Original Research Article

Research on Service Quality Evaluation of Teaching Archivists Based on Intuitionistic Fuzzy Bidirectional Projection Decision Making

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Abstract

Introduction: According to the characteristics of the service industry of the teaching archivists, an index system for the evaluation of the service quality of teaching archivists is established. By using the intuitionistic fuzzy set theory, the subjective evaluation information of the investigated object is converted into the intuitionistic fuzzy numbers. Based on the score function of the intuitionistic fuzzy set, a bidirectional projection-based multiple attribute decision making method with intuitionistic fuzzy numbers is developed. Through the bidirectional projection measure between each alternative decision matrix and the ideal alternative matrix, all the alternatives can be ranked to select the best one. Finally, an illustrative example related about the service quality evaluation of the teaching archivists demonstrates the application of the proposed method.
Keywords: teaching archivists, bidirectional projection, service quality evaluation, decision making.

INTRODUCTION

As the competent department of the archives work of the whole school and the business organization that centrally manages archives, the archives take serving the teaching and scientific research management of the school as the center, and strive to improve the level of archives management and service quality, vigorously develop and utilize the archives information resources, give full play to the information transmission of school archives. Archives management is a work that cannot be ignored in every enterprise or unit. Through the collation and preservation of all kinds of data and text materials, it can have important guiding significance and reference value for the current work and the overall development in the future. The teaching archives are important materials such as texts, charts, audio-visuals, electronic carriers, etc. that reflect the preservation of teaching management, teaching operation, teaching reform, and teaching construction in the teaching management work. Each secondary teaching department shall determine a archival staff member, who shall be specifically responsible for the collation, formation and transfer of archival materials to ensure the integrity, accuracy and systematicness of archived documents. Archivists are the maintenance and coordination staff of archival work, and their quality and ability play a key role in the development of archival management to a certain extent [1]. Under the new situation of continuous development of social economy, more and more people come into the teaching archives and use the literature of teaching archives to study the development of school education. Great changes have taken place in the work content of modern teaching archives. The role of teaching archives administrators has moved from simple entity custodians to just managers, and the service objects and service models of teaching archives administrators have presented diversified forms of development. Teaching archivists need to strengthen their professional ethics and knowledge level, and constantly strengthen their comprehensive quality capabilities. They should also pay attention to the improvement and exploration of the working mode of archival management in peacetime work, use scientific working methods, constantly improve the quality and efficiency of work, and promote the development of archival management in the direction of standardization, intelligence and efficiency, so as to truly meet the needs of the real society.

In view of the problems existing in the current teaching archivists in colleges and universities, many scholars have given how to take effective measures to improve the quality and service ability of teaching archivists. However, how to select the personnel with higher competence and stronger service ability from

many teaching archivists is also very important, which is helpful to concentrate effective resources and focus on the vocational ability training of teaching archivists with general service ability. In the evaluation and decision of the service quality of teaching archivists, because the attribute index is quantitatively ambiguous, it is obviously inappropriate to use a common number or a certain point in the fuzzy number to represent the indicator, and the fuzzy set or fuzzy number is more suitable for the expression of index quantification. The intuitionistic fuzzy set considers both the membership degree and the non-membership degree information, and has stronger expression ability than the traditional

METHODOLOGY
Analysis of the Work of Teaching Archivists

The role of teaching archivists is still very different from that of teachers. The basic point of work of teaching archivists is service. Service is the most fundamental and important work, and it is also an important way to realize its educational and management functions. Through the nuanced service provided by the teaching archivists, the readers can make more effective use of the teaching archives, and use and create value for work and study, so that the readers have comprehensive qualities in thought, morality and personality. This is the best embodiment of the service value of a teaching archivists [2]. Service quality is a measure, which not only means efficiency, achievement and benefit, but also measures the work according to the results presented. The service quality evaluation of teaching archivists is a kind of evaluation of teaching archives service. This evaluation method plays a more and more important role in improving the service level of teaching archivists and arousing their service enthusiasm. However, for a long time, because the service ability appraisal system of teaching archivists is unreasonable or the performance evaluation method is improper, it is difficult to evaluate the work performance of teaching archivists comprehensively, impartially and objectively, which affects the enthusiasm of teaching archivists and weakens the function of service ability assessment.

