EFFICIENCY OF TURKISH HEALTH MANAGEMENT DEPARTMENTS THROUGH DATA ENVELOPMENT ANALYSIS

Menderes Tarcan✉
Gözde Yeşilaydın

Eskisehir Osmangazi University, Faculty of Health Sciences, Department of Health Management, Turkey

✉ mtarcan@ogu.edu.tr

ABSTRACT

The purpose of this study was to determine which of the input and output variables made a statistically significant difference in the efficiency status of undergraduate departments offering Health Management education in Turkey, to identify areas where inefficient departments could improve, and to determine which of the input and output variables made a statistically significant difference in the efficiency status of inefficient departments. The output-oriented data envelopment analysis model was employed in the efficiency analysis. As a decision-making unit, there were 43 Health Management departments. Mann-Whitney U test was used to analyse whether or not there was a statistically significant difference between the efficiencies of the departments based on the input and output variables. In Turkey, 15 of 43 state universities providing formal undergraduate education in the field of Health Management are fully efficient. Also, there was a significant difference in terms of the "number of completed projects" and the "number of papers in journals screened within the scope of Web of Science Core Collection (WOSCC)" variables. No study examining the efficiency of Health Management departments has been found in the literature. Department administrators are encouraged to increase their publications and look into ways to design more initiatives.

KEYWORDS

Health management, Data Envelopment Analysis, efficiency, Turkey

HOW TO CITE

Tarcan M., Yeşilaydın G. (2023) 'Efficiency of Turkish Health Management Departments through Data Envelopment Analysis', *Journal on Efficiency and Responsibility in Education and Science*, vol. 16, no. 2, pp. 102-112. http://dx.doi.org/10.7160/eriesj.2023.160202

Article history
Received
June 3, 2022
Received in revised form
November 7, 2022
Accepted
February 20, 2023
Available on-line
June 30, 2023

Highlights

- *Evaluation of the efficiency of Health Management undergraduate departments in Turkey by use of data envelopment analysis.*
- *15 of 43 state universities providing formal undergraduate education in the field of Health Management are fully efficient.*
- *Especially in times of crisis such as pandemics, we think that it is vital to question the efficiency of health management departments.*
- *This study creates a paradigm for future studies about the efficiencies of health management departments.*

INTRODUCTION

Major changes in the healthcare sector have continued to have a faster impact on the industry of healthcare services in the new century. Changes in the reimbursement system have resulted in risk-based fixed-price financing and value-based pricing, raising concerns about patients' access to services, as well as their quality and satisfaction. In addition, notable advances have been made in information systems and information technology. Furthermore, changes in the administration and education of health institutions will be unpreventable in the future in order to adapt to the application and integration of possible new lines of work in fields such as e-health, as well as changing government regulations and vendor relationships (Kleinman, 2003). In this context, the health management profession has also included competencies, in which the roles of hospital administrators have changed significantly and which require qualities aimed at market success as well as complex business knowledge and skills, which have become increasingly important as a result of changes in the healthcare sector over time.

Furthermore, as emphasized by organizations such as the World Health Organization and the World Bank, improving healthcare systems is a global concern. Fundamentally, the forefront of strengthening the healthcare system is research aimed at enhancing the system's administration and administrative capability (Kebede et al., 2010). Despite the fact that administrative capacity has been established at all

levels of national healthcare systems, this issue has become more prominent due to the unique characteristics of hospital administration. Initially, hospitals are frequently perceived as highly complex organizations that necessitate administrative issue solutions and excellent resource coordination. Complexity of organizations providing healthcare service, healthcare service costs, which have increased in the past few years, and constant updating of the present payment structure, have made the management science an integral part of healthcare services in the recent years. It is critical that hospitals improve their administrative skills in order to provide a safe, high-quality, low-cost service that meets the needs of patients while also integrating and coordinating medical, administrative, and other medical human resorces. Furthermore, hospital administrations play crucial roles in complicated clinical and information technology, critical procedures and supplies, and healthcare facility equipment. Secondly, hospitals often account for more than half of a country's health-care spending, highlighting the need of better managing hospitals and their resources (Barnum and Kutzin, 1993; Lal and Roh, 2014). As a result, particularly during the last century, as hospitals grew in size and complexity and funding of the healthcare transitioned from out-of-pocket to prospective payment systems, healthcare administration as a profession evolved to deal with these new problems (Greenspan, 2009).

Gary Filerman, former chairman of the Association of University Programs in Health Administration (AUPHA), as Johnson et al. (1990) point out in their study, defines Health Management as "the most complex and important management responsibility in modern society" and points out importance of hospital management as a profession by emphasising that this job is a profession which is strong enough to directly affect the quality of life of a single individual in society. An administrator is responsible for ensuring that the public has access to high-quality, convenient healthcare services, which can only be accomplished with a financially solid organization, an efficient and effective structure, skilled and appropriate staff, and social sensitivity. A professional health institution administrator, according to Filerman, „contributes to this complicated, fascinating, and enthralling setting with his organizational leadership and management skills." Education should give the required information and abilities in the administration of health organizations to fulfill the various demands and obstacles of a dynamic healthcare services system (Johnson et al., 1990).

As a result, the importance attributed to the topic of „health institution management" grows by the day, and the increased demand for institutions providing health management education compels a re-examination of the education provided by these education systems (Sahin et al., 2011). Furthermore, within the framework of the Health Transformation Programme (HTP), which was attempted to be implemented after 2003, Turkey's healthcare industry has primarily become a sector in need of „management." As a result, there has been a surge in interest in health management concerns across the country (Akdag, 2009; OECD, 2008). Furthermore, hospital directors must be physician health sciences licensees with a bachelor's, master's, or doctoral degree in the field of health management, according to Decree Law No. 663 established under the http (MoH, 2011).

As a result of these practices, there has been a significant growth in the number of higher education programs offering health management education in Turkey. In 2003, two colleges offered undergraduate health management programs; by 2010, that number had risen to seventeen. The number of departments offering health management education expanded from 45 in 2015 to 58 in 2017, and to 79 in 2019 (YOK, 2003; YOK 2010; YOK 2015; YOK 2017; YOK 2019). Among the programs in the field of health sciences, the Health Management department has experienced remarkable growth.

With the expansion in the number of health management programs, particularly after 2007, it has become important to challenge the departments' qualitative competency and the success of the educational activities they provide. In this regard, it is believed that health management departments' efforts to assess their efficiency are critical. In this sense, the goal of this research is to assess the efficiencies of Health Management departments that provide formal undergraduate education in Turkey, make recommendations for inefficient departments, and determine which of the input and output variables made a statistically significant difference in the efficiency status.

The purpose of the study was to evaluate the efficiencies of Health Management departments providing formal undergraduate education in universities in Turkey through data envelopment analysis. The following questions were asked in order to achieve this goal:

- How many of the Health Management departments are efficient?
- Which input and output variables make more contribution to efficiency of efficient departments?
- What can be the improvement suggestions for inefficient Health Management departments?
- Which one of input and output variables creates a significant difference between efficient and inefficient departments?

