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Efficiency and Productivity Analysis of Schools in Ahvaz University of Medical Sciences during 2011-2015

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Abstract

Background & Objectives: Efficiency and productivity are considered as the most important performance indicators of an educational organization. This study aimed to estimate the efficiency and productivity of schools in Ahvaz University of Medical Sciences, Ahvaz, Iran.

Materials and Methods: This descriptive study was based on panel and time series data. In total, seven schools of Ahvaz Jundishapur University of Medical Sciences were assessed during 2011-2015 in terms of efficiency and productivity. The input and output indexes were determined based on research and educational performance of schools. In this research, data envelopment analysis method and the Malmquist productivity index (MPI) were used to analyze the efficiency and productivity of schools, respectively. Data analysis was performed in Deap.2 software.

Results: In this study, mean index of changes in management, scale, technical and technological efficiency over five years were 1 (constant), 0.991 (decreased), 0.991 (decreased), and 0.862 (decreased), respectively. In addition, all efficiency and productivity indexes grew in 2014, compared to the other years. Moreover, the mean total productivity of schools evaluated in the research was reported to be 0.855. Therefore, the schools had a relative decline in productivity (15.5%) during 2011-2015. Furthermore, the total productivity index increased in 2012 (+19.8%) and 2014 (+73.4%). Among the schools assessed, the schools of medicine (47%), health (43%), pharmacy (32%), nursing (14%), and dentistry (13%) had a reduction in productivity, respectively. On the other hand, the schools of paramedical (80.1%) and rehabilitation (18.4%) had the highest rate of productivity growth among the schools of Ahvaz University.

Conclusion: According to the results of this study, efficiency and productivity of evaluated schools required improvement. In this regard, the most important factor for the increase and decrease of total productivity index of the schools was technological efficiency.

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Introduction

Today, knowledge is one of the key factors in determining the development of a country and is an important factor in increasing the productivity and economic growth of organizations. Universities are among the custodians of producing and creating knowledge in the countries. A university uses sources such as government subsidies, staff and faculty, space, and educational facilities to produce knowledge. The main goal of a university is to reach the expected output by using these limited resources (1). All organizations, especially universities and science centers, need performance evaluation due to the importance of educational processes and their outputs. Generally, performance is a combination of efficiency and effectiveness. Performance evaluation (effectiveness and efficiency) in organizations is a process by which organizations can be assessed based on their goals and mission, and their level of success is evaluated in line with achieving goals or level of deviation from their objectives (2).

Sherman defines performance as "the ability to produce output or service with the minimum resources required". Efficiency is the ratio of the production of goods or services to the resources used in their production (1). In its general sense, efficiency means the degree and quality of reaching a set of desirable goals. On the other hand, technical efficiency means the ability of a firm to achieve maximum output using a specified amount of inputs (3).

Efficiency only focuses on the quantitative increase in production and performance and does not address the calculation of the favorable or desired target, which shows the concept of "effectiveness" (1). Various methods exist for measuring the efficiency and productivity of organizations, including data envelopment analysis which is one of the most useful and applicable evaluation methods for performance (2, 3). Data envelopment analysis is a linear planning technique that can be used by managers to model the best decision-making units for other units. In addition, data envelopment analysis is one of the techniques that in addition to assessing the efficiency and performance, suggests methods to increase them separately using the output to data ratio for each level, presenting techniques to increase productivity at all levels.

There are two general orientations in data envelopment analysis: focusing on inputs in

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input-oriented models and focusing on outputs in output-oriented models (3). This method is a technique that measures the efficiency of decision-making units by calculating the total weight of the output-to-input ratio. In this method, a model and reference unit is introduced for inefficient units so that inefficient units could increase their efficiency through modeling, bringing themselves closer to the efficiency border (4). In the data envelopment analysis method, technical (fit of the inputs and outputs of a unit), technological (efficiency obtained from the fit and use of equipment and technologies of a unit), scale (efficiency resulted from changes in the unit size), and managerial (efficiency obtained from available management methods) efficiencies are measured independently.

