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Fuzzy Logic in Accounting and Auditing

Mohsen Imeni*
Department of Accounting, Ayandegan Institute of Higher Education, Tonekabon, Iran.

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ABSTRACT

Many areas of accounting have highly ambiguous due to undefined and inaccurate terms. Many ambiguities are generated by the human mind. In the field of accounting, these ambiguities lead to the creation of uncertain information. Many of the targets and concepts of accounting with binary classification are not consistent. Similarly, the discussion of the materiality or reliability of accounting is not a two-part concept. Because there are degrees of materiality or reliability. Therefore, these ambiguities lead to the presentation information that is not suitable for decision making. Lack of attention to the issue of ambiguity in management accounting techniques, auditing procedures, and financial reporting may lead to a reduced role of accounting information in decision-making processes. Because information plays an important role in economic decision-making, and no doubt, the quality of their, including accuracy in providing it to a wide range of users, can be useful for decision-making. One of the features of the fuzzy set is that it reduces the need for accurate data in decision making. Hence this information can be useful for users.

1. Introduction

Ambiguity and imprecision in human judgments are in many scientific disciplines. Accountants in dealing with the issue of ambiguity and imprecision, they behave there is no ambiguity or it is a random [1]. In recent years, fuzzy logic has gained wide acceptance in the field of accounting and business. This acceptance is due to the ability to management in situations of ambiguity and lack of consistency that does not exist within other approaches to dual value logic. In dual value logic, the proposition is true or false. Also, accounting has ambiguous in many important respects [2]. The problem of ambiguity and imprecision in accounting and auditing is related to the rules and accounting system [3]. Ro [4] argues that the concept of materiality is not essentially two-dimensional, such as black or white and good or bad, but that there are degrees of materiality that are overlooked in accounting. However, ambiguity and imprecision is different from being random. Randomness refers to the uncertainty about the occurrence or non-occurrence of an event and is expressed in the form of probabilities. While, ambiguity and imprecision are related to the inaccuracy and lack of clarity in the definition of words, the occurrence of events and judgments [2]. Zariffard [1] argues that neglect of ambiguity and imprecision in decision models can limit the usability of accounting models due to reduced usefulness and predictive power. Therefore, it is important attention to ambiguity. The purpose of this study is to

* Corresponding author
E-mail address: mohsen.imeni86@yahoo.com
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introduce fuzzy logic and also is examine its major applications in accounting and auditing. The importance of this research is that considering that information is the main component of any decision making today, it has economic value.

2. Literature Review

2.1. Fuzzy Set Theory

In 1965, Zadeh discussed the existence of ambiguity and fuzziness in many human systems. According to Zadeh [5], the need to be very careful in decision analysis causes the analyst to ignore some related issues and consider only a part of this relationship with the real world. Fuzzy thinking followed the objection to Aristotelian logic about the distance between logic and reality. Aristotelian logic forms the basis of classical mathematics. This logic assumes that the world is black and white or two values one or 0. Zadeh [6] proposed the theory of fuzzy sets as a method for modeling in ambiguity and uncertainty. Sets can be divided into finite sets and fuzzy sets. In finite set, is there a member in a set or not? That is, it has no more than two values, one or 0. But not in the fuzzy set.

In fact, Aristotelian logic sacrifices accuracy for ease. But the real phenomena are not just black or white, they are somewhat gray. In other words, real phenomena are always fuzzy, that is, ambiguity and imprecision [7]. Fuzzy set theory reduces the possibility of making personal judgments by expressing qualitative and subjective information, and leads to more rational decisions [8].

2.2. Definition of Fuzzy Set

Let U be a classical (or ordinary) set of objects, called the universe, whose generic elements are denoted by x. That is, U={x}. A fuzzy set A in U is characterized by a membership function $\mu_A(X)$ which associates with each element in U a real number in the interval (0–1) [9]. The fuzzy set, A, is usually denoted by the set of pairs [10].

$$A = \{(x, \mu_A(X)), x \in U\}. \quad (1)$$

For an ordinary set, A

$$\mu_A(X) = \begin{cases} 1, & x \in A \\ 0, & x \notin A \end{cases}. \quad (2)$$

When U is a finite set $\{x_1,\ldots, x_n\}$, the fuzzy set on U may also be represented as

$$A = \sum_{i=1}^{n} x_i / \mu_A(x_i). \quad (3)$$

When U is an infinite set, the fuzzy set maybe represented as

$$A = \int (x / \mu_A(x))dx. \quad (4)$$

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2.3. Basic Concepts of Fuzzy Set

The complement, support, a-cut, convexity, normality and cardinality of a fuzzy set are presented in the following sections [9].

Complement of a fuzzy set. The definition of the complement of fuzzy set A is defined as

$$\mu_A(X) = 1 - \mu_A(X) \quad x \in U. \tag{5}$$

Support of a fuzzy set. Those elements which have nonzero membership grades are considered as support of that fuzzy set

$$S(A) = \{x \in U | \mu_A(X) \geq 0\}. \tag{6}$$

a-Cut of a fuzzy set. a-Cut of a fuzzy set is an ordinary set whose elements belong to fuzzy set A, at least to the degree of a

$$A\alpha = \{x \in U | \mu_A(X) \geq \alpha\}. \tag{7}$$

It is a more general case of the support of a fuzzy set. If α=0 then Aα=S(A).

Convexity of a fuzzy set. A fuzzy set is convex if

$$\mu_A(\lambda X_1 + (1-\lambda)X_2) \geq \min(\mu_A(X_1), \quad \mu_A(X_2)). \tag{8}$$

X_1 and $X_2 \epsilon U$ also $\lambda \epsilon$ (0–1).

Normality of a fuzzy set. A fuzzy set A is normal only if there are one or more x′ values such that $\mu_A(X') = 1$.

Cardinality of a fuzzy set. The cardinality of fuzzy set A evaluates the proportion of elements of U having the property A. When U is finite, it is defined as

$$|A| = \sum \mu_A(x), \quad x \in U. \tag{9}$$

For infinite U, the cardinality is defined as

$$|A| = \int_x \mu_A(x)dx. \tag{10}$$

For more details, enormous materials can be found in the literature about fuzzy set theory.

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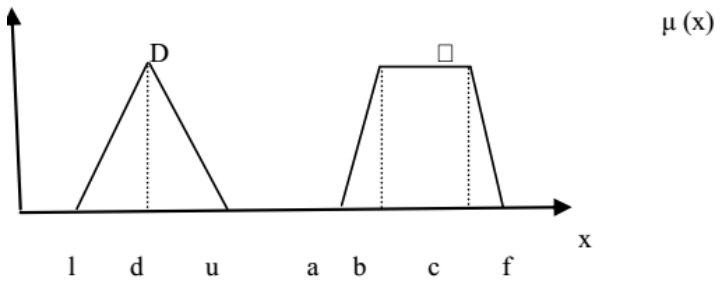

Fig. 1. *Triangular and trapezoidal fuzzy numbers.*

Fig. 1 defines a fuzzy and triangular number D as follows [8]:

D= {1, d, u} where 1, d, and u as the lower spread, the middle spread, and the upper spread. In this case the membership function $\mu_{(D)}$ X it is defined as follows:

$$\mu_D(x) = \begin{cases} 0; & x \le 1 \\ (x-1)/(d-1); & 1 < x \le d \\ (u-x)/(u-d); & d < x \le u \\ 0; & x > u \end{cases}. \qquad (11)$$

If the climax of the triangular number D is not unique; the fuzzy number is known as a trapezoid.

3. Fuzzy Set Theory and Accounting and Auditing

For a variety of reasons, fuzzy set theory can be of great value to accountants in practice. First, fuzzy set theory provides a mathematical framework which fuzzy concepts of accounting can be examined on a regular basis, for instance, materiality errors. Therefore, using fuzzy set theory, accountants will be able to apply fuzzy set theory in accounting. As a result, they no longer have to ignore ambiguities in accounting matters. Also, they will be able to deal with it like random events using probability theory. Accountants with ignoring the ambiguity cause inaccuracies in accounting matters [1].

In addition, unlike ordinary set theory, fuzzy set theory abandons the rule of excluding the mean and logic of two values. As a result, there will be no need for a binary classification of accounting objectives that are generally unrealistic and artificial. Many of the targets and concepts of accounting with binary classification are not consistent. For example, neutrality is not a debate of being black and white. There are different degrees of neutrality, or in the discussion of deviation analysis, controllable deviations or uncontrollable deviations are kinds of unrealistic integration. Similarly, the discussion of the materiality or reliability of accounting is not a two-part concept. Because there are degrees of materiality or reliability. One of the features of the fuzzy set is that it reduces the need for accurate data in decision making.

