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Model for evaluating the medical information resources on internet with linguistic information

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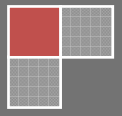
ABSTRACT

In this paper, we investigate the multiple attribute group decision making problems for evaluating the medical information resources on internet with linguistic information. We utilize the linguistic weighted averaging (LWA) operator and linguistic hybrid aggregation (LHA) operator to aggregate the linguistic information corresponding to each alternative and get the overall value with linguistic information, then rank the alternatives and select the most desirable one(s) by using the overall value with linguistic information. Finally, an illustrative example for evaluating the medical information resources on internet with linguistic information is given to verify the developed approach and to demonstrate its practicality and effectiveness.

KEYWORDS

Evaluation; Linguistic information; Linguistic weighted averaging (LWA) operator; linguistic hybrid aggregation (LHA) operator; Medical information resources.



INTRODUCTION

The two main topics of the development of the modern era are economy and information technology (IT), and matching with the time is a strong sound of the age conforming to the objective laws of the development of the human society. The networks economy progressing with a highly speed, led by IT, undulates a new hot upsurge of economy. The new economy based on knowledge is believed to promote the thorough study of the theory and practice of information resources management (IRM). In the current age of knowledge-based economy, information resources are ranked among the fundamental and essential strategic resources. Life science research of the 21st century is becoming the most active realm of all human scientific research activities, with biomedical science being one of the most important markings and key disciplines of the time. With the deepening of economic globalization and increasingly intensifying competition for comprehensive national strength, support and encouragement for creative activities via the information resources guarantee (IRG) system have become a vital component of creative strategies of the international community. The high-speed growth of biomedical science places a higher demand on biomedical information resources construction and service, the development and improvement of the biomedical IRG system will provide a greater support for updated knowledge and technological innovations in biomedicine. Modern information resources management theories, combined with data from surveys by the National CALIS Biomedical Literature Center, are applied to the analysis of customers' or users' demands for information within the context of the internet, biomedical information resources, current researches on biomedical information service, major problems and countermeasures. The analysis serves as a basis for a systematic and thorough exploration of the construction mode, management systems, operation mechanisms of China's biomedical IRG systems. In the light of philosophy, sociology, economics and legal theory, further study is done on theories regarding the establishment of the IRG system, and its implication of building such a system in China.

In this paper, we investigate the multiple attribute group decision making problems[1-10] for evaluating the medical information resources on internet with linguistic information. We utilize the linguistic weighted averaging (LWA) operator and linguistic hybrid aggregation (LHA) operator to aggregate the linguistic information corresponding to each alternative and get the overall value with linguistic information, then rank the alternatives and select the most desirable one(s) by using the overall value with linguistic information. Finally, an illustrative example for evaluating the medical information resources on internet with linguistic information is given to verify the developed approach and to demonstrate its practicality and effectiveness.

PRELIMINARIES

Let $S = \{s_i \,|\, i = 0,1,\cdots,t\}$ 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[11-18]:

(1) The set is ordered: $s_i > s_j$, if $i > j$; (2) There is the reciprocal operator: $rec(s_i) = s_j$ such that $i + j = t$; (3) Max operator: $\max(s_i, s_j) = s_i$, if $s_i \geq s_j$; (4) Min operator: $\min(s_i, s_j) = s_i$, if $s_i \leq s_j$. For example, S can be defined as

$$S = \{s_0 = extremely\ poor, s_1 = very\ poor, s_2 = poor, s_3 = medium,$$
$$s_4 = good, s_5 = very\ good, s_6 = extremely\ good\}$$

To preserve all the given information, we extend the discrete term set S to a continuous term set, whose elements also meet all the characteristics above. If $s_a \in S$, then we call s_a the original linguistic term, otherwise, we call s_a the virtual linguistic term, q is a large positive integer. In general, the decision maker uses the original linguistic term to evaluate attributes and alternatives, and the virtual linguistic terms can only appear in calculation[11-12].

Consider any two linguistic variables s_α and s_β, $s_\alpha, s_\beta \in \bar{S}$, $\lambda \in [0,1]$ we define their operational laws as follows[19]:

(1) $s_\alpha + s_\beta = s_{\alpha+\beta}$; (2) $\lambda s_\beta = s_{\lambda\beta}$.

