EFFICIENCY IN OPEN AND DISTANCE EDUCATION: A RESEARCH AT ANADOLU UNIVERSITY

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ABSTRACT

Limited time, physical and financial opportunities in education has caused the expansion of the education system and emergence of new alternatives. One of these alternatives is open education that emphasizes the philosophy of sharing the information and materials used in learning and teaching freely and openly, and one is distance education that offers a formal form of education blended with information systems and the internet. Anadolu University Open Education System, not only in Turkey, in many countries around the world offers learners the opportunity to open and distance learning. In this sense, it has one of the largest student communities in the world. Therefore, evaluating the efficiency of a large and powerful organization like the Anadolu University Open Education System has gained importance. This study was carried out to determine the activities of associate degree programs in Anadolu University Open Education System in the fall and spring semesters of 2016-2017, 2017-2018, 2018-2019 academic years. Anadolu University Open Education System associate degree programs are ranked according to their effeciency values, by the Slack-Based Measure Analysis.

Keywords: Open and Distance Education, Anadolu University Open Education System, efficiency, Slack-based measure analysis.

INTRODUCTION

The ongoing global shifts have had a deep transformative impact on the traditional approaches to education. Global challenges in education and economics have not only shaped working and living conditions, but also profoundly affected the ways of teaching and learning (OECD, 2016). In other words, ways of learning and teaching new knowledge are no longer bound by time and space. Consequently, although the individual learning process has not completely changed, platforms of education, along with learning resources, have become highly diverse (Stracke, 2017). Open education is an academic practice that emphasizes the philosophy of freely and openly sharing ideas, information, methods, platforms, tools, approaches and materials used in learning and teaching in higher education systems (Mossley, 2013, p. 12). Distance education is an institutional form of formal education in which learning groups are separated and interactive communication systems are used to connect learners, educational resources, and educators (Simonson, 2003).

The developments in information technologies and the widespread use of the internet have increased the global interest in open and distance education. Anadolu University Open Education System, celebrating its 39th year in 2021, plays a critical role in Turkish higher education thanks to its special projects and offering higher education services to more than 1 million students and 2.8 million graduates.

Anadolu University Open Education System has 19 undergraduate and 41 associate degree programs as of the 2019-2020 academic year. Anadolu University Open Education System, offers learners the opportunity to open and distance learning not only in Turkey, but also in many countries around the world. In this sense, it serves one of the largest student communities in the world. Anadolu University Open Education System reduces the cost of procuring or purchasing educational resources, and increases the quality of education by preparing and evaluating teaching materials. Adopting the lifelong learning and equal opportunity approaches in education, Anadolu University Open Education System offers sustainable education.

Anadolu University Open Education System is a flexible system that offers useful and rich learning environments regardless of time and place, tries to provide equality of opportunity and cost effectiveness, and pursues the goal of lifelong learning. This plays a key role in encouraging learners to enroll in open and distance learning programs. Due to the flexibility of the structure of the system, the number of learners choosing to become part of it has been steadily rising. As learners continue to earn degrees, certificates and diplomas from the system, the system will continue to be a rapidly growing part of higher education, maintain its sustainability and offer lifelong education.

With the gradual growth of the system, training in many programs has begun, and new technologies and learning environments have been included in the system with new programs. Thus, the number of learners, the number of users of Anadolum e-Campus and the number of graduates have increased. However, attendance in these programs is much lower than formal education programs. Many learners complete their education with very low GPAs or quickly drop out of the programs they are enrolled in, and thus experiencing financial losses. Therefore, efficiency analysis methods have become important tools for decision makers in the field of open and distance learning. As such, the aim of the study is to determine the relative efficiency of the associate degree programs in Anadolu University Open Education System in the fall and spring semesters of 2016-2017, 2017-2018, 2018-2019 academic years by applying the "Slack-Based Measure Analysis".

The Importance

Each institution has some predetermined goals. Determination of the status of the institution compared to similar institutions and its use of resources, and understanding its strengths or weaknesses play an important role in achieving these predetermined goals. Therefore, performance evaluation studies can be considered as the core of the measures to be taken by decision makers and the activities to be carried out.

Evaluation of the Open Education System's degree of efficiency is critical since this helps determine the performance of the programs and allows making accurate decisions about program objectives, strategic planning, quality assurance, identification of the strengths and weaknesses of the programs, and improving the overall quality of the programs and the services offered. In addition to these reasons, this study was carried out with the aim of being a guide and pioneer in the evaluation of the efficiency of distance education institutions with a large and dynamic structure such as Anadolu University Open Education System. The results of the efficiency model analysis created in this context is expected to provide useful information for the decision-makers of the Open Education System by pointing at many potential areas of improvement.

That universities are non-profit organizations and thus their inputs or outputs cannot be measured by any financial value, the existence of a wide variety of input and output variables, the difficulty of accessing data on these variables, and the difficulty of determining the best perspective to approach efficiency measurement, make the efficiency analysis performed in this study challenging yet invaluable.

LITERATURE REVIEW

The efficiency, which is indispensable for businesses, institutions and systems, has become indispensable for education as well. Using the available resources efficiently enables educational institutions to fully achieve their targets, while helping individuals to keep up with the dynamics of the changing and developing world (Bakirci & Babacan, 2010, p. 216).

Determining the status of a certain organizational unit of education vis-à-vis similar units is possible by periodically measuring performance with the help of measurable data. These measurements provide decision-making bodies with the opportunity to see the superior aspects and weaknesses of the units, and to take

measures for inefficient units. Although efficiency is a performance dimension, it is important for education units (Yesilyurt, 2003, p. 79).