THEORETICAL FRAMEWORK

It is classed as efficient if an organization provides the highest possible output (output-oriented) from a specified input group or utilizes the smallest possible input (input-oriented) for the result delivered (Gralka et al., 2019). In terms of management, efficiency assessment is critical for institutions to better understand their previous accomplishments and plan their future improvement and success (Kao, 2014).

Efficiency analysis is used in the education sector, as it is in all other sectors (Kashim et al., 2018; Mousa and Ghulam, 2019). Evaluation of efficiency in the education sector plays a key role in the growth and development of countries (Duan, 2019; Fuentes et al., 2016). Many research on efficiency analysis in higher education have been published in recent years. While some of these studies focused on the efficiency of universities, vocational high schools, grammar schools and faculties (Kempkes and Pohl, 2010; Ozel Kadılar, 2015), others looked at the efficiency of individual departments within a university or

faculty (Abdullah et al., 2017; Altamirano-Corro and Peniche-Vera, 2014; Barra and Zotti, 2016b; Jauhar et al., 2018; Kashim et al., 2018; Sirbu et al., 2016; Halásková et al., 2022).
There are other studies that compare the efficiency of the same departments at various institutions. When the literature is examined, it is seen that the efficiencies of Econometrics (Yesilyurt, 2008); Economics (Gnewuch and Wohlrabe, 2018; Johnes and Johnes, 1995; Madden et al., 1997; Wohlrabe and Friedrich, 2017; Yesilyurt, 2009); Banking and Finance (Duramaz, 2018); Statistics (Icoz and Sonmez, 2015); Accounting Training (Celik and Ecer, 2009; Tomkins and Green, 1988); Chemistry and Physics departments (Beasley, 1990; 1995); MBA programmes (Colbert et al., 2000), Engineering Programs (De La Hoz et al., 2021) and Business Management (Doyle et al., 1996) departments have been assessed. In the literature, on the other hand, there is no study examining the efficiencies of Health Management departments.

MATERIALS AND METHODS

Data Envelopment Analysis

Data envelopment analysis (DEA) is one of the most used approaches for evaluating the efficiency of higher education institutions (Aleskerov et al., 2017; Andersson et al., 2017; Chuanyi et al., 2016; Johnes and Tone, 2017; Mikušová, 2017). The DEA is often used for efficiency comparison in situations where numerous inputs and outputs are observed and these inputs and outputs cannot be transformed into a single variable (Altamirano-Corro and Peniche-Vera, 2014; Ozel, 2014; Wang, 2019). The DEA is a linear programming-based and non-parametric method used in measuring the relative efficiency of homogeneous and data-oriented decision-making units which produce a great number of outputs by using multiple inputs (Cooper et al., 2011; Ebrahimnejad and Tavana, 2014; Tavana and Khalili-Damghani, 2014).
The linear programming model for data envelopment analysis is obtained as follows (Santana et al., 2014):

$$\text{Min} \sum_{j=1}^{n} v_j . x_{j0} - w \qquad (1)$$

subject to

$$\sum_{i=1}^{m} u_i . y_{ik} - \sum_{j=1}^{n} v_j . x_{jk} + w \leq 0 \qquad \text{for } k = 1,2,\ldots.h \qquad (2)$$

$$\sum_{i=1}^{m} u_i . y_{i0} = 1 \qquad (3)$$

w without restriction of signal

where x_{jk} represents the amount of input j of *DMU* k; y_{ik} represents the amount of output i of *DMU* k; x_{j0} represents the amount of input j of *DMU* under analysis; y_{i0} represents the mount of output i of *DMU* under analysis; v_j represents the weight of input j for the *DMU* under analysis; u_i represents the weight of output i for the *DMU* under analysis; w represents the scale factor; m represents the number of outputs analyzed; n represents the number of inputs analyzed; and h represents the number of *DMUs* analyzed.

The DEA aims to find the "best" decision-making units which produce maximum output using minimum input compound (Visbal-Cadavid et al., 2017). When the efficiency value of decision-making units is 1 (100%), it is asserted that the decision-making unit is efficient. Units, whose efficiency value ranges from 0 to 1 (0 to 100%) or in other words is under 1 (100%), are inefficient decision-making units (Clermont et al., 2015; Gralka et al., 2019). The DEA also offers an improvement goal to decision-making units to increase their efficiency beyond calculating their efficiency value (Ando et al., 2012).

Selection of Decision-Making Units

Decision-making units which are one of the terms specific to the DEA, are units which have similar inputs and outputs and whose efficiency is intended to be measured (Charnes et al., 1978). Health Management departments of several state universities in Turkey that provide formal undergraduate education were examined as decision-making units in this study. There were 43 Health Management departments as a decision-making unit. These units were acquired from the Undergraduate Atlas of the CHE (Council of Higher Education, 2019) (https://yokatlas.yok.gov.tr/lisans-bolum.php?b=10238). Accordingly, the data of 43 state universities were accessed as of March 2019. When the geographical distribution of 43 decision-making units is examined, 30.2% of them are in the Central Anatolia; 20.9% of them are in the Marmara Region.
Since all data relating to foundation universities was not supplied in a healthy manner, this study solely included state universities in the analysis. Because formal undergraduate education was defined as a basic requirement, open university programs were not included in the study.

Selection of the Data Envelopment Analysis Model

Changes in input sources are not always achievable in universities. Universities or departments, as decision-making units, have more control over outputs than input sources and are more likely to optimize outputs (De La Torre et al., 2017a; Gralka et al., 2019; Wang, 2019). When dealing with inflexible (not completely under control) inputs, Tyagi et al. (2009) recommend using the output-oriented approach.
Moreover, numerous studies have adopted the output-oriented model for evaluating the efficiencies of universities/departments (Abdullah et al., 2017; Barra et al., 2018; Berbegal-Mirabent, 2018; De La Torre et al., 2017b; Duan, 2019; Gralka et al., 2019; Guironnet and Peypoch, 2018; Jauhar et al., 2018; Klumpp, 2018; Lehmann et al., 2018; Mikušová, 2017; Quiroga-Martínez et al., 2018; Visbal-Cadavid et al., 2017; Wang, 2019). The output-oriented strategy was used in this study as well, because the input sources were difficult to control and it was more critical to maximize the outputs, which is consistent with the literature.
The Variable Returns to Scale (VRS) strategy, on the other hand, was chosen because it was believed that changes in department input quantities would not be the same as changes in department output amounts. In addition, the VRS technique was commonly utilized in research evaluating the efficiency of

higher education institutions. Furthermore, the VRS technique was heavily employed in research evaluating the efficiency of higher education institutions (Agasisti and Ricca, 2016; Agasisti and Wolszczak-Derlacz, 2015; Barra and Zotti, 2016a; Barra and Zotti, 2016b; Guccio et al., 2016; Mikušová, 2017; Sirbu et al., 2016; Tyagi et al., 2009; Wang, 2019).

