International Business Management 10 (8): 1434-1438, 2016
ISSN: 1993-5250

Implementation of Fuzzy Activity-Based Costing (FABC) Model in Ordibehesht Hospital of Shiraz

[1]Parisa Akbarzadeh and [2]Mahmood Hematfar
[1]Department of Accounting, Khoramabad Branch, Islamic Azad University, Khoramabad, Iran
[2]Department of Accounting, Borujerd Branch, Islamic Azad University, Borujerd, Iran

Abstract: Considering complexities of business environment in new era, enhanced competition among the competitors, elevated customers' demand for high quality products and services and enhanced complexity of financial transactions, traditional costing systems are not able to deal with the demands of producing and service providing industries. Activity-Based Costing (ABC) is a new costing system which has entered business world in early 1990's. In this approach, costs are determined based on resource use. This costing system proved more accurate information for the managers enabling them to make more accurate and more reliable decisions. Application of ABC Model in Ordibehesht Hospital of Shiraz was investigated in the present study. Since, many comments on costing are expressed under uncertainty condition we used Fuzzy ABC (FABC) approach in this research. The results obtained in the present study revealed that there is significant difference between the costs estimated by FABC and those estimated by traditional systems.

Key words: Complexities, ABC Model, Ordibehesht Hospital, FABC, condition

INTRODUCTION

Companies are currently competition in medium characterized by diverse customers, various products and complex services. Sale is increased in proportion to enhanced complexity of firm's operational and executional process; however, enhancement of profitability is difficult. Thus, firms' demand for quick access to appropriate information on customers' profitability has been elevated (Everaert and Bruggeman, 2008). Moreover, the changes in current business environment have make the customers demand for faster, cheaper and of higher quality products and services. Therefore, producers and service providers should be equipped with quicker responsiveness with higher quality and lower cost. Under such condition, a proper tool is needed for understanding the costs and profitability according to enhanced commercial complexities and seasonal demands so that accurate information is provided in the best way.

Financial managers of hospitals should accurately percept hospital costs and processes to get able to achieve medical purposes properly. Financial profitability of hospital depends on how medical services with high quality can be provided so that costs are controlled and operational efficiency is enhanced. Since, current method for calculation of finished cost of medical services in Iran and most of the countries is based on fixed tariff, implementation of such system is not appropriate in many ways and can't provide required information for decision makers in new era. Thus, it is necessary to implement a system that solve existing defects and provide necessary information and data in an appropriate manner (Nair, 2010).

Application of a single cost driver in the traditional costing system not only deviates calculation of the cost atvarious activity levels but also in most casesleads to over-costing or under-costing of the product/service. This limitation of traditional costing system motivates theimplementation of anew accounting system such as Activity-Based Costing (ABC) Model for estimation of the product/service cost (Dwivedi and Chakraborty, 2015). Effective implementation of ABC Model in a medical organization provides more accurate and precise cost information for hospital managers on its different activities which helps the administration to set a more realistic budget, recognize the inefficiencies as fast as possible, set the unit price of each service delivered, enhance the profitability and promote the organization's competitiveness (Rajabi and Dabiri, 2012).

The main objective of the present study was to investigate efficacy of ABC Model in activity based costing in Ordibehesht Hospital of Shiraz. Since, many costing processes and decisions are performed under uncertain condition we used fuzzy logic in this study to make better estimation of real cost in radiology department of this hospital.

Corresponding Author: Parisa Akbarzadeh, Department of Accounting, Khoramabad Branch, Islamic Azad University, Khoramabad, Iran

Literature review: Cooper and Kaplan (1992) investigated application of Activity-Based Costing (ABC) in diverse production and service providing fields to achieve more exact costing data for accurate decision making. After successful implementation of ABC Model in various industries its application in other service sectors such as hospitals and medical centers increased. Accuracy of costing data of hospitals was promoted by means of ABC Model and the issue can be of great importance for hospital managers, doctors and governments. Over 20% of hospitals in United States and Canada used APC Model in 1990's (Aryeh *et al*., 2008).

