



Research Article

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Evaluation and Decision Making of Organization Quality Specific Immunity Based on MGDM-IPLAO Method

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Abstract: As the starting point, the immunity theory is introduced into the organization quality management, combined with the organization quality specific immunity system, the evaluation index system of organization quality specific immunity is designed. And the evaluation and multi-attribute group decision making model of organization quality specific immunity based on the immunity perspective is constructed by the method of multi-attribute group decision making of intuitive pure linguistic aggregation operators, empirical analysis is carried out by the research objects of relevant experts, representative and typical manufacturing enterprises, the empirical analysis results indicate that multi-attribute group decision making method of intuitive pure linguistic aggregation operators can choose and determine the optimization evaluation solution and the best decision making of partners, confirm the highest value over all partners for organization quality specific immunity system, the method of multi-attribute group decision making of intuitive pure linguistic aggregation operators has validity, feasibility and operability in evaluation and decision making of organization quality specific immunity. Empirical analysis results and conclusion have certain practical value, which provide new ideas to solve the problem of multi-attribute decision making of intuitive information mixed with pure linguistic information, and provides the basis for the effective selection of the best partners for manufacturing enterprises of the supply chain from the perspective of quality management.

Keywords: Organization quality specific immunity, Evaluation and multi-attribute group decision making, Intuitive pure linguistic aggregation operators

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1 Introduction

With the proposals of the industrial plan 4.0 and the guiding principle of “made in China 2025”, market competition has become increasingly fierce and cruel. Quality has gradually become a necessary condition for the survival and development of enterprises, playing a decisive role in the daily production and operation of enterprises [1, 2]. Quality management has also become an important competitive means to drive the development of enterprises [3]. However, as the uncertainty of the market environment is increasing, the demand of customers is changing, and the enterprise is gradually surrounded by countless viruses and bacteria [4, 5]. The occurrence of any quality security event may lead to the overall collapse of the organization quality management system [6]. After the outbreak of the Fukushima nuclear power plant in Japan in 2011, China immediately banned the inflow of food from the area around the accident. However, in 3.15 Party of CCTV this year, there were more than 13000 online merchants suspected of selling Japanese nuclear contaminated food. So far, a number of imported snacks supply chains led by kalebi appeared paralysis, and the directly related suppliers, agents and distributors have been badly hit. Xi’an subway “problem cable” incident in March of 2017 also highlighted the importance of quality safety of product quality, engineering quality and so on [7]. The above events are neither the responsibility of individuals or a single enterprise, nor simply about quality supervision, but because of the loopholes in quality management mode. According to the theory of medical immunization, the infection of the body is caused by the inability of its immunity system to identify the antigen, that is to say, the failure of immunity response causes the pathological changes and even the death of the body. Therefore, the orderly and stable immunity system

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has become the basis for ensuring the healthy and sustained development of the body. It is true for the enterprise. The purpose of carrying out the enterprise quality management is to enable enterprises to produce qualified quality products [8]. Any behavior and factor (variation source) that may cause the unqualified products are taken as the object of quality management, and put in the first place of the concerns in the management activities [4, 5]. The essence of the quality management of enterprises is to monitor and control the internal and external variation sources in real time and to remove them in time, that is, “immunity response” in the immunity theory. Immunity response is an important approach to play the role of the immunity system of the organism. Through the immunity response, the various mechanisms of the immunity system are realized [9]. For manufacturing enterprises, if their quality management immunity systems want to play a role, the immunity response activities are also needed to be relied on. If the organization quality specific immunity response fails or the immunity function loses, the quality management system will be infected with the virus, and it can not play a normal role. The domestic scholars of Lv and Wang [10–12] firstly applied the immunity theory to the study of organizational immunity research, and studied the organization adaptability from the perspective of immunization and got the inspirational results, which provided a reference for the further study of effect and mechanism of organization specific immunity on the quality performance. However, there is still a lack of research on how to evaluate the organization quality specific immunity and select the best partners from many enterprises [13]. In this paper, the immunity theory is introduced into the organization quality management, and the method of multiple attribute group decision making of intuitive pure language aggregation operators is used to evaluate the organization quality specific immunity, which will guide the enterprises to choose the best partners effectively from the perspective of quality management, and have a practical guiding value.

