ISSN : 0974 - 7435 Volume 10 Issue 16

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(16), 2014 [9404-9409]

Model for evaluating the enterprise management information system with 2-tuple linguistic information

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ABSTRACT

In this paper, we investigate the multiple attribute group decision making (MAGDM) problems for for evaluating the enterprise management information system with 2-tuple linguistic Information. Then, a model based on the 2-tuple weighted geometric (TWG) operators to evaluate the enterprise management information system is presented. In this model, alternative appraisal values are calculated by the aggregation of 2-tuple linguistic information. Thus, the ranking of alternative or selection of the most desirable alternatives is obtained by the comparison of 2-tuple linguistic information. Finally, an illustrative example for evaluating the enterprise management information system is given to verify the developed approach and to demonstrate its practicality and effectiveness.

KEYWORDS

Multiple attribute group decision-making (MAGDM); 2-tuple weighted geometric (TWG) operator; 2-tuple linguistic information; Enterprise management information system.

INTRODUCTION

Taking computer as the core of modern information technology has changed the structure of economy and organization, life manner and many other aspects of the world. The construction and application of enterprise management information system (EMIS) play a major role for the survival and development of the enterprises. However, while we are noticing the rapid development of MIS, we must pay attention to the problems that exist in the construction of enterprise management information system (EMIS) projects. The success rate of the construction of enterprise management information system (EMIS) projects is lower than that of other projects both in developed and developing countries. More and more investments in it can't reach expectation of the enterprises. Therefore, timely and impersonal evaluation of enterprise management information system (EMIS) seems particularly important. Because only by understanding the true value of MIS, enterprises would be able to resolve the important issues such as whether to continue to invest, and what areas should be improved etc. Then enterprises would summarize experiences and improve themselves continuously. However, stress of evaluation has been particularly laid on the analysis of MIS performance and financial perspective, and the influence on internal management, customer relationship and competition brought by enterprise management information system (EMIS) overlooked. Usually, the influence on these aspects is the most important, which needs frequent application and improvement in a long way. Particularly, in China, compared with the rapidly developing information industry, the evaluation of the value of enterprise management information system (EMIS) is more laggard. Therefore, there is an urgent need to strengthen the research on enterprise management information system (EMIS) theory and method of evaluation.

The problem of evaluating the enterprise management information system with 2-tuple linguistic information is the multiple attribute group decision making (MAGDM) problems[1-9]. The aim of this paper is to investigate the MAGDM problems for evaluating the enterprise management information system with 2-tuple linguistic information. The remainder of this paper is set out as follows. In the next section, we introduce some basic concepts related to 2-tuple linguistic information s. In Section 3 we introduce the MAGDM problem to evaluate the enterprise management information system with 2-tuple linguistic information. Then, a model based on 2-tuple weighted geometric (TWG) operators to evaluate the enterprise management information system is presented. In this model, alternative appraisal values are calculated by the aggregation of 2-tuple linguistic information. Thus, the ranking of alternative or selection of the most desirable alternatives is obtained by the comparison of 2-tuple linguistic information. In Section 4, an illustrative example is pointed out. In Section 5 we conclude the paper and give some remarks.

PRELIMINARIES

Let $S=\{s_i \mid i=1,2,\cdots,t\}$ be a linguistic term set with odd cardinality. Any label, s_i represents a possible value for a linguistic variable, and it should satisfy the following characteristics[10-12]:

(1) The set is ordered: $s_i > s_j$, if $i > j$; (2) Max operator: $\max(s_i, s_j) = s_i$, if $s_i \geq s_j$; (3) Min operator: $\min(s_i, s_j) = s_i$, if $s_i \leq s_j$. For example, S can be defined as

$$S = \{s_1 = extremely\ poor, s_2 = very\ poor, s_3 = poor, s_4 = medium,$$
$$s_5 = good, s_6 = very\ good, s_7 = extremely\ good\}$$

