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Organizational Quality Specific Immune Maturity Evaluation Based on Continuous Interval Number Medium Operator

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Abstract: This study sets immune theory as breakthrough points, introduces immune theory into organizational quality management scope with a view to evaluating and enhancing organizational quality specific immune maturity symmetrically and permanently. This study establishes an evaluation index system of organizational quality specific immune maturity and constructs a quality specific immune maturity evaluation and decision-making model based on an immune perspective. Further we used symmetrical methods of a continuous interval number median operator and multiple attribute decision making to carry out empirical analysis. The median idea is introduced, and the points in the 1/2 position of the basic interval monotone function are selected in evaluation and decision-making calculation by continuous interval number medium operator method. Empirical analysis research can avoid the influence of extreme value, provide new ideas and methods for effective evaluation and decision making of organizational quality specific immune maturity. The outcomes of this study have important practical significance for enhancing organizational quality specific immune maturity of equipment manufacturing enterprises.

Keywords: organizational quality specific immune maturity; evaluation and decision making; continuous interval number medium operator

1. Introduction

Quality is the life of enterprise. Organizational quality specific immune refers to the process of embedding immune theory into the organizational quality management system. Organizational quality specific immune puts emphasis on obtaining and activating the organizational quality management risk prevention function through the dynamic immune response mechanism and eliminating various threat factors. Organizational quality specific immune is the core classification of organizational quality immune, and organizational quality immune is the core systematization of organizational immune. The combination of immune theory with organizational quality management can enable enterprises to find problems such as deviations in quality, production, and operation. Using the immune recognition function can determine the crux of quality problems and carry out immune memory and self-stability to develop immune. Immune theory can fully exert positive effects in the process of ensuring quality and safety [1]. In the study of management problems, the theory of biological immune was first applied to the mechanism to explain organizational responses to environmental changes. Subba Narasimha [2] employed the ability of the immune system to recognize external unknown antigens to organizational dynamics and defined dynamic capabilities as a property that can produce antibodies. Wang et al. [3] applied immunology theory to organizations for the first time and proposed the concept of organizational immune. They believe that the organizational immune system is similar to biological immunity which can effectively eliminate threats by identifying external and internal dissidents. Through the immune and response process, memory is generated, and the ability of maintaining organizational health is generated [3–6]. In addition, they comprehensively expounded four aspects of the immune system's functions (i.e., immunological surveillance, defense, self-stability, and learning) and explored operational mechanisms and influencing factors of the organizational immune system.

Currently, studies on organizational immune, organizational specific immune, organizational quality immune, and organizational quality specific immune have yielded fruitful outcomes from the perspectives of the theoretical framework and business practices. The basic foundations have attracted much attention from academics and business professionals. Combing immune theories and ideas with organizations can form organizational immune and organizational specific immune. Fusing immune, organizational immune, and organizational specific immune into quality management scope is of great importance. The mixtures and combinations will generate and bring about organizational quality immune and organizational quality specific immune.

Organizational specific immune refers to the immune effect activities of organizations by integrating various departments and personnel in order to ensure the system's health [7–9]. Institutions carry out efficient and short-term response times to distinguish between self and non-self. In the process, companies use different resources to identify and judge antigens that may cause mass variation in the shortest time and remove and activate the role of memory and self-stability. When encountering the same or similar events again, the system is able to respond to the circumstances expeditiously [7–9]. Wang et al. [3–6] divided organizational immune behavior into two dimensions: specific immune and non-specific immune. The former includes three acquired, non-congenital, and cultivated components of organizational monitoring, defense, and memory. They indicate that organizational defense is the most important component of organizational specific immune. The construction dimensions of organizational defense refer to genetic replication, crossovers and mutations, variations, adaptations, selection and coordinating corrections (preventing bottlenecks). The latter one is mainly composed of organizational culture, structure, and institutional rule [3–6]. In addition, other scholars have further supplemented the theory of organizational immune. Xu et al. [10] embody the internal and external risks faced by enterprises into complex and various living environment. The action mechanism of the immune dimension on dissidents enriches and perfects the theory of risk management. Cheng et al. [11] defined the concept of corporate alien, cellular, and corporate immune and expounded the composition of the corporate immune system and various levels of structure. The research outcomes expand the corporate immune system function by exploring the relationships between corporate aliens and cells. They summarize the similarities and differences between the biological immune system and the corporate immune system. Shi et al. [12–16] conducted a large number of empirical studies on the factors that affect quality defect management based on immune theory. Further, they expounded on the concepts, connotations, classifications, contents, and mutual function mechanisms of organizational quality specific immune and quality performance. The improvement and upgrading paths of quality performance based on organizational quality specific immune were proposed and summarized. Liu et al. [17] employed immune theory to establish a hazard identification model for early warning crises in enterprises. The intensity and breadth of intrusion risk are identified, the dangerous areas are determined, and the efficiency and accuracy of crisis warning are improved. Li et al. [7,8] embedded the relevant elements of immune system into supply chain quality management based on the perspectives of biological immune. They enrich the concepts, connotations, and theoretical framework of organizational quality immune and organizational quality specific immune. A supply chain quality management immune model was constructed which is beneficial for explaining the operating mechanism of different dimensions of an immune system. Solving quality management immunodeficiency effectively can provide references for enhancing quality performance. Pan et al. [18] distinguished the similarities and differences between a biological immune system and an organizational quality immune system. The organizational quality immune response includes two types: an innate immune response and an adaptive immune response. After comparing the connotations, process, and mechanisms of the two types of responses, enterprises can further solve the problem of how to effectively improve the immune response capability. Li et al. [7,8] and Shi et al. [12–16] all assert that organizational quality immune can be divided into two major classifications: organizational quality specific immune (core classification) and organizational quality non-specific immune. The former one exerts immune functions and conducts quality management functions with the main nutrition, acquired and non-congenital components of organizational quality monitoring, defense (core component), and memory. Li et al. [7,8] suggest that the construction dimensions of organizational quality defense consist of genetic replication, crossovers and mutations, variations, adaptations, selection, coordinating corrections, and preventing bottlenecks. On the contrary, Shi et al. [12–16] take construction dimensions of organization quality defense into account which are involved in organizational quality defense soft elements (basic practices) and organizational quality defense hard elements (core practices).

