Available online at www.sciencedirect.com
SciVerse ScienceDirect
Systems Engineering Procedia 5 (2012) 49 – 54
Procedia
Systems Engineering

International Symposium on Engineering Emergency Management 2011

# Dynamic Engineering Multi-criteria Decision Making Model Optimized by Entropy Weight for Evaluating Bid

Zhaohong Wang[a], Wei Zhan [b]*

[a] College of Physical Education and Sports, Beijing Normal University, Beijing, China
[b] Graduate University of Chinese Academy of Sciences, Beijing, China

**Abstract**

Bid evaluation was a pivotal step in the process of bidding. In order to prevent subjective or arbitrary behavior in bid evaluation process, a dynamic engineering Multi-Criteria Decision Making Model optimized by entropy weight was proposed. In this model, the dynamic weight of quotation was obtained through mutual game playing of bidders. Besides, objective entropy weight was employed to determine weight of other criteria except quotation. Dynamics, objectivity and scientificity were realized in this model. Moreover, this model was applied to evaluate bid of an assets packet project for an assets management corporation. Scientific and satisfying results were obtained. The results showed that subjectivity and arbitrariness were avoided successfully.

***Keywords:*** engineering multi-criteria decision making, entropy, entropy weight, dynamic weight, bid evaluation

## 1. Introduction

Bid evaluation is the focus of bidder, tenderee and bid evaluation committee. Scientific and rational method of bid evaluation is the premise of open, fair and just during tender decision process. The advantage of traditional methods of bid evaluation is simple and easy to realize. Meanwhile, the disadvantages are as following: 1) They are influenced by subjective factors in the most degree. The traditional methods excessively dependent on committee members' subjective cognition and it will influence the fairness of bidding. 2) Evaluation criteria is not standardized. The traditional evaluation criteria system is irregularity and criteria content is uncertain. 3) The standard of bid evaluation is not detailed or accurate. In bid evaluation process, divergence of understanding standard between committee members is easy to lead to debate. In order to resolve these problems, this research established dynamic weight multi-criteria decision making model based on quotation. In this model, the objective entropy weight was employed as weight coefficient for other criteria except quotation.

## 2. Entropy and entropy weight

Entropy was one of concepts in thermodynamics originally and then Shannon firstly introduced the concept of information entropy in connection with communication theory. He considered entropy as an equivalent to uncertainty. It made a pervasive impact to many other disciplines in extending his work to other fields, ranging from

 doi:10.1016/j.sepro.2012.04.008

management science (Yang & Qiu, 2005; Willis, 2000), engineering technology (Yuan, Xiong & Huai, 2003; Shuiabi, Thomoson & Bhuiyan, 2005) and sociological economic field (Antoniou, 2002; Gill, 2005) . In these disciplines entropy is applied as a measure of disorder, unevenness of distribution, the degree of dependency or complexity of a system. Information entropy is an ideal measure of uncertainty and it can measure the quantity of effective information (Qiu, 2001). In an evaluation problem that has n evaluated objects and m criteria for each object (i.e. (m, n) evaluation problem), the ith criterion's entropy is defined as follows:

$$H_i = -k\sum_{j=1}^{n} f_{ij} \ln f_{ij} \qquad (1)$$

$$i = 1,2,\cdots,m \quad j = 1,2,\cdots,n$$

Where $f_{ij} = \dfrac{x_{ij}}{\sum_{j=1}^{n} x_{ij}}$ , $k = \dfrac{1}{\ln n}$

Assume that if $f_{ij} = 0$ , then $f_{ij} \ln f_{ij} = 0$ . Where $x_{ij}$ indicates the normalized eigenvalue of the $j^{th}$ bid with regard to the $i^{th}$ criterion.

In (m, n) evaluation problem, the $i^{th}$ criterion's entropy weight is defined as follows:

$$\omega_i = \frac{1 - H_i}{m - \sum_{i=1}^{m} H_i} \qquad (2)$$

From the above two definitions and general properties of entropy and entropy weight, there are a number of expected characteristics for entropy weight which make it appropriate as a measure of evaluation.

This is at a maximum, $H_{max}=1$, when all objects have the same performance rating at the $i^{th}$ cariterion, and the entropy weight of the $i^{th}$ criterion equal to zero. It reflects that this criterion can be eliminated since all the performance ratings against this criterion are the same and it transmits no information to the decision makers.

When each object has very different performance rating at the $i^{th}$ criterion, the entropy is low and the entropy weight is high, it means that this criterion provides valuable information and it should be considered especially.

The higher the entropy value, the lower the entropy weight and the less important the criterion. And the entropy weight satisfies

$$0 \le \omega_i \le 1, \quad \sum_{i=1}^{m} \omega_i = 1$$

The entropy weight represents the degree of the criterion providing useful information from the viewpoint of information theory.

The entropy weight has particular significance. Entropy weights of indices are determined by the contrast intensity of the objects' performance ratings with respect to each criterion. In other words, it is based on the context-dependent concept of informational importance.

## 3. Dynamic Multi-Criteria Decision Making Model setting

A systematic model was developed to evaluate the bids in the following four sequential steps: