



Environmental Cost Accounting and Importance of Activity Based Costing for Management

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Abstract

The recent studies show that although the environmental costs are significant and very important, they are ignored by managers. The environmental accounting equips the organization with tools which revise the traditional accounting system and modify it in a way that it processes environmental cost related information and presents the report appropriately to the managers. Meanwhile, the environmental costs such as costs resulted from pollution and its removal as a function of production or services should be identified and appropriated between products and services by using proper costing methods. Thus, costing and pricing of the products will be carried out with more precision. To realize this goal, the present research suggests to use fuzzy time driven activity based costing in firms and entities which use environmental accounting in their accounting systems.

Keywords: Costing; Environmental Accounting; Fuzzy Time Driven Activity Based Costing

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1. Introduction

Environmental accounting involves a set of fundamentals which can improve the accounting system capability to identify, record, and report the results of destructions and environmental pollution. Environmental accounting is based on the integration of environment as a capital resource and considering environmental costs as one of acceptable costs in economic and calculative processes [1].

Regarding the problem of lack of more appropriate and exact accounting data in companies which manage environmental activities besides their main activities, it seems necessary to have an appropriate costing system. Nowadays, a new outlook towards environmental outcomes resulted from industrial activities of the profit making entities, has emerged. This has caused major changes in the outlook of the profit making entities about designing products and processes to after sale services. Meanwhile, the real value of natural resources such as air, earth, water, which are used to manufacture different products is

not reflected in manufactured products' cost appropriately [2]. This problem can be resolved by using appropriate costing methods. The time driven activity based costing system does not identify the activities in first phase unlike the common activity based costing and does not appropriate the costs related to activities. Thus, the primary appropriation of costs to activities is not carried out. In this method, first the managers or the management team predict the required resources for cost issues (products, services, customers ...). Here instead of determining the time needed to do the activities based on interviewing the employees or presenting questionnaires for them, they determine cost resources based on the time equation appropriate them to activities and operations directly and automatically.

The effectiveness and success of time driven activity based costing lies in its time estimation capability. In time driven activity based costing trend we use the estimation of the needed time to administer each activity, although it should be

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noted that it is not related to the percentage of the time used by a staff to do an activity and it emphasizes on how much time is spent to complete a part of an activity [3].

On the other hand, using estimations and reckoning in calculating the cost of products and services is one of the main characteristics of costing and time driven activity based costing is not an exception in this trend. Thus, using fuzzy logic is suggested in this research to complement this method.

2. Environmental Accounting

Environmental accounting is a branch of accounting which is used to collect the environmental costs' data and use them in carrying out the related calculations to cost of goods and services. This accounting branch is used both in micro-economics and macro-economics.

Environmental accounting in micro-economics level or a business entity can be used in financial accounting and in management accounting. Financial accounting through which a business entity reports its economic activities' accounting data for the users out of the organization has determined some obligations to reveal liabilities and environmental costs. The function of environmental accounting in management accounting is that the business entities can measure the cost of materials and environmental costs used to do their operations based on the dominating fundamentals and also how the environmental costs can be identified or appropriated in materials' flow or other physical aspects of the entity's operations. Industrial accounting is an example of applying environmental accounting.

By using these concepts, an adaptation is made between the goals dominating environmental accounting and financial accounting of a business entity; it means that the improvement of the environmental performance can directly result in improving the financial status of a business entity and the existence of a direct bond between financial performance and environmental performance of a business entity makes using the strong environmental accounting approaches obligatory.

The present evidences show the fact that a limited number of business entities have ever tried to identify the environmental costs related to them and use the data to make effective decision; however, there are many business entities working without identifying the amount or resource of these costs and this has resulted in making undesirable decisions. Thus, the main goal of environmental accounting is to fill this gap.

In macro-economic level, the environmental accounting is used to do calculations related to underground resources' costs and the flows resulted from these resources. The definition presented for national revenue to do the

calculations related to environmental accounts such as national gross product, is an example of the environmental accounting application in macro-economics. One of the most important points which can be deviating regarding environmental accounting is that some environmental goods are not exchanged in the market although they create economic value added. The log collected from a jungle for heating, the fish hunted from the nature for consumption or the medical plants are examples of these goods. The value of water for drinking or watering the agricultural fields, reflect the cost of substructures of the transportation and distribution of water not the value of water itself. Another point is that the real value of natural resources such as air, earth, water used in manufacturing different products are not reflected properly in cost of the products and manufacturing services [4].