Selection of the Input and Output Variables

Universities are organizations which use multiple inputs to produce multiple outputs (Halkos et al., 2012). However, there is no agreed general rule regarding the most appropriate input and output cluster to be used in evaluating the efficiency of universities (Duan, 2019). The variables used in the study were obtained as a result of an extensive national and international literature review (Abdullah et al., 2017; De La Torre et al., 2017a; De La Torre et al., 2017b; Mousa and Ghulam, 2019; Quiroga-Martínez et al., 2018; Sagarra et al., 2017; Tzeremes and Halkos, 2010; Ferro and D'Elia, 2020).

Gralka et al., (2019) claim that „teaching" and „research" are the two main functions and primary activities of universities. Examining the literature reveals that „the number of academic staff" and „the number of students" are frequently included in the range of teaching activities, while „the number of publications" is the variable related to the research activities of universities.

According to De La Torre et al. (2017a), there are two components of human capital within the universities regarding the inputs. One of them is "the number of students" while the other is "the number of academic staff". When the studies in the literature that evaluate the efficiency of universities with DEA are examined, it is seen that "the number of students" is generally considered as the input variable and "the number of graduate students" as the output variable (Agasisti and Ricca, 2016; Andersson et al., 2017; Guccio et al., 2016; Jauhar et al., 2018; Barra et al., 2018; Lita, 2018; Mikušová, 2017). Similarly, in accordance with the literature, the number of undergraduate students was also taken into consideration as an input variable in this study. On the other hand, it is challenging to obtain precise information about the number of graduate students across all universities. Therefore, this variable is not used as an output variable.

When the studies in the literature that evaluate the efficiency of universities with DEA are examined, it is seen that the most used output variable is "the number of publications". This is an important variable that represents scientific production and research activity. In particular, publications in internationally accepted indexes are very valuable. Therefore, in this study, the number of publications in different categories were considered as output variables.

Input Variables	Data Source
Number of enrolled undergraduate students	Undergraduate Atlas of the CHE
Number of academic members (Prof., Assoc. Prof., Asst. Prof.)	Department web pages
Number of other academic staff members (Instr., Res. Asst., Expert, Lecturer)	Department web pages
Output Variables	
Number of papers in journals screened within the scope of WOSCC (within the scope of SCI, SSCI, SCI-E, and AHCI) [a]	CHE Academic Search module[b]
Number of completed projects[a]	CHE Academic Search module[b]
Number of publications published in international peer-reviewed journals[a]	CHE Academic Search module[b]

[a]Repeated publications and projects conducted by multiple people in the same university were eliminated and examined as a single study.
[b]https://akademik.yok.gov.tr/AkademikArama/

Table 1: Input and output variables used in the study

In the DEA, the number of variables to be used in the analysis is as important as variable choice. In the literature, there are different views on the correlation between the number of decision-making units and the number of input/output variables. The calculations for the two different views (Dyson et al., 2001; Cooper et al., 2001) are as follows.

$$N \geq 2m \times s \quad (1)$$

$$N \geq \max\{m \times s; 3 \times (m+s)\} \quad (2)$$

where n = number of decision making units, m = number of inputs and s = number of outputs

When the number of decision making units = 43, m = 3; and s = 3;

$$43 \geq 2.3 \times 3 \qquad 43 \geq 18 \quad (3)$$

$$43 \geq \max\{3 \times 3; 3 \times (3+3)\} \qquad 43 \geq \max\{9; 18\} \qquad 43 \geq 18 \quad (4)$$

Both views were confirmed.

RESULTS

In Turkey, 15 of 43 state universities providing formal undergraduate education in Health Management were fully efficient (efficiency value of 100%). The remaining 28 universities were inefficient. In this situation, it may be said that less than half of the departments in Turkey were efficient. Among inefficient universities, the lowest efficiency rate was 12% and the highest rate was 88.9%. All departments had an average efficiency rate of 69.28%, while 21 of the state universities had an efficiency rate that was below average (Table 2).

The factors were used to determine the prospective improvement rates of Health Management departments in order to make them more efficient. The primary variable which had a great importance in terms of improvement was the number of papers in journals screened within the scope of Web of Science Core Collection (75.36%). This variable was the primary variable which needed to be improved the most and was aimed in terms of improvement. Then, another variable which needed to be improved was the number of completed projects (23.79%) (Table 3).

Total Number of Departments:	43
Number of Efficient Departments:	15
Number of Inefficient Departments:	28
Lowest Efficiency %	12.0%
Highest Efficiency %:	88.9%
Average Efficiency %:	69.28%
Number of Departments below Average:	21

Table 2: Results of the efficiency analysis for Health Management departments

Variables	Improvement Rate
Number of enrolled undergraduate students	-0.15%
Number of academic members (Prof., Assoc. Prof., Asst. Prof.)	0.00%
Number of other academic staff (Instr., Res. Asst., Expert, Lecturer)	-0.06%
Number of publications published in international peer-reviewed journals	0.64%
Number of completed projects	23.79%
Number of papers in journals screened within the scope of WOSCC	75.36%

Table 3: Total potential improvement results

Another dimension of the study was testing whether or not there was a statistically significant difference between the efficiencies of the departments according to the input and output variables. Since the data did not meet the normal distribution hypothesis, the Mann-Whitney U test, a non-parametric test, was performed (Table 4).

Variables	*z*	*p*
Number of enrolled undergraduate students	-0.229	0.819
Number of academic members (Prof., Assoc. Prof., Asst. Prof.)	-0.576	0.564
Number of other academic staff (Instr., Res. Asst., Expert, Lecturer)	-0.814	0.416
Number of publications published in international peer-reviewed journals	-1.823	0.068
Number of completed projects	-3.658	0.000
Number of papers in journals screened within the scope of WOSCC	-2.662	0.008

z: Mann Whitney U test; p: significant level < .05

Table 4: Comparison of efficiency and inefficiency of the departments according to the variables

There was no statistically significant difference between the efficiency status of the departments and any of the input variables. However, when the output variables were examined, there was a significant difference between efficient and inefficient departments in terms of the "number of completed projects" and "number of papers in journals screened within the scope of WOSCC" variables. These two variables were crucial in the efficiency status of departments (Table 4). A similar result was observed in the improvement rates (Table 3). In this case, the improvement rates obtained as a result of the DEA were also confirmed with the gap analysis.

DISCUSSION

As a result of globalization, competition among educational institutions has intensified, and applications targeted at maximizing resource efficiency have accelerated (Ozel, 2014). This has made the efficiency evalution of higher education institutions'educational process and research outputs critical (Jablonsky, 2016). The results of the efficiency studies may provide useful information to higher education administrators, allowing them to identify areas that need to be addressed in higher education institutions (Jauhar et al., 2018). Furthermore, via comparisons with other similar education institutions or other universities overseas, it is possible to better comprehend development potential and assess the strengths and limitations of higher education institutions (Nazarko and Šaparauskas, 2014). The efficiency study's findings are also useful for decision-making units that want to use efficient institutions as a model for allocating resources more evenly (Wang, 2019). In light of these considerations, the study's major goal was to assess the efficiency of health management departments in providing formal undergraduate education in Turkish public institutions.

Many studies employing the DEA to evaluate educational efficiency have been published in the literature. When considering Turkey in particular; it is seen that efficiency analysis has been also performed in Econometrics, Statistics, Banking and Finance, Economics and Accounting departments. In the study conducted by Yesilyurt (2009), 48 Economics departments were examined as decision-making units and five departments were found to be efficient. Another study conducted by Icoz and Sonmez (2015) investigated the efficiencies of 18 Statistics departments. They also investigated whether the efficiency of departments in Turkey's higher education system was distinguished based on two distinct program types (day and night time education; solely day time education). They discovered that four departments were efficient as a consequence of their research, and that there was no statistically significant difference between the types of programs (Icoz and Sonmez, 2015). Two departments were

determined to be efficient in the other research examining the efficiency of Banking and Finance departments (Duramaz, 2018). Celik and Ecer (2009) examined the efficiency of accounting departments at 45 state colleges and found 10 to be efficient. Five departments were determined to be efficient in a research undertaken by Yesilyurt to analyze the efficiency of Econometrics departments (Yesilyurt, 2008). As is seen, it was determined that nearly half and fewer of higher education programmes were efficient. Similarly, less than half of Health Management departments were found to be efficient in this research.

Beasley investigated the efficiency of physics and chemistry departments in the United Kingdom, whereas Tomkins and Green investigated the efficiency of accounting departments in the worldwide literature (Beasley, 1995; Tomkins and Green, 1988). According to research done by Johnes and Johnes (1995) on the economics departments of UK universities, the DEA contributed positively to the development of measures impacting university performance. Gnewuch and Wohlrabe (2018) examined the efficiency of economics departments throughout the world and discovered a shaky relationship between efficiency and department reputation. Because some smaller departments may be more efficient in their use of limited resources, it was concluded that well-known Economics departments at reputable universities may not be efficient at the same time. Similarly in the study conducted by Wohlrabe and Friedrich (2017) to examine the efficiency of 207 Economics departments worldwide, no good correlation was determined between the efficiency and reputation. Colbert et al. (2000) evaluated the efficiency of 24 MBA programmes in the United States. They concluded that the combined use of factors linked to student and recruiter satisfaction increased the number of efficient programs. Madden et al. (1997) examined the efficiencies of Economics departments in Australian universities in two years (1987, 1991). Accordingly, they found that 7 out of 24 Economics departments were efficient in 1987 and 11 were efficient in 1991. It is not appropriate to make a comparison because Turkey‘s higher education system differs from that of other nations. However, in general, it can be said that the efficiencies of higher education institutions have been studied at an international level for many years.

As a result of the study, it has been seen that the primary need for the efficiencies of Health Management departments in Turkey is to increase the number of publications in journals screened within the scope of WOSCC and also projects. This result is remarkable in terms of making Health Management departments visible in the international arena. It is thought that the results obtained from this study will be useful in terms of implications practice. First of all, by increasing the number of qualified publications, the competencies of the academicians will be a step in terms of internationalization in the Health Management education offered in the country. Thus, it will contribute to the delivery of universal knowledge to students. It also demonstrates the importance of developing strategies for advancing the field of Health Management in Turkey. In addition, the results of this study will contribute to the current situation analysis of the departments and to determine their strengths and weaknesses. On the other hand, increasing the number of national and international projects will strengthen cooperation with stakeholders. Considering the effect of globalization; when faced with extraordinary situations especially pandemic, crisis, disasters, emergency situations etc., the importance of this cooperation becomes more evident.

The study had several limitations. One of these limitations was that the study only covers departments in state universities. Since all the data of foundation universities was not reached, these departments were not included in the study. Another limitation is that the study was conducted on departments that offer formal undergraduate education. Open education programs were not included in the analysis. Thanks to this limitation, the homogeneity of the decision-making units, which is one of the assumptions of data envelopment analysis, is ensured. Moreover, since there was no data related to the revenues of departments, financial variables were not used.

CONCLUSION

Only 15 of 43 state institutions that offer formal undergraduate health management education were determined to be efficient, according to the study‘s findings. As a result, it may be stated that fewer than half of Turkey‘s Health Management departments were efficient. When the distribution of efficient decision-making units according to geographical locations is examined, it is seen that 9 of the 15 decision-making units are located in the Aegean, Central Anatolia and Marmara regions. The reason for this situation may be the socioeconomic development values of the mentioned regions. Descriptive information about the decision-making units is presented in Table 5 in the Appendix. According to the SEGE 2017 (2019) report, the most developed provinces in Turkey are located in the Aegean, Central Anatolia and Marmara regions.

The possible improvement rates of Health Management departments were estimated based on variables in order for them to be efficient. According to the findings, the number of publications in journals screened within the scope of WOSCC was the most important variable for Health Management departments to improve. This variable was followed by the number of completed projects. As a result, it was discovered that Health Management departments often published as a research output in international peer-reviewed journals, with the number of publications in journals screened within the scope of WOSCC and projects being relatively low.

For the departments to be efficient, they primarily need to increase their publications in journals screened within the scope of WOSCC and conduct more projects. As a result of the gap analysis conducted regarding efficient and inefficient departments, a similar situation was encountered and it was determined that there was a statistically significant difference between the number of projects and number of papers in journals screened within the scope of WOSCC variables and the efficiency of departments. It is recommended for department administrations to investigate the ways of increasing these two variables. It is also suggested that academicians be supported in increasing their research outputs and that resource and workload distribution be balanced. In addition, the finding of the necessity of increasing the number of projects revealed the importance of carrying out projects in which students are

also included in practice. In Turkey, 2209-A Research Projects Support Programme for Undergraduate Students is carried out by Tübitak (https://www.tubitak.gov.tr/tr/burslar/lisans/burs-programlari/icerik-2209-a-universite-ogrencileri-arastirma-projeleri-destekleme-programi). In line with these results, it is recommended to increase the number of applications to this program and to expand the projects in which Health Management students are involved.

The study's conclusions were intended to assist decision-makers, department, faculty, and university administrators, department instructors, students receiving education in the department or student candidates, and, in general, the complete target group. In order for Health Management departments to improve their efficiency, information was presented to this target population to discover relevant solutions. As a result, policymakers, educators, Health Management department administrators, and academic staff members will be able to take strategic steps, determine efficiency parameters, and enable university administrators to develop strategies for departments to publish more research in their improvement plans. It is recommended for future research to include financial variables related to the research revenues of departments and the data related to student satisfaction in the analysis and to make comparisons by measuring long-term efficiency through the data related to multiple years.

