbul Gedik	TED	0.196	0	0	8
2	Avrasya	İstanbul Rumeli	0.491	0	0	10
3	KTO Karatay	Piri Reis	0.812	0	0	17
64	İbn Haldun	İhsan Doğramacı Bilkent	496.775	0	59	65
65	Atılım	İbn Haldun	630.575	63	64	65
66	Acıbadem Mehmet Ali Aydınlar	Atılım	868.191	62	65	0

After determining the formation of six clusters according to the academic, financial and administrative variables of the universities, k-mean cluster analysis was performed. Table 4 shows the places of universities in clusters as a result of the k-means clustering method.

Table 4. Clusters after K-Means Method

Cluster-1	İhsan Doğramacı Bilkent			
Cluster-2	İstanbul Gedik TED Yüksek Beykoz MEF Avrasya İstanbul Rumeli Kapadokya İstanbul Kent İzmir Kavram Acıbadem Mehmet Ali Aydınlar	Alanya Akev Lokman Hekim Piri Reis Demiroğlu Bilim Sanko Toros Türk Hava Kurumu Kocaeli Sağlık ve Teknoloji İstanbul Esenyurt Ufuk Fatih Sultan Mehmet Vakıf Çankaya	Özyeğin Altınbaş Biruni İzmir Ekonomi Haliç İstanbul Yeni Yüzyıl İstanbul Arel Işık Kadir Has Nuh Naci Yazgan Hasan Kalyoncu Çağ TOBB Ekonomi ve Teknoloji	İstanbul 29 Mayıs İstanbul Ticaret Fenerbahçe Konya Gıda ve Tarım Atılım İstinye İstanbul Sabahattin Zaim Doğuş Antalya Bilim Bezm-i Alem Vakıf KTO Karatay İstanbul Ayvansaray
Cluster-3	Maltepe			
Cluster-4	Koç, OSTİM Teknik, Sabancı, Yeditepe			
Cluster-5	Bahçeşehir, Başkent, Beykent, İstanbul Aydın, İstanbul Bilgi, İstanbul Gelişim, İstanbul Kültür, İstanbul Medipol, İstanbul Okan, Nişantaşı, Üsküdar			
Cluster-6	İbn Haldun			

The academic, financial and administrative indicators of the universities used in the cluster analysis and the clusters formed and their averages are given in Table 5.

Tablo 5. Last Cluster Centers

Indicators	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5	Cluster6
x1 (Total number of students)	0.397	-0.321	0.401	-0.379	1.957	-0.819
x2 (Number of permanent lecturers)	1.304	-0.307	1.085	0.070	1.643	-0.741
x3 (Number of permanent faculty members)	0.889	-0.328	1.328	0.202	1.659	-0.676
x4 (Library area)	2.849	-0.289	0.583	1.008	1.259	-0.302
x5 (Number of printed books)	5.293	-0.217	1.117	0.838	0.611	-0.314
x6 (Number of e-books)	0.638	-0.103	7.254	-0.150	-0.314	-0.348
x7 (Total indoor space per student)	2.139	-0.167	-0.219	0.992	-0.554	4.753
x8 (Full scholarship rate)	0.148	-0.157	-0.375	0.148	-0.222	7.038
x9 (Current expense per student)	1.101	-0.153	-0.198	3.580	-0.368	2.403

Gönderilme Tarihi: 24 Eylül 2022/ Kabul Tarihi: 10 Kasım 2022

x10 (Total R&D and library expenditures)	5.001	-0.296	-0.024	2.091	0.431	-0.197
x11 (Contribution of student income to total income)	-1.553	-0.002	0.666	-1.315	0.636	-2.781
x12 (Advertising promotion expense)	-0.477	-0.371	3.901	-0.444	1.446	-0.816
x13 (Student societies)	2.170	-0.212	0.203	-0.704	1.404	-1.082

* Data pertaining to academic, financial and administrative indicators were found with z values.

When the averages of the variables given in Table 5 in six clusters are examined, the lowest averages of x11 (contribution of student income to total income), x12 (advertising and promotion expenses) of the universities that make up the first cluster, x5 (number of printed books), x10 (total of R&D and library expenditures)), x7 (total closed area per student) and x4 (library area) are the variables with the highest averages.

