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Efficiency Evaluation of Higher Education Faculties through Output- and Input-Oriented DEA Models

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Abstract

Education holds a fundamental position in today's world and remains one of the most critical pillars of any society. The relationship between the education sector and the competencies of teachers and instructors is both significant and direct—enhancing this connection leads to improved educational standards and more effective teaching methodologies. Efficient and impactful education not only fosters active learning and critical thinking among individuals but also equips them with problem-solving skills, enabling them to address challenges effectively. Moreover, effective education stimulates creative thinking in higher education institutions and universities, consequently improving the overall quality of education within a society. It empowers individuals to make informed decisions, providing them with the ability to apply acquired knowledge practically. This represents the true essence of participation, which is a key component of social capital. This study evaluates the efficiency and comparative performance of three faculties—Management and Humanities, Engineering, and Basic Sciences—across both teaching and research dimensions. Using the Data Envelopment Analysis (DEA) methodology and employing data from 2021 to 2024, the research assesses faculty efficiency. The findings indicate that, under the assumption of constant returns to scale (CRS), the Faculty of Management and Humanities exhibits the highest efficiency, whereas the Faculty of Basic Sciences demonstrates the lowest efficiency. Under the assumption of variable returns to scale (VRS), all faculties—except the Faculty of Basic Sciences—are deemed efficient. The average technical efficiency over the examined period is approximately 74% under CRS and 98% under VRS. Additionally, scale efficiency is estimated at 76%.

Keywords: Efficiency, Data Envelopment Analysis, Educational Productivity, Research Productivity.

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1. Introduction

In contemporary society, living standards across different nations—whether industrialized, developed, or developing—have reached levels that previous generations could hardly have imagined. Significant disparities in welfare exist among countries, leading to considerable differences in factors such as nutrition, mortality rates, illiteracy, education, and other socio-economic indicators [1]. Historically, humankind has continuously sought to optimize the utilization of available resources, striving to attract efficient and productive assets that align with desired economic outcomes. In this pursuit, universities play a pivotal role in national economic growth and development by offering critical services, particularly through the generation and dissemination of knowledge [2].

In today's world, societies—whether developed or developing—place complete trust in the competencies of their teachers and instructors. Just as a skilled leader plays a crucial role in empowering individuals within an organization, efficient education assumes a significant managerial function within society. Effective and interactive education not only fosters critical thinking and mental stimulation among individuals but also equips them with problem-solving skills, enabling them to address challenges independently. Furthermore, high-quality education nurtures creative thinking at the level of higher education institutions and universities, ultimately leading to a broader enhancement of educational standards across society. A productive and efficient educational system strengthens decision-making capabilities, offering individuals clarity in their choices and enabling them to learn and apply informed judgments. This, in essence, represents the true meaning of participation, which is a fundamental parameter of social capital [3].

It is essential to recognize that efficient and effective education enhances decision-making processes at the societal level rather than merely determining decisions for individuals. Given the remarkable acceleration of scientific and technological advancements globally, the evolution of communication technologies has facilitated rapid and seamless access to academic resources in an unprecedented manner. Undoubtedly, these transformations have been driven by strategic planning, investments, and the relentless efforts of scientists, researchers, and skilled professionals across various fields.

The improvement of educational quality within a society is achievable when efficiency and productivity are simultaneously optimized, resulting in substantial impact on societal progress. This synergy not only fosters talent identification and the development of individual capabilities but also enhances creativity, further advancing the effectiveness of discoveries, inventions, and research endeavors. In Iran, a significant shortage of specialized professionals in certain periods led to the rapid establishment of universities without adequate consideration of societal needs and demands. The urgent need for professionals at the time resulted in the proliferation of universities across the country without a strategic focus on educational quality enhancement [4].

The expansion of universities, while intended to enhance access to education, has at times led to a decline in educational quality and an increase in the number of unemployed specialized graduates. A critical aspect of assessing universities from an educational perspective involves identifying strengths, leveraging opportunities, and strategically addressing weaknesses—a fundamental approach in measuring institutional efficiency [5]. The

Secretary-General of the Organization for Economic Cooperation and Development (OECD) emphasized in a report that education is one of the most crucial investments for nations. Governments must allocate resources efficiently and implement appropriate policies to enhance educational productivity and strengthen its connection with broader societal goals. The importance of efficiency and productivity in education is increasing, as optimal utilization of available resources ensures effective learning outcomes**.** Conversely, in an inefficient educational system**,** costs tend to rise, further straining institutional budgets. Improving educational quality requires more than just skilled professionals—it demands sufficient financial resources**,** time**,** and dedicated efforts to sustain high standards. Given these considerations, the productivity of education remains a priority for policymakers, educators, and stakeholders invested in the long-term development of human capital.