ACKNOWLEDGEMENT

This article was supported by the Scienctific Research Projects Fund of Eskisehir Osmangazi University under Grant [the project number 201842D26].

REFERENCES

Abdullah, D., Suwilo, S., Mawengkang, H. and Efendi, S. (2017) 'Data Envelopment Analysis With Upper Bound on Output to Measure Efficiency Performance of Departments in Malaikulsaleh University', *Journal of Physics: Conference Series*, Vol. 890, 012102, pp. 1–6. https://doi.org/10.1088/1742-6596/890/1/012102

Agasisti, T. and Ricca, L. (2016) 'Comparing The Efficiency of Italian Public and Private Universities (2007–2011): An Empirical Analysis', *Italian Economic Journal*, Vol. 2, No. 1, pp. 57–89. https://doi.org/10.1007/s40797-015-0022-7

Agasisti, T. and Wolszczak-Derlacz, J. (2015) 'Exploring Efficiency Differentials Between Italian and Polish Universities, 2001–11', *Science and Public Policy*, Vol. 43, No. 1, pp. 128–142. https://doi.org/10.1093/scipol/scv026

Aleskerov, F. T., Belousova, V. Y. and Petrushchenko, V. V. (2017) 'Models of Data Envelopment Analysis and Stochastic Frontier Analysis in The Efficiency Assessment of Universities', *Automation and Remote Control*, Vol. 78, No. 5, pp. 902–923. https://doi.org/10.1134/S0005117917050125

Altamirano-Corro, A. and Peniche-Vera, R. (2014) 'Measuring the Institutional Efficiency Using DEA And AHP: The Case of A Mexican University', *Journal of Applied Research and Technology*, Vol. 12, No. 1, pp. 63–71. https://doi.org/10.1016/S1665-6423(14)71606-2

Andersson, C., Antelius, J., Månsson, J. and Sund, K. (2017) 'Technical Efficiency and Productivity For Higher Education Institutions in Sweden', *Scandinavian Journal of Educational Research*, Vol. 61, No. 2, pp. 205–223. https://doi.org/10.1080/00313831.2015.1120230

Ando, K., Kai, A., Maeda, Y. and Sekitani, K. (2012) 'Least Distance Based Inefficiency Measures on the Pareto-Efficient Frontier in DEA', *Journal of the Operations Research Society of Japan*, Vol. 55, No. 1, pp. 73-91. https://doi.org/10.15807/jorsj.55.73

Barnum, H. and Kutzin, J. (1993) *Public hospitals in developing countries: resource use, cost, financing*, USA: John Hopkins University Press.

Barra, C., Lagravinese, R. and Zotti, R. (2018) 'Does Econometric Methodology Matter to Rank Universities? An Analysis of Italian Higher Education System', *Socio-Economic Planning Sciences*, Vol. 62, pp. 104-120. https://doi.org/10.1016/j.seps.2017.09.002

Barra, C. and Zotti, R. (2016a) 'A Directional Distance Approach Applied to Higher Education: An Analysis of Teaching-Related Output Efficiency', *Annals of Public and Cooperative Economics,* Vol. 87, No. 2, pp. 145-173. https://doi.org/10.1111/apce.12091

Barra, C. and Zotti, R. (2016b) 'Measuring Efficiency in Higher Education: An Empirical Study Using A Bootstrapped Data Envelopment Analysis', *International Advances in Economic Research*, Vol. 22, No. 1, pp. 11-33. https://doi.org/10.1007/s11294-015-9558-4

Beasley, J. E. (1990) 'Comparing University Departments', *Omega International Journal of Management Science,* Vol. 18, No. 2, pp. 171–183. https://doi.org/10.1016/0305-0483(90)90064-G

Beasley, J. E. (1995) 'Determining Teaching and Research Efficiencies', *Journal of the Operational Research Society,* Vol. 46, No. 4, pp. 441–452. https://doi.org/10.1057/jors.1995.63

Berbegal-Mirabent, J. (2018) 'The Influence of Regulatory Frameworks on Research and Knowledge Transfer Outputs: An Efficiency Analysis of Spanish Public Universities', *Journal of Engineering and Technology Management*, Vol. 47, pp. 68–80. https://doi.org/10.1016/j.jengtecman.2018.01.003

Celik, O. and Ecer, A. (2009) 'Efficiency in accounting education: evidence from Turkish Universities', *Critical Perspectives on Accounting*, Vol. 20, No. 5, pp. 614–634. https://doi.org/10.1016/j.cpa.2008.01.007

Council of Higher Education (2019) *Academic Search Module*, [Online], Available: https://akademik.yok.gov.tr/AkademikArama/ [18 Jun 2019].

Charnes, A., Cooper, W. W. and Rhodes, E. (1978) 'Measuring the Efficiency of Decision Making Units', *European Journal of Operational Research*, Vol. 2, No. 6, pp. 429–444. https://doi.org/10.1016/0377-2217(78)90138-8

Chuanyi, W., Xiaohong, L. and Shikui, Z. (2016) 'The Relative Efficiencies of Research Universities of Science and Technology in China: Based on the Data Envelopment Analysis and Stochastic Frontier Analysis', *Eurasia Journal of Mathematics, Science & Technology Education,* Vol. 12, No. 10, pp. 2753–2770. https://doi.org/10.12973/eurasia.2016.02302a

Clermont, M., Dirksen, A. and Dyckhoff, H. (2015) 'Returns to Scale of Business Administration Research in Germany', *Scientometrics*, Vol. 103, No. 2, pp. 583–614. https://doi.org/10.1007/s11192-015-1561-2

Colbert, A., Levary, R. R. and Shaner, M. C. (2000) 'Determining the Relative Efficiency of MBA Programs Using DEA', *European Journal of Operational Research*, Vol. 125, No. 3, pp. 656–669. https://doi.org/10.1016/S0377-2217(99)00275-1

Cooper, W. W., Li, S., Seiford, L. M., Tone, K., Thrall, R. M. and Zhu, J. (2001) 'Sensitivity and Stability Analysis in DEA: Some Recent Developments', *Journal of Productivity Analysis*, Vol. 15, pp. 217–246. https://doi.org/10.1023/A:1011128409257

Cooper, W. W., Seiford, L. M. and Zhu, J. (2011) 'Data envelopment analysis: history, models and interpretations', In Cooper, W. W., Seiford, L. M. and Zhu, J. (eds.) *Handbook on Data Envelopment Analysis. International Series in Operations Research & Management Science*, vol 164. Boston: Springer. https://doi.org/10.1007/978-1-4419-6151-8_1

Council of Higher Education (2019) *Undergraduate Atlas of the CHE*, [Online], Available: https://yokatlas.yok.gov.tr/lisans-bolum.php?b=10238 [18 Jul 2019].

