Investigating the Financial Performance of Universities of Medical Science and Health Services in Iran, Using Data Envelopment Analysis

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Abstract
Background: Universities of Medical Science and Health Services (UMSHS) are among the main organizations in Iran’s health-care section. Improving their efficiency in financial resource management through creating an appropriate coordination between consumption and resources is strategically vital. Investigating the financial performance as well as ranking the Iranian UMSHS is the research objective.

Methods: The study is of descriptive and applied type. The study population includes the UMSHS, of Iran (n=42) among which 24 UMSHS are selected. DEA is used with the aim to model and assess the financial performance including 4 inputs and 3 outputs. Also, linear regression is applied to determine the effectiveness of the applied indices as well as the level of the financial performance. Data are obtained from the Budgeting Center in the Ministry of Health and Medical Education, during 2010 mainly through forms designed based on the available balance sheets.

Results: The average score of financial performance assessment for UMSHS, based on the DEA of input-oriented data is 0.74, assuming a constant scale of DEA-CRS. Thus, approximately 25% of the studied UMSHS, have maximum relative performance and totally, there is about a 30% capacity to increase the financial performance in these UMSHS.

Conclusion: Most Iranian UMSHS, do not have high financial performance. This can be due to problems in financial resource management especially in asset combining. Therefore, compilation and execution of a comprehensive program for organizational change and agility with the aim to create a kind of optimized combination of resources and assets is strongly recommended.

Keywords: Financial performance, Technical efficiency, Managerial efficiency, Scale efficiency, Iran
Introduction

Nowadays, a global competition through vast cultural, social, and economic changes leads to remarkable changes in governmental structures, namely in replacing the traditional twentieth-century patterns of government administration with modern government administration (1). Modern government administration is an international phenomenon the impact of which is evident in various countries including England and the US (2).

On the other hand, reformation in health system is one of the fundamental and pioneering strategies and policies in different countries, considering the two following main bases:

- Structure reformation and decentralization
- Reformation of income-outcome financial systems (3, 4).

Accordingly, the financial system as the second feature affecting the reformation in addition to keeping a track of self-organization feature, and decentralization, as the first essential basis of health system reformation acting as a motivating force and the backbone for reformation both require comprehensive consideration (5, 6). It is mentioned, financial function is one major functions of health system (stewardship, resource generation, health financing and service provision); improving and transplanting of this function in UMSHS, is critical point and issue for health system reformation (5).

On the other hand, in most middle-income countries, more than 5% of the GDP and 5% to 10% of the total governmental costs is allocated to health section (7). Without an appropriate infrastructure for effective deployment of resources, especially financial ones, the effectiveness and efficiency assessment and monitoring of such resources will not be possible, and even a permanent increase in financial credits for this section cannot be useful in removing the system’s problems (8).

Therefore, efforts for reformation in financial management and responsiveness in governmental section has launched in Australia since 2000, with shifting their accounting method from cash to accrual as the most basic step derived from the reformation of financial management in governmental section (2). While in Iran, several major problems in health and medication affairs as one of the governmental parts pose to hinder the emergence of reformation; to mention a few, these problems can be counted: issues in cash registration and financial record of receptions and payments, as well as in registration of buying assets and properties, weakness in preparing financial reports and in preparing financial sheets, and ambiguity in real performance of the budget (9).

Among the most important priorities of health section for achieving financial optimal management system, one can consider the following: devoting credit at the time of creating or approving a cost, implementing the effective internal controls, integrating and standardizing the processes, activity-based budgeting, budget-controlling and analyzing the deviation from project, reforming the organizational structure, and homogenizing the data (9, 10).

In Iran, the Ministry of Health and Medical Education (MHME) is the governmental organization in charge of public health administration for formulating and establishing the policies and strategies, general monitoring, directing and developing the national health proceedings (10). Among the problems, there is a profound lack of powerful communication system in our information technology in this field; moreover, the available information about human, logistic, and financial resources and budget in the existing financial systems in Iran’s public health section is not comprehensive, and this, by itself, leads to a weakness in information-based decision-making (8). Thus, it seems that a reform in financial system of MHME as well as an implementation of a modern financial system is absolutely essential.

Furthermore, the importance of implementing a reform in modern financial system of health section is officially confirmed regarding the existing defections in our traditional system and consider-
ing the emphasis of governmental documents such as Plan Four in Iran’s Development Act, financial and transactional regulations of UMSHS nationwide, and the legislations of governmental administration in service-providing section (11). Thus, since the MHME is responsible for financial management of more than 40 UMSHSs, about 600 public hospitals, and 4000 urban and rural medical centers nationwide (12), the reform in financial management of the country’s health system has started.

