Health Policy and Technology (2015) 4, 58–67

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/hlpt

A comparative study on the activity based costing systems: Traditional, fuzzy and Monte Carlo approaches

Hamidreza Esmalifalak[a,*], Matthew S. Albin[b], Meysam Behzadpoor[a]

[a]*Department of Management and Economics, Science and Research Branch, Islamic Azad University (IAU), Tehran, Iran*
[b]*Department of Systems Engineering and Operations Research, Volgenau School of Engineering, George Mason University, Fairfax, VA, USA*

Available online 7 November 2014

KEYWORDS
Activity Based Costing (ABC);
Fuzzy Logic (FL);
Monte Carlo Simulations (MCS)

Abstract
Any model's usefulness depends largely on the accuracy and reliability of its output. Yet, because all models are imprecise abstractions of reality and because precise input data are rarely if ever available, all output values are subject to uncertainty. This paper discusses how to handle such uncertainty as it relates to the feasibility and benefits of implementing an Activity Based Costing (ABC) system in an uncertain medical care environment. In our investigation, the relationship between sources of uncertainty and systems cost estimates is depicted as an input-output model. We introduce a conceptual framework based on Fuzzy Logic (FL) and Monte Carlo Simulations (MCS) and describe the fundamental elements needed to model an ABC system in an unpredictable, real-world environment. Also, for the purpose of illustrating the discussed concepts and techniques, a case study is presented based on the methodology discussed during the inception phase of a public academic medical center providing patient-centered care. In our case study, we calculated the unit cost of services by three different types of ABC systems: traditional (TABC), fuzzy (FABC), and Monte Carlo (MCABC). Finally, we analyze statistically the results obtained by each system. Based on the results, utilizing FABC and MCABC systems in a large hospital with considerable uncertain information can lead to the significantly different cost estimates from TABC. However, we did not find such a difference between FABC and MCABC.

Introduction

Recent years, management accounting has experienced major evolution which has stimulated lively academic and professional discussion on the changing role of accountants, particularly management accountants. The International

*Corresponding author. Tel.: +1 832 582 1519.
E-mail addresses: huh_12@yahoo.com (H. Esmalifalak), matthew.s.albin@gmail.com (M.S. Albin).

http://dx.doi.org/10.1016/j.hlpt.2014.10.010
2211-8837/

Federation of Accountants has documented the evolution of management accounting and identified four stages of development or sophistication. Stage 1 is principally concerned with 'cost determination and financial control,' stage 2 with 'provision of information for management planning and control,' stage 3 with 'Reduction of waste of business resources,' and stage 4 with 'Creation of value through effective resource use'. This research paper addresses the feasibility and benefits of accurate cost accounting systems in light of Federation's four stages.

Cost accounting systems

In today's world, computerized cost accounting[1] systems play an important role in reducing the costs of products. The impact of profitability and cost management affects all management processes and is a key component of an overall enterprise performance management system. Estimation of the efficiency and effectiveness of a particular service or product requires combining the information on the cost of products with outcome measures to obtain cost effectiveness ratios and other measures of efficiency. Therefore, basic, consistent, and reliable cost information is necessary for any organization, from its pricing policies to its product designs and performance reviews.

In the service arena, better costing of various services can improve management of these costs with available funding help improve service outcomes. Information on the cost of services is also important in evaluating the equity of the services provided in terms of the quantities and types of resources spent on various groups or populations. These information also provides basis for estimating possible future resource needs. Accordingly, sophisticated cost accounting systems to determine which processes truly add value to a product or service have become a necessity.

In the healthcare industry's competitive environment, hospitals managers increasingly require precise cost data to organize delivery mechanisms that ensure effective care at a reasonable cost. It is also critical for hospitals managers to understand hospital production functions in order to improve the quality of provided services. Cost accounting can help managers with providing these valuable Information. Most healthcare providers have been working over the last three decades to implement costing methods that embody Activity Based Costing (ABC) concepts. Many U.S. hospitals and health organizations have explored and used ABC to improve resource management [1-3] and there are a growing number of publications about the usefulness of this method in hospital settings.

Handling uncertainty in ABC system

ABC is a costing system that assigns the cost of resources required by each activity to all products and services in each stage of production, marketing, sales process, and delivery [4]. The goal of ABC is to measure and then price out all the resources used for activities that generate the production of goods and services for customers [5]. All too often, however, there is insufficient data at the time of the initial design of ABC system. This dearth of information requires uninformed estimation, perhaps based on experience. The precision of calculated estimates, however, can be greatly influenced by initial estimates which themselves are uncertain and might lead to an inaccurate cost estimations. With real world problems facing uncertainty and imprecise information, the usual response is to manage uncertainty using a framework. By purposely including uncertainty in the models, we can not only handle the uncertainty of design and assessments but also trace critical success factors more effectively.

This paper contributes to the literature by presenting a conceptual framework that indicates the necessary steps required to develop ABC systems (Traditional, Fuzzy, and Monte Carlo approaches) in an uncertain business environment. We use this framework in a large public hospital with considerable uncertain information and compare the results to see whether there is a significant difference between each system or not. This would allow use to find out, improving the accuracy of inputs (with considering uncertainty) and handling uncertainty in ABC system would benefit to the accuracy of outputs or not. In the following, we introduce FABC and MCABC systems two methods of handling uncertainty in ABC system. Throughout the paper, we indicate the ABC system by "traditional ABC (TABC)" to differentiate this system from its new generations.

Fuzzy Activity Based Costing (FABC) system

The FABC, which combines ABC system with Fuzzy Logic (FL),[2] is an extension of standard ABC, designed specifically for organizations with uncertain information. Nachtmann and Needy presented the Companies that are most likely to benefit from FABC with the following characteristics: (1) operate in an uncertain environment; (2) do not have accurate and/or adequate historical costing information available; and (3) do not have confidence in the accuracy of their estimated costing data.

Monte Carlo Activity Based Costing (MCABC) system

The MCABC system which combines ABC system with Monte Carlo simulations (MCS)[3] is an industry standard format of ABC system for organizations engaged in an uncertain

[1] Cost accounting is an essential element of financial management that generates information about the costs of the products. Cost accounting first measures and records these costs individually and then compares input results to output or actual results to aid company management in measuring financial performance.

[2] Fuzzy logic and fuzzy sets are effective tools for modeling complex mathematical problems with parameters that demonstrate uncertainty (Kosko, 1994). Fuzzy set theory via the membership function was introduced by Zadeh (1965). Zadeh developed an axiomatic paradigm that generalizes the classical concept of a set by allowing an item to have specific membership in a set, as opposed to being either entirely in the set or entirely out of the set.

[3] Monte Carlo simulation (MCS), a computationally intensive mathematical technique, allows people to account for uncertainty in quantitative analysis and decision making. The invention of this method and especially the utilization of computers in making the calculations, belongs to Stanislaw Ulam, a mathematician working on the US "Manhattan Project" during World War II. This method builds models of possible outcomes by substituting a range of values (a probability distribution) for any factor that has inherent uncertainty.