Recently, this theory has been used to solve accounting problems. These studies can be divided into two groups. The first group deals with audit problems such as internal control, audit sampling, and

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judgment of materiality. The second group deals with management accounting issues and problems such as capital budgeting, cost deviations, and strategic planning. Some applications of fuzzy sets in the audit are summarized as:

Friedlob and Schleifer [11] argue that auditors usually express risk in the form of probabilities, examining different types of audit uncertainty. Finally, they introduced the fuzzy logic-based method as a new method of examining audit uncertainty.

Pathak et al. [12] indicates that in order to reduce the costs of detecting fraud in the claims made in their insurance companies, they designed fuzzy expert systems to evaluate and express the elements related to fraud in resolving insurance claims. This system is useful for deciding whether settled insurance claims are actual or whether there is evidence of fraud.

Comunale and Sexton [13] introduced a fuzzy logic approach to assess the importance of presenting financial statements. A fuzzy logic-based approach to significance assessment can provide an expert system for significance assessment compared to traditional approaches, which are based on binary valuation; In such a way that the importance of presenting financial statements correctly can be shown between zero and one, and on the other hand, quality criteria can be considered in evaluating the importance.

Dereli et al. [14] using a fuzzy mathematical programming model, they proposed a strategic algorithm to shape the quality audit team. In this study, the fuzzy ranking method has been used to determine the adequacy of the skills and expertise of each auditor in team auditing.

De Korvin et al. [15] examined the risk of internal controls in computer accounting information systems through a fuzzy set approach. The model presented in this research is used through a risk analysis matrix in a company active in the chemical industry. This model is useful in evaluating and applying new control procedures to increase the security of the company's information systems.

Also, some applications of fuzzy sets in the management accounting [16, 17] are summarized as:

Oderanti and De Wilde [18] used the concepts of fuzzy logic and game theory to model the strategic decision-making process by business organizations based on uncertain information. In this study, competition between business organizations is considered as a game and organizations are its actors. They model their decisions through strategic actions based on uncertain information.

Cassia et al. [19] examined the development of corporate management accounting systems in providing information to facilitate the strategic decision-making process and its relationship to the shape, development and size of companies through the general mode of fuzzy logic. The results of the study indicate that 511 Italian companies are always advances in the evolution of corporate management accounting system do not meet. In other words, you can find a large number of companies with a simple organizational structure but with an advanced management accounting system.

Rangone [20] according to strategic management accounting, strategic cost management and non-financial performance metrics are introduced as strategies to overcome the limitations of traditional management accounting systems. He provided an analytical framework using fuzzy logic to establish a relationship between the effectiveness of the organization, key indicators of success and performance measurement.

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Nagasawa [21] using fuzzy set theory, a model for value engineering and cost management was designed. The existence of different tools and solutions for value engineering, their prioritization as well as the related ambiguities related to them, have been expressed as reasons for the need to address fuzzy set theory in value engineering.

Nachtmann and Needy [22] through the application of fuzzy logic concepts in costing, they developed an activity-based costing system. This study demonstrates the benefits of a fuzzy activity based costing system and the stages of development and implementation in a pharmaceutical company.

Nachtmann and Needy [23] have introduced and compared methods of overcoming ambiguity and uncertainty over the input data of the activity-based costing system from the perspective of cost-benefit analysis. According to the comparison, the use of fuzzy method in activity-based costing to consider the conditions of ambiguity and uncertainty is more appropriate than the methods based on each of the standard models, distance and Monte Carlo with normal input variables.

Yuan [24] Using a fuzzy expert system, designed a model to analyze costs, activity volume and profit in ambiguous conditions by management. In this new system, unlike the traditional mode, which uses the break-even point and assumes a state of confidence, the information of experts and the concepts of fuzzy sets are used to overcome inaccuracies and ambiguities.

4. Conclusion

The purpose of this paper is to introduce fuzzy set theory in accounting and examine its relationship as a way to solve accounting problems in conditions of ambiguity. Fuzzy theory, unlike traditional quantitative methods, provides a mathematical framework for inaccurate phenomena in human systems and decision making that can be applied on a regular basis. This theory does not require accurate measurements. As a result, fuzzy theory can be invaluable to accountants, especially in times of ambiguity and when care cannot be taken. Therefore, due to the ambiguities that exist in accounting and auditing issues; accountants and auditors should not hesitate to use fuzzy set theory. One of the features of the fuzzy set is that it reduces the need for accurate data in decision making. Because today, information plays an important role in economic decision-making, and no doubt [25], the quality of their, including accuracy in providing it to a wide range of users, can be useful for decision-making [26].

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