On average, according to reports from the Organization for Economic Cooperation and Development (OECD)**,** education is more expensive than other goods available to individuals in a society, as it is often considered a luxury good. In some countries, such as the Netherlands, education costs fall below the Consumer Price Index, whereas in other countries, such as the United Kingdom**,** education costs have been increasing significantly [6]. Additionally, growing awareness of public sector productivity and the rising costs of education have intensified interest in research on educational efficiency. Given the importance of education and its productivity, the primary objective of this study is to estimate and assess the efficiency of three faculties: Basic Sciences, Engineering, and Management & Humanities. Education plays a crucial role at national, local, and individual levels, benefiting both society and its citizens. The development and implementation of educational programs in many countries have led to government subsidies covering a portion of public education costs. As public and private demand for education rises, government budgets and education expenditures increase accordingly, thereby enhancing the efficiency of educational systems and amplifying the importance of educational productivity [7].

In today's highly competitive environment, universities, higher education institutions, and even non-educational organizations strive to optimize the utilization of their available resources across various sectors. Therefore, the development of a model that provides feedback to enhance organizational performance and offers a tool for managers to meet this essential need is both necessary and logical.

This study employs a field research method, gathering data through direct consultation with statistical departments, alongside library research, involving information retrieval from the Ministry of Science, Research, and Technology and its affiliated organizations.

2. Literature and research background

Farrell (1957) was among the pioneers in addressing efficiency measurement, laying the foundation for contemporary performance assessment methodologies. His work underscored the importance of evaluating how economic planners could enhance industry performance without requiring additional resources. In his seminal article, Farrell introduced the concept of efficiency within the framework of performance appraisal, marking the first application of nonparametric methods to estimate efficiency levels. In essence, he provided the initial formal description of the nonparametric approach to efficiency measurement [8]. The primary objective of efficiency measurement for each decision-making unit is to maximize the ratio of weighted outputs to weighted inputs while accounting for inherent constraints, which should not exceed a value of one. Furthermore, the concepts of efficiency, effectiveness, and productivity are closely related, exhibiting minimal differences in their interpretation. In the context of decision-making, efficiency—defined as performing tasks proficiently—stems from internal parameter comparisons, whereas effectiveness—reflecting the ability to achieve intended goals—arises from external parameter assessments [9]. Efficiency refers to the capability of a process to function optimally, ensuring that the expected output level corresponds to the quantity of inputs utilized. It signifies that a task or process is executed correctly, yielding outcomes proportionate to the allocated resources. Broadly speaking, efficiency aims to quantify the extent to which an organization utilizes its resources to achieve superior performance relative to similar entities within a given timeframe [10].

- **types of Efficiency (Technical Efficiency)**

Technical efficiency refers to the ability of a production system to maximize output given a specific level of input while operating at the highest technological standard. It is independent of input costs and focuses instead on optimizing the use of production factors to achieve a predetermined level of output. Koopmans (1951) defines technical efficiency in terms of trade-offs [11]: a production enterprise is considered technically efficient when an increase in one output necessitates a decrease in at least one other output, or when reducing a production factor requires increasing another. Technical efficiency is generally categorized into two components: pure technical efficiency, which reflects an entity's ability to use resources optimally, and scale efficiency, which examines how production scale impacts efficiency [12].

- **Price efficiency**

Price efficiency focuses on optimizing a company's financial performance by minimizing costs and maximizing revenue generation. This form of efficiency assumes that the company operates with full technical efficiency, meaning all available resources are used in the most effective manner. By achieving price efficiency, firms can enhance profitability and competitiveness by strategically adjusting input costs and output prices within market constraints. This concept plays a crucial role in economic and financial analyses aimed at improving operational sustainability and long-term growth.

