A Consistency-Driven Service Supply and Demand Two-Sided Matching Method of Considering Subjective and Objective Preference Information

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Abstract. To ensure the reliability of the demand information provided by the matching subject of the service supply and demand two-sided matching problem and the diverse needs of different decision-makers for stable matching, this paper considers the service supply and demand two-sided matching problem by combining subjective and objective preference information, and proposes a Consistency-based analysis method. First, the realistic background and application scenarios of the problem are described. Then, according to the additive preference relationship (subjective preference information) and the multi-attribute matching decision matrix (objective preference information) given by the two-sided matching subjects, it is proposed to calculate the weights of the two-sided matching subjects on multiple attributes, and further, the feedback adjustment based on consistency is proposed. The method uses the *IR* and *DR* rules to adjust the multi-attribute matching decision matrix of the two-sided matching subject, and then builds a multi-objective satisfaction and stability-oriented matching optimization model, and solves it to obtain the corresponding optimal matching alternative. Finally, an example is given to prove the effectiveness and feasibility of the proposed method.

Keywords: Two-sided matching of service supply and demand · additive preference relationship · Multi-attribute matching decision matrix · Consistency · matching alternative

1 Introduction

Two-sided matching refers to the process of finding suitable matching objects for both parties by matching decision-makers based on various demand information provided by two-sided matching subjects [4]. The earliest two-sided matching research focused on marriage-matching and college admissions matching [1]. Currently, two-sided matching problem has gradually expanded to human resources, e-commerce, financial economy, and other fields. In recent years, with the vigorous development of the Internet and the service economy, two-sided matching of service supply and demand has emerged [10]. Although the massive and diverse service supply and demand information is presented on the website so that the service supply and demand party can break through the time

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and geographical constraints during the transaction, it also encounters challenges such as low search efficiency, which makes the service supply and demand parties usually ask for help We use third-party intermediaries to achieve high-quality service matching [6].

At present, the theory and method of two-sided matching or multi-attribute two-sided matching of information such as ordinal value [2] (or called preference order, etc.), ordinal relationship, language, interval number, and other information about the preferences of both parties have been relatively perfect [5]. For example, Tong et al. proposed a two-sided game model based on probabilistic language term sets [7]. Wang et al. studied a two-sided matching model and analyzed the impact of supplier and demander loss aversion on matching results [11]. Liang et al. improved the classic two-sided matching model and established a multi-objective decision-making model by maximizing the satisfaction of multilateral matching [3]. Wang Xinfan et al. proposed a decision analysis method for the problem of differential two-sided matching decision-making when subjects gave tolerance intervals in a language environment [8]. Aiming at the many-to-many matching problem of logistics service supply and demand with complete preference order information, Wang Na et al. proposed a two-sided matching method that considers both the overall satisfaction of logistics service supply and demand matching subjects and the balance of individual satisfaction [9].

Although the above literature have put forward their research ideas and methods, there are still some deficiencies in the research on the two-sided matching of service supply and demand: (1) Most of the existing research assumes accurate supply and demand information proposed by both parties, but in actual situations, Due to the limited knowledge and experience, it is sometimes difficult for both parties to provide more reliable supply and demand information; (2) When the subjective and objective information provided by an individual cannot satisfy the consistency, it indicates that the individual provides unreliable matching information. However, in the existing related research, the situation of giving both subjective and objective information has not been considered; (3) In the existing research, the individual's diverse needs for the stability of the matching alternative are rarely discussed.

To solve the above problems, this paper proposes a feedback adjustment method based on the consistency of subjective and objective information. Considering the stability of the matching alternative, a two-sided matching model of service supply and demand is constructed.

2 Problem Description

In the actual two-sided matching of service supply and demand, there are mainly three parties: suppliers, demanders, and intermediaries. The supplier and the demander submit their respective supply and demand information to the intermediary, and the intermediary matches the supplier and the demander.

Let $\mathrm{A} = \{\mathrm{A}_1, \mathrm{A}_2, \cdots ., \mathrm{A}_\mathrm{m}\}(\mathrm{m} \geq 2)$ and $\mathrm{B} = \{\mathrm{B}_1, \mathrm{B}_2, \cdots , \mathrm{B}_\mathrm{n}\}(\mathrm{n} \geq 2)$ represent the set of m suppliers and n demanders, respectively, where A_i represents the i-th supplier in A, $\mathrm{i} = 1, 2, \cdots , \mathrm{m}$, B_j represents the j-th demander in B, $\mathrm{j} = 1, 2, \cdots , \mathrm{n}$.

Let $p^{A_i} = \left(p_{kl}^{A_i}\right)_{m\times m}$ represent the additive preference relationship of supplier A_i with respect to the demand parties, where $p_{kl}^{A_i}$ represents the preference degree of A_i

with respect to the demand parties B_k and B_l, satisfying $p_{kl}^{A_i} + p_{lk}^{A_i} = 1$ and $p_{kl}^{A_i} \geq 0$. The larger $p_{kl}^{A_i}$, the more A_i prefers the demand parties B_k.

Let $p^{B_j} = \left(p_{kl}^{B_j}\right)_{n \times n}$ represent the additive preference relationship of demander B_j with respect to suppliers, where $p_{kl}^{B_j}$ represents the preference degree of B_j with respect to suppliers A_k and A_l, satisfying $p_{kl}^{B_j} + p_{lk}^{B_j} = 1$ and $p_{kl}^{B_j} \geq 0$. The larger $p_{kl}^{B_j}$, the more B_j prefers supplier A_k.

Let $C = \{C_1, C_2, \cdots., C_y\}$ represent the attribute set of the supplier evaluating the demander, where C_e represents the eth attribute in the set, $e = 1, 2, \cdots, y$;

Let $R = \{R_1, R_2, \cdots., R_g\}$ represent the attribute set that the demander evaluates the supplier, and R_t represents the tth attribute in the set, $t = 1, 2, \cdots, g$.

Let $G^i = \left(g_{je}^i\right)_{n \times y}$ represent the multi-attribute matching decision matrix that A_i evaluates the demander, and g_{je}^i represents the evaluation value of A_i on the attribute C_e of the demander B_j;

Let $H^j = \left(h_{it}^j\right)_{m \times g}$ represent the multi-attribute matching decision matrix of B_j evaluating suppliers, where h_{it}^j represents the evaluation value of B_j on the attribute R_t of supplier A_i.

The problem to be solved in this paper is: how to determine satisfactory and stable matching pairs according to the preference relationship p^{A_i} and multi-attribute matching decision matrix G^i provided by the supplier, and the preference relationship p^{B_j} and multi-attribute matching decision matrix H^j provided by the demander.

3 Service Supply and Demand Matching Method

In this section, firstly, the methods for calculating the multi-attribute weights of suppliers and demanders are presented respectively, then, a feedback adjustment method based on consistency is proposed, and finally, the optimal modeling and solution of supply and demand matching are obtained.

3.1 Calculate the Multi-attribute Weights of Supply and Demand Parties

Let w_{ie}^A represent the weight of A_i on attribute C_e, let $U_i^A(B_j)$ represent the comprehensive evaluation value of A_i on the demander B_j, where

$$U_i^A(B_j) = \sum\nolimits_{e=1}^{y} w_{ie}^A g_{je}^i$$

$$i = 1, 2, \cdots, m, j = 1, 2, \cdots n \tag{1}$$

Let $\overline{p}^{A_i}(w) = \left(\overline{p}_{kl}^{A_i}(w)\right)_{m \times m}$ denote the preference relation generated by the multi-attribute matching decision matrix G^i, where

$$\overline{p}_{kl}^{A_i}(w) = \frac{U_i^A(B_k)}{U_i^A(B_k) + U_i^A(B_l)} k, l = 1, 2, \cdots, n \tag{2}$$

Further, the deviation between preference relations $p_{kl}^{A_i}$ and $\overline{p}_{kl}^{A_i}(w)$ can be calculated as

$$d\left(p_{kl}^{A_i}, \overline{p}_{kl}^{A_i}(w)\right) = \left[U_i^A(B_k) + U_i^A(B_l)\right]p_{kl}^{A_i} - U_i^A(B_k) \tag{3}$$

According to formula (5), the following model can be established to determine the weight w_{ie}^A

$$min \sum\nolimits_{k=1}^{n} \sum\nolimits_{l=1}^{n} d\left(p_{kl}^{A_i}, \overline{p}_{kl}^{A_i}(w)\right) \tag{4a}$$

$$s.t. \sum\nolimits_{e=1}^{y} w_{ie}^A = 1 \tag{4b}$$

$$w_{ie}^A \geq 0 \tag{4c}$$

where w_{ie}^A is the decision variable.

For the convenience of description, denote model (4a)-(4c) as P_1, and set w_{ie}^{*A} as the optimal weight obtained by solving model (P_1).

Similarly, the following model P_2 can be established to calculate the multi-attribute weight of the demander

$$min \sum\nolimits_{k=1}^{m} \sum\nolimits_{l=1}^{m} d\left(p_{kl}^{B_j}, \overline{p}_{kl}^{B_j}(w)\right) \tag{5a}$$

$$s.t. \sum\nolimits_{t=1}^{g} w_{jt}^B = 1 \tag{5b}$$

$$w_{jt}^B \geq 0 \tag{5c}$$

Denote model (5a)-(5c) as P_2, and let w_{jt}^{*B} be the optimal weight obtained by solving model (P_2).

3.2 Feedback Adjustment Method Based on the Consistency of Subjective and Objective Preference Information

Definition 1:

Let $p^{A_i} = \left(p_{kl}^{A_i}\right)_{m\times m}$, $\overline{p}^{A_i}(w) = \left(\overline{p}_{kl}^{A_i}(w)\right)_{m\times m}$, $p^{B_j} = \left(p_{kl}^{B_j}\right)_{n\times n}$ and $\overline{p}^{B_j}(w) = \left(\overline{p}_{kl}^{B_j}(w)\right)_{n\times n}$ be as described above, then the consistency of the subjective and objective information of supplier A_i can be defined as.

$$MCI\left(p^{A_i}, \bar{p}^{A_i}\right)\frac{2}{(m-1)(m-2)} \sum\nolimits_{k<l}\left|log_2\left(p_{kl}^{A_i}/\bar{p}_{kl}^{A_i}\right)\right| \tag{6}$$

Similarly, the consistency of the subjective and objective information of the demander B_j can be defined as

$$MCI\left(p^{B_j}, \bar{p}^{B_j}\right)\frac{2}{(n-1)(n-2)} \sum\nolimits_{k<l}\left|log_2\left(p_{kl}^{B_j}/\bar{p}_{kl}^{B_j}\right)\right| \tag{7}$$

Obviously, the smaller $MCI\left(p^{A_i}, \overline{p}^{A_i}\right)$ and $MCI\left(p^{B_j}, \overline{p}^{B_j}\right)$ are, the better the consistency between the preference relationship given by A_i and B_j and its multi-attribute matching decision matrix, and the stronger the decision information provided by A_i and B_j.

According to definition 8, when $MCI\left(p^{A_i}, \overline{p}^{A_i}\right) \leq \alpha$, it indicates that the preference relation of supplier A_i has acceptable consistency with its multi-attribute matching decision matrix. When $MCI\left(p^{A_i}, \overline{p}^{A_i}\right) > \alpha$, the preference relationship of A_i and its multi-attribute matching decision matrix need to be adjusted. Demand parties B_j is the same. Specifically, the following identity rules and direction rules can be established.

Let *IR* and *DR* denote the identity rules and direction rules for the matching subject to adjust the multi-attribute matching decision information and the additive preference relationship, respectively.IR and DR are specifically described below.

Rule *IR* 1. If $MCI\left(p^{A_i}, \overline{p}^{A_i}\right) > \alpha$ and $\left|\log_2\left(p_{uv}^{A_i}/\bar{p}_{uv}^{A_i}\right)\right| max_{k,l}\left\{\left|\log_2\left(p_{uv}^{A_i}/\bar{p}_{uv}^{A_i}\right)\right| | k < l, k, l = 1, 2, \cdots, n\right\}$, then A_i should adjust preference information about B_u and B_v;

Rule *IR* 2. If $MCI\left(p^{B_j}, \overline{p}^{B_j}\right) > \beta$ and $\left|\log_2\left(p_{uv}^{B_j}/\bar{p}_{uv}^{B_j}\right)\right| max_{k,l}\left\{\left|\log_2\left(p_{uv}^{B_j}/\bar{p}_{uv}^{B_j}\right)\right| | k < l, k, l = 1, 2, \cdots, m\right\}$, then B_j should adjust preference information about A_u and A_v.

Rule *DR* 1. Let $\tilde{p}^{Ai} = \left(\tilde{p}_{kl}^{A_i}\right)_{m \times m}$ denote Supplier A_i's adjusted additive preference relationship, then

$$\begin{cases} \tilde{p}_{kl}^{A_i} = p_{kl}^{A_i}, k \neq u \text{ and } l \neq v \\ \tilde{p}_{kl}^{A_i} \in \left[min\left(p_{kl}^{A_i}, \bar{p}_{kl}^{A_i}\right), max\left(p_{kl}^{A_i}, \bar{p}_{kl}^{A_i}\right)\right], k = u, l = v \end{cases} \tag{8}$$

Let $\tilde{G}^i = \left(\tilde{g}_{je}^i\right)_{n \times y}$ denote the multi-attribute matching decision matrix adjusted by supplier A_i, and consider the following two situations:

(a) When $i \neq u, v$

$\tilde{g}_{je}^i = g_{je}^i j = 1, 2, \cdots, n$

(b) when $i = u, v$

$$\begin{cases} \tilde{g}_{ue}^i \leq g_{ue}^i, \tilde{g}_{ve}^i \geq g_{ve}^i & , \log_2\left(p_{uv}^{A_i}/\bar{p}_{uv}^{A_i}\right) < 0 \\ \tilde{g}_{ue}^i \geq g_{ue}^i, \tilde{g}_{ve}^i \leq g_{ve}^i & , \log_2\left(p_{uv}^{A_i}/\bar{p}_{uv}^{A_i}\right) > 0 \end{cases} \tag{9}$$

Rule *DR* 2. Let $\tilde{p}^{B_j} = \left(\tilde{p}_{kl}^{B_j}\right)_{n \times n}$ denote the adjusted additive preference relation of demander B_j, then

$$\begin{cases} \tilde{p}_{kl}^{B_j} = p_{kl}^{B_j} & , \quad k \neq u \text{ and } l \neq v \\ \tilde{p}_{kl}^{B_j} \in \left[min\left(p_{kl}^{B_j}, \bar{p}_{kl}^{B_j}\right), max\left(p_{kl}^{B_j}, \bar{p}_{kl}^{B_j}\right)\right] & , \quad k = u, l = v \end{cases} \tag{10}$$

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Let $\tilde{H}^j = \left(\tilde{h}_{it}^j\right)_{m \times g}$ represent the multi-attribute matching decision matrix adjusted by demander B_j, and consider the following two situations:

(a) When $j \neq u, v$

$$\tilde{h}_{it}^j = h_{it}^j \, i = 1, 2, \cdots, m$$

(b) when $j = u, v$

$$\begin{cases} \tilde{h}_{ut}^j \leq h_{ut}^j, \tilde{h}_{ve}^j \geq h_{ve}^j & , \log_2\left(p_{kl}^{B_j}/\bar{p}_{kl}^{B_j}\right) < 0 \\ \tilde{h}_{ut}^j \geq h_{ut}^j, \tilde{h}_{ve}^j \leq h_{ve}^j & , \log_2\left(p_{kl}^{B_j}/\bar{p}_{kl}^{B_j}\right) > 0 \end{cases} \tag{11}$$

3.2.1 Optimal Modeling and Solution for Two-Sided Matching of Service Supply and Demand

In the constructed supply and demand matching model, the goal of this paper is to find a matching alternative that makes the evaluation value of suppliers and demanders as high as possible.

Let Z_1 denote the overall evaluation of all suppliers on the demand parties participating in the matching.

$$max\, Z_1 = \sum\nolimits_{i=1}^{m} \sum\nolimits_{j=1}^{n} U_i^A\left(B_j\right) x_{ij} \tag{12}$$

Let Z_2 denote the overall evaluation of all demanders on the suppliers participating in the matching.

$$maxZ_2 \sum\nolimits_{i=1}^{m} \sum\nolimits_{j=1}^{n} U_j^B(A_i) x_{ij} \tag{13}$$

Then, since the considered supply-demand matching is a one-to-one two-sided matching, there are the following constraints

$$\sum\nolimits_{j=1}^{n} x_{ij} \leq 1, \, i \in I \tag{14}$$

$$\sum\nolimits_{i=1}^{m} x_{ij} \leq 1, j \in J \tag{15}$$

$$x_{ij} \in \{0, 1\}, \, i \in I, j \in J \tag{16}$$

In addition, considering that different demanders and suppliers have different requirements for stability, the following matching stability constraints are constructed.

$$\sum\nolimits_{U_i^A(B_h) > U_i^A(B_j) + \varepsilon_i^A} x_{ih} + \sum\nolimits_{U_j^B(A_k) > U_j^B(A_i) + \varepsilon_j^B} x_{kj} + x_{ij} \geq 1, \, i \in I, j \in J. \tag{17}$$

In summary, the constructed supply and demand matching model can be summarized as follows:

$$maxZ_1 = \sum\nolimits_{i=1}^{m} \sum\nolimits_{j=1}^{n} U_i^A\left(B_j\right) x_{ij} \tag{18a}$$

$$maxZ_2 = \sum_{i=1}^{m} \sum_{j=1}^{n} U_j^B(A_i)x_{ij} \tag{18b}$$

$$s.t. \sum_{j=1}^{n} x_{ij} = 1, \; i \in I \tag{18c}$$

$$\sum_{i=1}^{m} x_{ij} \leq 1, \; j \in J \tag{18d}$$

$$\sum_{U_i^A(B_h) > U_i^A(B_j) + \varepsilon_i^A} x_{ih} + \sum_{U_j^B(A_k) > U_j^B(A_i) + \varepsilon_j^B} x_{kj} + x_{ij} \geq 1, \; i \in I, j \in J \tag{18e}$$

$$x_{ij} \in \{0, \; 1\}, \; i \in I, j \in J \tag{18f}$$

4 Examples

In this subsection, the intermediary matches between service supply and demand subjects to illustrate the practicability and effectiveness of the method proposed above.

The matching decision-making platform D is mainly responsible for providing two-sided matching decisions to the logistics service demander and the logistics service provider, recently received matching demands from 5 suppliers $A = \{A_1, A_2, A_3, A_4, A_5\}$ and 4 demanders $B = \{B_1, B_2, B_3, B_4\}$. After the intermediary D sends the relevant information of the supplier and the demander to the other party, the matching subjects of both parties respectively give the corresponding preference relationship. Specifically, the given additive preference relation $p^{A_i} = \left(p_{kl}^{A_i}\right)_{4\times4}$ is expressed as follows:

$$p^{A_1} = \begin{pmatrix} 0.5 & 0.6 & 0.4 & 0.5 \\ 0.4 & 0.5 & 0.4 & 0.4 \\ 0.6 & 0.6 & 0.5 & 0.6 \\ 0.5 & 0.6 & 0.4 & 0.5 \end{pmatrix}$$

$$p^{A_2} = \begin{pmatrix} 0.5 & 0.6 & 0.4 & 0.6 \\ 0.4 & 0.5 & 0.4 & 0.4 \\ 0.6 & 0.6 & 0.5 & 0.6 \\ 0.4 & 0.6 & 0.4 & 0.5 \end{pmatrix}$$

$$p^{A_3} = \begin{pmatrix} 0.5 & 0.4 & 0.5 & 0.4 \\ 0.6 & 0.5 & 0.6 & 0.5 \\ 0.5 & 0.4 & 0.5 & 0.4 \\ 0.6 & 0.5 & 0.6 & 0.5 \end{pmatrix}$$

$$p^{A_4} = \begin{pmatrix} 0.5 & 0.6 & 0.5 & 0.6 \\ 0.4 & 0.5 & 0.4 & 0.5 \\ 0.5 & 0.6 & 0.5 & 0.5 \\ 0.4 & 0.5 & 0.5 & 0.5 \end{pmatrix}$$

$$p^{A_5} = \begin{pmatrix} 0.5 & 0.4 & 0.5 & 0.4 \\ 0.6 & 0.5 & 0.6 & 0.6 \\ 0.5 & 0.4 & 0.5 & 0.5 \\ 0.6 & 0.4 & 0.5 & 0.5 \end{pmatrix}$$

At the same time, the preference relationship $p^{B_j} = \left(p_{kl}^{B_j}\right)_{5\times5}$ given by the 4 demanders to the 5 suppliers is expressed as follows:

$$p^{B_1} = \begin{pmatrix} 0.5 & 0.4 & 0.6 & 0.4 & 0.5 \\ 0.6 & 0.5 & 0.6 & 0.5 & 0.6 \\ 0.4 & 0.4 & 0.5 & 0.4 & 0.5 \\ 0.6 & 0.6 & 0.6 & 0.5 & 0.6 \\ 0.4 & 0.4 & 0.5 & 0.4 & 0.5 \end{pmatrix}$$

$$p^{B_2} = \begin{pmatrix} 0.5 & 0.5 & 0.5 & 0.5 & 0.4 \\ 0.5 & 0.5 & 0.4 & 0.5 & 0.4 \\ 0.5 & 0.6 & 0.5 & 0.4 & 0.4 \\ 0.5 & 0.5 & 0.6 & 0.5 & 0.5 \\ 0.6 & 0.6 & 0.6 & 0.5 & 0.5 \end{pmatrix}$$

$$p^{B_3} = \begin{pmatrix} 0.5 & 0.5 & 0.5 & 0.4 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.4 & 0.4 \\ 0.6 & 0.5 & 0.6 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.6 & 0.5 & 0.5 \end{pmatrix}$$

$$p^{B_4} = \begin{pmatrix} 0.5 & 0.5 & 0.5 & 0.5 & 0.6 \\ 0.5 & 0.5 & 0.5 & 0.4 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.5 & 0.6 \\ 0.5 & 0.6 & 0.5 & 0.5 & 0.6 \\ 0.4 & 0.5 & 0.4 & 0.4 & 0.5 \end{pmatrix}$$

The supplier and the demander also conducted a multi-attribute evaluation of each other. The supplier mainly considers the logistics transportation service price (ie profit) (C_1), the logistics transportation service time requirement (C_2), and the demand-parties enterprise reputation (C_3). The demand parties mainly consider the cost of logistics and transportation services (R_1), the actual time required for logistics and transportation services (R_2), the reputation of suppliers (R_3), and the risk of logistics and transportation services(R_4). Specifically, the multi-attribute matching decision matrix $G^i = \left(g_{je}^i\right)_{4\times3}$ of 5 suppliers on 4 demanders is as follows:

$$G^1 = \begin{pmatrix} 0.7 & 0.8 & 0.7 \\ 0.5 & 0.6 & 0.8 \\ 0.8 & 0.7 & 0.9 \\ 0.8 & 0.6 & 0.6 \end{pmatrix} G^2 = \begin{pmatrix} 0.8 & 0.6 & 0.9 \\ 0.7 & 0.8 & 0.7 \\ 0.9 & 0.9 & 0.7 \\ 0.7 & 0.8 & 0.6 \end{pmatrix}$$

$$G^3 = \begin{pmatrix} 0.5 & 0.8 & 0.8 \\ 0.9 & 0.9 & 0.7 \\ 0.7 & 0.5 & 0.5 \\ 0.7 & 0.8 & 0.9 \end{pmatrix} G^4 = \begin{pmatrix} 0.8 & 0.8 & 0.6 \\ 0.4 & 0.7 & 0.7 \\ 0.6 & 0.6 & 0.8 \\ 0.5 & 0.8 & 0.7 \end{pmatrix}$$

$$G^5 = \begin{pmatrix} 0.5 & 0.9 & 0.5 \\ 0.6 & 0.9 & 0.9 \\ 0.7 & 0.6 & 0.6 \\ 0.9 & 0.5 & 0.8 \end{pmatrix}$$

The demand-parties multi-attribute matching decision matrix $H^j = \left(h_{it}^j\right)_{5\times 4}$ is as follows:

$$H^1 = \begin{pmatrix} 0.6 & 0.8 & 0.7 & 0.7 \\ 0.7 & 0.9 & 0.9 & 0.8 \\ 0.5 & 0.5 & 0.6 & 0.7 \\ 0.7 & 0.8 & 0.9 & 0.9 \\ 0.5 & 0.8 & 0.7 & 0.6 \end{pmatrix} H^2 = \begin{pmatrix} 0.6 & 0.9 & 0.7 & 0.8 \\ 0.5 & 0.5 & 0.8 & 0.7 \\ 0.7 & 0.7 & 0.8 & 0.6 \\ 0.6 & 0.8 & 0.6 & 0.8 \\ 0.8 & 0.9 & 0.9 & 0.6 \end{pmatrix}$$

$$H^3 = \begin{pmatrix} 0.7 & 0.6 & 0.5 & 0.9 \\ 0.7 & 0.8 & 0.6 & 0.8 \\ 0.6 & 0.6 & 0.8 & 0.7 \\ 0.9 & 0.7 & 0.7 & 0.5 \\ 0.9 & 0.5 & 0.8 & 0.6 \end{pmatrix} H^4 = \begin{pmatrix} 0.7 & 0.9 & 0.6 & 0.7 \\ 0.8 & 0.7 & 0.5 & 0.7 \\ 0.7 & 0.7 & 0.8 & 0.8 \\ 0.8 & 0.5 & 0.9 & 0.8 \\ 0.6 & 0.9 & 0.6 & 0.6 \end{pmatrix}$$

The matching decision-making method proposed in Sect. 4 is used to solve the above-mentioned service supply and demand matching problem.

The weight w_{ie}^A of the logistics service provider A_i on the attribute $C_y(y = 1, 2, 3)$ is obtained as:

$w_1^A = (0.42, 0.52, 0.48, 0.41, 0.37)^T$,
$w_2^A = (0.27, 0.23, 0.30, 0.26, 0.39)^T$,
$w_3^A = (0.31, 0.25, 0.22, 0.33, 0.24)^T$,

The weight w_{jt}^B of the demander B_j with respect to the attribute $R_g(g = 1,2,3,4)$ is obtained as:

$w_1^B = (0.29, 0.51, 0.44, 0.42)^T$,
$w_2^B = (0.27, 0.12, 0.25, 0.18)^T$,
$w_3^B = (0.13, 0.24, 0.23, 0.17)^T$,
$w_4^B = (0.31, 0.13, 0.08, 0.23)^T$,

Further, the consistency $MCI\left(p^{A_i}, \overline{p}^{A_i}\right)(i = 1, 2, 3, 4, 5)$ and $MCI\left(p^{B_j}, \overline{p}^{B_j}\right)(j = 1, 2, 3, 4)$ of the subjective and objective information of 5 suppliers and 4 demanders are calculated as follows:

$MCI\left(p^{A_1}, \overline{p}^{A_1}\right) = 0.307$, $MCI\left(p^{A_2}, \overline{p}^{A_2}\right) = 0.443$, $MCI\left(p^{A_3}, \overline{p}^{A_3}\right) = 0.200$, $MCI\left(p^{A_4}, \overline{p}^{A_4}\right) = 0.220$, $MCI\left(p^{A_5}, \overline{p}^{A_5}\right) = 0.288$.

$MCI(p^{B_1}, \overline{p}^{B_1}) = 0.162$, $MCI(p^{B_2}, \overline{p}^{B_2}) = 0.246$, $MCI(p^{B_3}, \overline{p}^{B_3}) = 0.163$, $MCI(p^{B_4}, \overline{p}^{B_4}) = 0.164$.

Assuming $\alpha = 0.30$ and $\beta = 0.20$, since $MCI(p^{A_1}, \overline{p}^{A_1}) > \alpha$, $MCI(p^{A_2}, \overline{p}^{A_2}) > \alpha$, $MCI(p^{B_2}, \overline{p}^{B_2}) > \beta$, A_1, A_2, B_2 do not meet acceptable consistency and need to be adjusted.

Based on the above, the adjustment results are as follows:

$$\tilde{p}^{A_1} = \begin{pmatrix} 0.5 & 0.5 & 0.4 & 0.5 \\ 0.5 & 0.5 & 0.4 & 0.5 \\ 0.6 & 0.6 & 0.5 & 0.6 \\ 0.5 & 0.6 & 0.4 & 0.5 \end{pmatrix} \tilde{p}^{A_2} = \begin{pmatrix} 0.5 & 0.5 & 0.4 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.5 \\ 0.6 & 0.5 & 0.5 & 0.6 \\ 0.5 & 0.5 & 0.4 & 0.5 \end{pmatrix}$$

$$\tilde{G}^1 = \begin{pmatrix} 0.6 & 0.7 & 0.7 \\ 0.5 & 0.6 & 0.7 \\ 0.8 & 0.8 & 0.9 \\ 0.7 & 0.6 & 0.6 \end{pmatrix} \tilde{G}^2 = \begin{pmatrix} 0.7 & 0.6 & 0.8 \\ 0.7 & 0.8 & 0.8 \\ 0.9 & 0.9 & 0.7 \\ 0.7 & 0.8 & 0.7 \end{pmatrix}$$

$$\tilde{p}^{B_2} = \begin{pmatrix} 0.5 & 0.6 & 0.5 & 0.5 & 0.6 \\ 0.4 & 0.5 & 0.5 & 0.5 & 0.4 \\ 0.5 & 0.4 & 0.5 & 0.5 & 0.4 \\ 0.5 & 0.5 & 0.5 & 0.5 & 0.4 \\ 0.4 & 0.6 & 0.6 & 0.6 & 0.5 \end{pmatrix} \tilde{H}^2 = \begin{pmatrix} 0.7 & 0.9 & 0.7 & 0.8 \\ 0.5 & 0.5 & 0.8 & 0.7 \\ 0.7 & 0.6 & 0.7 & 0.6 \\ 0.6 & 0.8 & 0.6 & 0.8 \\ 0.8 & 0.9 & 0.9 & 0.6 \end{pmatrix}$$

The consistency of subjective and objective information of A_1, A_2, and B_2 after adjustment is obtained again as follows:

$MCI(p^{A_1}, \overline{p}^{A_1}) = 0.090$, $MCI(p^{A_2}, \overline{p}^{A_2}) = 0.175$, $MCI(p^{B_2}, \overline{p}^{B_2}) = 0.156$.

At this time, all logistics service providers and demanders meet the acceptable consistency of subjective and objective information.

Further, calculate the comprehensive evaluation value $U_i^A(B_j)$ of supplier A_i with respect to demander B_j as:

$$U^A = (U_i^A(B_j))_{5\times 4} = \begin{pmatrix} 0.66 & 0.59 & 0.83 & 0.64 \\ 0.70 & 0.75 & 0.85 & 0.73 \\ 0.66 & 0.86 & 0.60 & 0.78 \\ 0.73 & 0.58 & 0.67 & 0.65 \\ 0.66 & 0.79 & 0.64 & 0.72 \end{pmatrix}$$

At the same time, the comprehensive evaluation value $U_j^B(A_i)$ of the demander B_j regarding the logistics service provider A_i is:

$$U^B = (U_j^B(A_i))_{4\times 5} = \begin{pmatrix} 0.70 & 0.74 & 0.65 & 0.72 \\ 0.81 & 0.60 & 0.71 & 0.71 \\ 0.58 & 0.67 & 0.66 & 0.74 \\ 0.82 & 0.65 & 0.77 & 0.76 \\ 0.64 & 0.81 & 0.75 & 0.66 \end{pmatrix}^T$$

Table 1. Valid solutions to the model

serial number t	effective match	Target $Z_1^{(t)}$	Target $Z_2^{(t)}$
1	x_{23}=1, x_{34}=1 x_{41}=1, x_{52}=1	3.15	3.08
2	x_{21}=1, x_{34}=1 x_{43}=1, x_{52}=1	2.94	3.13
3	x_{13}=1, x_{24}=1 x_{32}=1, x_{41}=1	3.15	2.85

Further, let $\varepsilon = 0.2$, obtain the effective solution of the two-sided matching model of supply and demand of the service above, as shown in the following table.

Further, assuming that the preference function set by the matching decision-making platform D is $f(Z_1, Z_2) = 0.5 \times (Z_1 - Z_1^*)^2 + 0.5 \times (Z_2 - Z_2^*)^2$, and the valid solutions in Table 1 are brought into $f(Z_1, Z_2)$ in turn, $f(Z_1^{(1)}, Z_2^{(1)}) = 0.00125$, $f(Z_1^{(2)}, Z_2^{(2)}) = 0.02205$, $f(Z_1^{(3)}, Z_2^{(3)}) = 0.0392$ can be obtained.

Since A is the smallest, the effective solutions corresponding to B and C are the optimal matching solutions, namely (A_2, B_3),(A_3, B_4),(A_4, B_1),

(A_5, B_2).

5 Conclusion

With respect to the problem of service supply and demand two-sided matching of service supply and demand, this paper presents an analysis method driven by the consistency of subjective and objective preference information, then considers the constraints of stable matching, and establishes a two-sided service supply and demand to maximize the overall evaluation of the demander and the supplier. Match the model.

Compared with the existing research results, this paper proposes and uses a feedback adjustment method based on the consistency of subjective and objective information to ensure that the supply and demand sides of the service provide more reliable supply and demand information while taking into account the stability requirements of both parties. Since the actual service supply and demand matching agent may have a strategy of accepting or rejecting the matching alternative, how to discuss the strategy evolution behavior of both parties of the service supply and demand matching agent is the next research focus.

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