2 Review of related theories and literature

The organization quality management from the perspective of immunity takes the operation mechanism of the biological immunity system as the foundation to simplify the quality management problem, build a systematic organization quality management platform through the way of biological immunity embedding, and study its synergy

mechanism so as to achieve an effective integration of all quality management departments, ultimately, achieve the purpose of integration of organization quality management [19]. Lv and Wang [10–12] chose most enterprises as the research objects, and divided the behavior of enterprise organization into two dimensions after deep interviews, namely, organization specific immunity and organization non-specific immunity. The former refers to the organization non-specific immunity including organizational structure, organizational culture and regulations which has been set up in advance, if the invasion of external harmful factors exists, the system will take a series of specifically immunity response behaviors including three elements of organization monitoring, organization defense and organization memory. Xu, Ji, Li, Zhou and Jin [14] explored the risk coping mechanism of technological SMEs based on the idea of organizational immunity idea, pointing out that when dealing with general environmental risks, compared with non-specific immunity, the specific immunity is more suitable for dealing with critical environmental risks. Li, Sun and Jin [15], Li and Wang [16], Liu [17] carried out the operation mechanism of quality management immunity in supply chain, and constructed supply chain quality management model based on immunization thought. The research points out that the independent manufacturing enterprises, as the core part of the supply chain, can be regarded as an organism with a complete immunity structure. In the immunity system, the central immunity organ corresponds to the quality management department of the enterprise, the peripheral immunity organ corresponds to other related departments of the enterprise, and the quality management personnel in the enterprise, as the immunity cells in the immunity system, generates immunity response combined with the antigen. Pan and Wang [9] used immunity theory as the starting point to compare the immunity system of organism with the quality immunity system of enterprises, pointing out that the innate immunity response and adaptive immunity response form the enterprise immunity system together. The characteristics, the response process and the mechanism of action are described respectively. Combined with previous studies, the organization quality immunity can be divided into two dimensions, namely, the organization quality non-specific immunity and organization quality specific immunity. Among them, the organization quality specific immunity is the core of the function of the organization quality immunity system. In this process, firstly, the immunity system monitors quality risk and external threat, when finding the virus, it recognizes it quickly. And it induces and analyzes characteristics of the target event, extracts the relevant information from

the existing database of organization to determine, and remove the source of variability threatening the quality safety timely. For the target event that is not involved in the current database, it is necessary for the quality manager to make an attempt on the basis of previous experience. Thus, the initial immunity response is completed. Then it is to record the process and results of the trial processing of the quality managers, and learn and summarize them. Finally, according to the results obtained, new data information is formed to provide support for the recurrence of the immunity response [9]. Shi, Liu, Wu and Du [4], Shi, Liu and Tang [5] took the monitoring, defense and memory of the organization quality as the perspective to get the promotion path of organizational quality performance by the projection pursuit method and other methods, providing practical guidance for enterprises. Dai and Ding [18] took organizational immunity theory as a base to research the internal organization control, built an internal control evaluation model by AHP and evaluated the level of internal control by fuzzy comprehensive evaluation method, and the qualitative problems were quantified to provide a new idea for the enterprise internal evaluation. Su and Jia [19] put the idea of organizational immunity into the research of SMEs' strategic transformation risk, constructed the fuzzy comprehensive evaluation model, and found that enterprise organizational immunity can effectively resist the risk of strategic transformation in SME management through the empirical analysis. In summary, the scholars use different methods to evaluate the application of immunity theory in various fields, but taking the immunity theory as a starting point to study the organization quality management is very little, and the existing research is lack of the research on the decision making and evaluation of organization quality specific immunity by any effective method [20, 21]. Therefore, based on the perspective of organization quality specific immunity, this paper focuses on the construction of evaluation system of organization quality specific immunity from the aspects of monitoring and recognition, defense cleanness and repair, and memory and immunity homeostasis of the organization quality, applies the intuitive pure linguistic information aggregation method into the multi-attribute group decision making, and comprehensively evaluates the organization quality specific immunity system of manufacturing enterprises based on the given attribute value, experts weights and attribute weights. This method is practical and scientific, providing a basis for selecting the optimal supply chain partners, which has an important significance to improve the quality management practice of the enterprises.