- **Structural efficiency**

Structural efficiency is determined by comparing the performance of an industry against an efficient production function, specifically through an analysis of the firms within the industry. In essence, technical efficiency in such firms is achieved by retaining the most optimal producers—those operating at the lowest cost and at an ideal scale. In the short run, the industry's optimal production results in a redistribution of output across firms. Notably, an industry where all firms exhibit uniform inefficiency may demonstrate greater structural efficiency than an industry containing both efficient and inefficient producers. This suggests that structural efficiency assessments must be conducted relative to production curves representing uniformly efficient firms.

- **Overall or Economic Efficiency**

Economic efficiency is derived from the product of technical efficiency and allocative efficiency, aiming to maximize profit given prevailing input prices and resource levels. A key approach in assessing economic efficiency involves distinguishing between technical price and technical performance. The former evaluates a firm's ability to select the most optimal combination of inputs, while the latter measures its capacity to generate maximum output from the available resources.

- **Scale Efficiency**

Scale efficiency is defined as the ratio of observed efficiency to the efficiency at the optimal scale, serving as an indicator of whether production occurs at an ideal level. When discrepancies arise between performance scores under variable returns to scale (VRS) and constant returns to scale (CRS)**,** it signifies the presence of scale inefficiencies within an organization or institution. In such cases, achieving optimal production requires aligning operations with a consistent return to scale.

- **Absolute efficiency**

Absolute efficiency is assessed under the assumption that a global standard exists for an input-output unit, denoted as Y^* for specific decision-makers. In this framework, if a decision-maker utilizes one unit of input to generate an output of Y_0, absolute efficiency is mathematically defined as $\frac{Y_0}{Y^*}$.However, when universally accepted standards are unavailable, not adhered to, or significantly distant from the community under evaluation, absolute efficiency becomes impractical, and relative efficiency is applied instead.

- **Relative efficiency**

In many developing economies—such as Iran—the performance gap between actual units and international benchmarks can be considerable, often rendering direct alignment with global standards unfeasible. This discrepancy makes absolute efficiency an unsuitable measure for some managers in firms and organizations, as comparisons with external benchmarks may not provide a realistic pathway for improving inefficient units. A key advantage of relative efficiency is its ability to reflect the actual position of evaluated units, making it a more practical tool for assessing decision-making performance. For this reason, relative efficiency is frequently employed in evaluations of firms and institutions.

Contini and Salza (2020). examined higher education efficiency in Italy and the remarkably low number of university graduates in their study. Based on the results obtained from an assessment of data from a large Italian higher education institution, it was found that Italy lags most developed countries in terms of the proportion of young people with higher education qualifications**.** The pathways that students and most young individuals in Italy pursue for their lives and career advancement vary considerably. For instance, the probability of dropping out within four years ranges from 10% to 77%**.** While student enrollment rates in Italy have been increasing, the academic progress of students does not seamlessly transfer into university education, leading to inefficiencies within the university system and significant concerns for the Italian government [13].

Moreno-Gómez et al. (2020) conducted a study titled *Measuring the Efficiency of Colombia's Higher Education System Using a Two-Stage Approach.* The primary objective of this research was to assess the efficiency of Colombia's higher education system and distinguish between public and private universities. The study employed a Data Envelopment Analysis (DEA) model to evaluate the efficiency of educational and research activities separately and collectively. The empirical framework encompassed a sample of 78 Colombian universities during the period 2015–2017**.** A two-stage DEA approach was implemented, wherein DEA scores were initially assessed and subsequently subjected to regression analysis using operational variables. The findings indicate that public universities outperform their private counterparts in both educational and research efficiency**,** demonstrating higher overall efficiency levels. Furthermore, the proportion of faculty members holding doctoral degrees positively influenced all dimensions of efficiency**,** with research emerging as the sole factor driving efficiency improvements [14].

Martínez-Campillo and Fernando-Santos (2020) conducted a study titled *The Impact of the Economic Crisis on the Inefficiency of Public Higher Education Institutions in Southern Europe: A Case Study of Spanish Universities*. The regression analysis in their research confirmed that the crisis variable had a statistically significant and positive impact on university efficiency**.** Furthermore, their findings indicate that age positively influenced the way these institutions utilized their resources to generate educational and research outputs**,** although it had a negative effect on technical efficiency**.** Additionally, the regional location of public universities was identified as a key determinant of their efficiency levels. These findings provide valuable insights for policymakers and university administrators to assess whether public universities were adequately managed during the crisis and to identify factors that could enhance their efficiency [15].