To achieve more effective use of public resources, cash accounting is proved not to be appropriate for implementing the government plans (10), nor does it provide the required information; thus, the MHME has started to reform its accounting system from cash accounting into accrual, as the first step towards creating an efficient financial information base for decision-making in asset combination and financial resources management (13). This first phase has been accomplished in 2010 and UMSHSs of the country are now able to present their financial sheets based on accrual accounting.

Still, the performance analysis and the assessment of these financial sheets is a vital step to be taken in order to make feasible the process of decision-making regarding the mentioned issues; for this reason, this study aimed to investigate the financial performance of UMSHSs over the country using Data Envelopment Analysis.

Materials & Methods

The present study is of descriptive, periodical, and applied type, regarding method, time, and objectives, respectively conducted in 2012. In addition, it is of quantitative type, using financial sheets of Iran’s UMSHSs; the research method applied is DEA.

In order to implement the model for financial performance assessment based on DEA, all UMSHSs of the country were selected as our research population (n=42). Considering the accrual-accounting report in the form of financial sheets, and the correctness and deficiency of financial information, 24 UMSHSs were selected, and the remaining 18 were excluded from the population (10 did not present their financial reports in accrual form, 5 provided incomplete information, and 4 lacked the reliability in their financial information).

In line with the policies for reducing the costs and for avoiding resources wasting, the DEA method was applied to all input data; the financial performance of the studied UMSHSs was calculated in EMS software based on CCR model and BCC input; and finally, a complete ranking (AP model) was performed.

In conducting the DEA, the inputs included $X_1$=current assets, $X_2$=constant assets, $X_3$=public budget, and $X_4$=operational costs, while the outputs included $Y_1$=cash flow of operation, $Y_2$=operational income, and $Y_3$= cash surplus/deficit rate.

The Input-oriented CCR:

\[
\text{Min} \quad \theta \\
\text{s.t} \quad \sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{i0} \\
\sum_{j=1}^{n} \lambda_j y_{ij} \geq y_{i0}
\]

The Input-oriented BCC:

\[
\text{Min} \quad \theta \\
\text{s.t} \quad \sum_{j=1}^{n} \lambda_j x_{ij} \leq \theta x_{i0} \\
\sum_{j=1}^{n} \lambda_j y_{ij} \geq y_{i0} \\
\sum_{j=1}^{n} \lambda_j = 1
\]

Data collection for the determined indices of financial sheets including the balance sheets, income and cost, consumptions, resources, and cash flow was conducted based on the reports of 2010 provided by each UMSHS for the Budgeting Center at the MHME. Linear regression is applied in order to determine the effectiveness of the applied indices as well as the level of the financial performance.
Results

The numbers in input-output indices model are in 1000 billion Rls. As represented in Table 1: In inputs part, the average of “current assets” without DEA ratio was 1.209, the minimum rate of which belonging to UMSHS, no. 20 and no. 48, and the maximum rate being that of UMSHS, no. 13; the average of “fixed assets” was 2.919, the minimum of which belonging to UMSHS, no. 35 and no. 48, and the maximum rate being that of UMSHS, no. 37; and finally, the average of “public budget” was 6.147, the minimum rate of which belonging to UMSHS, no. 31 and no. 48, and the maximum rate being that of UMSHS, no. 7. The average of “operational costs” was 0.780, the minimum rate of which belonging to UMSHS, no. 48 and the maximum rate being that of UMSHS, no. 13.

And in output part, the average of “cash flow” resulted from the operation was 0.383, the minimum rate of which belonging to UMSHS, no. 48, and the maximum rate being that of UMSHS, no. 33; the average of “operational income” was 0.859, the minimum rate of which belonging to UMSHS, no. 20 and no. 48, and the maximum rate being that of UMSHS, no. 13; the average of “cash surplus/deficit” was 0.223, the minimum of which belonging to UMSHS, no. 30 and no. 48 and the maximum rate being that of UMSHS, no. 10.