The usefulness reasons of environmental accounting:

Manufacturing and service companies incur different types of expenses. The environmental expenses are among them. The performance of environment is one of the most important factors in assessing the success of the company. Expenses and a company's environmental performance should be noticed by the management for the following reasons:

➤ Most of environmental expenses can be reduced considerably by using better business decision makings, investing in more environmental adjustable technologies and redesigning the processes and the manufactured products or even we can omit them totally because some of these expenses may never add any value for the system or the products.

➤ A better management of environmental expenses can improve the company's environmental performance and can have considerable advantages (through the reduction of air pollution and public health care programs) for the society.

➤ The appropriate understanding of environmental expenses and having knowledge about environmental performance of processes and the manufactured products can improve the correct and proper costing and also pricing the products and can help companies in designing the processes and more environmentally compatible products.

➤ It has been proved that regarding the processes and the manufactured products compatible with environmental conditions, the competitive advantages for the products of a company among customers are created.

3. The use of environmental accounting in costing

The term environmental accounting remarks at least to two important perspectives:

Expenses which affect the company's financial activities directly: These expenses are called private, special or internal company expenses.

Environmentally unique expenses for which the companies are not responsible and do not have any direct economic outcome for the financial activities of the company: these expenses are called social expenses [5], and in this research we will mainly focus on company's special expenses.

Generally, the entities consider market conditions to assess the demand for their product and the price the market is ready to pay for it. To determine the sufficient profitability and convince the product's price, we should compare the cost with market price. The producers consider factors such as market conditions, customer maintenance and long-term growth of the industry when they are making decisions to determine the type, amount and price of their products. The proper costing is the most important factor to study about a product. When we cannot appropriate environmental expenses properly, a type of abandoning subsidy will happen. In most cases, the different products are manufactured in the form of different production processes and every process has its own environmental expenses. As an example, consider two factories with two production processes of A and B in which the same number of persons and the same working hours for each group of the products is used. But the A process of production uses harmful chemicals while in B process of production such a condition does not exist. When A process of production is used, the company incurs environmental expenses resulted from the application of the harmful chemicals such as: the recognition and purchase of chemicals which include the assessment of different papers containing different safety information, designing a process to minimize the workers contacts with chemicals, moving and transforming chemicals, inspection, report and receiving the authorization according to the rules, training employees to carry materials and emergency reactions of the staff, storekeeping and demolishing the chemicals.

Besides that, there may be some intangible expenses such as the negative feelings of the public about the business entity and inability in accomplishing the qualitative requirements. If all these expenses can be considered as overload expenses and are appropriated based on working hours or production amount to production processes A and B, the products produced by using the process B, will act as a subsidy for products produced by using process A. In other words, the traditional costing system for production process B

will be shown more expensive and the production process A will be shown cheaper than the real amounts.

This type of appropriation and costing system can put a business entity in an undesirable competitive condition compared to other rivals. On the whole, managers can make better decisions regarding the composition of their products by appropriating and costing these expenses more exactly and thus override their company than other rivals [4].

This research suggests using fuzzy time driven activity based costing to remove this problem. It removes the faults of the traditional costing and prepares more exact and proper data for the managers, decision makers and users of these data, compared to other methods.

4. Time Driven Activity Based Costing

Time driven activity based costing model eliminates the activity identification phase and thus there is no need to appropriate costs to multi-purpose activities done by a unit. Also this model avoids questionnaires presented to the staff which is carried out in the common ABC method and is costly, time-consuming, and abstract. Practically it uses equations through which the costs of resources are appropriated directly to the activities and transactions. Time driven activity based costing estimates only two parameters of: 1) capacity cost rate for the bureau, 2) using the capacity in each transaction processed in the bureau. Both parameters can be estimated easily and documentarily.

The rate of capacity cost is achieved by the following formula [6]:

Supplied Capacity Costs

The rate of Capacity Costs = Practical Capacity of

5. Supply Resources

The estimation of practical capacity for each employee or each part of equipment is straightforward. The total number of each employee's working days and the average of machineries used during the month are calculated. How many hours or minutes an employee or the equipment have access to perform real activities during the day, is calculated. Then the time appropriated to relaxation, education, meetings, repairs and retaining and other items are subtracted. There is no need to calculate these items accurately. Several percent of error can barely be dangerous and the main errors will be identified through shortages and surplus of capacity [6].