Definition 1. Let $S=\{s_1, s_2, \cdots, s_t\}$ be a linguistic term set and $\beta \in [1,t]$ be a value representing the result of a symbolic aggregation operation; then 2-tuple that expresses the equivalent information to β is obtained with the following function:

$$\Delta : [1,t] \to S \times [-0.5, 0.5) \quad \textbf{(1)}$$

$$\Delta(\beta) = \begin{cases} s_i, i = round(\beta) \\ \alpha = \beta - i, \ \alpha \in [-0.5, 0.5) \end{cases} \quad \textbf{(2)}$$

where round (.) is the usual round operation, s_i has the closest index label to β and α is the value of the symbolic translation[10-12].

Definition 2. Let $S=\{s_1,s_2,\cdots,s_t\}$ be a linguistic term set and (s_i,α_i) be a 2-tuple; a function Δ^{-1} can be defined, such that, from a 2-tuple (s_i,α_i) it return its equivalent numerical value $\beta\in[1,t]\subset R$, which is obtained with the following function[10-12]:

$$\Delta^{-1}: S\times[-0.5,0.5)\to[1,t] \tag{3}$$

$$\Delta^{-1}(s_i,\alpha)=i+\alpha=\beta \tag{4}$$

Definition 3[13]. Let $x=\{(r_1,a_1),(r_2,a_2),\ldots,(r_n,a_n)\}$ be a set of 2-tuple and $\omega=(\omega_1,\omega_2,\cdots,\omega_n)^T$ be the weighting vector of 2-tuple (r_j,a_j) $(j=1,2,\cdots,n)$ and $\omega_j\in[0,1]$, $\sum_{j=1}^{n}\omega_j=1$, The 2-tuple weighted geometric operator is

$$(\tilde{r},\tilde{a})=TWG_{\omega}((r_1,a_1),(r_2,a_2),\ldots,(r_n,a_n))=\Delta\left(\prod_{j=1}^{n}\left(\Delta^{-1}(r_j,a_j)\right)^{\omega_j}\right)$$

$$\tilde{r}\in S,\tilde{a}\in[-0.5,0.5) \tag{5}$$

MODEL FOR EVALUATING THE ENTERPRISE MANAGEMENT INFORMATION SYSTEM WITH 2-TUPLE LINGUISTIC INFORMATION

The following assumptions or notations are used to represent the MAGDM problems for evaluating enterprise management information system with 2-tuple[10-13] linguistic information. Let $A=\{A_1,A_2,\cdots,A_m\}$ be a discrete set of alternatives, and $G=\{G_1,G_2,\cdots,G_n\}$ be the set of attributes, $\omega=(\omega_1,\omega_2,\cdots,\omega_n)$ is the weighting vector of the attributes G_j $(j=1,2,\cdots,n)$, where $\omega_j\geq 0$, $j=1,2,\cdots,n$, $\sum_{j=1}^{n}\omega_j=1$. Let $D=\{D_1,D_2,\cdots,D_t\}$ be the set of decision makers. Suppose that $R_k=\left(r_{ij}^{(k)}\right)_{m\times n}$ is the decision matrix, where $r_{ij}^{(k)}\in S$ is a preference value, which takes the form of linguistic variables, given by the decision maker $D_k\in D$, for the alternative $A_i\in A$ with respect to the attribute $G_j\in G$. Let $A=\{A_1,A_2,\cdots,A_m\}$ be a discrete set of alternatives.

In the following, we apply the proposed model to MAGDM for evaluating the enterprise management information system with 2-tuple linguistic information.

Step 1. Transforming linguistic decision matrix $R_k=\left(r_{ij}^{(k)}\right)_{m\times n}$ into 2-tuple linguistic decision matrix $R_k=\left(r_{ij}^{(k)},0\right)_{m\times n}$.

Step 2. Utilize the decision information given in matrix R_k, and the TWG operator

$$z_i^{(k)}=\left(r_i^{(k)},a_i^{(k)}\right)=\Delta\left(\prod_{j=1}^{n}\left(\Delta^{-1}\left(r_{ij}^{(k)},0\right)\right)^{\omega_j}\right),r_i^{(k)}\in S,a_i^{(k)}\in[-0.5,0.5) \tag{6}$$

to derive the individual overall preference value $\tilde{r}_i^{(k)}$ of the alternative A_i.