Definition 1[19]. A linguistic ordered weighted geometric (LWA) operator of dimension n is a mapping LWA: $\bar{S}_n \to S_n$, which has associated with it an exponential weighting vector $\omega = (\omega_1, \omega_2, \cdots, \omega_n)^T$, with $\omega_j \in [0,1]$ and $\sum_{j=1}^{n} \omega_j = 1$, such that:

$$\mathrm{LWA}_\omega(s_{\alpha_1}, s_{\alpha_2}, \cdots, s_{\alpha_n}) = \omega_1 \otimes s_{\alpha_1} \oplus \omega_2 \otimes s_{\alpha_2} \oplus \cdots \oplus \omega_n \otimes s_{\alpha_n} \quad (1)$$

Definition 2[19]. Let $s_{\alpha_i}\ (i=1,2,\cdots,n)$ be a linguistic terms sets, and

$$\mathrm{LOWA}_w\left(s_{\alpha_1},s_{\alpha_2},\cdots,s_{\alpha_n}\right)=w_1s_{\beta_1}\oplus w_2s_{\beta_2}\oplus\cdots\oplus w_ns_{\beta_n} \quad (2)$$

Where $w=\left(w_1,w_2,\cdots,w_n\right)$ is the associated weighting vector, with $w_j\in[0,1]$, $\sum_{j=1}^{n}w_j=1$,and s_{β_j} is the j-th largest element in the linguistic variables set $\left(s_{\alpha_1},s_{\alpha_2},\cdots,s_{\alpha_n}\right)$, then the function LOWA is called the linguistic ordered weighted averaging (LOWA) operator of dimension n.

Definition 3[19]. Let $s_i\ (i=1,2,\cdots,n)$ be a linguistic terms sets, and

$$\mathrm{LHA}_{w,\omega}\left(s_1,s_2,\cdots,s_n\right)=w_1\times r_1\oplus w_2\times r_2\oplus\cdots\oplus w_n\times r_n=\overset{n}{\underset{i=1}{\oplus}}w_i\times r_i \quad (3)$$

Where $w=\left(w_1,w_2,\cdots,w_n\right)$ is the associated weighting vector, with $w_j\in[0,1]$, $\sum_{j=1}^{n}w_j=1$,and r_i is the i-th largest element of the linguistic weighted argument $r_i'\left(r_i'=n\omega_is_i\right)$, $\omega=\left(\omega_1,\omega_2,\cdots,\omega_n\right)$ is the weighting vector of linguistic variables $s_i\ (i=1,2,\cdots,n)$,with $\omega_i\in[0,1]$, $\sum_{i=1}^{n}\omega_i=1$, and n is the balancing coefficient, then the function LHA is called the linguistic hybrid aggregation (LHA) operator of dimension n.

MODEL FOR EVALUATING THE MEDICAL INFORMATION RESOURCES ON INTERNET WITH LINGUISTIC INFORMATION

In this section, we investigate the multiple attribute group decision making problems for evaluating the medical information resources on internet with linguistic information. Let $A=\left\{A_1,A_2,\cdots,A_m\right\}$ be a discrete set of alternatives, and $G=\left\{G_1,G_2,\cdots,G_n\right\}$ be the set of attributes, $\omega=\left(\omega_1,\omega_2,\cdots,\omega_n\right)$ is the exponential weighting vector of the attributes $G_j\ (j=1,2,\cdots,n)$, where $\omega_j\in[0,1],\sum_{j=1}^{n}\omega_j=1$. Let $D=\left\{D_1,D_2,\cdots,D_t\right\}$ be the set of decision makers, and $\nu=\left(\nu_1,\nu_2,\cdots,\nu_t\right)$ be the weight vector of decision makers, where $\nu_k\in[0,1],\sum_{k=1}^{t}\nu_k=1$. 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 $G_j\in G$.

In the following, we apply the LWA and LHA operators to MAGDM for evaluating the medical information resources on internet with linguistic information.

Step 1. Utilize the decision information given in matrix R_k, and the LWA operator

$$r_i^{(k)}=\mathrm{LWA}_\omega\left(r_{i1}^{(k)},r_{i2}^{(k)},\cdots,r_{in}^{(k)}\right),\ i=1,2,\cdots,m,k=1,2,\cdots,t. \quad (4)$$

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

Step 2. Utilize the LHA operator:

$$r_i=\mathrm{LHA}_{\nu,w}\left(r_i^{(1)},r_i^{(2)},\cdots,r_i^{(t)}\right),\ i=1,2,\cdots,m. \quad (5)$$

To derive the collective overall preference values $\tilde{r}_i\left(i=1,2,\cdots,m\right)$ of the alternative A_i,where $v=\left(v_1,v_2,\cdots,v_n\right)$ be the weight vector of decision makers, with $v_k\in\left[0,1\right]$, $\sum_{k=1}^{t}v_k=1$, $w=\left(w_1,w_2,\cdots,w_t\right)$ is the associated weighting vector of the LHA operator, with $w_k\in\left[0,1\right]$, $\sum_{k=1}^{t}w_k=1$.

Step 3. Rank all the alternatives $A_i\left(i=1,2,\cdots,m\right)$ and select the best one(s) in accordance with $r_i\left(i=1,2,\cdots,m\right)$.

Step 4. End.