The studies examining the efficiency of universities or departments (or faculties) at universities constitute the majority of efficiency analysis studies conducted in the field of education. The efficiency of universities are frequently evaluated at national and international scale due to the fact that universities are non-profit and knowledge-producing organizations and have a wide range of inputs and outputs. The related research literature mostly employs the traditional Data Envelopment Analysis (DEA) and focuses on the efficiency of universities in terms of using finance and human resources, adapting to increasing competition conditions, and ensuring sustainability in education.

The opportunities offered by education systems and the competencies gained during and after the education process are important in terms of evaluating the success of education systems. The extent to which the opportunities and competencies offered are transformed into output can be determined by efficiency performance measurement. For example, by using the relative efficiency variables in the exams conducted nationwide, Yesilyurt (2009) analyzed the efficiency of the economics departments of state and private universities in Turkey, and Icoz (2013) evaluated the efficiency of the state university statistics departments in Turkey.

The increasing global competition has been forcing all types of organizations to use their resources more efficiently. Efficient use of the available resources is an important performance indicator for economic decision-making units. According to Kao and Hung (2008), the decrease in the state contributions allocated to universities in Taiwan in recent years has necessitated more efficient use of resources. Accordingly, they evaluated the relative efficiencies of academic departments at National Cheng Kung University in Taiwan. According to Johnes and Johnes (1993), the financial pressures on public institutions in the UK in the early nineties caused a rapid increase in interest in measuring the performance of such bodies. Accordingly, they evaluated the research performance of economics departments in the UK for the period of 1984-88. It is of great importance in academic, administrative and financial terms that universities, which produce qualified human resources with specialized knowledge and technology, use their existing resources (student, general budget, academic staff, etc.) in the most effective way. Cinaroglu et al. (2018) determined the efficiency levels of 18 faculties of Erciyes University, which adheres to the principle of being an efficient institution in academic and administrative terms. When analyzing the performance of an organization or a system, it is necessary to determine its efficency and whether its resources are used efficiently. Turker (2012) conducted an efficiency analysis of 14 Industrial Engineering Departments in Turkey; Uzgoren and Sahin (2013) carried out an efficiency analysis of Dumlupinar University Vocational Schools; and Bakirci and Babacan (2010) carried out efficiency analysis of the Economics and Administrative Sciences Faculties of various universities in Turkey.

The education system can be considered as a service-based industry. With no motivation to profit, education systems aim to produce well-qualified graduates and successful research results. Therefore, the performance of education systems should be evaluated for a nation to grow and prosper. Thus, many countries strive to evaluate and improve the performance of their education systems. According to Jakaitiene, Zilinskas and Stumbriene (2018), evaluation of the performance of education systems is an issue that needs to be addressed worldwide. Although there are many studies evaluating the performance of schools, a limited number of studies have analyzed the education system as a whole. According to Aziz, Janor, and Mahadi (2013), universities are complex organizations that use multiple inputs to produce multiple outputs, and evaluating the relative efficiency of institutions is difficult. Tyagi, Yadav, and Singh (2009), who reported determining how to evaluate the performance of academic programs as one of the difficulties encountered, state that the data envelopment analysis method is used to evaluate the performance of academic institutions in many countries such as the USA, UK and Australia. Later, Kulshreshtha and Nayak (2015) evaluated the educational efficiency of the technical universities in India.

The concept of efficiency is vital for organizations to survive. Organizations need to measure efficiency not only to see where they are but also to understand their strengths and weaknesses. It is not possible to decide what is good or bad without measuring it. Ulucan (2011) analyzed the efficiency of universities in Turkey, while Cunha and Roche (2012) carried out an efficiency analysis of the universities in Portugal through data envelopment analysis. Efficiency measurement should not be considered to be only about the efficient use

of resources. Ozel (2014), who stated that it is possible to determine the place of a unit compared to similar units through periodic efficiency analysis, performed efficiency rankings of the state universities in Turkey.

A review of the literature reveals that the number of studies evaluating the efficiency of open and distance education is much lower than the efficiency studies focusing on traditional higher education. These studies have mostly adopted the DEA analysis as their efficiency measurement method. With the advances in information technologies, students in modern societies are able to apply what they have learned through open and distance education. Stating that education provided through internet, teleconferencing and e-learning is not worse than traditional education, Xiaoming, Shieh, and Wu (2014) examined the distance education activities of universities in China.

Like any organization, educational institutions should attach importance to needs assessment and performance measurement to improve the use of limited resources and increase the efficiency of programs. Stating that one of the most practical methods used in the evaluation of performance is DEA, Jalalvand and Navabakhsh (2017) evaluated the performance of 33 distance education units in the second semester of the 2014-2015 academic year. In the 21st century, the main competitive power of a nation is the power it generates from knowledge. According to Liu (2017), e-learning based knowledge and competition are the most powerful tools. Services such as information, skills, policies and regulations provided to the public make brand new e-learning methods possible. As such, Liu (2017) tried to determine the performance of e-learning in the public sector in the city of Kaohsiung with the help of DEA.

According to Akmese, Demir and Dunder (2016), the increasing demand for distance education has led to the opening of new distance education programs. The ever-growing number of distance education programs has made it essential to investigate the efficiency of these programs. Universities that offer distance education open new programs and improve their existing programs to meet the education, diploma and certificate needs of the society. Gok (2017) also investigated the service quality of distance education programs offered at universities in Turkey and evaluated their performance.