Table 1: Rate of model indices without DEA

| University No. | X1   | X2   | X3   | X4   | Y1   | Y2   | Y3   |
|----------------|------|------|------|------|------|------|------|
| 2              | 0.344| 2.785| 0.506| 0.284| 0.085| 0.341| 2.338|
| 3              | 0.257| 2.582| 0.459| 0.43 | 0     | 0.417| 2.292|
| 7              | 2.127| 0.308| 30.808| 2.069| 1.08 | 2.503| 1.833|
| 8              | 0.364| 0.933| 0.725| 0.415| 0.805| 0.416| 2.286|
| 10             | 0.459| 0.256| 1.935| 0.86 | 0.34 | 0.176| 2.972|
| 11             | 0.774| 2.611| 1.273| 0.752| 0.014| 0.93 | 2.094|
| 13             | 5.903| 9.212| 3.164| 3.24 | 2.292| 2.728|
| 14             | 0.369| 0.517| 0.623| 0.286| 0.385| 0.361| 2.212|
| 19             | 0.312| 0.452| 0.246| 0.186| 0.083| 0.171| 2.302|
| 20             | 0.094| 0.359| 0.229| 0.059| 0     | 0.056| 2.292|
| 21             | 0.332| 0.189| 0.499| 0.328| 0.105| 0.336| 2.28 |
| 23             | 1.278| 0.474| 0.839| 1.882| 0.272| 1.769| 2.4  |
| 25             | 0.235| 3.246| 0.478| 0.377| 0.17 | 0.384| 2.4  |
| 30             | 1.738| 7.319| 2.269| 1.811| 0.24 | 2.338| 1.806|
| 31             | 0.114| 2.728| 0.164| 0.171| 0.027| 0.133| 2.325|
| 32             | 0.399| 4.091| 1.547| 0.792| 0.117| 0.848| 2.269|
| 33             | 0.396| 0.13 | 0.505| 0.804| 1.458| 0.959| 2.132|
| 34             | 0.171| 0.141| 0.341| 0.146| 0.048| 0.16 | 2.274|
| 35             | 0.095| 0.02 | 0.243| 0.174| 0.102| 0.269| 2.192|
| 37             | 0.998| 10.404| 1.718| 1.171| 0.116| 1.472| 1.972|
| 39             | 0.716| 2.518| 1.001| 0.466| 0.183| 0.679| 2.061|
| 41             | 1.198| 0.266| 1.543| 0.629| 0.488| 0.783| 2.132|
| 44             | 0.267| 0.063| 0.437| 0.254| 0.029| 0.211| 2.331|
| 45             | 0.288| 1.347| 0.469| 0.191| 0.013| 0.203| 2.276|
| 48             | 0.094| 0.02 | 0.164| 0.059| 0     | 0.056| 1.806|
| Minimum        | 0.094| 0.02 | 0.164| 0.059| 0     | 0.056| 1.806|
| Maximum        | 5.903| 10.404| 30.808| 3.24 | 1.458| 3.248| 2.972|
| Average        | 1.209| 2.919| 6.147| 0.78 | 0.383| 0.859| 0.223|
Results of implementing the model of input-oriented DEA financial ratios:

As illustrated in Table 2, the technical efficiency average of AP DEA for UMSHS of the country was 1.21, with the managerial efficiency of 1.63, and the average of scale efficiency being 0.74; the technical efficiency average of DEA for these UMSHS, was 0.84, with the managerial efficiency of 0.98, and the average of scale efficiency being 0.85. In other words, based on the results of DEA model and by assuming DEA-VAR, the capacity of the efficiency promotion in Iran’s UMSHS, without any increase in costs and with application of the same inputs was about 16%. Among all studied UMSHS, 6 UMSHS (16.66%) had maximum technical efficiency of DEA (1 and above), 17 UMSHS (70.83%) ranged from 0.5 to 1, and one UMSHS (4.61% of all population) had an efficiency less than 0.5.

According to results of the AP model of DEA in 2010, the maximum technical efficiency belonged to Kerman UMSHS (5.56) while the minimum was that of Markazi UMSHS (0.38).