Chan (1993) evaluated applicability of ABC Model to estimate the cost of laboratory tests and concluded that the implementation of ABC system would provide better and more reliable cost information than the traditional costing system. Ramsey (1994) investigated the implementation of ABC Model in a radiology department and nursing station of a hospital. Canby (1995) examined the applicability of ABC Model in a hospital's radiology department. Udpa (1996) used ABC Model for costing of the services provided to patients and compared the results with those resulting from traditional costing systems. Devine *et al*. (2000) developed a framework integrating ABC Model, life cycle costing and value chain analysis in assisting healthcare providers as a mechanism for cost reduction to sustain competitiveness.

MATERIALS AND METHODS

Since, the main objective of the present study was to investigate application of information technology in accounting system and fuzzy ABC in a certain hospital it can be said that this study is an applied research regarding its goal. Moreover, since library and field methods such as questionnaire was used in this research, it can be concluded that this is a descriptive survey regarding the nature and methodology of the study.

Data collection: The present study was conducted in Shiraz Ordibehesht Hospital which is located in a 22000 m^2 area and has a 10000 m^2 substructureand 100 patient beds. Particularly, we investigated the radiology department of in Shiraz Ordibehesht Hospital. Statistical population includes 19 services provided for the patients in radiology department of this hospital. Data were collected by investigation of the related documents, observation and interviewing with personnel of various parts of the hospital and also by studying financial statements of 2012. Data were collected by library and field methods. Library method was used to collect data on literature review and research background; while field methods were used to gather primary data for approving or rejecting the research hypotheses. Information of medical activities was collected by observation and interviewing. Finally, an researcher synthesized questionnaire was prepared and submitted to the radiology staff.

Hypothesis test: To conduct hypothesis test, normality of the statistical population should be first determined so that an appropriate statistical method is adopted according to its parametric or non-parametric nature. Normality of data distribution was evaluated by Kolmogorov-Smirnov test. In this test if decision making criteria (p-value) is lower than 5% then null hypothesis is rejected meaning that data can't follow a certain distribution such as normal, poison, exponential or steady and the population is composed of non-parametric data. Three hypotheses were considered in the present study as follows:

- There is a significant difference between services finished cost determined by traditional costing systems and approved tariffs
- There is a significant difference between services finished cost determined by traditional costing systems and that determined by fuzzy approach
- There is a significant difference between average services finished cost determined by traditional costing systems and that determined by fuzzy approach

Hypotheses were verified by Mann-Whitneyu test.

Fuzzy Activity-Based Costing Model (FABC): According to partitioning of hospital in to three sections as support, diagnosis and operational parts, Activity-Based Costing Model was implemented in radiology department. ABC Model was designed in Ordibehesht Hospital through following steps:

Step 1 (Separation of hospital parts based on operation): Activity centers of every hospital are mainly categorized in to three groups, namely:

- Operational centers: these include sections such as surgery or health caring departments that are directly involved in service providing to patients and are called patient-oriented sections
- Diagnosis centers: these centers (such as laboratory or radiology) are active in providing diagnosis and subsidiary services to operational centers and patients and can be regarded as independent costing systems. These centers are called output-oriented
- General support centers: these centers provide general services and support for operational and diagnosis centers and are called service-oriented

Step 2 (Determination and identification of activity centers for each section): Activity is a task performed by a man, a machine or both of them to achieve predetermined goals. The main element in determining the activity is cost. To separate activity centers for better implementation of system, these activity centers should be defined so that they become in accordance with accounting and organizational structure of hospital.

Step 3 (Determining managerial goals for costing in hospital centers): Since, the main goal of ABC Model in hospital centers is to determine finished cost of diagnosis and operational services and because the main philosophy behind formation and management of support centers is to deliver necessary services to other centers, the cost should be allocated to these centers according to related cost drivers. Thus, support centers are regarded as mediate cost centers and diagnosis and operational centers are considered as final cost centers.