In recent years, studies have been carried out that show that DEA has some disadvantages, and some new DEA models have been proposed to eliminate these disadvantages. Jablonksy (2016) stated that new DEA models should be formulated to evaluate the efficiency of decision-making units and introduced new models. To illustrate these models, he analyzed the research and education performance of 19 economics faculties in Czech Republic over a four-year period.

According to Johnes and Tone (2017), DEA is a method frequently used to evaluate the efficiency of higher education institutions, and many alternative non-parametric measurement methods are available for researchers. Johnes and Tone (2017) analyzed the efficiency of higher education institutions in the UK for the period of 2013-2014 in three different ways and compared the results. They used the DEA method developed by Charnes et. al. (1978), and and the Slack-Based Measure (SBM-Min and SBM-Max) developed by Tone. Abdullah et. al. (2018) stated that DEA is a performance evaluation method used when the set of decision units is represented with multiple inputs and outputs. They evaluated the efficiency of the departments at Malikussaleh University using the SBM. Luan (2017) determined the efficiency values of 11 faculties of Qufu Normal University in China for the year of 2016 through SBM.

With new approaches to public administration, the quality and efficiency of higher education has been increasingly questioned. Thus, many researchers have attempted to measure the quality and efficiency of universities as if they were evaluating businesses. According to these researchers, universities have turned into private enterprises. Because universities have to deal with certain inputs and outputs, pursuing maximum outputs under resource constraints. As such, Chuanyi, Xiaohong, and Shikui (2016) used traditional DEA methods and SBM (Slack-Based Measure) methods to determine the relative efficiency of China's science and technology universities. They emphasized that radial data envelopment models reveal proportional changes while ignoring slack variables. They stated that slack-based measure models can detect both proportional change and change in slack variables.

METHOD

Determining the input and output variables to be used constitutes the basis of evaluating the efficiencies of Anadolu University Open Education System associate degree programs. The same input and output

variables must be used for each program in evaluating the efficiency of associate degree programs in the system. Therefore, first of all, input and output variables of each decision unit must be determined.

Efficiency Model Variables

Since open and distance education feature structural differences in the higher education system compared to formal education, it is inevitable for the variables used in the relative measurement of the efficiency of the distance education system to differ. In the current study, since the efficiency of the associate degree programs of the Open Education System was investigated, various system variables that were thought to reflect the efficiency of the system better were used. The variables in the efficiency model created in the study, the units, and the abbreviations used for the variables in the mathematical structure of the model are given in Table 1.

Table 1. Variables and units used in the efficiency model

Input Variables	Unit
k: The ratio of active learners	%
a: Anadolum e-Campus use rate	%
Desirable Output Varible	
$\mathbf{m^{good}}$**:** The ratio of graduating learners (within three years)	%
Undesirable Outputs Variable	
$\mathbf{uz^{bad}}$**:** The learner ratio variable whose GPA is below 2.00 (adjusted from 0.00)	%
$\mathbf{uv^{bad}}$**:** The rate of learners who took the midterm exam and did not take the final exam	%

The ratio of active learners refers to distance learners who renew their registration periodically in the Open Education System. In other words, the ratio is obtained by proportioning the number of learners who renewed their registration to the number of all learners in the relevant program. Anadolum e-Campus use rate is calculated by the ratio of the number of learners using Anadolum e-Campus to the number of learners who renew their registration. These variables were calculated separately for each associate degree program before they were included in the analysis.

Unlike the formal education system, the Open Education System has no restriction on the duration of completion of education, so learners can stay in the system for a long time. Since this high number of learners who stay in the system for a long time do not comply with the goals of the system, it is thought that it will affect the efficiency of the programs negatively. Therefore, a limitation has been introduced in the model for the values to be taken by the graduated learner ratio variable in terms of time frame, and the ratio of learners who graduated within three years from the moment of inclusion in the system is taken into account as the desirable output variable. *The ratio of graduating learners* is obtained by proportioning the number of learners who graduated in this time period (within three years) to the number of learners who renewed the registration for each of the associate degree programs.

To graduate from a higher education institution in Turkey, a learner must have 2.00 or higher GPA. Due to the flexible structure of the Open Education System, learners with low GPA usually lose a semester or graduate with a low grade point average. Such factors are thought to affect the efficiency of the system negatively. *The learner ratio variable whose GPA is below 2.00 (adjusted from 0.00)* is obtained by proportioning the number of learners with a GPA below 2.00 to the number of learners who renew their registration. One of the main problems of the Open Education System is the difference between the number of learners who take the midterm exam and the number of learners who take the final exam. Most of the learners prefer not to take the final exam when they cannot achieve the success they desire in the midterm exam. *The rate of learners who took the midterm exam* and did not take the final exam was calculated by the ratio of the difference between the number of students taking the midterm exam and the number of students taking the final exam to the number of students taking the midterm exam. These two variables are taken into account as the undesirable output variable in the model.

In the 2019-2020 academic year, there were 41 associate degree programs in the Anadolu University Open Education System. Since the data of 6 associate degree programs for the periods in which efficiency analysis were to be made were not fully formed, these programs could not be included in the analysis. Therefore, an efficiency model was created for the remaining 35 associate degree programs in the Open Education System. According to the data envelopment analysis theory used in the model created, the number of decision units cannot be less than five times the total number of input and output variables (Chen & Jia, 2017, p. 848). To meet this prerequisite, the efficiency evaluation of Anadolu University Open Education System associate degree departments was carried out using a total of five variables (two inputs and three outputs).