3 Construction of index system of organization quality specific immunity

According to the relevant theories and literature review, with reference to the related literatures [1–12, 14–19], this paper selects construct dimensions of organization quality monitoring and awareness, organization quality defense, removal and repair (soft elements of organization quality defense, removal and repair, hard elements of organization quality defense, removal and repair), the organization quality memory and organization quality immunity homeostasis. Construction dimensions corresponds to each scale and their evaluation indicators, and the scale and evaluation indicators system of organization quality specific immunity are constructed as in Table 1.

4 Evaluation and decision making model of organization quality specific immunity based on MGDM-IPLAO method

4.1 Outlines and advantages of MGDM-IPLAO method

In recent years, the application of multi-attribute group decision making theory has attracted wide attention from scholars. Fuzzy multi-attribute group decision-making has become hot research topic home and abroad [20–23]. As an important content of modern decision-making theory, fuzzy multi-attribute group decision making is being applied to many fields in economic and management scope. The essence of multi-attribute group decision making is to sort out a limited number of alternatives by making use of certain integrating method based on the existing information by many decision experts, and select the best plan from them [24, 25]. But because the human mind has certain ambiguity in making decisions on complex issues, experts are often affected by a lot of factors, so that some attributes of the evaluation object are often difficult to evaluate by the exact numerical value, but given in fuzzy linguistic decision information of different forms [26–29]. In this case, the aggregation operators based on intuitive pure linguistic information can effectively overcome the decision result influence of the unfair evaluation effected by subjective factors of decision makers (assigned low weight to

Table 1: Index system of organization quality specific immunity

| Construction dimensions | | Scale and evaluation indicators |
|---|---|--|
| Organization quality monitoring and awareness | | External environmental monitoring of organization quality |
| | | Internal environmental monitoring of organizational quality |
| | | Organizational quality internal activities and behavior monitoring |
| | | Value judgment |
| Organization quality defense, removal and repair | Soft elements of organization quality defense, removal and repair | Cognitive motivation (internal motivation, external motivation) |
| | | Cognitive diversity |
| | Hard elements of organization quality defense, removal and repair | Leader attention |
| | | Employee participation |
| | | Supplier relationship management |
| | | Customer demand |
| Organization quality memory and organization quality immunity homeostasis | | Product design |
| | | Process management |
| | | Statistical control and feedback |
| | | Study |
| | | Record |
| | | Summary |
| | Preservation | |
| | Communication and diffusion | |
| | Communication control and supervision | |

high or low attribute value etc.) [17, 26–29], then obtain the optimal decision, providing new ideas and methods to make effective evaluation and decision-making.

4.2 Principles and steps of MGDM-IPLAO method

Suppose the expert set of group decision making is d_k , $d_k \in D$, ($k = 1, \dots, m$), and the weight vector of its language scale is $h_v = (h_{v_1}, \dots, h_{v_m})^T \in \bar{H}$. The attribute set is $G = \{g_1, \dots, g_l\}$, and its attribute weight vector is $h_w = (h_{w_1}, \dots, h_{w_l})^T \in \bar{H}$. Suppose the solution set is $X = \{x_1, \dots, x_n\}$, and each decision expert $d_k \in D$ measures the solution set $x_i \in X$ according to the relevant attribute $g_i \in G$, so that the attribute value z_{ij}^k of x_i about g_j is obtained. Aggregate the attribute value z_{ij}^k , and establish the decision matrix of intuitive linguistic variable $Z^{(k)} = (z_{ij}^k)_{l \times n}$. The constructed evaluation index system of organization quality specific immunity is integrated as above, and the relevant principles and steps of evaluation and decision making of organization quality specific immunity based on the method of multi-attribute group decision making of intuitive pure linguistic aggregation operators (abbreviation is MGDM-IPLAO method) are given by this paper are as follows [17, 20–29]:

Step 1. Giving the decision matrix of intuitive linguistic variables $Z^{(k)} = (z_{ij}^k)_{l \times n}$ by experts, use the intuitive pure linguistic weighted averaging operators (IPLWA) to aggregate the attribute values of each column respectively, and get the comprehensive attribute value of solution x_i evaluated by decision expert d_k .

