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Abstract

Background: The importance of paying attention to improving productivity in different departments of health system become increasingly evident due to increased costs of health care goods and services, limited resources and production facilities. The aim of this study was to measure the productivity of medical records departments of hospitals affiliated with Urmia University of Medical Sciences (UUMS) in order to provide a comprehensive analysis of their performance.

Method: In this study, total productivity and total factor productivity changes of medical record department in hospitals affiliated with UUMS were calculated by Kendrick-Creamer and Malmquist indexes in 2016-2020 and has examined the trend of each One of them.

Results: The results of Malmquist index showed that average total productivity changes of medical record departments of hospitals during the study period was equal to 1,096 which is greater than one, therefore it can be concluded that productivity has decreased by about 9.6% during the study period; Technological efficiency changes has had the greatest impact on reducing productivity compared to other factors.

Conclusion: The main cause for decreased productivity due to technological changes in the studied departments is the lack of sufficient knowledge of the medical record department staff of hospitals in the use of technology and equipment in providing services correctly and holding training courses for the correct use of technology by personnel can be useful in this regard.

Keywords: Productivity, Medical Record Department, Malmquist Index, Kendrick-Creamer Index

Background

The healthcare sector is considered as one of the most important service sectors and its performance is one of the indicators of development and social welfare, whose economic analysis is vital for health decision-makers [1-3]. The hospital is one of the most important and influential segments of society in all health systems that plays an important role in providing medical services and health promoting [4, 5]. Thus, hospitals benefit from a large share of trained and specialized personnel in the health care system in many countries and consume about 50 to 80 percent of health funding [6]. National statistics in Iran show that about 40% of government health expenditures are related to hospitals [7, 8]. Thus, managing hospitals and its departments in a favorable manner as the most important center for providing health services should always be considered by health policy makers and decision makers. The Medical Record Department (MRD) is one of these hospital departments, where all documents related to medical services provided to a patient in the hospital are prepared and kept in an accessible manner, in the order of the date, to be used when necessary for the subsequent treatment of patients, research and training and review of services provided in terms of quantity and quality. The MRD is considered as the most important and richest source of information for evaluating and planning health care services in health care organizations such as hospitals. In this department, the patient's medical record is the most important tool for storing and retrieving information and analyzing health care and expressing all information related to the patient's medical history, diseases, health risks, diagnoses, tests, examinations, treatment methods, disease course, the patient's response to treatment and follow-up [9].

Waste of resources is one of the consequences of poor management of hospitals' MRD. Available resources can be used to provide more services and improve service quality by preventing and reducing resource waste [10]. Therefore, improving productivity has the most effect on cost control planning and prevention of waste of resources in different departments of hospitals [11]. MRDs are no exception and it is necessary to implement effective strategies of the managers of these departments to reduce costs and increase productivity.

Calculating productivity enables the managers of MRD to monitor the trend of productivity changes, and identify potential problems and take timely corrective action. Therefore, measuring total factor productivity (TFP) changes, a criterion for describing the correct and optimal use of production factors, and identifying the factors affecting these changes, will lead to the adoption of corrective measures to improve productivity [12].

In general, Data Envelopment Analysis (DEA) and Kendrick-Creamer Index are the most important and accurate methods of measuring productivity. The Kendrick-Creamer Index measures total and final productivity of the production factors of hospital's MRD. Total factor productivity (TFP) is defined as the ratio of total production to the sum of all inputs consumed; while final productivity, is the amount of change in total production per unit of change in the use of the production factor. The amount of changes in total productivity for all MRDs of hospitals can be calculated using the DEA method by Malmquist index, which is an accurate measure of productivity monitoring [13]; and divides productivity changes into changes resulting from technological, managerial, and scale efficiency [14-16].

There is no study conducted to evaluate the productivity of MRD in Iranian hospitals, especially using the Kendrick Creamer index. The results reported by Dargahi et al., Nabilou et al., Lee et al., Silwal et al., and Moffat et al., confirmed the attention to the productivity in hospitals.

This study was aimed to determine the total factor productivity changes and also to measure the productivity of production factors in the MRD of hospitals affiliated to UUMS during 2016-2020 in order to plan to improve the performance of the MRD as well as the allocation of resources to this important department optimally.