Lysenko et al. (2020) conducted a study titled *Efficiency Indicators and Regional Innovation Clusters in the Higher Education System*. The primary focus of the research was to analyze innovation, business development, education growth, and competition as key indicators of the effectiveness of regional innovation clusters within higher education. The study employed content analysis, statistical methods, correlation and regression analysis, econometric modeling, and graphical techniques to examine these relationships. Ultimately, efficiency indicators of regional innovation clusters were identified, and their impact on the higher education system was evaluated. The researchers demonstrated that there is a strong correlation between the level of development of regional innovation clusters, business growth indicators, innovation, and competitiveness [16]**.**

De Witte and López-Torres (2017) conducted a study titled *Efficiency in Education: A Review of Its Past and Foundations, A Path Toward Progress*. This research utilized existing studies on education as its foundation, employing Data Envelopment Analysis (DEA), the MPI index, and frontier efficiency analysis as methodological approaches. The study aimed to establish a connection between education economics and efficiency in the education system**.** The researchers highlighted the similarities between productivity conditions and variations in different efficiency levels of education**,** modeling them through quantitative regressions and partial frontiers in econometrics**.** By using conditional efficiency modeling through regression and frontier analysis**,** they demonstrated a direct correlation between the added value of efficient education and its impact on societal effectiveness**.** Their findings suggest that education functions as a luxury good**,** given its influence on productivity and economic development [6].

Aristovnik (2012) conducted a study aimed at measuring the relative efficiency of public education utilization and research and development (R&D) expenditures in the new member states of the European Union (EU) compared to selected EU countries, including Croatia, and members of the Organization for Economic Co-operation and Development (OECD). Given the limited resources allocated to education and R&D, the study emphasized the importance of efficient utilization within institutional and regulatory constraints. To achieve this, the researchers applied a non-parametric method—Data Envelopment Analysis (DEA)—where efficiency is defined as the efficiency frontier, representing the maximum achievable output per unit of input. The output-oriented efficiency analysis revealed that among the new EU member states, Hungary, Estonia, and Slovenia demonstrated strong performance in primary, secondary, and higher education, respectively. On the other hand, Cyprus and Hungary exhibited dominance and full efficiency in R&D activities for various reasons. Additionally, empirical findings indicated that while the new EU member states exhibit relatively high efficiency in higher education, they lag significantly in R&D efficiency measures [17].

3. The Model, Results and Discussions

This research employs Data Envelopment Analysis (DEA) to assess the average efficiency of Iranian cinemas, utilizing both the Constant Returns to Scale (CRS or CCR) and Variable Returns to Scale (VRS or BCC) assumptions. DEA, a mathematical programming methodology, is particularly suitable for evaluating the performance of Decision-Making Units (DMUs) that operate with multiple inputs and outputs. The topic of performance measurement continues to attract scholarly attention due to its essential role in assessing productivity in firms and production systems. Farrell’s pioneering work in 1957 introduced an engineering-inspired method for measuring output efficiency per unit, laying the groundwork for DEA. One of the DEA’s strengths lies in its ability to foster collaboration between analysts and decision-makers, especially in the careful selection of input and output variables, accurate performance assessment, and identification of models that approximate best practices.

DEA models are generally classified into two main types. The first type is the CCR model, which evaluates the efficiency of decision-making units (DMUs) under the assumption of *constant returns to scale*—meaning that increasing all inputs by a certain factor results in a proportional increase in outputs. This approach allows for the comparison of both small and large units on equal footing. The model, introduced by Charnes, Cooper, and Rhodes, derives its name from the initials of its creators (CCR) [9]. The following formulation illustrates how this model analyzes the performance of *n* units, each utilizing *m* inputs to produce *s* outputs.

$$Max_{DMU_k} \rightarrow E_K = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}} \rightarrow \left(k = 1, \ldots, n\right)$$

$$s.t. \qquad E_j = \frac{\sum_{r=1}^{s} u_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \le 1 \left(j = 1, \ldots, n\right)$$

$$u_r, v_i \ge 0,\ r = 1, \ldots, s\ ,\ i = 1, \ldots, m$$

$$Max_{DMU_k} \rightarrow \begin{cases} E_K = \dfrac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}} \quad \rightarrow (k=1,...,n) \\ = \dfrac{u_1 y_{1k} + ... + u_s y_{sk}}{v_1 x_{1k} + ... + v_m x_{mk}} \end{cases}$$