In addition, the total efficiency index is the product of the multiplication of the types of efficiency. In the mentioned method, total productivity is affected by the efficiency indexes of the unit studied (3-5). Studies have been conducted to measure the efficiency of universities, schools, and educational institutions. However, little attention has been paid to the productivity index. In a similar study by Aghajani et al., the performance of 12 academic units was assessed with two input (educational and service) and output (educational and research productivity) variables (2). In another study, Alem Tabriz et al. conducted a study on the efficiency of schools of Shahid Beheshti University, Tehran, Iran using data envelopment analysis method, concluding that the mentioned technique had a higher efficiency in distinguishing between decision-making units based on goal programming approach, compared to classic methods. Research findings indicated the inefficiency of the faculty of law and efficiency of the schools of science, management, accounting, and earth sciences (3).

Rashidian et al. also used the data envelopment analysis method to measure the efficiency of medical universities of the country, marking that about half of these universities had a declining return to scale. The low efficiency of medical universities causes the waste of healthcare resources in the country. A solution to increase the efficiency of universities with a surplus capacity of production factors is reducing the capacity of units and increasing the educational, research and health-treatment performances (6). Assessing the efficiency and productivity of schools of a university and evaluating the causes of their efficiency and inefficiency are

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of paramount importance for proper planning to optimally allocate resources and correct the inefficient units. With this background in mind, this study aimed to evaluate the efficiency and productivity of schools of Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.

Materials and Methods

This descriptive study was based on panel and time series data. The research sample involved all schools of Ahvaz Jundishapur University of Medical Sciences, including health, paramedical, nursing and midwifery, rehabilitation and pharmacy, and dentistry. The efficiency and productivity of the schools were evaluated during 2011-2015. In this study, the indexes and statistics required in the field of education and research activities were obtained and collected as the main performance areas in schools by using checklists and referring to the related units.

In this study, the data envelopment analysis method was used to assess the efficiency and productivity of schools. This is a non-parametric method and is classified as a linear planning technique. In the data envelopment analysis method, each school was evaluated as a unit. The data envelopment analysis method is able to estimate the percentage needed to increase output for each inefficient unit to reach the efficiency border. In this study, three input indexes, including the number of professors, number of higher-education students, and the existing equipment (number of computers at site) and four outputs, including mean research score of each school, the number of published articles (type one-three), seminars and conferences held by the school, and the number of graduates of each school, were considered to estimate the efficiency of the schools (1-4).

Deap.2 software was used to analyze the data and calculate the efficiency and productivity of schools. In addition, the Malmquist productivity index (MPI) was exploited to measure productivity. After estimating the efficiency of units (schools), the software considered one reference unit and analyzed the efficiency level of other units in comparison to the reference unit.

In this analysis, the input-oriented approach was used with a variable return to scale assumption. In order to classify the efficiency indexes, the efficiency of schools can be regarded as high (<0.5), moderate (0.51-0.8) and low (>0.81) efficiency (5). Efficiency equal to one was regarded as a complete and constant efficiency, whereas lower values were indicative of decreased efficiency. The

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more inefficient units must increase their output (indexes of results) to be more efficient. In the estimation of changes in the total efficiency and productivity, values below one demonstrated reduced efficiency and productivity while values above one were interpreted as improved (positive changes) efficiency and productivity.

Total productivity changes= technical efficiency (fit of a unit's inputs and outputs) × technological efficiency (efficiency obtained from the fit and function of equipment and technologies of a unit) × scale efficiency (efficiency obtained from changes in a unit's size) × management efficiency (efficiency obtained from the current management methods and techniques)

This study was approved by the ethics committee of Ahvaz Jundishapur University of Medical Sciences (code of ethics: IR.AJUMS.REC.1395.235). The researchers committed to observing all ethical considerations during the implementation of the research.

Results

According to Table 1, the total mean of efficiencies (technical, management, and scale, with the exception of technological) was higher in schools of health, medicine, and pharmacy, compared to other schools. In addition, the schools of dentistry and nursing-midwifery had a lower mean of efficiency, compared to the other schools, and required improvement.

Table1: Average of efficiency between studied schools from 2011 to 2015

Allied Medical Sciences	Rehabilitation	Nursing and Midwifery	Dentistry	Pharmacy	Medicine	Public Health	Year
1	1	0.741	0.501	1	1	1	**2011**
0.951	1	0.789	0.763	1	1	1	**2012**
1	1	0.847	1	1	1	1	**2013**
0.814	1	0.889	0.608	1	1	1	**`2014**
1	0.958	1	0.51	1	1	1	**2015**