Open Education System Efficiency Model

Depending on the status of the output variables, The Slack-Based Measure model is divided into: one is the model based on undesirable outputs and the other is the nonseparable outputs model based on the link between output variables. While the "Undesirable Outputs Model" handles desirable (good) and undesirable (bad) outcomes independently, the "NonSeparable Outputs Model" establishes a link between desirable and undesirable outputs. Here, the term "link" indicates that reducing undesirable outputs will also reduce desirable outputs (Tone, 2004, p. 6).

The efficiency of the Open Education System associate degree programs is determined in terms of input and output variables as modeled in Eq. (1).

$$A=\{(k,a,m,uz,uv) \mid (k,a) \textit{ can produce } (m,uz,uv)\} \quad (1)$$

Considering the variables of input, desirable output, and undesirable output in terms of open and distance education, cluster A is generally assumed to be a closed and restricted set. In other words, finite amount of input can only produce finite amount of output (Choi et al., 2012). Two additional assumptions must be applied to reasonably model the joint production of desirable and undesirable outputs (Färe vd., 1989).

i) If $(k,a,m,uz,uv) \in A$ and $0 \leq \alpha \leq 1$, then $(k,a,\alpha m,\alpha uz,\alpha uv) \in A$.

ii) If $(k,a,m,uz,uv) \in A$ and $uz=uv=0$, then $m = 0$.

The first assumption states that reducing the unwanted outcomes cannot be achieved in an easy way. It implies that the reduction of undesirable outcomes is possible by reducing both the desirable and undesired outcomes proportionately. The second assumption emphasizes that learners may have a low GPA and there may be learners who took the midterm exam and did not take the final exam, and that undesirable outcomes are inevitable. The only way to eliminate these conditions would be to stop the educational activities, in other words, the closing of the related associate degree program. Thus, under these two assumptions, it can be accepted that cluster A is the production group of the Open Education System associate degree programs. Due to the limitations of radial efficiency measurements, the Slack-Based Measure was used, and since the model contained some undesirable outputs, the "Undesirable Outputs Model" was used.

Suppose that the number of Open Education System associate degree programs is n, and two inputs (k, a) for each program and one desirable (m) and two undesirable outputs (uz, uv) will be used. Accordingly, we can show the inputs, desirable outputs and undesirable outputs with the help of three matrices defined below.

$$x = \begin{bmatrix} k_1 k_2 \dots k_n \\ a_1 a_2 \dots a_n \end{bmatrix} \in R^{2xn}$$

$$Y^g = \begin{bmatrix} m_1 m_2 \cdots m_n \end{bmatrix} \in R^{1xn}$$

$$Y^b = \begin{bmatrix} uz_1 uz_2 \cdots uz_n \\ uv_1 uv_2 \cdots uv_n \end{bmatrix} \in R^{2xn}$$

Then we can define the production group

$$P=\{(x,y^g,y^b) \mid x,(y^g,y^b) \textit{ produce}, x \geq X\lambda, y^g \leq Y^g\lambda, y^b \geq Y^b\lambda, \lambda \geq 0\} \quad (2)$$

as set in the form Eq (2). Here, λ is the non-negative density vector. This indicates that the above definition corresponds to the assumption of constant returns to scale. Based on the concept of slack, the efficiency of decision units should be measured by considering how much the input surplus can be reduced for a given output level and how much the output can be increased for a given input level (Tone, 2001; Tone 2004). The Slack-Based used in this study to measure the efficiency of the Open Education System associate degree programs can be expressed with the mathematical structure of the Undesirable Outputs Model Eq. (3) and Eq. (4).

$$p_i^* = min \frac{1 - \frac{1}{2}\left(\frac{s_i^k}{k_i} + \frac{s_i^{a-}}{a_i}\right)}{1 + \frac{1}{3}\left(\frac{s_i^{m+}}{m_i} + \frac{s_i^{uz-}}{uz_i} + \frac{s_i^{uv-}}{uv_i}\right)} \tag{3}$$

$$\left.\begin{aligned} k_i &= \sum_{j=1}^{n} \lambda_j k_j + s_i^{k-} \\ a_i &= \sum_{j=1}^{n} \lambda_j a_j + s_i^{a-} \\ m_i &= \sum_{j=1}^{n} \lambda_j m_j - s_i^{m+} \\ uz_i &= \sum_{j=1}^{n} \lambda_j uz_j + s_i^{uz-} \\ uv_i &= \sum_{j=1}^{n} \lambda_j uv_j + s_i^{uv-} \\ s_i^{k-}, s_i^{a-}, s_i^{m+}, s_i^{uz-}, s_i^{uv-}, \lambda &\geq 0 \end{aligned}\right\} \tag{4}$$

Here, s_i^{k-}, s_i^{a-} shows the excesses of input variables, which are the active learners ratio in the i. program and *rate of Anadolum e-Campus* s_i^{m+}; use, respectively. indicates the shortfall the desirable output variable, which is the ratio of graduating learners of the i. program. s_i^{uz-}, s_i^{uv-} shows the learner ratio in i. program with a GPA below 2.00 and the rate of learners who took the midterm exam and did not take the final exam as the excesses of undesirable output variables, respectively. $\lambda_j=[\lambda_1,\lambda_2,\ldots,\lambda_n]$ represents the non-negative intensity vector of the j. program, and n represents the total number of programs. The objective function, ρ_i^*, represents the efficiency of the program that is expected to be measured and must have values in the range $0 \leq \rho_i^* \leq 1$. If $\rho_i^* = 1$ and $s_i^{k-} = s_i^{a-} = s_i^{m+} = s_i^{uz-} = s_i^{uv-} = 0$, then the Open Education System program is efficient. If $\rho_i^* < 1$, then the Open Education System program is inefficient and the input and output variables should be improved. The larger the value of the objective function ρ_i^*, the more efficient the i. program is. By improving $\sum_{j=1}^{n} \lambda_j = 1$, this model can be constructed with the help of the variable return to scale assumption (Choi et. al.., 2012; Zhang & Choi, 2013).