Service Quality Index system of Teaching Archivists

In order to improve the service performance and service level of teaching archivists, it is generally considered that it is necessary to investigate the knowledge and skills, cognitive ability, moral characteristics, physical quality, scientific research ability, service ability, management ability and service effect of teaching archivists [3, 4]. Knowledge and skills refer to the teaching archivists must have certain academic qualifications and professional skills. Since most of the collections of teaching archives have realized computer information management, teaching archivists should not only master the traditional theory and method of file management, but also be familiar with the theory and method of file information management under the network environment. Teaching

fuzzy set in dealing with uncertain information such as quantitative service index.

According to the professional quality requirements of the teaching archivists, this paper establishes an index system for the evaluation of the service quality of teaching archivists. By using the intuitionistic fuzzy set theory, the subjective evaluation information of the investigated object is converted into the intuitionistic fuzzy number, and the intuitionistic fuzzy multi-attribute decision model of the service quality evaluation of the teaching archivists is constructed, and the validity of the model is illustrated by an example.

archivists need to be able to use the library management information system skillfully at work, and must have certain professional knowledge to provide readers with in-depth information consulting services. Cognitive ability is the ability to learn and accept new knowledge and skills. The future development trend of teaching archives work is to provide readers with deeper information consulting services, such as providing readers with the professional knowledge and related information needed for scientific research, and providing readers with corresponding literature according to the requirements of readers. These require teaching archivists to study professional knowledge and constantly improve their professional quality. Moral characteristics include integrity, honesty, respect for others, sense of responsibility and other qualities. The work of teaching archives is a service work, which can not be simply evaluated quantitatively. Therefore, the moral characteristics of staff are the main factors that determine the efficiency and quality of service. Physical quality includes physical and mental health. Teaching archives work contains a certain amount of physical labor, so the practitioners are required to have a healthy physique and be able to undertake a certain amount of physical work. The scientific research ability is embodied in whether the archivists have the professional background and technical qualification of books and information, as well as whether they undertake the scientific research topics of books and information or the published papers on books and information, etc. The service ability includes whether the teaching archivists have mastered the ability of book cataloguing, the use of library management information system and the circulation of documents. The management ability refers to whether the teaching archivists has the leadership ability of the cataloging department, the reader service department and so on, the team cooperation spirit and the organization ability of the reader training lecture and reading promotion activity, and the service effect mainly refers to the timeliness and completeness of the teaching archivists service to the reader.

Basic Concepts of Intuitionistic Fuzzy Sets

Let X be a reference set. A fuzzy set A in X is given by

$$A = \{< x, \mu_A(x) >| x \in X\},$$

Where $\mu_A(x)$ indicates the membership degree of the element x to the set X [5].

From the definition of fuzzy sets, it can be seen that the basic component of the fuzzy set A in X is only a membership degree $\mu_A(x)$ with the non-membership degree being $1 - \mu_A(x)$. While in real-life situations, it is very difficult for a person to express his/her uncertainty degree to an object. To solve this problem, Atanassov [6] extended the fuzzy set to the intuitionistic fuzzy set (for short, IFS) by adding an uncertainty degree and defined it as follows:

$$A = \{< x, \mu_A(x), \nu_A(x) >| x \in X\},$$

$$\pi_A(x) = 1 - \mu_A(x) - \nu_A(x)$$

is called the intuitionistic index of the element x to A. It is a hesitancy degree of x to A, and obvious that $0 \le \pi_A(x) \le 1$ for any $x \in X$.

For an IFN $a = (\mu_a, \nu_a)$, $s(a) = \mu_a - \nu_a$ and $h(a) = \mu_a + \nu_a$ are the score function and the accuracy function of a, respectively [7]. For two IFNs a and b, if $s(a) < s(b)$, then $a < b$; and if $s(a) = s(b)$, then

(i) if $h(a) = h(b)$, then $a = b$;
(ii) if $h(a) < h(b)$, then $a < b$;
(iii) if $h(a) > h(b)$, then $a > b$.

Bidirectional Projection models for multiple attribute decision making with intuitionistic fuzzy information

Intuitionistic fuzzy sets are able to describe imprecise knowledge in some specific problems, and they are proved to be a more nature information representation scheme, thus intuitionistic fuzzy sets have attracted many scientists to develop new tools and applications to apply them. Based the traditional idea of projection models [8, 9], in this section, we shall propose the bidirectional projection models for multiple attribute decision making with intuitionistic fuzzy information.

Let $Y = \{Y_1, Y_2, \cdots, Y_m\}$ 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 attribute $G_j (j = 1, 2, \cdots, n)$, where

Which is characterized by a membership degree $\mu_A(x)$ and a non-membership degree $\nu_A(x)$, where $\mu_A : X \to [0,1]$, $\nu_A : X \to [0,1]$ with the condition

$$0 \le \mu_A(x) + \nu_A(x) \le 1$$

for any $x \in X$. For the convenience of description, $a = (\mu_a, \nu_a)$ is referred as an intuitionistic fuzzy number (for short, IFN) and used to represent the element in IFS, where $\mu_a \in [0,1], \nu_a \in [0,1]$ and $\mu_a + \nu_a \le 1$.

For each intuitionistic fuzzy set A in X,

$\omega_i \in [0,1]$ such that $\sum_{i=1}^{n} \omega_i = 1$. Suppose that $D = (d_{ij})_{m \times n} = (\mu_{ij}, \nu_{ij})_{m \times n}$ is the intuitionistic fuzzy decision matrix, where μ_{ij} indicates the degree of membership degree that the alternative Y_i satisfies the attribute G_j given by the decision maker, ν_{ij} indicates the degree of non-membership degree that the alternative Y_i satisfies the attribute G_j given by the decision maker.

For the convenience of depiction, we denote the alternative $Y_i (i = 1, 2, \cdots, m)$ based on the

$$D = (d_{ij})_{m \times n} = (\mu_{ij}, \nu_{ij})_{m \times n}$$

as: $Y_i = (d_{i1}, d_{i2}, \cdots, d_{in}), i = 1, 2, \cdots, m.$ And we also introduce the weighted score vector of Y_i as

$$s_\omega(Y_i) = (\omega_1 s(d_{i1}), \omega_2 s(d_{i2}), \cdots, \omega_n s(d_{in})).$$

The module of the weighted score vector $s_\omega(Y_i)$ of Y_i is defined by:

$$\|s_\omega(Y_i)\| = \sqrt{\sum_{j=1}^{n} (\omega_j s(d_{ij}))^2}.$$

In multiple attribute decision making environments, the concept of an ideal alternative has been used to help identify the best alternative in the decision set. Hence, we define the intuitionistic fuzzy ideal solution denoted by the following:

$$Y^* = (d_1^*, d_2^*, \cdots, d_n^*),$$

Where, $d_j^* = (\mu_j^*, v_j^*) = (\max_i \mu_{ij}, \min_i v_{ij})$.

Let $Y_i = (d_{i1}, d_{i2}, \cdots, d_{in})$ be the i-th alternative and $Y^* = (d_1^*, d_2^*, \cdots, d_n^*)$ be the intuitionistic fuzzy ideal solution, where

$d_{ij} = (\mu_{ij}, v_{ij})$, $i = 1, 2, \cdots, m$, and $d_j^* = (\mu_j^*, v_j^*)$, $j = 1, 2, \cdots, m$. The bidirectional projection between the weighted score vectors $s_\omega(Y_i)$ and $s_\omega(Y^*)$ is defined as the follows:

$$\text{BPrj}(s_\omega(Y_i), s_\omega(Y^*))$$

$$= \frac{1}{1 + \left| \dfrac{s_\omega(Y_i) \cdot s_\omega(Y^*)}{\|s_\omega(Y^*)\|} - \dfrac{s_\omega(Y_i) \cdot s_\omega(Y^*)}{\|s_\omega(Y_i)\|} \right|}$$

$$= \frac{\|s_\omega(Y_i)\| \cdot \|s_\omega(Y^*)\|}{\|s_\omega(Y_i)\| \cdot \|s_\omega(Y^*)\| + \|s_\omega(Y_i)\| - \|s_\omega(Y^*)\| \cdot \left(s_\omega(Y_i) \cdot s_\omega(Y^*) \right)}$$

Where, $s_\omega(Y_i) \cdot s_\omega(Y^*) = \sum_{j=1}^{n} s(d_{ij}) \cdot s(d_j^*)$.

Then, the procedure of the decision making problem based on bidirectional Projection models is described as follows:

Step 1. Obtain the intuitionistic fuzzy decision matrix $D = (d_{ij})_{m \times n} = (\mu_{ij}, v_{ij})_{m \times n}$ and the weighting vector $\omega = \{\omega_1, \omega_2, \cdots, \omega_n\}$ of the attribute $G_j (j = 1, 2, \cdots, n)$.

Step 2. Determine the intuitionistic fuzzy ideal solution $Y^* = (d_1^*, d_2^*, \cdots, d_n^*)$.

Step 3. Calculate the weighted score vectors $s_\omega(Y_i)$, $i = 1, 2, \cdots, m$, and $s_\omega(Y^*)$.

Step 4. Calculate the bidirectional projection $\text{BPrj}(s_\omega(Y_i), s_\omega(Y^*))$ between the weighted score vector $s_\omega(Y_i)$ of the alternative Y_i and the weighted score vector $s_\omega(Y^*)$ of the intuitionistic fuzzy ideal solution Y^*.

Step 5. Rank the preference order of alternatives Y_i ($i = 1, 2, \cdots, m$) according to the value of the bidirectional projection $\text{BPrj}(s_\omega(Y_i), s_\omega(Y^*))$.

After the above steps, it is not difficult to come up with that the greater the value $\text{BPrj}(s_\omega(Y_i), s_\omega(Y^*))$, the closer Y_i to Y^*, and thus the closer the alternative Y_i to the intuitionistic fuzzy ideal solution Y^*. That is to say, the better the alternative Y_i.

RESULTS AND FINDINGS

In this section, the bidirectional projection measure are used for the multiple attribute decision-making problems of service quality evaluation of teaching archivists with intuitionistic fuzzy information.

In order to enable the teaching archivists clear their work tasks, duties and archives, and to mobilize the enthusiasm and creativity of the teaching archivists, the director of archives will evaluate the service quality of the teaching archivists. Support there are five teaching archivists in a university archives denoted by $Y = \{Y_1, Y_2, Y_3, Y_4, Y_5\}$. The director of archives (decision-maker) must take a decision according to the eight attributes (criteria): (1) G_1 is the knowledge and skills; (2) G_2 is the cognitive ability; (3) G_3 is the moral characteristics; (4) G_4 is the physical quality; (5) G_5 is the scientific research ability; (6) G_6 is the service ability; (7) G_7 is the management ability; (8) G_8 is the service effect. The weight vector of the eight attributes is given by the decision maker as follows:

$$\omega = \{0.22, 0.18, 0.34, 0.15, 0.19, 0.35, 0.18, 0.24\}$$

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Table-1: The Intuitionistic Fuzzy Decision Matrix

	G_1	G_2	G_3	G_4	G_5	G_6	G_7	G_8
Y_1	(0.2, 0.6)	(0.5, 0.4)	(0.7, 0.2)	(0.2, 0.6)	(0.5, 0.4)	(0.3, 0.6)	(0.8, 0.1)	(0.5, 0.3)
Y_2	(0.5, 0.3)	(0.7, 0.2)	(0.9, 0.1)	(0.8, 0.2)	(0.7, 0.2)	(0.8, 0.1)	(0.7, 0.2)	(0.6, 0.4)
Y_3	(0.6, 0.1)	(0.8, 0.2)	(0.7, 0.3)	(0.6, 0.3)	(0.8, 0.2)	(0.5, 0.4)	(0.1, 0.6)	(0.8, 0.2)

Y_4	(0.4, 0.4)	(0.5, 0.3)	(0.6, 0.1)	(0.5, 0.5)	(0.5, 0.3)	(0.8, 0.2)	(0.4, 0.6)	(0.9, 0.1)
Y_5	(0.8, 0.2)	(0.2, 0.7)	(0.7, 0.2)	(0.4, 0.6)	(0.2, 0.7)	(0.6, 0.4)	(0.7, 0.3)	(0.3, 0.7)

In order to avoid influence each other, the five possible alternatives of Y_i ($i = 1, 2, \cdots, 5$) are to be evaluated by the decision maker under the eight attributes according to intuitionistic fuzzy concept "excellence" , and the decision matrix $D = (d_{ij})_{5 \times 8}$ is presented in Table 1, where are in the form of IFNs.

To get the most ideal alternative, the following steps are involved:

Step 1. Based on the Table-1, we can obtain the intuitionistic fuzzy decision matrix $D = (d_{ij})_{5 \times 8}$ and the alternative $Y_i (i = 1, 2, \cdots, 5)$ based on $D = (d_{ij})_{5 \times 8}$ is

$$Y_i = (d_{i1}, d_{i2}, \cdots, d_{i8}), i = 1, 2, \cdots, 5.$$

Step 2. Based on the Table-1, we can get the intuitionistic fuzzy ideal solution

$$Y^* = \{(0.8, 0.1), (0.8, 0.2), (0.9, 0.1), (0.8, 0.2),$$
$$(0.8, 0.2), (0.8, 0.1), (0.8, 0.1), (0.9, 0.1)\}.$$

Step 3. Calculate the weighted score vectors $s_\omega(Y_i)$, $i = 1, 2, \cdots, 5$, and $s_\omega(Y^*)$.

$$s_\omega(Y_1) = (-0.048, 0.009, 0.075, -0.056,$$
$$0.012, -0.033, 0.105, 0.024),$$

$$s_\omega(Y_2) = (0.024, 0.045, 0.120, 0.084,$$
$$0.06, 0.077, 0.075, 0.024),$$

$$s_\omega(Y_3) = (0.060, 0.054, 0.060, 0.042,$$
$$0.072, 0.011, -0.075, 0.072),$$

$$s_\omega(Y_4) = (0.000, 0.018, 0.075, 0.000,$$
$$0.024, 0.066, -0.03, 0.096),$$

$$s_\omega(Y_5) = (0.072, -0.045, 0.075, -0.028,$$
$$-0.06, 0.022, 0.060, -0.048),$$

$$s_\omega(Y^*) = (0.084, 0.054, 0.120, 0.084,$$
$$0.072, 0.077, 0.105, 0.096).$$

Step 4. Calculate the bidirectional projection $\mathrm{BPrj}(s_\omega(Y_i), s_\omega(Y^*))$.

$$\mathrm{BPrj}(s_\omega(Y_1), s_\omega(Y^*)) = 0.9703,$$
$$\mathrm{BPrj}(s_\omega(Y_2), s_\omega(Y^*)) = 0.9548,$$

$$\mathrm{BPrj}(s_\omega(Y_3), s_\omega(Y^*)) = 0.9550,$$
$$\mathrm{BPrj}(s_\omega(Y_4), s_\omega(Y^*)) = 0.9377,$$
$$\mathrm{BPrj}(s_\omega(Y_5), s_\omega(Y^*)) = 0.9770.$$

Step 5. Rank the preference order of alternatives Y_i according to the value of the bidirectional projection $\mathrm{BPrj}(s_\omega(Y_i), s_\omega(Y^*))$ ($i = 1, 2, \cdots, 5$).

$$Y_5 \succ Y_1 \succ Y_3 \succ Y_2 \succ Y_4$$

Thus, the most desirable teaching archivist is Y_5.

CONCLUSION

In the decision-making of the service quality evaluation of teaching archivists, due to the complexity of the external environment and the ambiguity of human thinking, it is more realistic to express the subjective judgment of decision makers in the form of intuitionistic fuzzy numbers. By constructing the attribute set of service quality evaluation decision problem for teaching archivists, the multi-attribute decision making method based on the bidirectional projection is applied to the service performance evaluation problem of teaching archivists. The preference order of alternatives are ranked by calculating the value of the bidirectional projection of each alternative and the intuitionistic fuzzy ideal solution. Finally, an example is given to prove that the method is effective.

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