***1=full efficient; <1=relative efficient**

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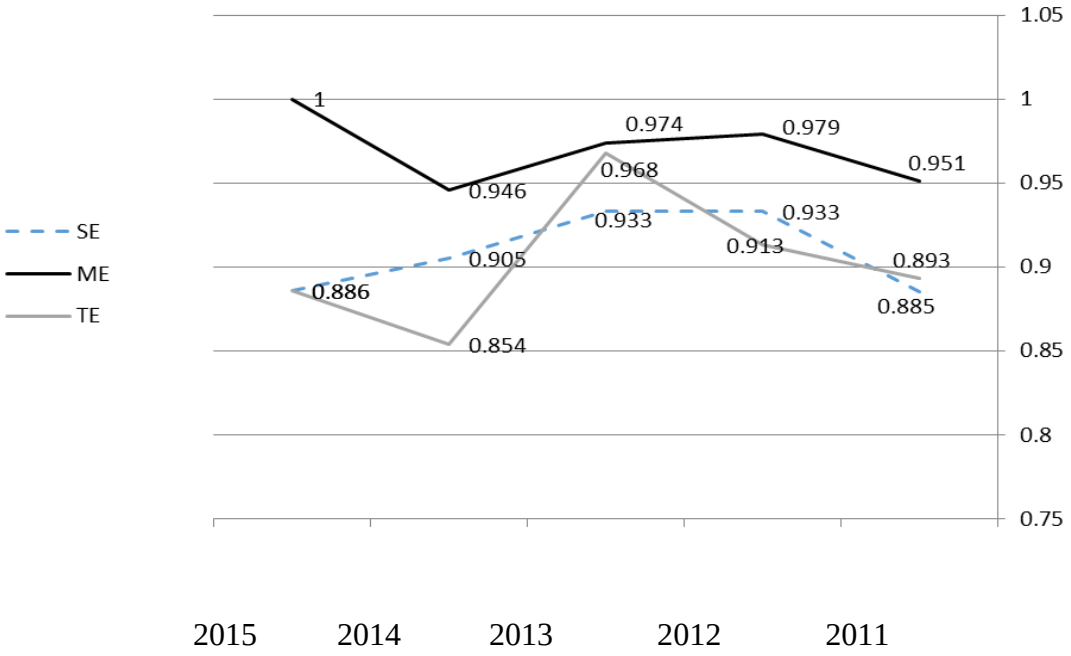
According to Diagram 1, management efficiency had a higher improvement, compared to other efficiency indexes. In addition, the mean management efficiency (efficiency obtained from the existing management methods) of schools in Ahvaz University of Medical Sciences was higher, compared to the mean technical and scale efficiencies (total efficiency=1). In total, the mean management, scale, and technical efficiencies of the schools were reported to be 0.97, 0.908, and 0.886, respectively. Therefore, the total mean of efficiency indexes was relatively high and close to full efficiency.



***TE: technical efficiency ME: Managerial efficiency SE: Scale efficiency**

Diagram1: Mean efficiency of studied schools between 2011 to2015

According to Table 2, mean index of management, scale, technical and technological efficiency changes in five years was reported to be one (constant), 0.991 (decreased), 0.991 (decreased), and 0.862 (decreased), respectively. In this regard, all efficiency and productivity indexes were improved in 2014 and were at a higher level, compared to the other years. The total mean productivity in the university was 0.855 in five years, which means that the university was faced with a slight decrease in its productivity (15.5%) during 2011-2015.

In addition, the total mean productivity had a

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relative growth in years 2012 (+19.8%) and 2014 (+73.4%). According to Table 2, the most effective factor for improved productivity of the university in 2012 was the technologyefficiency index (efficiency caused bytheoptimaluseoftechnology and equipment) (20.7% growth). In 2014, the most effective factors were the efficiency indexes of technology (31.9% growth), technical (fit of the production technical factors)(31.5% growth),management (management methods) (22.5% growth) and scale (efficiency caused by changes in the size of organization, compared to its outputs) (7.3% growth).