Data Analysis

In the efficiency analysis conducted in the study, the data complied by the Computer Research and Application Center (BAUM) unit and created in the institutional archive of Anadolu University Open Education System were used as the quantitative secondary data for the variables considered in the study. The efficiency values of the Open Education System associate degree programs for 2016-2017, 2018-2017 and 2018-2019 fall and spring terms were calculated separately, and the efficiency rankings of the associate degree programs were thus obtained.

Since the measurement of the relative performance of the Open Education System associate degree programs is based on linear programming, optimization programs such as GAMS, and LINDO, or commercial software such as Frontier Analyst, DEA Solver PRO, On Front, and Warwick, or non-commercial software such as DEA Excel Solver, DEAP, EMS, and Pioneer can be used (Babacan, 2006). In this study, DEA Solver PRO software was used to evaluate the efficiency of the Open Education System associate degree programs.

FINDINGS

The data on the 2016-2017 academic year fall term efficiency values obtained by using the Slack-Based Measure "Undesirable Outputs Model" of the Anadolu University Open Education System associate degree programs are shown in Table 2, and the data on the spring term efficiency values are shown in Table 3. The data on the fall term efficiency values of the 2017- 2018 academic year are shown in Table 4, the data on the spring term are in shown in Table 5. The 2018-2019 academic year fall term efficiency values are shown in Table 6, and the spring term data are given in Table 7. In these tables, instead of the full names of the associate degree programs, "Prg No" is used to indicate them.

Table 2. Efficiency values of the 2016-2017 fall term associate degree programs

Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values
1.	Prg 28	**1,0000**	**13.**	Prg 9	0,4124	**25.**	Prg 10	0,1222
1.	Prg 27	**1,0000**	**14.**	Prg 23	0,3426	**26.**	Prg 22	0,1183
1.	Prg 25	**1,0000**	**15.**	Prg 15	0,3425	**27.**	Prg 13	0,0888
1.	Prg 24	**1,0000**	**16.**	Prg 8	0,3017	**28.**	Prg 12	0,0875
5.	Prg 32	0,9191	**17.**	Prg 7	0,2891	**29.**	Prg 21	0,0685
6.	Prg 14	0,9186	**18.**	Prg 18	0,2738	**30.**	Prg 26	0,0396
7.	Prg 6	0,6489	**19.**	Prg 5	0,2491	**31.**	Prg 3	0,0001
8.	Prg 11	0,6116	**20.**	Prg 33	0,2456	**32.**	Prg 35	0,0000
9.	Prg 20	0,5909	**21.**	Prg 34	0,2199	**33.**	Prg 19	0,0000
10.	Prg 30	0,5525	**22.**	Prg 2	0,2081	**34.**	Prg 4	0,0000
11.	Prg 17	0,4436	**23.**	Prg 1	0,1540	**35.**	Prg 16	0,0000
12.	Prg 29	0,4196	**24.**	Prg 31	0,1249			

When the efficiency values of the 2016-2017 fall term associate degree programs in Table 2 are examined, Prg 24, Prg 25, Prg 27 and Prg 28 are observed to be fully efficient programs, while Prg 14 and Prg 32 are the programs closest to the efficiency limit. In addition, Prg 3, Prg 35, Prg 19, Prg 4 and Prg 16, whose efficiency values are the smallest (the values converge to zero since four digits are used after the comma), are the programs farthest from the efficiency limit. These programs are the newly opened associate degree programs, and the values of these programs in the input and output variables in the efficiency model are very low compared to the values of other programs. Hence, these programs were placed at the end of the ranking.

Table 3. Efficiency values of the 2016-2017 spring term associate degree programs

Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values
1.	Prg 24	**1,0000**	**13.**	Prg 20	0,2245	**25.**	Prg 4	0,1367
2.	Prg 11	0,5801	**14.**	Prg 15	0,2085	**26.**	Prg 17	0,1297
3.	Prg 29	0,4102	**15.**	Prg 8	0,1933	**27.**	Prg 5	0,1153
4.	Prg 30	0,4003	**16.**	Prg 31	0,1789	**28.**	Prg 26	0,1084
5.	Prg 23	0,3670	**17.**	Prg 7	0,1725	**29.**	Prg 22	0,1053
6.	Prg 32	0,3344	**18.**	Prg 18	0,1696	**30.**	Prg 34	0,0875
7.	Prg 28	0,2929	**19.**	Prg 9	0,1651	**31.**	Prg 12	0,0771
8.	Prg 25	0,2836	**20.**	Prg 27	0,1636	**32.**	Prg 35	0,0595
9.	Prg 1	0,2621	**21.**	Prg 21	0,1629	**33.**	Prg 19	0,0348
10.	Prg 33	0,2498	**22.**	Prg 13	0,1415	**34.**	Prg 16	0,0214
11.	Prg 6	0,2392	**23.**	Prg 2	0,1399	**35.**	Prg 3	0,0000
12.	Prg 14	0,2309	**24.**	Prg 10	0,1377			

When the efficiency values of the 2016-2017 spring term associate degree programs in Table 3 are examined, only Prg 24 emerges as the fully efficient program, and Prg 3 with the lowest efficiency value is the program farthest from the efficiency limit. As stated before, the values of the newly opened Prg 3 in the input and output variables in the efficiency model are quite small compared to the values regarding the other programs. Thus, this program was placed at the end of the ranking.