$$s.t. \quad \begin{cases} DMU_1 \rightarrow E_1 = \dfrac{\sum_{r=1}^{s} u_r y_{r1}}{\sum_{i=1}^{m} v_i x_{i1}} \leq 1 \\ DMU_2 \rightarrow E_1 = \dfrac{\sum_{r=1}^{s} u_r y_{r2}}{\sum_{i=1}^{m} v_i x_{i2}} \leq 1 \\ \vdots \\ DMU_n \rightarrow E_1 = \dfrac{\sum_{r=1}^{s} u_r y_{rn}}{\sum_{i=1}^{m} v_i x_{in}} \leq 1 \end{cases}$$

$$u_r, v_i \geq 0, \; r=1,...,s \; , \; i=1,...,m$$

The variables u_i and v_r represent the weights attributed to the output and input indicators, respectively, while x_{in} and ر denote the input and output parameters. Due to the nonlinear nature of the model, solving it directly poses significant challenges. To address this complexity, several mathematical strategies are employed. These include normalizing the objective function’s denominator to one, applying the same principle to the denominators within each constraint by fixing them to the constants on the right-hand side, and subsequently converting the expressions on the left-hand side of the inequalities into a linear format, resulting in the following structure:

$$Max_{DMU_k} \rightarrow E_K = \sum_{r=1}^{s} u_r y_{rk}$$

$$\begin{aligned} s.t. \quad & \sum_{i=1}^{m} v_i x_{ik} = 1 \\ & \sum_{r=1}^{s} u_r y_{r1} - \sum_{i=1}^{m} v_i x_{i1} \leq 0 \\ & \sum_{r=1}^{s} u_r y_{r2} - \sum_{i=1}^{m} v_i x_{i2} \leq 0 \\ & \vdots \\ & \sum_{r=1}^{s} u_r y_{rn} - \sum_{i=1}^{m} v_i x_{in} \leq 0 \\ & u_r, v_i \geq 0 \; , \; r=1,...,s \; , \; i=1,...,m \end{aligned}$$

When the output-oriented orientation is used to calculate efficiency, the model is modified as follows:

$$Min_{DMU_k} \rightarrow E_K = \sum_{i=1}^{m} u_r y_{rk}$$

$$\begin{aligned} s.t. \quad & \sum_{r=1}^{s} v_i x_{ik} = 1 \\ & \sum_{r=1}^{s} u_r y_{r1} - \sum_{i=1}^{m} v_i x_{i1} \leq 0 \\ & \sum_{r=1}^{s} u_r y_{r2} - \sum_{i=1}^{m} v_i x_{i2} \leq 0 \\ & \vdots \\ & \sum_{r=1}^{s} u_r y_{rn} - \sum_{i=1}^{m} v_i x_{in} \leq 0 \\ & u_r, v_i \geq 0 \; , \; r=1,...,s \; , \; i=1,...,m \end{aligned}$$

The second major model in DEA is known as the BCC model, which was developed by modifying the original CCR approach. Introduced by Charnes and colleagues, this model accounts for *variable returns to scale* and is designed to assess the relative efficiency of decision-making units under more flexible production conditions. Compared to models assuming constant returns to scale, variable returns models such as BCC allow for a broader and often more accurate representation of efficiency, particularly when scaling effects differ across units.

Unlike the CCR model, which can be more restrictive due to its assumption of proportional input-output scaling, the BCC model introduces an additional free variable, commonly denoted as W. This variable is critical in identifying the nature of returns to scale in the evaluation process and helps distinguish between increasing, decreasing, or constant returns depending on its behavior in the solution. In this framework, the symbol $\underline{W}$ characterizes the nature of returns to scale:

- When $\underline{W}$ is less than zero, the system exhibits decreasing returns to scale.
- When $\underline{W}$ equals zero, the returns to scale are constant.
- When $\underline{W}$ is greater than zero, it reflects increasing returns to scale.