Table2: Efficiency and productivity change in university from 2012 to 2015

Total Productivity Change	Technical Efficiency Change	Technologic Efficiency Change	Pure Efficiency Change	Scale Efficiency Change	Year
1.198	0.993	1.207	1	0.993	**2011**
0.277	0.74	0.374	0.806	0.918	**2012**
1.734	1.315	1.319	1.225	1.073	**2013**
0.928	1	0.929	1.013	0.987	**`2014**
0.855	0.991	0.862	1	0.991	Total mean

***1=full efficient; <1=relative efficient**

****Total productivity change=Technical efficiency change×Technologic efficiency change×Pure efficiency change×Scale efficiency change**

In Table 3, results demonstrated that among the schools evaluated, the schools of medicine (47%), health (43%), pharmacy (32%), nursing (14%), and dentistry (13%) had a higher decrease in their productivity, respectively. On the other hand, the schools of paramedical (80.1% growth) and rehabilitation (18.4% growth) had an improved productivity. According to Table 3, the technology efficiency index was the most important factor for positive and negative changes in the total productivity of the mentioned schools. In other words, if schools with low productivity level improve their technology and equipment use, they will experience enhanced productivity. Finally, it must be pointed out that the total productivity index of the university was slightly low (0.855), and all schools were faced with a 14.5% decrease in their total productivity.

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Table3: Efficiency and productivity change between schools from 2012 to 2015

Rank	Productivity Status	Total Productivity Change	Technical Efficiency Change	Technologic Efficiency Change	Pure Efficiency Change	Scale Efficiency Change	Year
6	Decreasing	0.571	1	0.571	1	1	**Public Health**
7	Decreasing	0.532	0.909	0.585	1	0.090	**Medicine**
5	Decreasing	0.686	1.002	0.685	1	1.002	**Pharmacy**
3	Decreasing	0.87	1	0.87	1	1	**Dentistry**
4	Decreasing	0.862	1.032	0.835	1	1.032	**Nursing and Midwifery**
2	Increasing	1.184	1	1.184	1	1	**Rehabilitation**
1	Increasing	1.801	1	1.801	1	1	**Allied Medical Sciences**
-	Decreasing	0.855	0.991	0.862	1	0.991	**Total Mean**

***1=full efficient; <1=relative efficient**

****Total productivity change=Technical efficiency change×Technologic efficiency change×Pure efficiency change×Scale efficiency change**

Discussion

The present study aimed to measure the efficiency and productivity of schools of Ahvaz Jundishapur University of Medical Sciences using the data envelopment analysis method. Evaluation of the efficiency and productivity of medical schools and universities of the country, which are the custodians of community health, is a vital step toward the improvement of their management (6). In the current research, the data envelopment analysis method was used to estimate the efficiency and productivity of schools. The total productivity is an index obtained as the product of technical, technological, scale and management efficiencies and has a linear relationship with efficiency. According to our findings, the total mean efficiency (technical, management, and scale, with the exception of technology) was relatively higher in schools of health, medicine, and pharmacy, compared to the other schools. On the other hand, the dentistry and nursing-midwifery schools had a relatively lower mean of efficiency, compared to the other schools. The mean of changes in the index of management, scale, technical, and technological efficiency in five years was 1 (constant), 0.991 (decreased), 0.991 (decreased), and 0.862 (decreased), respectively. All efficiency and productivity indexes were improved in 2014 and were higher, compared to the other years.

Several studies have been conducted on the

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evaluation of educational centers in the country. In this respect, Rashidian et al. marked in a research that the mean efficiency of medical universities of the country was 0.812 estimated using the DEA approach. Therefore, the capacity to increase the technical efficiency of production in these universities was approximately 19%. About half of the medical universities had a descending return to scale (6). In another study by Pourmiri, who evaluated the performance of non-clinical educational departments in Isfahan University of Medical Sciences, Isfahan, Iran in 2011 applying the data envelopment analysis method, from 13 groups evaluated, six were efficient and seven were inefficient (7).

Aghajani et al. performed a research to assess the performance of units of Islamic Azad University, Mazandaran Province, by using the data envelopment analysis method. These researchers reported that some units had a relatively suitable efficiency, whereas some other units had a relatively poor efficiency. According to their results, the Nour Branch had a relatively suitable efficiency while the Tonekabon Branch had a relatively poor efficiency. It was suggested in the mentioned research that all units with relatively poor efficiency move toward the performance of the units with relatively appropriate efficiency through modeling (2). Mousavi conducted a similar study on the performance of humanities schools of Shahid Beheshti University, Tehran, Iran, marking a significant difference between the schools evaluated in different years regarding efficiency (8).

In a research, Khosravi et al. evaluated the educational performance of schools and educational departments of Persian Gulf University, Bushehr, Iran applying the data envelopment analysis method. These researchers affirmed that three out of seven schools and seven out of 24 educational departments had full efficiency and were defined as reference units (9).