Step 4 (Determining output of activity centers): After identifying activity centers, output of every center should be determined. Output determination for each center depends on decision making about two key factors: first, the purpose of costing and cost analysis is determined. Second, output type should be considered in determination and separation of outputs of each activity center.

Step 5 (Determining cost drivers related to support activity center): In this step, cost drivers related to support centers were identified. In this regard, causal interaction between activities and costs, experts' comments and evaluation of sectors' supervisors were used.

Step 6 (Collecting data related to cost drivers): In this step, information about the rate of each cost driver was collected. The information was gathered via information system of the hospital and information system of hospital activity reporting management. Since, a large part of information on cost drivers could not be exactly extracted, thus triangular fuzzy number method was used in this step.

Step 7 (Dividing costs of diagnosis and supporting centers on operational centers and determining finished cost based on each output): After determining the costs of final centers or centers with output to calculate finished cost of each output, total cost allocated to each center was divided by the number of outputs defined for the center and hence, finished cost based on each output was determined.

Costing operations in radiology activity center: Radiology unit is a diagnosis center in hospital which is partitioned in to numerous sub-sections regarding its wide operations in different hospitals. This unit was considered as a final activity center in which costing operation based on output is performed according to its cost and output type. The costs of human resource, equipment depreciation, electricity power and equipment maintenance were shared and calculated according to time required for delivering a service. Then, the costs allocated from other sections, building depreciation cost and the cost of water gas and telephone were first divided by 19 services and then allocated among the services regarding the number of services.

Cost calculation based on fuzzy logic: Since, occasionally a cost is estimated under uncertainty condition, thus assigning a crisp value for cost can enhance error probability. To reduce error in cost estimation, triangular fuzzy numbers were used. Triangular Fuzzy Number (TFN) is a fuzzy number represented by three real number as F = (l, m, u). Upper bound represented by u is the maximum value that can be assigned for fuzzy number F. Lower bound represented by l is the minimum value that can be assigned for fuzzy number F. m is the most probable value of a fuzzy number. Then, defuzzification was performed to express the cost based on crisp values.

RESULTS AND DISCUSSION

In the present study, the cost of radiology department of Shiraz Ordibehesht Hospital was studied by fuzzy ABC approach. Regarding uncertainty in estimation of costs, triangular fuzzy numbers were used to enhance reliability of the data. Then, using defuzzification operations, fuzzy numbers were changed in to crisp values. Crisp values resulting from such process regarding 19 different services in radiology department are presented in Table 1.

Through analysis, the normality of the data was first investigated using Kolmogorov-Smirnov test. The results of Kolmogorov-Smirnov are presented in Table 2. As can be inferred from the Table 2, significance value in all the cases was higher than 0.05; thus, there is no reason to reject null hypothesis and it can be claimed that data distribution is normal. Then, hypotheses of the investigation were tested using Mann-Whitney U test. Results of hypothesis test are presented in Table 3. The data in Table 3 shows that all the three hypotheses were approved.

Table 1: Total costs in crisp values estimated using TFN

Cost classification	Z
Brain CT scan	363,089
Chest CT scan without injection	129,169
High resolution CT scan	726,130
Lung CT scan	548,767
Rear, fore and profile backbone, radiography	240,060
Elbow radiography	200,870
Eye CT scan	142,746
3D CT scan	304,705
Back CT scan	339,245
Neck spine radiography	318,040
Finger radiography	78,116
Gen radiography	101,754
Heap bilateral radiography	176,678
Ankle radiography	168,489
Knee radiography	171,727
Shoulder radiography	112,405
Abdomen and pelvis radiography	104,439
Sinus radiography	89,843
Back spine radiography	189,162