Table 4. Efficiency values of the 2017-2018 fall term associate degree programs

Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values
1.	Prg 5	**1,0000**	**13.**	Prg 13	0,3656	**25.**	Prg 9	0,1136
1.	Prg 6	**1,0000**	**14.**	Prg 28	0,2939	**26.**	Prg 20	0,1072
1.	Prg 15	**1,0000**	**15.**	Prg 7	0,2928	**27.**	Prg 1	0,0793
1.	Prg 24	**1,0000**	**16.**	Prg 21	0,2889	**28.**	Prg 12	0,0665
5.	Prg 14	0,5507	**17.**	Prg 29	0,2600	**29.**	Prg 19	0,0521
6.	Prg 27	0,4851	**18.**	Prg 25	0,2495	**30.**	Prg 26	0,0491
7.	Prg 34	0,4622	**19.**	Prg 32	0,2495	**31.**	Prg 2	0,0481
8.	Prg 18	0,4274	**20.**	Prg 30	0,2002	**32.**	Prg 10	0,0393
9.	Prg 4	0,4219	**21.**	Prg 33	0,1967	**33.**	Prg 35	0,0288
10.	Prg 8	0,4167	**22.**	Prg 22	0,1572	**34.**	Prg 16	0,0247
11.	Prg 11	0,3948	**23.**	Prg 31	0,1421	**35.**	Prg 3	0,0000
12.	Prg 17	0,3939	**24.**	Prg 23	0,1336			

When the efficiency values of the 2017-2018 fall term associate degree programs in Table 4 are examined, it is observed that Prg 5, Prg 6, Prg 15 and Prg 24 are fully efficient programs, and Prg 3, with the lowest efficiency value, is the farthest from the efficiency ranking. In addition, Prg 3 values for the input and output variables included in the model are very low in the fall period of 2017-2018 compared to the values for the other programs.

Table 5. Efficiency values of the 2017-2018 spring term associate degree programs

Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values
1.	Prg 24	**1,0000**	13.	Prg 19	0,3510	**25.**	Prg 18	0,1790
1.	Prg 32	**1,0000**	14.	Prg 14	0,3460	**26.**	Prg 33	0,1706
1.	Prg 35	**1,0000**	15.	Prg 31	0,3456	**27.**	Prg 2	0,1632
4.	Prg 23	0,6757	16.	Prg 9	0,3365	**28.**	Prg 22	0,1602
5.	Prg 1	0,5484	17.	Prg 16	0,2930	**29.**	Prg 26	0,1446
6.	Prg 11	0,5307	18.	Prg 15	0,2778	**30.**	Prg 12	0,1441
7.	Prg 29	0,4465	19.	Prg 30	0,2727	**31.**	Prg 27	0,1437
8.	Prg 28	0,4183	20.	Prg 13	0,2310	**32.**	Prg 10	0,1425
9.	Prg 6	0,4058	21.	Prg 17	0,2005	**33.**	Prg 5	0,1120
10.	Prg 21	0,4046	22.	Prg 8	0,1958	**34.**	Prg 34	0,0803
11.	Prg 25	0,3920	23.	Prg 7	0,1950	**35.**	Prg 3	0,0000
12.	Prg 4	0,3880	24.	Prg 20	0,1881			

When the efficiency values of the 2017-2018 spring term associate degree programs in Table 5 are examined, Prg 24, Prg 32 and Prg 35 can be seen to be fully efficient programs, and Prg 3, with the lowest efficiency value, is the program farthest from the efficiency limit. Since the values of Prg 3 in the input and output

variables in the model remained small compared to the values of other associate degree programs in this period, this program was placed at the end of the efficiency ranking.

Table 6. Efficiency values of the 2018-2019 fall term associate degree programs

Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values
1.	Prg 4	**1,0000**	**13.**	Prg 18	0,3361	**25.**	Prg 31	0,1623
1.	Prg 8	**1,0000**	**14.**	Prg 17	0,3256	**26.**	Prg 5	0,1581
1.	Prg 19	**1,0000**	**15.**	Prg 23	0,2817	**27.**	Prg 11	0,1454
1.	Prg 35	**1,0000**	**16.**	Prg 29	0,2491	**28.**	Prg 12	0,145
5.	Prg 24	0,6171	**17.**	Prg 30	0,2415	**29.**	Prg 1	0,1197
6.	Prg 15	0,5254	**18.**	Prg 21	0,2201	**30.**	Prg 25	0,1176
7.	Prg 13	0,4866	**19.**	Prg 7	0,2186	**31.**	Prg 2	0,1132
8.	Prg 6	0,4822	**20.**	Prg 22	0,2058	**32.**	Prg 34	0,0934
9.	Prg 16	0,4588	**21.**	Prg 10	0,1968	**33.**	Prg 27	0,0724
10.	Prg 32	0,4372	**22.**	Prg 9	0,1919	**34.**	Prg 26	0,0425
11.	Prg 33	0,4361	**23.**	Prg 28	0,1745	**35.**	Prg 3	0,0424
12.	Prg 20	0,3656	**24.**	Prg 14	0,1658			

When the efficiency values of the 2018-2019 fall term associate degree programs in Table 6 are examined, Prg 4, Prg 8, Prg 19 and Prg 35 are observed to be fully efficient programs, while Prg 3 and Prg 26 are the programs found to be the farthest from the efficiency limit. Since the values of Prg 3 in the input and output variables in the model increased slightly in the fall period of 2018-2019, the fall period efficiency value of this program also increased.