De La Hoz, E., Zuluaga, R. and Mendoza, A. (2021) 'Assessing and Classification of Academic Efficiency in Engineering Teaching Programs', *Journal on Efficiency and Responsibility in Education and Science,* Vol. 14, No. 1, pp. 41–52. http://dx.doi.org/10.7160/eriesj.2021.140104

De La Torre, E. M., Agasisti, T. and Perez-Esparrells, C. (2017a) 'The Relevance of Knowledge Transfer For Universities' Efficiency Scores: An Empirical Approximation on the Spanish Public Higher Education System', *Research Evaluation*, Vol. 26, No. 3, pp. 211–229. https://doi.org/10.1093/reseval/rvx022

De La Torre, E. M., Gómez-Sancho, J. M. and Perez-Esparrells, C. (2017b) 'Comparing University Performance By Legal Status: A Malmquist-Type Index Approach For the Case of the Spanish Higher Education System', *Tertiary Education and Management*, Vol. 23, No. 3, pp. 206–221. https://doi.org/10.1080/13583883.2017.1296966

Doyle, J. R., Arthurs, A. J., Green, R. H., Mcaulay, L., Pitt, M. R. and Bottomley, P. A. (1996) 'The Judge, The Model of the Judge, and the Model of the Judged as Judge: Analyses of the UK 1992 Research Assessment Business and Exercise Data For Management Studies', *Omega International Journal of Management Science*, Vol. 24, No. 1, pp. 13–28. https://doi.org/10.1016/0305-0483(95)00044-5

Duan, S. X. (2019) 'Measuring University Efficiency an Application of Data Envelopment Analysis and Strategic Group Analysis to Australian Universities', *Benchmarking: An International Journal,* Vol. 26, No. 4, pp. 1161–1173. https://doi.org/10.1108/BIJ-10-2017-0274

Duramaz, S. (2018) 'Measurement the Efficiency of Banking and Finance Departments at Undergraduate Level in Higher Education Institutions in Aegean Region by Data Envelopment Analysis', *5th International Congress on Political, Economic and Social Studies*, Nigde-TURKEY, pp. 403–412.

Dyson, R. G., Allen, R., Camanho, A. S., Podinovski, V. V., Sarrico, C. S. and Shale, E. A. (2001) 'Pitfalls and Protocols in DEA', *European Journal of Operational Research*, Vol. 132, No. 2, pp. 245–259. https://doi.org/10.1016/S0377-2217(00)00149-1

Ebrahimnejad, A. and Tavana, M. (2014) 'A New Link Between MOLP and DEA Models in the Presence of Undesairable Outputs', *Recent Developments in Data Envelopment Analysis and Its Applications Proceedings of the 12th International Conference of DEA*, Malaysia, pp. 29–34.

Ferro G. and D'Elia V. (2020) 'Higher Education Efficiency Frontier Analysis: A Review of Variables to Consider', *Journal on Efficiency and Responsibility in Education and Science*, Vol. 13, No. 3, pp. 140–153. http://dx.doi.org/10.7160/eriesj.2020.130304

Fuentes, R., Fuster, B. and Lillo Banuls, A. (2016) 'A Three-Stage DEA Model to Evaluate Learning Teaching Technical Efficiency: Key Performance Indicators and Contextual Variables', *Expert Systems with Applications*, Vol. 48, pp. 89–99. https://doi.org/10.1016/j.eswa.2015.11.022

Gnewuch, M. and Wohlrabe, K. (2018) 'Super-Efficiency of Education Institutions: An Application to Economics Departments', *Education Economics*, Vol. 26, No. 6, pp. 610–623. https://doi.org/10.1080/09645292.2018.1471663

Gralka, S., Wohlrabe, K. and Bornmann, L. (2019) 'How to Measure Research Efficiency in Higher Education? Research Grants vs. Publication Output', *Journal of Higher Education Policy and Management*, Vol. 41, No. 3, pp. 322–341. https://doi.org/10.1080/1360080X.2019.1588492

Greenspan, B. J. (2009) 'Hospitals', In Mullner R. M. (ed.), *Encyclopedia of Health Services Research*. Los Angeles: SAGE Publications.

Guccio, C., Martorana, M. F. and Monaco, L. (2016) 'Evaluating The Impact of the Bologna Process on The Efficiency Convergence of Italian Universities: A Non-Parametric Frontier Approach', *Journal of Productivity Analysis*, Vol. 45, No. 3, pp. 275–298. https://doi.org/10.1007/s11123-015-0459-6

Guironnet, J. P. and Peypoch, N. (2018) 'The Geographical Efficiency of Education and Research: The Ranking of US Universities', *Socio-Economic Planning Sciences*, Vol. 62, pp. 44–55. https://doi.org/10.1016/j.seps.2017.07.003

Halásková R., Mikušová Meričková B. and Halásková M. (2022) 'Efficiency of Public and Private Service Delivery: The Case of Secondary Education', *Journal on Efficiency and Responsibility in Education and Science*, Vol. 15, No. 1, pp. 33–46. http://dx.doi.org/10.7160/eriesj.2022.150104

Halkos, G. E., Tzeremez, N. G. and Kourtzidis, S. A. (2012) 'Measuring Public Owned University Departments' Efficiency: A Bootstrapped DEA Approach', *Journal of Economics and Econometrics*, Vol. 55, No. 2, pp. 1–24.

Icoz, C. and Sonmez, H. (2015) 'Measuring the Relative Efficiencies of Statistics Departments in Turkey Using Data Envelopment Analysis', *Alphanumeric Journal*, Vol. 3, No. 1, pp. 44–50. https://doi.org/10.17093/aj.2015.3.1.5000105942

Jablonsky, J. (2016) 'Efficiency Analysis in Multi-Period Systems: An Application to Performance Evaluation in Czech Higher Education', *Central European Journal of Operations Research*, Vol. 24, No. 2, pp. 283–296. https://doi.org/10.1007/s10100-015-0401-z

Jauhar, S. K., Pant, M. and Dutt, R. (2018) 'Performance measurement of an Indian Higher Education Institute: A Sustainable Educational Supply Chain Management Perspective', *International Journal of System Assurance Engineering and Management*, Vol. 9, No. 1, pp. 180–193. https://doi.org/10.1007/s13198-016-0505-4

Johnes, G. and Tone, K. (2017) 'The Efficiency of Higher Education Institutions in England Revisited: Comparing Alternative Measures', *Tertiary Education and Management*, Vol. 23, No. 3., pp. 191–205. https://doi.org/10.1080/13583883.2016.1203457

Johnes, J. and Johnes, G. (1995) 'Research Funding and Performance in U.K. University Departments of Economics: A Frontier Analysis', *Economics of Education Review*, Vol. 14, No. 3, pp. 301–314. https://doi.org/10.1016/0272-7757(95)00008-8