Set the intuitive linguistic variables as: $a_i = \langle h_{a(a_i)}, (\mu_{A(x_i)}, \nu_{A(x_i)}) \rangle$, $i = 1, 2, \dots, n$, the intuitive pure linguistic weighted averaging operators (IPLWA) are:

$$IPLWA_{h_w}(a_1, a_2, \dots, a_n) = \sum_{i=1}^n h_{w_i} a_i \quad (1)$$

Among them, $h_w = (h_{w_1}, h_{w_2}, \dots, h_{w_n})^T$ are weighted vectors of intuitive pure linguistic variables $a_i = (a_1, a_2, \dots, a_n)$. A group of new intuitive pure linguistic variables are obtained to assemble a_i through the formula (1), and

$$IPLWA_{h_w}(a_1, a_2, \dots, a_n) = \langle h_{\sum_{i=1}^n \omega_i a(a_i)}, (1 - \prod_{i=1}^n (1 - \mu_{A(x_i)})^{\omega_i}, \prod_{i=1}^n (\nu_{A(x_i)})^{\omega_i}) \rangle \quad (2)$$

Meanwhile,

$$Z_i^{(k)} = IPLWA_{h_w} = (a_1^k, a_2^k, \dots, a_{l_i}^k), \quad (3)$$

Step 2. Using the intuitive pure linguistic hybrid averaging operator (IPLHA) to aggregate the comprehensive attribute value $Z_i^{(k)}$ calculated in step 1, and calculate the group comprehensive attribute values constituted by each decision plan x_i , written as Z_i .

Set the intuitive linguistic variables as $a_i = \langle h_{\alpha(a_i)}, (\mu_{A(x_i)}, \nu_{A(x_i)}) \rangle, i = 1, 2, \dots, n$, the intuitive pure linguistic hybrid averaging operator (IPLHA) are:

$$IPLHA_{h_\omega, \varpi}(a_1, a_2, \dots, a_n) = \sum_{j=1}^n \varpi_j b_{\delta_j} \quad (4)$$

Among them, $\varpi = (\varpi_1, \varpi_2, \dots, \varpi_n)^T$ are the weighted vectors (position weights) associated with the intuitive pure linguistic hybrid averaging operator (IPLHA), b_{δ_j} is the j largest element in b_k . $h_\omega = (h_{\omega_1}, h_{\omega_2}, \dots, h_{\omega_n})^T$ are the weighted vectors of the intuitive linguistic variables $a_i = (a_1, a_2, \dots, a_n)$. The new intuitive pure linguistic variables are obtained to assemble a_i through the formula (4), and

$$IPLHA_{h_\omega, \varpi}(a_1, a_2, \dots, a_n) = \langle h_{\sum_{j=1}^k \varpi_j a(b_{\delta_j})}, (1 - \prod_{j=1}^n (1 - \mu_A(b_{\delta_j}))^{\varpi_j}, \prod_{j=1}^n (\nu_A(b_{\delta_j}))^{\varpi_j}) \rangle \quad (5)$$

Meanwhile,

$$Z_i^{(k)} = IPLHA_{h_\omega, \varpi}(Z_i^1, Z_i^2, \dots, Z_i^{(m)}), \quad i = 1, 2, \dots, n \quad (6)$$

Step 3. In view of the group comprehensive attribute values Z_i derived from the above steps, consider the nature of the decision problem, the mathematical expectation $E(a)$ and the exact function $H(a)$ are calculated according to the needs.

Set intuitive pure language variables as: $a_i = \langle h_{\alpha(a_i)}, (\mu_{A(x_i)}, \nu_{A(x_i)}) \rangle, i = 1, 2, \dots, n$. Its mathematical expectation is:

$$E(a) = \frac{1}{2} (\mu_A(x) + (1 - \nu_A(x))) \times h_{\partial(x)} \quad (7)$$

$$= h_{\partial(x)(\mu_A(x)+(1-\nu_A(x)))/2}$$

$$H(a) = I(E(a))(\mu_A(x) + \nu_A(x)) \quad (8)$$

Among them, $I(h_x) = x$ represents the subscript function.

Step 4. According to the calculation results of mathematical expectation $E(a)$ and accurate function $H(a)$, sort out decision schemes x_i , and select the best scheme from them. For any intuitive pure language variables, for example a_1 and a_2 , there are the following sorting methods:

(1) if

$$E(a_1) > E(a_2), \quad a_1 > a_2. \quad (9)$$

(2) if

$$E(a_1) = E(a_2) \quad (10)$$

1) if $H(a_1) > H(a_2), a_1 > a_2$.