Table 6.Distances Between Last Cluster Centers

Clusters	**1**	**2**	**3**	**4**	**5**	**6**
1		9.406	11.282	7.121	8.218	12.068
2	9.406		8.992	5.123	4.804	9.576
3	11.282	8.992		8.029	8.029	13.613
4	7.121	5.123	10.104		6.548	8.679
5	8.218	4.804	8.029	6.548		11.461
6	12.068	9.576	13.613	8.679	11.461	

Looking at the distance matrix between the cluster centers given in Table 6, it is seen that the distance between the first and second clusters is 9.406 and the distance between the first and the third cluster is 11.282. ANOVA test was applied to find out the difference between the clusters of the academic, financial and administrative variables of the universities used in the analysis. The ANOVA table of the variables to which the k-average method was applied is shown in Table 7.

Table 7. ANOVA Table for Variables

	Cluster		Hata			
	Mean of squares	Sd	Mean of squares	Sd	F	p
x1 (Total number of students)	10.359	5	0.277	61	37.341	0.000
x2 (Number of permanent lecturers)	7.958	5	0.464	61	17.142	0.000
x3(Number of permanent faculty members)	8.189	5	0.461	61	17.762	0.000
x4 (Library area)	6.787	5	0.563	61	12.059	0.000
x5 (Number of printed books)	7.563	5	0.546	61	13.857	0.000
x6 (Number of e-books)	10.741	5	0.288	61	37.263	0.000
x7 (Total indoor space per student)	6.962	5	0.286	61	24.368	0.000
x8 (Full scholarship rate)	10.284	5	0.108	61	94.983	0.000
x9 (Current expense per student)	9.634	5	0.334	61	28.853	0.000
x10(Total R&D and library expenditures)	8.926	5	0.402	61	22.207	0.000
x11 (Contribution of student income to total income)	4.126	5	0.767	61	5.376	0.000
x12 (Advertising promotion expense)	9.568	5	0.349	61	27.376	0.000
x13 (Student societies)	6.559	5	0.562	61	11.669	0.000

* Calculated with the z values of the data belonging to academic, financial and administrative indicators.

The ANOVA table is used to determine whether academic, financial and administrative indicator variables are significant in the clustering process. When Table 7 is examined, it is clearly seen that the academic, financial and administrative variables determined in the clustering of the universities in six clusters are significant in the clustering process ($p<0.05$). It is seen that the most effective academic, financial and administrative indicator variable in clustering is x8 ($F=94.983$). The least effective variable is x11 ($F=5.376$). Such a result is due to the maximization of the difference between clusters. That is, the distribution of universities in the clusters is not random.Cluster analysis tries to create clustering groups according to the distances between data groups.

Gönderilme Tarihi: 24 Eylül 2022/ Kabul Tarihi: 10 Kasım 2022

Results and Evaluation

University rankings are an important performance measure because they are used by all universities (Elbawab, 2022). This study analyses university rankings from a different perspective. The study emphasizes that we should evaluate universities based on the defined clusters rather than their position in the success rankings.The aim of this study, which examines the academic, financial and administrative indicators of universities, is to examine which foundation universities are similar and which foundation universities are different in terms of academic, financial and administrative variables by looking at cluster analysis methods. In this study, 76 foundation universities were classified according to their academic, financial and administrative indicators. As an academic, financial and administrative indicator; total number of students, full scholarship rate, number of permanent faculty members, current expenditure per student, number of permanent faculty members, library area, number of printed books, number of e-books, total closed area per student, total R&D and library expenditures, The contribution of student income to total income, advertising and promotion expenses, student communities variables were determined and used. In the study, universities were clustered according to Ward's method and k-mean method. As the first method, Ward's method was applied and Euclidean distance was taken as a measure of distance. It was deemed appropriate that universities should be divided into six clusters. It was determined that the academic, financial and administrative variables used for clustering of universities were significantly effective ($p<0.05$). In this study, the use of cluster analysis methods in the classification of universities according to academic, financial and administrative variables was tested and the stages of the method were presented in detail. At the same time, it was determined in the study that many foundation universities were divided into meaningful clusters and few clusters depending on their academic, financial and administrative variables. According to the results, six clusters were formed in Ward's method. 18 universities came together in Cluster-1, 22 universities in Cluster-2, 5 universities in Cluster-3, 9 universities in Cluster-4, 8 universities in Cluster-5 and 4 universities in Cluster-6. It was seen that the academic, financial and administrative indicator variables that are effective in dividing the universities into six clusters with the ANOVA table are statistically significant.

The results of this study will contribute to the development of foundation universities to provide an efficient education service. Considering that the education quality and academic achievement performance of universities in the world are evaluated with different variables and criteria, it will be beneficial for foundation universities to determine their goals in this direction, to increase the quality of higher education services in Turkey and to transform universities into preferred educational institutions. The study's main limitation is that accurate data could not be obtained directly from universities. The results show that foundation universities focus on research, administrative and financial roles apart from their aims such as higher quality education. The results of this research can be extended by comparing foundation and state universities in future studies. Data from the Higher Education Institution, as well as direct data from universities, can be collected for a more comprehensive study.

References

Ağıralioğlu, N. (2012). An Approach to Determine the Quality of Universities in Turkey. *Journal of Higher EducaϴϴOn and Science*, 147-165.

Al Kindhi, B., Sardjono, T., Purnomo, M., & Verkerke, G. (2019). Hybrid K-Means, Fuzzy C-Means, and Hierarchical Clustering for DNA Hepatitis C Virus Trend Mutation Analysis. *Expert Systems with Applications*, 121, 373-381.

Anderberg, M. (1973). Cluster Analysis for Applications Academic Press. *New York*, 553-55.

Bartelse, J., & Vught, F. (2007). Institutional profiles: Towards a typology of higher education institutions. *IAU Horizons*, 13(2-3),9-11.

Elbawab, R. (2022). University Rankings and Goals: A Cluster Analysis. *Economies*, 10, 209.

Gözükara, İ. (2015). Examining Foundation Universities with Cluster Analysis in the Context of Academic Criteria. *Journal of Business Research*, 156-171.

Günay, D., & Günay, A. (2011). 1933'den günümüz Türk yükseköğretiminde niceliksel gelişmeler. *Yükseköğretim ve Bilim Dergisi*, 1(1),1-22.

Gönderilme Tarihi: 24 Eylül 2022/ Kabul Tarihi: 10 Kasım 2022

Hubert, L. (1974). Approximate Evaluation Techniques for the Single-Link and Complete-Link Hierarchial Clustering Procedures. *Journal of the American Statistical Association*, 69, 698-704.

Johnson, R. (2002). *Applied Multivariate Statistical Analysis.*

Küçükcan, T., & Gür, B. (2009). *Türkiye'de yükseköğretim: Karşılaştırmalı bir analiz.* Ankara: SETA Yayınları.

Ma, Z., JN, R., & Tavares, J. (2009). A Review on the current segmentation algorithms. *In IMACAPP*, 135-40.

MacQueen, J. (1967). Some Methods for Classification and Analysis of Multivariate Observations. *Proceedings of the Fifth Berkeley Symposium on Mathematical Statistics and Probability*, 1(14), 281-97.

Pérez-Esparrells, C., & Orduna-Malea, E. (2018). Do the technical universities exhibit distinct behaviour in global university rankings? A Times Higher Education (THE) case study. *Journal of Engineering and Technology Management*, 97-108.

Raan, V., & F. J., A. (2005). Fatal attraction: Conceptual and methodological problems in the ranking of universities by bibliometric methods. *Scientometrics*, 133,143.

Raponi, V., Martella, F., & Maruotti, A. (2016). A biclustering approach to university performances: An Italian case study. *Journal of Applied Statistics*, 43(1), 31-45.

Shin, J. (2009). Classifying higher education institutions in Korea: A performance-based approach. *Higher Education*, 57(2), 247-266.

Tosun, H. (2015). *Devlet üniversiteleri: Performans değerlendirme finansman modeli ve yeniden yapılanma.* Ankara: Uzman Matbaacılık.