Johnson, J. A., Jones, W. J. and Whittemore, K. R. (1990) 'Health Administration Education: A Challenge For The 1990s', *Public Productivity & Management Review*, Vol. 14, No. 2, pp. 203–209. https://doi.org/10.2307/3380966

Kao, C. (2014) 'Network Data Envelopment Analysis: A Review', *European Journal of Operational Research,* Vol. 239, No. 1, pp. 1–16. https://doi.org/10.1016/j.ejor.2014.02.039

Kashim, R., Kasim, M. M. and Rahman, A. R. (2018) 'Measuring Efficiency of a University Faculty Using a Hierarchical Network Data Envelopment Analysis Model', *Journal of Information and Communication Technology*, Vol. 17, No. 4, pp. 569–585. https://doi.org/10.32890/jict2018.17.4.3

Kebede, S., Abebe, Y., Wolde, M., Bekele, B., Mantopoulos, J. and Bradley, E. H. (2010) 'Educating Leaders in Hospital Management: A New Model in Sub-Saharan Africa', *International Journal for Quality in Health Care*, Vol. 22, No. 1, pp. 39–43. https://doi.org/10.1093/intqhc/mzp051

Kempkes, G. and Pohl, C. (2010) 'The Efficiency of German Universities–Some Evidence From Nonparametric and Parametric Methods', *Applied Economics*, Vol. 42, No. 16, pp. 2063–2079. https://doi.org/10.1080/00036840701765361

Kleinman, C. S. (2003) 'Leadership Roles, Competencies and Education - How Prepared Are Our Nurse Managers?', *Journal of Nursing Administration*, Vol. 33, No. 9, pp. 451–455. https://doi.org/10.1097/00005110-200309000-00005

Klumpp, M. (2018) 'The Index Number Problem with DEA: Insights from European University Efficiency Data', *Education Sciences*, Vol. 8, No. 2, 79. https://doi.org/10.3390/educsci8020079

Lal, T. M. and Roh, T. (2014) 'An overview of management engineering and best practices for management engineering departments', in Larson J. A. (Ed.), *Management Engineering: A Guide to Best Practices for Industrial Engineering in Health Care*, CRC Press, pp. 27–33.

Lehmann, E. E., Meoli, M., Paleari, S. and Stockinger, S. A. (2018) 'Approaching Effects of The Economic Crisis on University Efficiency: A Comparative Study of Germany and Italy', *Eurasian Business Review*, Vol. 8, No. 1, pp. 37–54.

Lita, I. (2018) 'Data Envelopment Analysıs Techniques-DEA and Malmquist Indicators, In CRS Mode, for Measuring the Effıcıency of Romanian Public Higher Education Institutions', *Economic Computation & Economic Cybernetics Studies & Research*, Vol. 52, No. 3, pp. 249–264.

Madden, G., Savage, S. and Kemp, S. (1997) 'Measuring Public Sector Efficiency: A Study of Economics Departments at Australian Universities', *Education Economics*, Vol. 5, No. 2, pp. 153–168. https://doi.org/10.1080/09645299700000013

Mikušová, P. (2017) 'Measuring the Efficiency of the Czech Public Higher Education Institutions: An Application of DEA', *Journal on Efficiency and Responsibility in Education and Science*, Vol. 10, No. 2, pp. 58–63. https://doi.org/10.7160/eriesj.2017.100204

MoH (2011). *Sağlık Bakanlığı ve Bağlı Kuruluşlarının Teşkilat ve Görevleri Hakkında Kanun Hükmünde Kararname* [Decree-Law No. 663 on the Organization and Duties of the Ministry of Health and its Affiliates], [Online], Available: www.resmigazete.gov.tr [27 May 2023].

Mousa, W. and Ghulam, Y. (2019) 'Exploring Efficiency Differentials Between Saudi Higher Education Institutions', *Managerial and Decision Economics*, Vol. 40, No. 2, pp. 180–199. https://doi.org/10.1002/mde.2995

Nazarko, J. and Šaparauskas, J. (2014) 'Application of DEA Method in Efficiency Evaluation of Public Higher Education Institutions', *Technological and Economic Development of Economy*, Vol. 20, No. 1, pp. 25–44. https://doi.org/10.3846/20294913.2014.837116

Ozel, G. (2014) 'Efficiency Analysis of State Universities: A Case of Turkey', *H.U. Journal of Education*, Vol. 29, No. 3, pp. 124–136.

Ozel Kadılar, G. (2015) 'Efficiency Analysis of Foundation Universities in Turkey', *Education and Science*, Vol. 40, No. 177, pp. 31–41.

Quiroga-Martínez, F., Fernández-Vázquez, E. and Alberto, C. L. (2018) 'Efficiency in Public Higher Education on Argentina 2004–2013: Institutional Decisions and University-Specific Effects', *Latin American Economic Review*, Vol. 27, No. 1, pp. 1–18. https://doi.org/10.1186/s40503-018-0062-0

Sagarra, M., Mar-Molinero, C. and Agasisti, T. (2017) 'Exploring the Efficiency of Mexican Universities: Integrating Data Envelopment Analysis and Multidimensional Scaling', *Omega*, Vol. 67, pp. 123–133. https://doi.org/10.1016/j.omega.2016.04.006

Santana, N. B., Rebelatto, D. A. N., Perico, A. E. and Mariano, E. B. (2014). 'Sustainable Development in the BRICS Countries: An Efficiency Analysis by Data Envelopment', *International Journal of Sustainable Dvelopment & World Ecology*, Vol. 21, No. 3, pp. 259–272. https://doi.org/10.1080/13504509.2014.900831

SEGE 2017 (2019) *İllerin ve Bölgelerin Sosyo-ekonomik Gelişmişlik Sıralaması Araştırması* [Socio-economic Development Ranking Research of Provinces and Regions], Republic of Turkey Ministry of Industry and Technology Directorate General of Development Agencies Research Report, No:3., [Online], Available: https://www.sanayi.gov.tr/merkez-birimi/b94224510b7b/sege [01 Dec 2022].

Sirbu, A., Cimpoieş, D. and Racul, A. (2016) 'Use of Data Envelopment Analysis to Measure the Performance Efficiency of Academic Units', *Agriculture and Agricultural Science Procedia*, Vol. 10, pp. 578–585. https://doi.org/10.1016/j.aaspro.2016.09.037

Tavana, M. and Khalili-Damghani, K. (2014) 'A New Two-Stage Stackelberg Fuzzy Data Envelopment Analysis Model', *Measurement*, Vol. 53, pp. 277–296. https://doi.org/10.1016/j.measurement.2014.03.030

Tomkins, C. and Green, R. (1988) 'An Experiment in the Use of Data Envelopment Analysis For Evaluating The Efficiency of UK University Departments of Accounting', *Financial Accountability and Management*, Vol. 4, No. 2, pp. 147–164. https://doi.org/10.1111/j.1468-0408.1988.tb00296.x

Tübitak (The Scientific and Technological Research Council of Türkiye), *Tubitak 2209-A Research Projects Support Programme for Undergraduate Students*, [Online], Available: https://www.tubitak.gov.tr/tr/burslar/lisans/burs-programlari/icerik-2209-a-universite-ogrencileri-arastirma-projeleri-destekleme-programi [01 Dec 2022].