**Table 2**: Results of the simple model without input-oriented DEA ratio of Iran’s UMSHS, during 2010

| UMSHS_Name     | Efficiency AP-DEA | Efficiency DEA |
|----------------|-------------------|----------------|
|                | Technical         | Managerial     | Ratio | Technical | Managerial | Ratio |
| No.            |                   |                |       |           |            |       |
| 1              | 5.56              | Big            | -     | 1         | 1          | 1     |
| 2              | 3.25              | 3.36           | 0.97  | 1         | 1          | 1     |
| 3              | 2.48              | 2.62           | 0.95  | 1         | 1          | 1     |
| 4              | 1.47              | 1.79           | 0.82  | 1         | 1          | 1     |
| 5              | 1.11              | 1.28           | 0.87  | 1         | 1          | 1     |
| 6              | 1.11              | 7.37           | 0.15  | 1         | 1          | 1     |
| 7              | 0.98              | 0.99           | 0.99  | 0.98      | 0.99       | 0.99  |
| 8              | 0.96              | 1.12           | 0.86  | 0.96      | 1          | 0.96  |
| 9              | 0.95              | 1.1            | 0.86  | 0.95      | 1          | 0.95  |
| 10             | 0.94              | 1.08           | 0.87  | 0.94      | 1          | 0.94  |
| 11             | 0.87              | 1.7            | 0.51  | 0.87      | 1          | 0.87  |
| 12             | 0.85              | 1              | 0.85  | 0.85      | 1          | 0.85  |
| 13             | 0.81              | 0.98           | 0.83  | 0.81      | 0.98       | 0.83  |
| 14             | 0.8               | 0.94           | 0.85  | 0.8       | 0.94       | 0.85  |
| 15             | 0.79              | Big            | -     | 0.79      | 1          | 0.79  |
| 16             | 0.78              | 1.07           | 0.73  | 0.78      | 1          | 0.78  |
| 17             | 0.75              | 1.05           | 0.71  | 0.75      | 1          | 0.75  |
| 18             | 0.74              | Big            | -     | 0.74      | 1          | 0.74  |
| 19             | 0.73              | 0.83           | 0.88  | 0.73      | 0.83       | 0.88  |
| 20             | 0.7               | 1.22           | 0.57  | 0.7       | 1          | 0.7   |
| 21             | 0.7               | 0.83           | 0.84  | 0.7       | 0.83       | 0.84  |
| 22             | 0.69              | 1.33           | 0.52  | 0.69      | 1          | 0.69  |
| 23             | 0.66              | 0.98           | 0.67  | 0.66      | 0.98       | 0.67  |
| 24             | 0.38              | Big            | -     | 0.38      | 1          | 0.38  |
| Minimum        | 0.38              | 0.38           | 0.83  | 0.46      | 0.38       | 0.38  |
| Maximum        | 5.56              | 5.56           | 7.37  | 0.75      | 1          | 1     |
| Average        | 1.21              | 1.21           | 1.49  | 0.14      | 0.16       | 0.05  |

Linear regression was applied in order to determine the effectiveness of the applied indices as well as the level of the financial performance of the Iranian UMSHS; the results are demonstrated in Table 3. In this case, among the indices of simple model without the ratio in input-oriented...
DEA, by constant scale, only two indices of cash flow resulted from “operation” and “current assets” showed 18.8% and 16% of the efficiency of the studied UMSHSs, respectively.

Table 3: results of the linear regression between the indices and the financial performance rate of the UMSHSs

| Model No | Model/Ratio                          | Modified R | Rate of changes |
|----------|--------------------------------------|------------|-----------------|
| 1m       | cash flow resulted from “operation”  | 0.188      | 0.188           |
| 2m       | 1m + current assets                  | 0.348      | 0.160           |

Discussion

The study showed that there is generally a high cash volume in Iranian UMSHSs, which is owing to the cash created by government at the end of each financial year. However, these UMSHSs do not have satisfactory situation in comparison with other fields regarding their financial activity (deficit/surplus, charges recovering period, and charges paying period) and return (return of assets, return of budget, and gross return of assets).

Based on the results of input-oriented DEA, about one fifth of these UMSHSs had high performance and most of them (about three fifths) showed unsatisfactory financial performance. Results obtained from the findings of linear regression test in various models proved that the constant assets index and the return of assets had the most significant impact on financial performance. Then, the combined index of activity return and cash flow had the most significant impact. Makoee et al. study also verified the impact of these indicators on the financial performance (14). Thus, the method of combining the assets with the resources of the UMSHSs, allocated to the defined missions is a key point in improving the financial performance of the UMSHSs.

According to the obtained results, a decrease in the amount of the current and constant assets, dependency on public budget and operational costs should be achieved in order to increase the financial performance and, accordingly, the return of assets. Of course, UMSHSs, have to perform effectively in line with their missions in order to increase the return of assets and the activity index. In other words, the quality of services presented in line with the defined missions should be increased so as to have an increase in profit and effectiveness cost. Thus, through a logical decrease of the assets volume of the UMSHSs along with creating an appropriate combination of productive assets, it would be possible to simultaneously decrease the operational costs (especially constant costs) and increase the incomes. Applying these efforts would be supported by the Neo public Management theory in which productivity improvement has been highlighted (15).

To achieve agility in an organization through the above-mentioned objectives, special consideration should be given to implementation of administrative reform in financial-administrative system of the UMSHSs. One of the important required steps would be to change the infrastructures of the UMSHSs toward decentralization in order to manage their resources and assets more efficiently and effectively. Therefore, developing the cooperative structure of hospitals and a true autonomy of UMSHSs’ subunits is recommended.

Conclusion

Currently, most Iranian UMSHSs do not have high financial performance. This can be due to problems in financial resource management especially in asset combining. Therefore, compilation and execution of a comprehensive program for organizational change and agility with the aim to create a kind of optimized combination of resources and assets is strongly recommended.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or fal-
sification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

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