2) if $H(a_1) = H(a_2), a_1 = a_2$.

5 Empirical analysis

Manufacturing enterprises are the core and key bodies of supply chain of manufacturing industry. As the key linkages in the supply chain, the quality management of manufacturing enterprises is the key to determine the sustainable and stable development of the supply chain of manufacturing industry. Therefore, it is essential to select the most stable partners of manufacturing enterprises with the organization quality specific immunity system to establish closer partnerships. The most mature manufacturing enterprises with the organization quality specific immunity system play key roles in selecting, establishing and maintaining the partnerships. Through the comprehensive evaluation of the quality specific immunity components of each enterprise organization, the manufacturing enterprises with the most developing advantages are determined, further the optimal decision-making and partnership evaluation is made according to organization quality specific immunity, choose the best partner of manufacturing enterprises. Firstly, this paper sets one large-scale manufacturing enterprise of eastern region in China as investigation object, which is representative and typical for asset, profit, customer satisfaction, market competitiveness, quality management and ISO certification, which has higher qualified rates of products, which belongs to core and key manufacturing enterprise of supply chain of manufacturing industry [30]. And this paper further adopts snowball sampling method for reporting out five representative and typical partners in quality management fields of the core and key manufacturing enterprise in the supply chain of manufacturing industry, five partners are all belong to large-scale manufacturing enterprises, which are representative and typical for assets, profits, customer satisfaction, market competitiveness, quality management and ISO certification in the eastern regions in China, five enterprises all have higher qualified rates of products [31]. Secondly, two top-managers, three middle-managers, two primary-managers and three

Table 2: Decision matrix $Z^{(1)}$

| | x_1 | x_2 | x_3 | x_4 | x_5 |
|-------|--------------------------------------|-----------------------------------|--------------------------------------|-----------------------------------|--------------------------------------|
| c_1 | $\langle h_2, (0.4, 0.4) \rangle$ | $\langle h_1, (0.5, 0.4) \rangle$ | $\langle h_0, (0.7, 0.2) \rangle$ | $\langle h_3, (0.5, 0.3) \rangle$ | $\langle h_1, (0.4, 0.4) \rangle$ |
| c_2 | $\langle h_{-1}, (0.3, 0.6) \rangle$ | $\langle h_2, (0.6, 0.1) \rangle$ | $\langle h_1, (0.5, 0.3) \rangle$ | $\langle h_1, (0.5, 0.4) \rangle$ | $\langle h_2, (0.7, 0.2) \rangle$ |
| c_3 | $\langle h_1, (0.5, 0.2) \rangle$ | $\langle h_1, (0.3, 0.6) \rangle$ | $\langle h_2, (0.8, 0.1) \rangle$ | $\langle h_2, (0.6, 0.3) \rangle$ | $\langle h_{-1}, (0.5, 0.2) \rangle$ |
| c_4 | $\langle h_1, (0.4, 0.5) \rangle$ | $\langle h_0, (0.5, 0.3) \rangle$ | $\langle h_1, (0.4, 0.3) \rangle$ | $\langle h_1, (0.7, 0.3) \rangle$ | $\langle h_1, (0.3, 0.5) \rangle$ |
| c_5 | $\langle h_2, (0.2, 0.7) \rangle$ | $\langle h_1, (0.3, 0.6) \rangle$ | $\langle h_1, (0.4, 0.2) \rangle$ | $\langle h_2, (0.5, 0.3) \rangle$ | $\langle h_1, (0.5, 0.4) \rangle$ |
| c_6 | $\langle h_{-1}, (0.4, 0.3) \rangle$ | $\langle h_0, (0.6, 0.4) \rangle$ | $\langle h_{-1}, (0.5, 0.4) \rangle$ | $\langle h_1, (0.7, 0.1) \rangle$ | $\langle h_1, (0.6, 0.2) \rangle$ |
| c_7 | $\langle h_{-1}, (0.7, 0.1) \rangle$ | $\langle h_1, (0.7, 0.2) \rangle$ | $\langle h_1, (0.6, 0.1) \rangle$ | $\langle h_2, (0.8, 0.2) \rangle$ | $\langle h_1, (0.7, 0.3) \rangle$ |