To calculate the denominator above, we can use the following methods:

1- The practical capacity is considered to be 80 to 90 percent of the nominal capacity (maximum capacity).

2- Using the analytical method: in this method the nominal or desired capacity is considered and then some hours will be subtracted for the employees to relax or take time off.

To estimate the numerator above, we should take into consideration the following items:

- Staff salary costs
- Directors salary costs
- Indirect wage costs and other indirect supportive costs [7].

The first estimation needed for TDABC is determining the needed capacity. Here and in most cases the time of doing each transaction is considered.

The common ABC model also uses the transaction driver. Whenever an activity such as machine adjustment, delivering customer orders, or processing the customer's demand is posed, almost the same amount of time is utilized. In TDABC model, instead of using this transaction easily, the projecting team is asked to estimate the time needed to carry out each of these transactional activities. Time estimations can be achieved through direct observation or through interviews [6].

6. Fuzzy set theory

Professor Lotfizadeh is the founder of fuzzy logic. He carried out many efforts in this field and the present state in fuzzy logic all over the world owes a lot to his great efforts. He introduced fuzzy logic as a scientific method. Fuzzy logic proposed different methods to study knowledge and sciences with ambiguities and non-absolute states logically [8]. We can divide sets into common (absolute) and fuzzy sets. In usual sets the membership or belonging of a member in a set is an absolute and exact concept. Thus, an object or a member is a member of a set or not and there is no state in between. In other words, everything belongs (it is 1) or does not belong (it is 0) to a set.

Fuzzy sets are defined as regular or even sets in a bidirectional relationship of $A = \{x, \mu(x) / x \in [0, 1]\}$. In this equation $\mu_A(x)$ is the membership function. $\mu_A(x)$ shows a degree or rank in which each X element in the set A belongs to the fuzzy set A with that degree [9].

Fuzzy number is a normal and convex fuzzy set. Triangular Fuzzy Number is a special type of fuzzy number which is shown as $A = (a_1, a_m, a_3)$. Here a_1, a_2 are the support range of $A = [a_1, a_2]$ in triangular numbers and a_1 the smallest possible and a_2 the

largest possible values, respectively. Also a_m is considered to be the most promising value within the support range of $A = [a_1, a_2]$.

A triangular fuzzy number with a membership function of $\mu_A(x)$ is identified as follows:

- 1- $\mu_A(x) = (x - a_1) / (a_m - a_1)$ when $a_1 \leq x \leq a_m$
- 2- $\mu_A(x) = (x - a_2) / (a_m - a_2)$ when $a_1 \leq x \leq a_2$
- 3- $\mu_A(x) = 0$ other points and the figure can be shown as follows [9]:

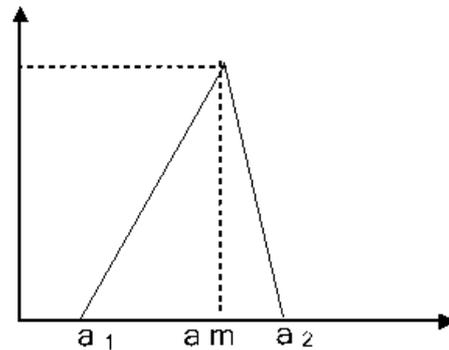


Figure 1. Triangular Fuzzy Numbers

In this paper, triangular fuzzy numbers are suggested to express input parameters of time driven activity-based costing. The reason is that its application is easy and it is naturally superior regarding other complicated types of fuzzy numbers such as trapezoid or bell fuzzy numbers. These critical advantages seem to be necessary both regarding mathematical calculations and inferring the data of costing development processes by using fuzzy logic.

Triangular fuzzy calculation is in fact an extended form of usual calculations, regarding both administration and interpretation. Additionally, triangular fuzzy numbers present a logical basis for quantification of the ambiguous knowledge related to most decision-making issues [10].

For more accurate calculations by using triangular fuzzy numbers to estimate the time and reduce prediction error coefficient and timing estimations, Delphi fuzzy method is used in the form of triangular numbers which are broadly used in long-term prediction.