Table 7. Efficiency values of the 2018-2019 spring term associate degree programs

Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values
1.	Prg 35	**1,0000**	**13.**	Prg 28	0,4521	**25.**	Prg 22	0,2237
1.	Prg 24	**1,0000**	**14.**	Prg 3	0,4493	**26.**	Prg 20	0,2219
3.	Prg 9	0,6981	**15.**	Prg 21	0,442	**27.**	Prg 2	0,2185
4.	Prg 19	0,616	**16.**	Prg 32	0,3799	**28.**	Prg 27	0,1873
5.	Prg 23	0,6098	**17.**	Prg 31	0,346	**29.**	Prg 18	0,1741
6.	Prg 4	0,5421	**18.**	Prg 25	0,3434	**30.**	Prg 26	0,1731
7.	Prg 16	0,5216	**19.**	Prg 6	0,323	**31.**	Prg 10	0,1707
8.	Prg 1	0,4995	**20.**	Prg 30	0,3091	**32.**	Prg 17	0,1666
9.	Prg 29	0,4963	**21.**	Prg 7	0,2916	**33.**	Prg 5	0,1645
10.	Prg 11	0,4906	**22.**	Prg 14	0,2783	**34.**	Prg 12	0,1533
11.	Prg 33	0,4895	**23.**	Prg 13	0,2562	**35.**	Prg 34	0,1397
12.	Prg 15	0,4574	**24.**	Prg 8	0,2435			

When the efficiency values of the 2018-2019 spring term associate degree programs in Table 7 are examined, it is clear that Prg 24 and Prg 35 are fully efficient programs, and Prg 34 is the farthest from the efficiency limit. In addition, the values of Prg 3 in input and output variables in the model increased further in the fall period of 2018-2019, and Prg 3, which was the farthest from the limit in the previous periods, rose to the 14th place in the efficiency ranking in the relevant period.

As the efficiency value increases, the efficiency of the relevant associate degree program increases, and the smaller the value, the less efficient the program is. In the fall and spring semesters of 2016-2017, 2017-2018, 2018-2019 academic years, 12 different programs (Prg 4, Prg 5, Prg 6, Prg 8, Prg 15, Prg 19, Prg 24, Prg 25, Prg 27, Prg 28, Prg 32 and Prg 35) were found to have an efficiency value of "1". Among these programs, Prg 24 reached the efficiency value of "1" in five of the six periods and Prg 35 had the value of "1" in the last three periods. For this reason, Prg 24 and Prg 35 ranked at the top in terms of average efficiency by period (Table 8). The values in Table 8 were obtained by taking the average of the efficiency values in Table 2, Table 3, Table 4, Table 5, Table 6 and Table 7.

Table 8. Associate degree programs the average of the efficiency values and rankings

Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values	Ranking	Associate Degree Programs	Efficiency Values
1.	Prg 24	0,9362	**13.**	Prg 29	0,3803	**25.**	Prg 18	0,2600
2.	Prg 32	0,5533	**14.**	Prg 19	0,3423	**26.**	Prg 7	0,2433
3.	Prg 6	0,5165	**15.**	Prg 27	0,3420	**27.**	Prg 16	0,2199
4.	Prg 35	0,5147	**16.**	Prg 30	0,3294	**28.**	Prg 31	0,2166
5.	Prg 15	0,4686	**17.**	Prg 9	0,3196	**29.**	Prg 34	0,1805
6.	Prg 11	0,4589	**18.**	Prg 5	0,2998	**30.**	Prg 22	0,1618
7.	Prg 28	0,4386	**19.**	Prg 33	0,2980	**31.**	Prg 2	0,1485
8.	Prg 14	0,4150	**20.**	Prg 20	0,2830	**32.**	Prg 10	0,1349
9.	Prg 4	0,4148	**21.**	Prg 1	0,2772	**33.**	Prg 12	0,1122
10.	Prg 23	0,4017	**22.**	Prg 17	0,2767	**34.**	Prg 26	0,0929
11.	Prg 25	0,3977	**23.**	Prg 21	0,2645	**35.**	Prg 3	0,0820
12.	Prg 8	0,3918	**24.**	Prg 13	0,2616			

Similarly, for the fall and spring semesters of the 2016-2017, 2017-2018, 2018-2019 academic years, the efficiency values of 5 different programs (Prg 3, Prg 4, Prg 16, Prg 19 and Prg 35) were close to "0" since four digits were used after the comma. Prg 4, Prg 16, Prg 19 and Prg 35 had a value close to "0" for only one semester (the 2016-2017 academic year spring semester), while Prg 3 had an efficiency value converging to "0" in four of these six semesters. For this reason, Prg 3 ranked lowest in terms of average efficiency values by period (Table 8). As the periods progressed, the efficiency values of these five programs, except Prg 3, increased. Prg 4, Prg 19 and Prg 35 received "1" as the most efficient programs in the fall semester of 2018-2019 (Table 6). Prg 3, on the other hand, increased in efficiency value with the fall semester of the 2018-2019 academic year, and continued to rise in both efficiency value and efficiency ranking in the spring of the same academic year (Table 6 and Table 7).

CONCLUSION AND DISCUSSIONS

The performances of education systems can be evaluated from perspectives such as academic achievement, financial situation and use of human resources. Tomkins and Green (1988), Breu and Raab (1994), Kutlar and Kartal (2004), Fandel (2007), Tyagi, Yadav and Sing (2009), Cunha and Rocha (2012), Selim and Bursalioglu (2015), Arik and Seyhan (2016), Erkoc (2016) and Uslu, Ertas and Yayar (2018) discussed academic achievement, financial situation and human resource use perspectives as hybrids in their studies. In this study, performance analyzes of the Open Education System were made by considering the perspectives mentioned in a hybrid way.