Step 3. Utilize the TWG operator:

$$z_i = (r_i, a_i) = \Delta\left(\prod_{k=1}^{t}\left(\Delta^{-1}\left(\hat{r}_i^k, \hat{a}_i^k\right)\right)^{v_k}\right), r_i \in S, a_i \in [-0.5, 0.5) \quad \textbf{(7)}$$

to derive the collective overall preference values $z_i = (r_i, a_i)(i = 1, 2, \cdots, m)$ of the alternative A_i, where $\left(\hat{r}_i^k, \hat{a}_i^k\right)$ is the k-th largest of the 2-tuple linguistic weighted arguments $\left(r_i^{(k)}, a_i^{(k)}\right)(k = 1, 2, \cdots, t)$, $v = (v_1, v_2, \cdots, v_n)$ is the associated 2-tuple linguistic weighting vector of the TWG operator, $v_k \geq 0$, $j = 1, 2, \cdots, n$, $\sum_{j=1}^{n} v_k = 1$.

Step 4. Rank all the alternatives $A_i (i = 1, 2, \cdots, m)$ and select the best one (s) in accordance with $z_i (i = 1, 2, \cdots, m)$. If any alternative has the highest z_i value, then, it is the most important alternative.

Step 5. End.

NUMERICAL EXAMPLE

This section presents a numerical example to evaluate the enterprise management information system with 2-tuple linguistic information to illustrate the method proposed in this paper. There are five possible enterprise management information systems $A_i (i = 1, 2, 3, 4, 5)$ for four attributes $G_j (j = 1, 2, 3, 4)$. The four attributes include the system performance (G_1), internal processes (G_2), learning and growth (G_3) and social objectives (G_4), respectively. The five possible enterprise management information systems $A_i (i = 1, 2, \cdots, 5)$ are to be evaluated using the linguistic term set

$$S = \{s_1 = extremely\ poor, s_2 = very\ poor, s_3 = poor, s_4 = medium,$$
$$s_5 = good, s_6 = very\ good, s_7 = extremely\ good\}$$

by the three decision makers $D_k (k = 1, 2, 3)$ under the above five attributes whose weighting vector $\omega = (0.15, 0.25, 0.10, 0.30, 0.20)^T$), and construct, respectively, the decision matrices as follows $\tilde{R}_k = \left(\tilde{r}_{ij}^{(k)}\right)_{5\times 4} (k = 1, 2, 3)$:

$$\tilde{R}_1 = \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{matrix}\begin{pmatrix} s_3 & s_2 & s_4 & s_4 & s_3 \\ s_2 & s_3 & s_1 & s_6 & s_4 \\ s_4 & s_4 & s_6 & s_6 & s_5 \\ s_6 & s_6 & s_4 & s_5 & s_3 \end{pmatrix}$$

$$\tilde{R}_2 = \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{matrix}\begin{pmatrix} s_2 & s_3 & s_3 & s_3 & s_3 \\ s_3 & s_5 & s_2 & s_3 & s_4 \\ s_4 & s_4 & s_4 & s_6 & s_6 \\ s_2 & s_5 & s_5 & s_4 & s_2 \end{pmatrix}$$

$$\tilde{R}_3 = \begin{matrix} T_1 \\ T_2 \\ T_3 \\ T_4 \end{matrix} \begin{pmatrix} s_3 & s_2 & s_2 & s_3 & s_3 \\ s_4 & s_3 & s_3 & s_2 & s_2 \\ s_5 & s_3 & s_5 & s_4 & s_5 \\ s_3 & s_5 & s_6 & s_5 & s_6 \end{pmatrix}$$

In the following, we shall utilize the proposed approach in this paper getting the most desirable enterprise management information systems:

Step 1. Transforming linguistic decision matrix $R_k = \left(r_{ij}^{(k)}\right)_{m\times n}$ into 2-tuple linguistic decision matrix $R_k = \left(r_{ij}^{(k)}, 0\right)_{m\times n}$ as follows

$$\tilde{R}_1 = \begin{pmatrix} (s_3,0) & (s_2,0) & (s_4,0) & (s_4,0) & (s_3,0) \\ (s_2,0) & (s_3,0) & (s_1,0) & (s_6,0) & (s_4,0) \\ (s_4,0) & (s_4,0) & (s_6,0) & (s_6,0) & (s_5,0) \\ (s_6,0) & (s_6,0) & (s_4,0) & (s_5,0) & (s_3,0) \end{pmatrix}$$

$$\tilde{R}_2 = \begin{pmatrix} (s_2,0) & (s_3,0) & (s_3,0) & (s_3,0) & (s_3,0) \\ (s_3,0) & (s_5,0) & (s_2,0) & (s_3,0) & (s_4,0) \\ (s_4,0) & (s_4,0) & (s_4,0) & (s_6,0) & (s_6,0) \\ (s_2,0) & (s_5,0) & (s_5,0) & (s_4,0) & (s_2,0) \end{pmatrix}$$

$$\tilde{R}_3 = \begin{pmatrix} (s_3,0) & (s_2,0) & (s_2,0) & (s_3,0) & (s_3,0) \\ (s_4,0) & (s_3,0) & (s_3,0) & (s_2,0) & (s_2,0) \\ (s_5,0) & (s_3,0) & (s_5,0) & (s_4,0) & (s_5,0) \\ (s_3,0) & (s_5,0) & (s_6,0) & (s_5,0) & (s_6,0) \end{pmatrix}$$

Step 2. Utilize the decision information given in matrix $\tilde{R}_k$, and the TWG operator to derive the individual overall preference value $z_i^{(k)} = \left(r_i^{(k)}, a_i^{(k)}\right)$ of the enterprise management information system A_i.

$$z_1^{(1)} = (s_3, 0.13), z_2^{(1)} = (s_3, 0.34), z_3^{(1)} = (s_6, -0.42), z_4^{(1)} = (s_5, 0.44)$$
$$z_1^{(2)} = (s_3, -0.20), z_2^{(2)} = (s_3, 0.23), z_3^{(2)} = (s_5, -0.43), z_4^{(2)} = (s_3, 0.43)$$
$$z_1^{(3)} = (s_3, -0.21), z_2^{(3)} = (s_2, 0.23), z_3^{(3)} = (s_4, 0.34), z_4^{(3)} = (s_2, 0.32)$$

Step 3. Utilize the TWG operator to derive the collective overall preference values $z_i = (r_i, a_i)(i = 1,2,3,4)$ of the enterprise management information system A_i, $w = (0.20, 0.45, 0.35)$ is the associated weighting vector of the TWG operator.

$$z_1 = (s_3, -0.12), z_2 = (s_3, -0.36), z_3 = (s_5, 0.35), z_4 = (s_4, -0.18)$$

Step 4. Ranking all the enterprise management information systems $T_i\ (i=1,2,3,4)$ in accordance with the $z_i\ (i=1,2,3,4)$: $T_3 \succ T_4 \succ T_2 \succ T_1$. And thus the most desirable enterprise management information system is T_3.

CONCLUSION

In this paper, we investigate the multiple attribute group decision making (MAGDM) problems for for evaluating the enterprise management information system with 2-tuple linguistic Information. Then, a model based on the 2-tuple weighted geometric (TWG) operators to evaluate the enterprise management information system is presented. In this model, alternative appraisal values are calculated by the aggregation of 2-tuple linguistic information. Thus, the ranking of alternative or selection of the most desirable alternatives is obtained by the comparison of 2-tuple linguistic information. Finally, an illustrative example for evaluating the enterprise management information system is given to verify the developed approach and to demonstrate its practicality and effectiveness.

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