Delphi fuzzy method is the generalization of the classical long-term prediction. It was first created by Rand Company in Santamonica California. The bases for Delphi method are as follows [9]:

- 1) The scholars are asked to present their predictions (regarding triangular numbers) in the form of the smallest possible value, the largest possible value, and the most promising value.

2) Abstract information should be statistically analyzed by calculating the averages and the results should be announced for other scholars.

3) The scholars study the results and present new estimations which will be sent to the scholars by using statistics analyzed again.

4) These processes are repeated again and again to achieve a convergent sensible resolution regarding the viewpoints of a manager or a governmental agent (usually two or three times are enough).

Thus, it seems that those issues which face long term prediction can entail insufficient and inaccurate information. Additionally, those decisions which are made by relying on scholars' competency are abstract. So, it would be very appropriate to use fuzzy numbers to describe the information instead of definite numbers. Triangular numbers are specifically more appropriate for this goal because they are made by identifying three amounts of the smallest, the largest, and the most promising. Instead of a definite average, analyses will be carried out based on fuzzy average rate. Delphi fuzzy method was established by Kofmaan & Gopta (1988).

Delphi fuzzy method is a sample of prediction methods with several scholars to aggregate the ideas and viewpoints [9].

As it can be seen in the following figure, the general structure of an organized fuzzy system includes three phases.

Fuzzy making → Deduction → defuzzification

1) Fuzzy making: the conversion of qualitative data into quantitative data is done through a process called overgeneralization. In this phase, fuzzy set and set members and input variables along with output variables are identified.

2) Deduction: in this phase the rule "if ... then" is formed. Membership degree is determined and expressed in Persian language. Then the rules are assessed and fuzzy output is formed.

3) Defuzzification: in this phase the ambiguities of outputs are resolved and as a result of it, the decision (operation) is expressed [8].

7. Fuzzy Time Driven Activity Based Costing

In time driven activity based costing (TDABC), the management predicts the time needed to perform any activity (for example, moving raw materials in the warehouse, order form completion, placement of goods in shelves ...). Anyway, management should be assured that these predictions reflect the real activities and operations [3]. These predictions mostly create lack of assurance or lack of accuracy of time driven activity based costing system. Fuzzy logic is one of the most effective methods to modify the data in lack of assurance situation which causes the creation of a system called fuzzy time driven activity based costing which can result in more

accurate and more appropriate results compared with time driven activity based costing system. In fuzzy time driven activity based costing, management uses triangular fuzzy numbers in the form of Delphi fuzzy to predict the time needed to administer each activity. Management predicts the needed estimations for doing each activity such as doing an order and predicting practical capacity within a range including three numbers in the form of the smallest possible value, the most probable possible amount, and the most promising amount. In this article, we have tried to maximize our precision in estimations. So, using triangular numbers in themselves were not able to satisfy all our needs. Thus, fuzzy Delphi method can help the results achieve the highest amount of assurance and be appropriate and effective in long-term predictions.

In the next phase for a better decision making, aggregation of the three predicted values in needed and it is shown with a definite number. This is called defuzzification. There are several methods for defuzzification through which, focal point is the most common one.

The value resulted from defuzzification is used as the amount needed for doing each order and the practical capacity in fuzzy time driven activity based costing system.

The major and most important advantage of using triangular fuzzy number in the form of Delphi fuzzy is that the standard system of time driven activity based costing in the form of the most probable possible value and relying on the competency of the enlightened scholars in each part, will be retained in analyzing fuzzy time driven activity based costing system. This will result in gaining assurance that input fuzzy data will create additional information about costing system and none of the information will be lost by using this system compared with the standard analysis of time driven activity. Thus, by using fuzzy logic we can take into consideration the items related to natural inaccuracy and inappropriateness of the data and lack of assurance in time driven activity based costing system and by overcoming this defect, study the results with more assurance [11].

8. Conclusion

Environmental accounting is a concise and over generalized instrument to take the environmental concerns into consideration in business decision makings. Including environmental expenses in accounting system will help companies to make decisions which improve the environmental performance besides increasing long-term profitability and foster the stockholders' wealth increase by introducing it as a green industry to the capital market.

To do so, the expenses resulted from the pollution and its removal should be appropriated by using proper costing methods such as the method posed in this research as a function of production or services appropriately between the products and the related services. In this way the cost of products and services will be identified more properly to help the management and other users of these data in making decisions for different purposes.

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