Methods

This descriptive-analytical study has examined all MRDs of teaching hospitals affiliated to UUMS, West Azerbaijan, (including 24 hospitals) for the period 2016-2020. The results of the MRD of each hospital with the number assigned will be provided to that hospital in order to comply with ethical considerations. The required data and information were collected from the studied hospitals as well as the vice-chancellor for treatment affairs of UUMS using checklists designed by the researcher.

According to the results of previous studies, a combination of the most important and common inputs and outputs was selected to estimate total factor productivity changes. These data include: the number of outpatient and inpatient medical records prepared for patients in the MRD and the number of responses to letters and of patients referred to the department as output and the variables of the number of personnel working in the MRD, holders of associate and lower and bachelor and higher degrees as well as the number of equipment (computer, printer, wristband printer, barcode reader and ICD-10 (International Statistical Classification of Diseases) books are considered as inputs [10, 17, 18].

At first, productivity changes of the studied hospitals were evaluated for the period 2016-2020 using non-parametric method of Data Envelopment analysis and Malmquist index through Deap2.1 software after the required data were collected from the MRDs of the hospital Affiliated to UUMS. The Malmquist productivity index is defined using distance functions as follows:

$$M_i^{t+1}(q^{t+1}, X^{t+1}, q^t, X^t) = \frac{D_i^t(q^{t+1}, x^{t+1})}{D_i^t(q^t, x^t)} \left[\frac{D_i^t(q^{t+1}, x^{t+1})}{D_i^{t+1}(q^{t+1}, x^{t+1})} \cdot \frac{D_i^t(q^t, x^t)}{D_i^{t+1}(q^t, x^t)} \right]^{1/2} = E_i^{t+1} \times T_i^{t+1} \quad (1)$$

In this formula, M_i^{t+1} (total factor productivity index) is equal to multiplying technological changes (T_i^{t+1}) [which is measured by transferring the frontier production function between period t+1 and t] by efficiency changes (E_i^{t+1}) in the same period. D_i is the input distance function, (q^{t+1}, X^{t+1}) is the output and input values in period t+1, and (q^t, X^t) is equal to the output and input values in period t, respectively.[19] Finally, the total productivity changes for the MRD of each hospital are obtained from the following equation:

Total productivity changes= managerial efficiency changes × scale efficiency changes × Technological changes

If the Malmquist index is less than one based on minimizing production factors, it means that performance improves, while a value greater than one indicates performance reduction over time [20].

Then, Kendrick-Creamer index was used to measure the total productivity of production factors. The existence of total production elasticity relative to the production factors is necessary to

calculate the mentioned index, which required estimating the production function to measure these elasticities. Parametric method of Stochastic Frontier Analysis (SFA) and Frontier_{4.1} software were used to estimate the function. In the following function, the power of each of the production factors indicates its corresponding elasticity:

$$Y = AP^{\alpha}N^{\beta} \quad (2)$$

At this stage, the total productivity of production factors of the hospitals under study was calculated through the Kendrick-Creamer index using the elasticity of production factors. The mathematical form of the Kendrick-Creamer function is as follows:

$$TFP_i = \frac{Q_i}{P.e_p + N.e_n} \quad (3)$$

Where TFP_i is total productivity of MRD, Q_i is output, the number of outpatient and inpatient medical records for patients in the MRD and the number of responses to letters and clients referred to this department were used as output in this study, P is the number of personnel input, N is the number of equipment input, e_p is the elasticity of personnel input and e_n is the elasticity of equipment input in the MRD of the studied hospitals.

Results

The Kendrick-Creamer index was used to calculate the total factor productivity. The existence of total production elasticity relative to production factors of personnel and capital is necessary to calculate the mentioned index, which required estimating the production function to calculate these factors. Frontier_{4.1} software was used to estimate the production function. The results of estimating the production function are as follows:

$$\ln Y = 10.11 + 0.44 \ln L + 0.48 \ln K$$

Standard deviation (0.14) (0.19) (0.25)

t statistics (71.04) (2.32) (1.9)

LR= 13.4

As can be seen, all coefficients are statistically significantly different from 0. Given that the obtained LR is above 4, the estimated function is therefore suitable.

In the next step, the total factor productivity of MRD of hospitals affiliated to UUMS was calculated using the elasticity of the production factors. According to the calculations listed in the following table, the average total productivity has reached 17885.26 in 2020 from 13984.94 in 2016 during a fluctuation. That is, the total MRDs of university hospitals, on average, for each unit of labor (personnel) and capital (equipment available in the MRD) have been able to create an output (services provided in the MRD) by 17885.26 in 2020 (Table 1).