This model allows input levels to be scaled by any factor, which may lead to proportionate, lesser, or greater output levels. Unlike fixed-scale models, the BCC formulation incorporates variable returns to scale, offering flexibility in evaluating performance. The equation below represents the analytical expression used to assess efficiency under this assumption.

$$
\begin{aligned}
& Min_{DMU_k} \rightarrow E_K = \sum_{r=1}^{s} v_i x_{ik} + v_0 \\
s.t. \quad & \sum_{i=1}^{m} u_r y_{rk} = 1 \\
& \sum_{r=1}^{s} u_r y_{r1} - \sum_{i=1}^{m} v_i x_{i1} - v_0 \leq 0 \\
& \sum_{r=1}^{s} u_r y_{r2} - \sum_{i=1}^{m} v_i x_{i2} - v_0 \leq 0 \\
& \quad \vdots \\
& \sum_{r=1}^{s} u_r y_{rn} - \sum_{i=1}^{m} v_i x_{in} - v_0 \leq 0 \\
& u_r, v_i \geq 0 \;, r = 1,\dots,s \;,\; i = 1,\dots,m
\end{aligned}
$$

4. Introducing research inputs and outputs to measure efficiency

The application of Data Envelopment Analysis (DEA) for measuring the productivity and efficiency of academic faculties requires the identification of inputs and outputs**.** Therefore, this section introduces the selected inputs and outputs used in this study to estimate the productivity and efficiency of faculties within an educational institution.

To assess efficiency and examine productivity, two inputs have been considered:

- The number of incoming students each year
- The number of faculty members

For measuring productivity and evaluating efficiency, one output has been selected:

- The number of graduates from each academic faculty

This structured approach ensures that the DEA model captures the key dynamics influencing faculty performance in terms of student intake, faculty resources, and educational outcomes.

Table 2 presents the technical efficiency results under both Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS) assumptions, as well as scale efficiency, for the years 2021 to 2024. Additionally, Table 3 reports the average efficiency scores of each educational faculty over the same period, using the output-oriented approach.

Table 1. Number of Inputs and Outputs in the Educational Faculties Under Evaluation

Outputs	Inputs		
Number of Graduates	**Number of Faculty Members**	**Number of Incoming Students**	**Faculties**
555	25	1090	**Management and Humanities**
600	27	1108	**Engineering**
507	45	1124	**Basic Sciences**

Source: Research calculations

Table 2. Estimating the Ranking of The Faculties Efficiency by The Output Orientated Method

2024			2023			2022			2021			Faculties
CRS	**VRS**	**SCALE**	**CRS**	**VRS**	**SCALE**	**CRS**	**VRS**	**SCALE**	**CRS**	**VRS**	**SCALE**	
0.816	0.975	0.816	0.712	0.942	0.712	0.910	0.845	0.910	0.816	0.963	0.816	**Basic Sciences**
0.646	1	0.920	0.534	1	0.554	0.607	1	0.661	0.646	1	0.920	**Engineering**
0.792	1	0.885	0.463	1	0.488	0.719	1	0.786	0.792	1	0.885	**Management and Humanities**

Source: Research calculations

Table 3. Average Estimated Efficiency of Educational Faculties Using the Output-Oriented Approach

the Efficiency average of Faculties			Faculties
SCALE	**VRS**	**CRS**	
0.857	0.968	0.721	**Basic Sciences**
0.854	1	0.847	**Engineering**
0.574	1	0.796	**Management and Humanities**

Source: Research calculations

An examination of the average results for the period 2021–2024, as presented in the table above, reveals that the average technical efficiency of educational faculties under the assumption of Constant Returns to Scale (CRS) was approximately 72% for the Faculty of Basic Sciences, 84% for the Faculty of Engineering, and 79% for the Faculty of Management and Humanities. Under the assumption of Variable Returns to Scale (VRS), the corresponding figures were approximately 96%, 100%, and 100%, respectively. Regarding scale efficiency, the scores were around 85% for both the Basic Sciences and Engineering faculties, and 57% for the Management and Humanities faculty. According to the CRS model, the Engineering faculty—with a relative efficiency of 85%—is classified as efficient, whereas the other faculties exhibit lower efficiency levels. In contrast, under the VRS model, both the Engineering and the Management and Humanities faculties demonstrate full relative efficiency (100%) and are thus deemed efficient.

Table 4 reports the results of technical efficiency estimation under the assumptions of Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS), along with scale efficiency, for the period 2021 to 2024. Table 5 presents the average efficiency scores for each educational faculty over the same period, based on the input-oriented approach.

Table 4. Estimating the Ranking of The Faculties Efficiency by The Input Orientated Method

2024			2023			2022			2021			Faculties
CRS	**VRS**	**SCALE**	**CRS**	**VRS**	**SCALE**	**CRS**	**VRS**	**SCALE**	**CRS**	**VRS**	**SCALE**	
0.816	0.975	0.816	0.712	0.942	0.712	0.910	0.845	0.910	0.816	0.963	0.816	**Basic Sciences**
0.646	1	0.720	0.534	1	0.554	0.607	1	0.661	0.646	1	0.702	**Engineering**
0.858	1	0.858	0.677	1	0.677	0.888	1	0.888	0.858	1	0.858	**Management and Humanities**

Source: Research calculations

Table 5. Average Estimated Efficiency of Educational Faculties Using the Input-Oriented Approach

the Efficiency average of Faculties			Faculties
SCALE	**VRS**	**CRS**	
0.856	0.968	0.721	**Basic Sciences**
0.854	1	0.847	**Engineering**
0.574	1	0.796	**Management and Humanities**

Source: Research calculations

An analysis of the average values for the period 2021–2024, as shown in the table above, indicates that under the Constant Returns to Scale (CRS) assumption, the average technical efficiency of educational faculties was approximately 72% for the Faculty of Basic Sciences, 84% for the Faculty of Engineering, and 79% for the Faculty of Management and Humanities. Under the Variable Returns to Scale (VRS) model, the corresponding values were approximately 96%, 100%, and 100%, respectively. Regarding scale efficiency, the coefficients were around 85% for both the Basic Sciences and Engineering faculties and 57% for the Management and Humanities faculties. According to the CRS results, the Engineering faculty—with a relative efficiency of 85%—is classified as efficient, whereas the other faculties exhibit lower efficiency. In contrast, under the VRS model, both the Engineering and the Management and Humanities faculties demonstrate full relative efficiency (100%) and are thus considered efficient.

The presence of variable returns to scale (VRS) among active academic departments indicates that, under ceteris paribus conditions, expanding university services and utilizing greater input resources can have a positive impact on their efficiency levels. Conversely, the existence of constant returns to scale (CRS) suggests that these departments can maintain their provided academic services and improve relative efficiency by employing more inputs without compromising performance.

Finally, the key factors contributing to the efficiency and inefficiency of educational faculties, based on an examination of the academic and instructional domains, are identified, and strategies for enhancing the performance of these sectors are proposed. Factors such as the increase in the number of incoming students at each academic level, the decline in the average national entrance exam ranks, the rise in the number of students awarded scholarships to study at foreign universities, the enhanced admission of top-tier students into master's and doctoral programs, the expansion of academic opportunities and study trips for each faculty member, the improvement in both the quantity and quality of faculty research output, and the implementation of instructional workshops and teaching courses for university lecturers are all cited as contributing to the educational center's efficiency.

The following strategies are also proposed to enhance the efficiency of educational institutions: increasing constructive engagement between faculty members and students in educational programs; enhancing collaborative involvement of faculty in classroom management and instruction; strengthening the faculty's active participation and constructive interaction with the broader national educational community; and encouraging greater faculty-student collaboration in university research and scholarly initiatives.

5. Conclusions and Suggestions

This study estimated the efficiency of educational centers and faculties using input and output statistics processed through DEAP software. Efficiency assessments were conducted using both output-oriented and input-oriented approaches, under assumptions of constant and variable returns to scale.

Tables 2 and 4 present the technical and scale efficiency results for the period 2021 to 2024, based on output- and input-oriented models, respectively. Tables 3 and 5 summarize the average efficiency scores across faculties over the same timeframe.

Under the CRS model, average technical efficiency scores were approximately 72% for Basic Sciences, 84% for Engineering, and 79% for Management and Humanities. Under the VRS model, these scores increased to 96%, 100%, and 100%, respectively. Scale efficiency was estimated at roughly 85% for both Basic Sciences and Engineering, and 57% for Management and Humanities. The Engineering faculty was classified as efficient under the CRS model, while both Engineering and Management and Humanities faculties achieved full efficiency under VRS assumptions.

These results indicate that most faculties operate under variable returns to scale, suggesting that increased input utilization can have a positive impact on performance. In contrast, constant returns to scale imply the potential for proportional output growth without loss of efficiency.

Key drivers of institutional efficiency included increased student enrollment, selection of top-ranking students, international scholarship placements, and active faculty participation in research and professional development. To enhance efficiency further, the study recommends fostering faculty-student collaboration, strengthening instructional involvement, expanding engagement with national academic networks, and supporting collaborative research initiatives.

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