Table 3: Decision matrix $Z^{(2)}$

| | x_1 | x_2 | x_3 | x_4 | x_5 |
|-------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|-----------------------------------|
| c_1 | $\langle h_2, (0.6, 0.1) \rangle$ | $\langle h_1, (0.5, 0.3) \rangle$ | $\langle h_2, (0.5, 0.4) \rangle$ | $\langle h_2, (0.7, 0.1) \rangle$ | $\langle h_3, (0.6, 0.2) \rangle$ |
| c_2 | $\langle h_0, (0.7, 0.3) \rangle$ | $\langle h_1, (0.7, 0.2) \rangle$ | $\langle h_1, (0.5, 0.2) \rangle$ | $\langle h_1, (0.6, 0.2) \rangle$ | $\langle h_1, (0.2, 0.4) \rangle$ |
| c_3 | $\langle h_1, (0.2, 0.4) \rangle$ | $\langle h_0, (0.4, 0.3) \rangle$ | $\langle h_1, (0.6, 0.3) \rangle$ | $\langle h_0, (0.8, 0.1) \rangle$ | $\langle h_0, (0.6, 0.2) \rangle$ |
| c_4 | $\langle h_1, (0.5, 0.4) \rangle$ | $\langle h_1, (0.7, 0.1) \rangle$ | $\langle h_1, (0.5, 0.5) \rangle$ | $\langle h_2, (0.3, 0.3) \rangle$ | $\langle h_1, (0.8, 0.1) \rangle$ |
| c_5 | $\langle h_1, (0.8, 0.1) \rangle$ | $\langle h_2, (0.8, 0.2) \rangle$ | $\langle h_2, (0.7, 0.1) \rangle$ | $\langle h_1, (0.8, 0.1) \rangle$ | $\langle h_1, (0.7, 0.2) \rangle$ |
| c_6 | $\langle h_1, (0.5, 0.3) \rangle$ | $\langle h_0, (0.4, 0.4) \rangle$ | $\langle h_1, (0.3, 0.5) \rangle$ | $\langle h_0, (0.4, 0.5) \rangle$ | $\langle h_1, (0.6, 0.3) \rangle$ |
| c_7 | $\langle h_1, (0.6, 0.3) \rangle$ | $\langle h_2, (0.8, 0.1) \rangle$ | $\langle h_1, (0.7, 0.2) \rangle$ | $\langle h_2, (0.7, 0.2) \rangle$ | $\langle h_1, (0.5, 0.4) \rangle$ |

Table 4: Decision matrix $Z^{(3)}$

| | x_1 | x_2 | x_3 | x_4 | x_5 |
|-------|-----------------------------------|-----------------------------------|-----------------------------------|--------------------------------------|-----------------------------------|
| c_1 | $\langle h_0, (0.4, 0.5) \rangle$ | $\langle h_1, (0.5, 0.2) \rangle$ | $\langle h_1, (0.3, 0.6) \rangle$ | $\langle h_0, (0.6, 0.3) \rangle$ | $\langle h_1, (0.7, 0.2) \rangle$ |
| c_2 | $\langle h_2, (0.6, 0.2) \rangle$ | $\langle h_1, (0.6, 0.3) \rangle$ | $\langle h_1, (0.7, 0.2) \rangle$ | $\langle h_2, (0.6, 0.2) \rangle$ | $\langle h_1, (0.5, 0.4) \rangle$ |
| c_3 | $\langle h_0, (0.2, 0.5) \rangle$ | $\langle h_1, (0.3, 0.3) \rangle$ | $\langle h_1, (0.3, 0.5) \rangle$ | $\langle h_1, (0.4, 0.4) \rangle$ | $\langle h_0, (0.2, 0.6) \rangle$ |
| c_4 | $\langle h_2, (0.5, 0.3) \rangle$ | $\langle h_1, (0.7, 0.2) \rangle$ | $\langle h_1, (0.7, 0.1) \rangle$ | $\langle h_2, (0.5, 0.2) \rangle$ | $\langle h_1, (0.6, 0.3) \rangle$ |
| c_5 | $\langle h_3, (0.7, 0.3) \rangle$ | $\langle h_2, (0.7, 0.2) \rangle$ | $\langle h_1, (0.6, 0.3) \rangle$ | $\langle h_1, (0.9, 0.1) \rangle$ | $\langle h_1, (0.8, 0.1) \rangle$ |
| c_6 | $\langle h_0, (0.5, 0.4) \rangle$ | $\langle h_1, (0.4, 0.4) \rangle$ | $\langle h_1, (0.3, 0.5) \rangle$ | $\langle h_{-1}, (0.8, 0.2) \rangle$ | $\langle h_1, (0.5, 0.1) \rangle$ |
| c_7 | $\langle h_2, (0.3, 0.2) \rangle$ | $\langle h_1, (0.6, 0.1) \rangle$ | $\langle h_1, (0.5, 0.4) \rangle$ | $\langle h_2, (0.7, 0.1) \rangle$ | $\langle h_2, (0.4, 0.2) \rangle$ |

core employees of one core and key manufacturing enterprise of supply chain are selected to analyze and evaluate their organization quality specific immunity system of each partner, the evaluation level of the language scale is $H = \{h_{-3}, h_{-2}, h_{-1}, h_0, h_1, h_2, h_3\}$, they finish fifty effective questionnaires by survey investigation, on-site interview and field research. Thirdly, five representative and typical partners (decision schemes) $x_i (i = 1, 2, \dots, 5)$ are selected to analyze and evaluate their own organization quality specific immunity system, each partner selects and invites two top-managers, three middle-managers, two primary-managers and three core employees of the manufacturing enterprise, the evaluation level of the language scale is also $H = \{h_{-3}, h_{-2}, h_{-1}, h_0, h_1, h_2, h_3\}$, they finish fifty effective questionnaires by survey investigation, on-site interview and field research. Based on the 100 questionnaires, three decision-making experts $d_k (k =$

$1, 2, 3)$ are invited to evaluate 100 questionnaires of manufacturing enterprises respectively with outlier and exception handling, discretization processing, centralized processing, extreme treatment, averaging processing, comprehensive and integration processing, and further three decision-making experts $d_k (k = 1, 2, 3)$ give out the final results. Finally, the weight vector of each expert is $h_v = (h_1, h_0, h_1)^T$ respectively. According to the immunology theory and immunity response process, this paper integrates the constructed evaluation index system of organization quality specific immunity, sets seven key links including organization quality monitoring (c_1), organization quality recognition (c_2), organization quality defense (c_3), organization quality removal (c_4), organization quality repair (c_5), organization quality memory (c_6) and organization quality homeostasis (c_7) as evaluation index (attribute), the weights of every index are $h_\omega =$

$(h_0, h_1, h_2, h_1, h_{-1}, h_1, h_{-1})$. The decision-making experts evaluated the above seven attributes based on the given scale of language evaluation, and gave out the final evaluation results in the form of intuitive pure linguistic variable decision matrix, which are seen from Table 2 to 4.

The decision schemes are sorted and the best manufacturing enterprise is selected from them. The following steps are used to find the solution:

Step 1. By formula (2) and formula (3), use the intuitive pure linguistic weighted averaging operator (IPLWA) to aggregate the attribute values of the columns in the decision matrix respectively, and get the comprehensive attribute values:

$$\begin{aligned} Z_1^{(1)} &= \langle h_0, (0.74, 0.05) \rangle & Z_2^{(1)} &= \langle h_2, (0.81, 0.04) \rangle \\ Z_3^{(1)} &= \langle h_3, (0.97, 0.02) \rangle & Z_4^{(1)} &= \langle h_3, (0.93, 0.02) \rangle \\ Z_5^{(1)} &= \langle h_0, (0.84, 0.01) \rangle & Z_1^{(2)} &= \langle h_2, (0.40, 0.19) \rangle \\ Z_2^{(2)} &= \langle h_{-2}, (0.51, 0.04) \rangle & Z_3^{(2)} &= \langle h_2, (0.69, 0.23) \rangle \\ Z_4^{(2)} &= \langle h_0, (0.89, 0.02) \rangle & Z_5^{(2)} &= \langle h_1, (0.93, 0.01) \rangle \\ Z_1^{(3)} &= \langle h_{-1}, (0.70, 0.10) \rangle & Z_2^{(3)} &= \langle h_2, (0.71, 0.11) \rangle \\ Z_3^{(3)} &= \langle h_3, (0.85, 0.02) \rangle & Z_4^{(3)} &= \langle h_2, (0.52, 0.13) \rangle \\ Z_5^{(3)} &= \langle h_0, (0.47, 0.22) \rangle \end{aligned}$$

Step 2. By formula (4) and formula (5), use the intuitive pure linguistic hybrid averaging operators (IPLHA) to aggregate the above comprehensive attribute values given by decision-making experts. According to the nature of the enterprise and the actual situation, the position weights $\omega = (0.3162, 0.4380, 0.2458)$ corresponding to the IPLHA operators are given, and the group comprehensive attribute values of the decision schemes are calculated.

$$\begin{aligned} Z_1 &= IPLHA_{h,\omega}(Z_1^{(1)}, Z_1^{(2)}, Z_1^{(3)}) \\ &= \langle h_{-0.25}, (0.66, 0.10) \rangle \\ Z_2 &= IPLHA_{h,\omega}(Z_2^{(1)}, Z_2^{(2)}, Z_2^{(3)}) \\ &= \langle h_{1.51}, (0.71, 0.06) \rangle \\ Z_3 &= IPLHA_{h,\omega}(Z_3^{(1)}, Z_3^{(2)}, Z_3^{(3)}) \\ &= \langle h_{2.26}, (0.89, 0.04) \rangle \\ Z_4 &= IPLHA_{h,\omega}(Z_4^{(1)}, Z_4^{(2)}, Z_4^{(3)}) \\ &= \langle h_{1.82}, (0.86, 0.04) \rangle \\ Z_5 &= IPLHA_{h,\omega}(Z_5^{(1)}, Z_5^{(2)}, Z_5^{(3)}) \\ &= \langle h_0, (0.83, 0.03) \rangle \end{aligned}$$

Step 3. Calculate the expectation of the group comprehensive attribute value $Z_i (i = 1, 2, \dots, 5)$ of the

decision scheme according to the formula (7).

$$\begin{aligned} E(A_1) &= h_{-0.20} & E(A_2) &= h_{1.25} \\ E(A_3) &= h_{2.09} & E(A_4) &= h_{1.66} \\ E(A_5) &= h_0 \end{aligned}$$

Step 4. Sort the decision scheme X_i according to the expected value of the group’s comprehensive attribute value, the result is: $X_3 \succ X_4 \succ X_2 \succ X_5 \succ X_1$. Therefore, X_3 is the best scheme, i.e. the comprehensive evaluation value of the organization quality specific immunity system of the third enterprise is the highest.

6 Conclusion

This paper introduces the immunity theory into the organization quality management, designs the evaluation index system combined with organization specific quality immunity system, and constructs evaluation and decision model based on the organization specific quality immunity from the immunity perspective by the method of multi-attribute group decision making of intuitive pure linguistic aggregation operators, which not only helps the organization realize the dynamic evaluation of quality specific immunity system, but also provides a reference for managers to make the best decisions. Due to the complexity of the evaluation of organization specific quality immunity, and in the comprehensive evaluation of the process, the experts are easily affected by personal preference, to use the fuzzy language such as “excellent”, “good” for the evaluation, which makes the relative importance of each attribute of the object waiting for the evaluation is difficult to quantify. The multiple attribute group decision making method based on intuitive pure language aggregation operator can effectively solve the multi-attribute group decision-making problem under uncertain information, which can be well applied to the information given in the form of pure language, and overcome the errors caused by subjective factors of individual decision-makers. At present, there are few studies on the effective application of pure language information to decision-making and comprehensive evaluation, especially in the evaluation of quality specific immunity. This paper gives the aggregation method for intuitive pure linguistic information, and effectively applies it to the evaluation of quality specific immunity system, which is not only to further broaden the application of decision making method for intuitive information, but also to provide a new idea to solve multi attribute decision problem of intuitive information integrated with

pure linguistic information. Similarly, it provides the basis for the field the supply chain enterprises to choose the best partners, and provides an important practical guidance for the enterprise to improve the quality management practice. However, this is only a preliminary exploration on the evaluation of organization quality specific immunity by the method of the multiple attribute group decision making, the designed model is only for a self evaluation and provides certain reference value for supply chain management decision makers to choose the best partners, yet it fails to replace all evaluation standards of organization quality specific immunity. In the future study, the specific evaluation methods of organization quality specific immunity will further improved on this base.

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