Various studies have been conducted to evaluate the performance and productivity of educational organizations in other countries as well. In a study in Australia entitled “determining the cost of efficiency in the University of Australia”, 36 academic units were assessed in 2002. In the mentioned research, the mean efficiency was estimated at 45%, and from 36 academic departments evaluated, 2.7% had one efficiency, 25% had 0.5-1 efficiency, and 72.3% had below 0.5 efficiency (10). In a study by Aziz et al. on the relative efficiency of schools of a

university in Malaysia, it was concluded that the humanities schools had a better efficiency, compared to basic sciences schools (11).

In another research by Johns and Yu on 109 universities of China, the data envelopment analysis method was exploited, results of which demonstrated that when all input and output variables were considered, the mean efficiency of universities was above 90% (12). On the other hand, Khosravi et al. conducted a study to evaluate the efficiency of health information technology education departments of medical universities of the country applying the comprehensive statistical method. These researchers reported that the educational departments with efficiency evaluation scores below 1 must increase their research achievements by presenting a higher number of research projects, articles, and book publications. In addition, these groups must reduce their educational inputs (number of students) and their credits based on the surplus amount specified in the form of a long-term plan (13).

According to the results of the present study, some of the schools had lower efficiency. Therefore, it is necessary for these schools to model the reference schools to reach an acceptable efficiency. In a study, Feyzi et al. evaluated the efficiency of healthcare centers by assessing the efficient reference units. The evaluation of efficient reference units can provideagood pattern of resource management by providing a proper pattern of inputs and outputs from a unit (school) (14, 15). Furthermore, the total productivity changes of schools were measured using MPI, which has twomain components, including technological and performance changes (16). The total productivityindexincludes the total coefficient of variation of scale, technical, technology and management efficiency (15, 16).

According to the results of the present study, the total mean productivity of the schools evaluated was estimated at 0.855. Therefore, the schools had a relative reduction in their productivity level (15.5%) during 2011-2015. However, the total productivity index of the schools increased in 2012 (+19.8%) and 2014 (73.4%). Among the schools assessed in the current research, the medicine, health, pharmacy, nursing, and dentistry schools had a reduction in their productivity level, respectively. On the other hand, the paramedical and rehabilitation schools had improved productivity. Our findings can be utilized to classify the performance of schools of the university.

With the managerial, technical, and especially technological (optimal application of

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technology) interventions and structural interventions in schools, they can improve their total productivity index of production factors. One of the most important reasons for decreased efficiency is lack of attention to faculty members (in terms of facilities and access to other articles and participation in seminars abroad and welfare facilities). Generally, decreased efficiency is associated with reduced productivity. Improvement of efficiency requires encouraging faculty members to publish qualitative articles and establishing a strong relationship between facultymembers'research papers and obtaining a scientific rank, which will be effective in improving the status of research units.

On the other hand, university units must provide the foundation for faculty members to have access to valid domestic and international scientific databases (14). Measuring efficiency and productivity via the data envelopment analysis method eliminates the defects caused by ignoring the simultaneous impacts of several indexes. This is a multivariate decision-making technique that provides more valid results by relative ranking of units, compared to other methods (17). It is recommended that studies be conducted to evaluate efficiency by relying on mathematical techniques and logical calculations, including data envelopment analysis so that the power of decision-making for improving the weaknesses of an organization would be increased by quantifying the performance of its units. In addition, it is suggested that this performance assessment method be presented in the form of a decision-making supporting system and an information management system so that organizations could pass the path of performance improvement by having a relevant evaluation dashboard.

Research Limitations

One of the major drawbacks of the present research was the use of data envelopment analysis method since it was unable to determine the cause of inefficiency. Therefore, other methods are required to complete the results. In addition, this technique reports results in relative terms, and the impact of each input on the outputs cannot be reported by this technique. Another limitation of the current study was the lack of presence of information and organizational indicators in schools, which might have affected the final results.

Conclusion

According to the results of the present

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study, the efficiency and productivity of the schools assessed required improvement, and most of the schools had relative inefficiency. Results demonstrated that the most important factor for changes in the total productivity index of the schools was technological efficiency. Therefore, by optimizing the organization's technology, efficient resource management, controlling the inputs and outputs of the organization, and performing effective management interventions, we can improve the efficiency and productivity of schools of a university. Efficiency improvement ultimately leads to improved productivity.

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