[Table 1 about here]

Figure 1 shows the trend of average total productivity of production factors in all MRDs of hospitals affiliated to UUMS during the years 2016-2020.

[Figure 1 about here]

The sum of the elasticities of the production factors (function coefficient) indicates the return to scale.

$$\varepsilon = E_{YL} + E_{YK}$$

The elasticities of the production factors in the Cobb-Douglas production function with logs on both sides are the same function coefficient. The elasticity of each of the production factors is shown in the table 2.

[Table 2 about here]

The function coefficient is obtained approximately equal to one by summing the elasticities, which represents constant return to the scale.

$$\varepsilon = E_{YL} + E_{YK} = 0.44 + 0.48 = 0.92 \cong 1$$

The results of calculating total factor productivity changes using Deap_{2.1} software and analysis of its changes based on the factors affecting it are as follows:

[Table 3 about here]

As the calculations in the table 3 show during the period under study, the average total productivity changes was equal to 1.096. Given that the number obtained is greater than one, productivity has decreased during the period under study. Also, the average technological efficiency changes was 1.142, the average technical efficiency changes was 0.959, the average managerial efficiency changes was 0.979 and the average scale efficiency changes was 0.979. During the studied period, technical, managerial and scale efficiency had a positive effect on productivity, while it was observed that technological efficiency had a negative effect on productivity.

The results of the table 4 show that hospitals 20 (2.880) and 10 (0.866) achieved the worst and best performance among the MRDs of the studied hospitals, respectively. Also, the departments 10 (0.793), 4 (1.075), 19 (0.728), 10 (0.793) gained the most improvement in the index of changes in technical efficiency, technological efficiency, managerial efficiency and scale efficiency during the years 2016-2020 respectively. Total productivity changes of MRDs of hospitals affiliated to UUMS are largely affected by the negative effect of technological efficiency changes. As a result, it is necessary must pay attention to how to use new technologies to increase productivity.

[Table 4 about here]

Discussion

The use of physical, technology and manpower resources optimally is the main motivation for the use of scientific and applied methods in evaluating the activities and performance of organizations. One of the most important performance appraisal indicators for how to combine factors and production resources to achieve the goal of optimal resource allocation and cost reduction is productivity. The present study was aimed to investigate the productivity of MRD of hospitals affiliated with UUMS.

The Kendrick-Creamer index was used to calculate the average total production factor productivity of MRDs of the studied hospitals in all the studied years, which is equal to 18725.53; In other words, all MRDs of the hospitals under study have been able to provide services, equal to 18725.53, on average for each unit of total production factors. The results of this index show that productivity has increased in all studied years except 2019.

In this study, the average total productivity changes of MRDs of hospitals affiliated with UUMS using Malmquist index was equal to 1.096. Given that the number obtained is greater than one, ie the total production factor productivity of MRDs of the studied hospitals has decreased despite the increasing trend of productivity growth during the years 2016-2020 and the amount of this

decrease has been 9.6%. In the meantime, technological efficiency changes have had the greatest impact on reducing productivity compared to other factors. In other words, MRDs under study did not take advantage of technological advances correctly. Therefore, we need to look at how new technologies can be used to increase productivity. According to the results reported by Sahin et al., due to technological advances in providing services following by government investment, the total productivity of Turkish hospitals has increased in public hospitals in that country [21]. Thus, improving technology can play an important role in increasing the productivity of MRDs especially in large hospitals. During the studied period, the technical, managerial and scale efficiency of MRDs of hospitals also had a positive effect on productivity.

In this study, the sum of the elasticities of the production factors (function coefficient) was approximately equal to one; that is the return to scale is almost constant in the MRDs of the studied hospitals; it means that a one percent change in the amount of utilization of production factors leads to a one percent change in the amount of production.

The results of Malmquist index indicated that the average technical efficiency of MRDs of hospitals was 0.959; that is, these hospitals can increase their output by 4.1% without increasing the amount of production inputs and due to the use of resources optimally.

The average managerial efficiency has obtained 0.979 in this study; in other words, productivity can be increased by up to 2.1% using the correct management techniques and motivation of the staff of the MRDs of the hospitals without changing the amount of inputs. Therefore, effective steps can be taken to improve the productivity of MRDs of these hospitals by proper management, using the opinions of staff and creating favorable working environments.

The average scale efficiency was 0.979 in this study; this means that an annual average of 2.1% can be added to the output of MRDs in the studied hospitals due to the savings caused by providing services on a large scale. Therefore, departments with increasing returns to scale should increase the level of providing services due to economic justification; and departments with decreasing returns to scale should review the overall structure of their department and adjust their capital and additional personnel inputs to avoid negative marginal production.

The main reason for decreased total factor productivity can be the lack of sufficient knowledge of the personnel of the MRDs of the studied hospitals in utilizing the existing equipment and technologies of this department in providing services in the right way. Therefore, training courses should be provided for using equipment correctly by personnel in departments where the main reason for the decreased productivity is technological changes. In this study, the average annual output of MRDs has been reduced by 14.2% due to technological changes. According to the results of Malmquist index, the range of changes in total factor productivity of MRDs of the studied hospitals in the review period was between 0.866 and 2.880, so that, productivity has increased only in 7 departments out of 20 MRDs of the studied hospitals and productivity have decreased in another 13 departments. Therefore, high efficiency departments can be considered as a peer for other departments in terms of using production factors to increase efficiency and productivity.

In this regard, effective measures such as quantitative and qualitative improvement of providing services, continuous performance appraisal as well as the optimal use of personnel and equipment of departments to increase the efficiency of hospital MRDs are proposed. Also, by continuously monitoring the performance of MRDs, the results can be used for planning and policy-making and to avoid wasting resources, and the causes of their progress or decline can be determined by

examining trends in total productivity changes. According to the results of the indexes calculated in this study, the amount of total productivity changes and its trend in MRDs of hospitals can be identified; thus, it is suggested that managers pay special attention to these methods to improve their productivity and performance.

Most of the studies carried out on the productivity of total factor production in the health system have focused on the medical departments, and so far only one domestic study has been conducted on the productivity of MRDs of Tehran University of Medical Sciences through Malmquist index, and no study has been conducted to compare with the results of this study. Therefore, the main limitation of this study was the impossibility of comparing the results of the present study with other studies. This study is the only study that has investigated the total factor productivity of all MRD using two indexes of Malmquist and Kendrick-Creamer, which is considered as its most important advantage compared to the study conducted by Dargahi et al. during a study investigated the changes in the productivity of the MRDs of the hospitals of Tehran University of Medical Sciences through the years 2006-2007 and used DEA method (Malmquist index) assuming maximization of the production factors, total productivity changes were calculated in their study, which was equal to 0.938, which this number indicates that the productivity of MRDs of hospitals has decreased during the studied period due to the wrong assumption adopted to calculate the amount of productivity changes. Also, changes in technological and technical efficiency had the highest effect on reducing amount of total productivity changes and changes in managerial efficiency and scale efficiency were in the next ranks, respectively [10], which is consistent with the results of this study. In general, in the health system, they aren't able to control the number of patients referred to hospitals; thus, it is wrong to use the assumption of output maximization in calculations. Nouraei Motlagh et al. during a study investigated changes in the total factor productivity in hospitals affiliated with Lorestan University of Medical Sciences using DEA method in 2010-2016. In this study, the average total productivity changes of hospitals during the studied period was 1.023, which indicates productivity has decreased during the studied period, and technological changes had the most negative effect on productivity reduction compared to other factors [17], which is consistent with the results of this study. Also, technological changes in the studies of Torabipour in Ahvaz hospitals [22], Krigia in Angola hospitals [23] and Yawe in Uganda hospitals [24] were the main cause of decreased total productivity which is consistent with the results of present study. Therefore, the productivity of all departments in the hospital, including the MRD can be increased by upgrading technology and using the up to date equipment.

Conclusions

The results of the Kendrick-Creamer and Malmquist indices can help managers improve productivity and thus reduce the costs of hospital medical records departments.

Abbreviations

UUMS, Urmia University of Medical Sciences; DEA, Data Envelopment Analysis

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Authors' contributions

AM, BN, SA and HY contributed to the conception of the article. HY and BN performed the statistical analysis of the manuscript. HY, BN and SA revised the drafts. All authors approved the final article.

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Availability of data and materials

The datasets of this study are available from the corresponding author.

Declarations**Ethics approval and consent to participate**

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Consent for publication

Not applicable.

Competing interests

Authors declare that they have no competing interests.

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Figures

Figure 1

Average total factor productivity in all MRDs of hospitals affiliated to Urmia University of Medical Sciences during 2016-2020