Evaluation of efficiency in education can be perform between educational institutions as well as between faculties and programs. While evaluating the effeciency of universities in Kulshreshtha and Nayak (2015) and Caglar and Gurler (2020) studies, Cinaroglu et al. (2018) performed the efficiency evaluations of the faculties, Tyagi, Yadav and Singh (2009) and Aziz, Janor and Mahadi (2013) programs.

Organizations or systems should determine which indicators will be used in the process of achieving the determined goals, form sets of indicators and analyze the sets of indicators to reach results. It can be said that the variables in the indicator sets used for efficiency analysis in the literature differ according to the performance perspectives. It has been found that variables such as "number of publications, number of graduates, number of projects" are used for academic success, "personnel expenses, government supports, project budgets" for financial status, and "number of academic staff, number of students" for human resources. (Tomkins & Green, 1988; Breu & Raab, 1994; Kutlar & Kartal, 2004; Fandel, 2007; Tyagi, Yadav & Sing, 2009; Ulucan, 2011; Cunha & Rocha, 2012; Aziz, Janor & Mahadi, 2013; Selim & Bursalioglu, 2015; Arik & Seyhan, 2016; Erkoc, 2016; Caglar & Gurler, 2020). Due to the structure of the distance education system, it has been inevitable that the variables used in this study show some differences. For this reason, variables that are specific to the system and that are thought to better reflect the efficiency of the system were used in the study.

Differing from the formal education system, the Open Education System places no restriction on the maximum duration of study. However, the large number of learners staying in the system for a long time does not comply with the goals of the system. Hence, a limitation has been imposed in terms of the time period for the values to be taken by the "number of graduating learners" variable, which is included as the desirable output variable in the efficiency model, and the "number of graduating learners" within three years from the moment they are included in the system is taken into account. This reduced the values of the "graduating learner ratio" variable by programs. Along with this, the efficiency values of the programs also decreased and the efficiency rank of the associate degree programs changed as well. Therefore, steps should be taken to ensure a standard of efficiency for associate degree programs that are at the top of the efficiency rankings, it should be ensured that the learners in the lower associate degree programs remain loyal to the system, and the advantages of graduating from these programs should be advertised and communicated better.

When the efficiency analysis results of the Open Education System associate degree programs are examined, some common characteristics of the programs that are at the top of the efficiency rankings stand out. It is clear that the programs that rank high are those that contribute to individual development, enable the development of skills and abilities, and offer job opportunities due to the recent human resources needs arising in some fields of the public sector. These qualities can be argued to increase the efficiency of associate degree programs. The programs that rank low are those that have recently been opened or those that have been in the system for a long time, have reached occupational saturation, and begun to attract less interest. Therefore, the lower-ranking associate degree programs need to be equipped with the qualities stated above to keep the student interest in them strong.

Open and distance education is a relatively recent interdisciplinary field where technology plays an instrumental role. It is clear that as technology advances, these fields develop accordingly, and they offer new learning opportunities to learners. Consequently, it has become important to develop a more comprehensive understanding of open and distance education and to examine these fields from different perspectives (Bozkurt, 2019, p. 252). Thus, the current study, which evaluates the efficiency of Anadolu University Open Education System associate degree programs, which has one of the largest learning communities in the world, aimed to bring a new perspective to the discipline of open and distance learning, and to show that interdisciplinary studies can be carried out by bringing this discipline and other disciplines together. This study is expected to guide system administrators, decision-makers and scientists interested in this discipline in terms of evaluating the efficiency of similar open and distance education systems. In evaluating the efficiency of systems that provide open and distance education services, first considering the characteristics of the systems and then creating models by determining the appropriate variables for these characteristics is strongly recommended.

In open and distance education systems, the learner and instructor are separated from each other, and interaction between the learner and teacher is provided with the help of information and communication technologies. It can be said that the technological tools and platforms, learning environments and learning materials in open and distance education systems are the actors that increase the interaction between the learner and instructor. The increasing learner-instructor interaction has brought about the creation of big data for open and distance education systems and organizations. Using the cloud technologies specific to

systems or organizations to process and store big data is highly recommended. The use of such technologies is expected to facilitate access to data in studies to be carried out in these areas, and to increase the number of such studies.

With the COVID-19 pandemic, which spread all over the world in the first half of 2020, and was responded by most countries through strict preventive measures in the second half of 2020, social solidarity has increased, the importance of individual hygiene has been emphasized and new concepts such as social distance has become an essential part of our daily lives. Under these circumstances, traditional education could not be continued in many countries, and emergency open and distance learning has become the only viable solution. It is worth bearing in mind that open and distance learning is not simply a fad arising from dramatic changes or crises (such as a pandemic) brought about by technological possibilities and changing global conditions, but it is a genuine necessity.

Suggestions or Future Research

After determining the characteristics of the systems or institutions that provide open and distance education services and the variables for these features, efficiency analyses can be performed in various other ways. In future efficiency analysis studies in the field of open and distance education, more than one efficiency analysis can be performed using different combinations of the variables discussed, and the efficiency values of decision units can be compared. In addition, the efficiency levels of decision units can be determined by using reference-based Multi-Criteria Decision Making (MCDM) methods. Further studies comparing the efficiency of institutions or systems that provide open and distance education services can be carried out. Moreover, whether the effects of the current COVID-19 pandemic play a role in the efficiency of open and distance education systems can be investigated. By comparing the efficiency of the open and distance education systems in this pandemic period with their pre-pandemic efficiency, the positive and negative aspects of the characteristics of these systems can be revealed.

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