Tyagi, P., Yadav, S. P. and Singh, S. P. (2009) 'Relative Performance of Academic Departments Using DEA With Sensitivity Analysis', *Evaluation and Program Planning*, Vol. 32, No. 2, pp. 168–177. https://doi.org/10.1016/j.evalprogplan.2008.10.002

Tzeremes, N. and Halkos, G. (2010) *A DEA approach for measuring university departments' efficiency,* MPRA Working Paper Issue, [Online], Available: http://mpra.ub.uni-muenchen.de/24029/ [14 May 2019].

Visbal-Cadavid, D., Martínez-Gómez, M. and Guijarro, F. (2017) 'Assessing the Efficiency of Public Universities Through DEA: A Case Study', *Sustainability*, Vol. 9, No. 8, pp. 1–19. https://doi.org/10.3390/su9081416

Wang, D. D. (2019) 'Performance-Based Resource Allocation For Higher Education Institutions in China', *Socio-Economic Planning Sciences*, Vol. 65, pp. 66–75. https://doi.org/10.1016/j.seps.2018.01.004

Wohlrabe, K. and Friedrich, E. (2017) 'The Efficiency of Economics Departments Reconsidered', *Economics Bulletin*, Vol. 37, No. 3, pp. 1602–1611.

Yesilyurt, C. (2008) 'Measuring Relative Performance of Econometrics Departments by Using DEA', *Journal of the Institute of Social Sciences*, Vol. 2, pp. 221–232.

Yesilyurt, C. (2009) 'Türkiye'deki İktisat Bölümlerinin Göreceli Performanslarının VZA Yöntemiyle Ölçülmesi: KPSS 2007 Verilerine Dayalı Bir Uygulama [Measuring Relative Performances of Economics Departments in Turkey by DEA Method: An Application Based on KPSS 2007 Data]', *Atatürk* Üniversitesi İktisadi *ve* İdari *Bilimler Dergisi*, Vol. 23, No. 4, pp. 135–147.

YOK (2003) *Yükseköğretim Programları ve Kontenjanları Kılavuzu* 2003 [*Handbook of higher education programs and quotas 2003*], [Online], Available: www.oysm.gov.tr [18 Jun 2019].

YOK (2010) *Yükseköğretim Programları ve Kontenjanları Kılavuzu* 2010 [*Handbook of higher education programs and quotas 2010*], [Online], Available: www.oysm.gov.tr [18 Jun 2019].

YOK (2015) *Yükseköğretim Programları ve Kontenjanları Kılavuzu* 2015 [*Handbook of higher education programs and quotas 2015*], [Online], Available: www.oysm.gov.tr [18 Jun 2019].

YOK (2017) *Yükseköğretim Programları ve Kontenjanları Kılavuzu* 2017 [*Handbook of higher education programs and quotas 2017*], [Online], Available: www.oysm.gov.tr [18 Jun 2019].

YOK (2019) *Yükseköğretim Programları ve Kontenjanları Kılavuzu* 2019 [*Handbook of higher education programs and quotas 2019*], [Online], Available: www.oysm.gov.tr [18 Jun 2019].

APPENDIX

Decision Making Unit	Geographical Location of Universities	Efficiency Scores	No. of Students	No. of Academic Members	No. of Other Academic Staff	No. of international peer-reviewed journals	No. of Projects	No. of Journals Screened Within the Scope of WOSCC
DMU 1	Aegean	100	71	4	7	27	23	3
DMU 2	Central Anatolia	46.5	120	4	1	25	2	0
DMU 3	Central Anatolia	100	462	9	11	112	26	22
DMU 4	Central Anatolia	100	339	7	9	49	34	17
DMU 5	Central Anatolia	81.8	62	3	2	36	0	8
DMU 6	Marmara	31.8	66	3	1	14	1	1
DMU 7	Black Sea	20.5	77	3	0	9	0	0
DMU 8	Mediterrenian	76.6	279	5	2	49	5	6
DMU 9	Southeastern Anatolia	100	314	1	1	16	4	2
DMU 10	Black Sea	71.2	306	4	2	30	11	1
DMU 11	Eastern Anatolia	29.2	176	3	5	9	4	1
DMU 12	Central Anatolia	60.1	175	3	1	12	7	7
DMU 13	Black Sea	57.0	221	4	5	33	5	1
DMU 14	Central Anatolia	100	171	10	18	141	26	104
DMU 15	Black Sea	100	60	2	2	13	4	0
DMU 16	Marmara	75.0	126	3	2	33	2	3
DMU 17	Marmara	37.3	320	6	4	19	4	17
DMU 18	Aegean	100	61	2	1	3	8	1
DMU 19	Aegean	100	40	5	0	49	18	22
DMU 20	Mediterrenian	56.4	350	3	2	24	5	5
DMU 21	Black Sea	27.0	217	3	3	10	3	1
DMU 22	Central Anatolia	29.5	71	3	0	13	2	0
DMU 23	Central Anatolia	81.9	283	4	4	36	13	9
DMU 24	Southeastern Anatolia	100	41	2	1	12	1	10
DMU 25	Marmara	100	367	11	6	52	33	63
DMU 26	Aegean	69.1	214	5	2	26	14	10
DMU 27	Central Anatolia	63.8	232	5	1	36	4	2
DMU 28	Black Sea	88.8	208	4	3	41	13	4
DMU 29	Marmara	63.3	224	6	0	31	1	4
DMU 30	Central Anatolia	68.7	65	3	0	20	3	7
DMU 31	Marmara	100	314	7	4	84	14	13
DMU 32	Central Anatolia	88.9	337	7	6	79	6	3
DMU 33	Central Anatolia	35,3	275	5	3	20	6	6
DMU 34	Mediterrenian	100	319	9	7	88	31	3
DMU 35	Marmara	31.7	319	4	2	13	5	4
DMU 36	Central Anatolia	59.2	60	3	1	19	1	9
DMU 37	Eastern Anatolia	100	132	4	0	11	14	32
DMU 38	Marmara	100	62	3	0	44	8	10
DMU 39	Marmara	17.7	241	4	4	10	2	4
DMU 40	Mediterrenian	100	253	2	0	23	6	5
DMU 41	Eastern Anatolia	44.3	227	3	6	19	4	1
DMU 42	Black Sea	12.0	225	3	0	5	1	0
DMU 43	Aegean	54.6	131	3	0	8	5	0

**Data with a value of 0 were included in the analysis as 0.0*

Table 5: Descriptive information on decision-making units