NUMERICAL EXAMPLE

In this section, we present an empirical case study of evaluating the medical information resources on internet with linguistic information. The project's aim is to evaluate the medical information resources on internet with linguistic information. There are five possible companies $A_i\left(i=1,2,3,4,5\right)$ to be evaluated according to the following four attributes: G1 is the medical website content; G2 is the medical web site users; G3 is the medical website technical value; G4 is the medical website academic value. The five possible companies $A_i\left(i=1,2,3,4\right)$ are to be evaluated using the linguistic term set S by the three decision makers $D_k\left(k=1,2,3\right)$ (whose weighting vector $v=\left(0.30,0.40,0.30\right)$) under the above four attributes (whose weighting vector $\omega=\left(0.30,0.10,0.40,0.20\right)^T$), and construct, respectively, the decision matrices as follows $R_k=\left(r_{ij}^{(k)}\right)_{5\times4}\left(k=1,2,3,4\right)$:

$$R_1=\begin{array}{c} \\ A_1\\A_2\\A_3\\A_4\\A_5\end{array}\begin{array}{c}\begin{array}{cccc}G_1&G_2&G_3&G_4\end{array}\\\begin{pmatrix}s_1&s_5&s_1&s_4\\s_2&s_2&s_3&s_5\\s_6&s_5&s_6&s_2\\s_2&s_2&s_2&s_6\\s_5&s_6&s_2&s_3\end{pmatrix}\end{array}$$

$$R_2=\begin{array}{c} \\ A_1\\A_2\\A_3\\A_4\\A_5\end{array}\begin{array}{c}\begin{array}{cccc}G_1&G_2&G_3&G_4\end{array}\\\begin{pmatrix}s_5&s_5&s_2&s_5\\s_1&s_5&s_1&s_4\\s_2&s_6&s_3&s_6\\s_0&s_2&s_5&s_5\\s_5&s_4&s_4&s_1\end{pmatrix}\end{array}$$

$$R_3=\begin{array}{c} \\ A_1\\A_2\\A_3\\A_4\\A_5\end{array}\begin{array}{c}\begin{array}{cccc}G_1&G_2&G_3&G_4\end{array}\\\begin{pmatrix}s_5&s_6&s_2&s_5\\s_1&s_1&s_3&s_2\\s_3&s_3&s_4&s_4\\s_5&s_4&s_2&s_5\\s_6&s_5&s_5&s_5\end{pmatrix}\end{array}$$

To get the most desirable companies with best medical information resources on internet, the following steps are involved:

Step 1. Utilize the decision information given in matrix $\tilde{R}_k$, and the LWA operator $\left(let\ \omega = (0.30, 0.10, 0.40, 0.20)^T\right)$:

$$r_i^{(k)} = \mathrm{LWA}_{\omega}\left(r_{i1}^{(k)}, r_{i2}^{(k)}, \cdots, r_{in}^{(k)}\right), i = 1,2,3,4,5, k = 1,2,3$$

to derive the individual overall preference value $r_i^{(k)}$ of companies with best medical information resources on internet with linguistic information A_i.

$$r_1^{(1)} = s_{3.45}, r_2^{(1)} = s_{4.51}, r_3^{(1)} = s_{2.89}, r_4^{(1)} = s_{4.65}, r_5^{(1)} = s_{2.70}$$

$$r_1^{(2)} = s_{2.09}, r_2^{(2)} = s_{3.18}, r_3^{(2)} = s_{6.34}, r_4^{(2)} = s_{4.07}, r_5^{(2)} = s_{3.56}$$

$$r_1^{(3)} = s_{3.43}, r_2^{(3)} = s_{3.8}, r_3^{(3)} = s_{5.98}, r_4^{(3)} = s_{4.29}, r_5^{(3)} = s_{3.76}$$

Step 2. Utilize the LHA operator:

$$r_i = \mathrm{LHA}_{v,w}\left(r_i^{(1)}, r_i^{(2)}, r_i^{(3)}\right), i = 1,2,3,4$$

to derive the collective overall preference values $r_i\ (i = 1,2,3,4)$ of companies with best medical information resources on internet, where $v = (0.30, 0.40, 0.30)$ be the weighting vector of decision makers, $w = (0.50, 0.30, 0.20)$ is the associated weighting vector of the LHA operator.

$$r_1 = s_{4.28}, r_2 = s_{5.76}, r_3 = s_{7.98}, r_4 = s_{6.21}, r_5 = s_{5.37}$$

Step 3. Rank all the companies $A_i\ (i = 1,2,3,4,5)$ in accordance with the overall preference values $r_i\ (i = 1,2,3,4,5)$: $A_3 \succ A_4 \succ A_2 \succ A_5 \succ A_1$. Thus the most best company with medical information resources on internet is A_3.

CONCLUSION

In this paper, we investigate the multiple attribute group decision making problems for evaluating the medical information resources on internet with linguistic information. We utilize the linguistic weighted averaging (LWA) operator and linguistic hybrid aggregation (LHA) operator to aggregate the linguistic information corresponding to each alternative and get the overall value with linguistic information, then rank the alternatives and select the most desirable one(s) by using the overall value with linguistic information. Finally, an illustrative example for evaluating the medical information resources on internet with linguistic information is given to verify the developed approach and to demonstrate its practicality and effectiveness.

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