Table 2: Results of data normality test

Results	Fixed cost	Total estimated cost in crisp	Total estimated cost in fuzzy value
N	19	19	19
Mean	158.7474622	105.12334989	421.7708383
Standard deviation	055.5297203	219.9657618	113.5373819
Kolmogorov-Smirnov	639.3	97.2	934.2
Significance	215.0	261.0	700.0

Table 3: Summary of the results obtained in the present study

Hypotheses	Results
There is a significant difference between services finished cost determined by traditional costing systems and approved tariffs	Approved
There is a significant difference between services finished cost determined by traditional costing systems and that determined by fuzzy approach	Approved
There is a significant difference between average services finished cost determined by traditional costing systems and that determined by fuzzy approach	Approved

CONCLUSION

The main objective of the present study was to develop a model based on fuzzy set theory to solve the limitations and defects relating to data estimation or inaccuracy of the data collected in activity based costing system. Moreover, we tried to analyze applicability of such system in hospital and medical organizations for calculation and presentation of data and information on finished costs of services and other information required by decision makers. Activity-Based Costing Model is an approach for exact estimation of costs in various organizations which has higher accuracy compared to traditional systems (Cooper and Kaplan, 1992).

Implementation of ABC Model in medical units has been already investigated by Chen (1993) and Canby (1995). It was observed in the present study that application of FABC Method is more efficient than traditional ways of costing in hospital. This finding is in agreement with those reported by other researchers. For example, Rajabi and Dabiri (2012) implemented ABC Model in Faghihi hospital and indicated that this system has higher efficacy compared to traditional costing systems. Moreover in their research in India, Dwivedi and Chakraborty (2015) reported that application of ABC Model in the hospitals of this country enables the managers to have better perception on the costs of various units and thus they are able to make better decisions; this will result in higher level of cost saving and hence, reduces governmental costs devoted to medical sector.

Although, many investigators have evaluated implementation of ABC Model in hospital service field (Nair, 2010), the advantage of the present study over similar research is resulted from application of fuzzy approach. Since, there is high level of uncertainty in hospital environment, application of fuzzy approach will boost accuracy of the results. We used triangular fuzzy numbers in the present study; thus, application of other types of fuzzy number such as trapezoidal, bell shaped, etc in implementation of ABC Model is recommended. Moreover, implementing FABC in other hospital is recommended as the topic of future researches.

REFERENCES

Aryeh, S., H. Axel, O. Sherr, G. Hans and R. Donat, 2008. Activity based costs of blood transfusions in surgical patients at four hospitals. Transfusion J., 50: 753-765.

Canby, J.B., 1995. Applying activity based costing to healthcare settings. J. Healthcare Financ. Manage. Assoc., 49: 50-56.

Chan, Y.C.L., 1993. Improving hospital cost accounting with activity based costing. Health Care Manage. Rev., 18: 71-77.

Cooper, R. and R.S. Kaplan, 1992. Activity based systems: measuring the costs of resource usage. Account. Horiz., 6: 1-12.

Devine, K., P. O'Clock and D. Lyons, 2000. Health care financial management in a changing environment. J. Buss. Res., 48: 183-191.

Dwivedi, R. and S. Chakraborty, 2015. Development of an activity based costing model for a government hospital. Uncertain Supply Chain Manage., 3: 27-42.

Everaert, P. and W. Bruggeman, 2008. Cost modeling in logistics using time driven ABC Experiences from a wholesaler. Int. J. Phys. Distrib. Logistics Manage., 38: 172-191.

Nair, R., 2010. Activity based costing methodology as tool for costing in hematopathology laboratory. Indian J. Pathol. Microbiol., 53: 68-74.

Rajabi, A. and A. Dabiri, 2012. Applying activity based costing (ABC) method to calculate cost price in hospital and remedy services. Iran. J. Public Health, 41: 100-107.

Ramsey, R., 1994. Activity based costing for hospitals. Hosp. Health Serv. Admin., 39: 385-396.

Udpa, S., 1996. Activity based costing for hospitals. Health Care Manage. Rev., 21: 83-96.