At present, research outcomes on organizational quality specific immune are still insufficient, and the independent innovation and empirical analysis results associated with organizational quality specific immune are relatively lacking [19,20]. Organizational quality specific immune maturity can reflect the development level, grade, stage, degree, and situation of organizational quality specific immune. In view of the importance of organizational quality specific immune maturity, it is necessary to further develop and validate how to effectively evaluate and execute decision making in organizational quality specific immune maturity Therefore, this study constructed an evaluation index system from the perspectives of biological immune, developing and demonstrating an evaluation and decision-making model based on a continuous interval number medium operator. Empirical studies on organizational quality specific immune maturity are of theoretical and practical significance.

2. Materials and Methods

2.1. Evaluation Index System Construction

Based on the relevant theoretical basis [1–18], this study selected construction dimensions of genetic replication, crossovers and mutations (organizational quality defense soft elements), variations (organizational quality defense basic practices), adaptations (organizational quality defense hard elements), selection (organizational quality defense core practices), and coordinating corrections (preventing bottlenecks).

The dimensions corresponded to diverse scales and evaluation indexes. The organizational quality specific immune maturity evaluation index system can be seen in Table 1. Genetic replication was composed of an evaluation index of a11, a21, a31, a41, a51, a61, and a71. Crossovers and mutations consisted of an evaluation index of b11 and b21, respectively. Variations were composed of an evaluation index of c11 and c21. Adaptations consisted of an evaluation index of d11, d21, and d31. Selection was composed of an evaluation index of e11, e12, e13, and e14. Coordinating corrections consisted of an evaluation index of f11, f12, f13, f14, f15, f16, f17, and f18.

Table 1. Organizational quality specific immune maturity evaluation index system.

Evaluation Target	Dimension	Evaluation Index
Organizational quality specific immune maturity	Genetic replication	Organization quality monitoring frequency a11 Organizational quality monitoring efficiency a21 Organizational quality monitoring intensity (strength) a31 Organizational quality monitoring width (broadness) a41 Organizational quality monitoring depth Organizational quality monitoring mobility (richness) a51 Organizational quality monitoring granularity(refinement) a61 Organizational quality monitoring agency and measure ratio a71
	Crossovers and mutations (Organizational quality defense soft elements)	Leadership commitment and support (emphasis on quality objectives and guiding principles, quality policies, quality strategies, quality plans) b11 Employee participation, employee authorization, employee education and training b21
	Variations (Organizational quality defense basic practices)	Customer orientation c11 Supplier relationships management c21
	Adaptations (Organizational quality defense hard elements)	Product design d11 Statistical control and feedback (quality control methods, techniques and tools) d21 Processes management d31
	Selection (Organizational quality defense core practices)	Benchmarking e11 Continuous improvement and innovation e12 Technical skills e13 Information and measurement analysis e14
	Coordinating corrections (preventing bottlenecks)	Organization quality memory frequency f11 Organizational quality memory efficiency f12 Organizational quality memory intensity (strength) f13 Organizational quality memory width (broadness) f14 Organizational quality memory depth f15 Organizational quality memory mobility (richness) f16 Organizational quality memory granularity (refinement) f17 Organizational quality memory agency and measure ratio f18

2.2. Evaluation Method and Model Based on a Continuous Interval Number Median Operator

An ordered weighted average (OWA) operator is characterized by firstly re-arranging the data in order of largest to smallest and then weighting the set of values [21–23]. The OWA operator does not consider the size of weight value, an arranges the position where the value is located. In recent years, the ordered weighted average operator has been widely used in evaluation, management decision making, artificial intelligence, and other fields. However, decision information in real decision-making problems often corresponds to a certain complexity and ambiguity, and decision information is usually in the form of an interval number, and the evaluator cannot give accurate information [24–26]. Therefore, the OWA operator is extended to a continuous interval, and scholars have proposed the continuous order weighted average (COWA) operator. Subsequently, other scholars have proposed a series of transformations. Although there are a large number of expansion forms, it is essentially a sum style and way of weighted average; that is, the interval number is represented by the mean [27,28]. In this case, when the interval number distribution is highly skewed, the mean calculation will have different effects on the calculation results [29]. For the characteristics of non-uniform distribution, the median method is more conducive to save a large amount of original information, and the result is more accurate. Namely, the continuous interval number median (CINM) operator is less susceptible to the risk preference extreme value of the decision maker than the OWA operator. Therefore, in the case of attitude preference of the evaluator, this study introduces the median idea and selects the points in the one-half position of the basic interval monotonic function to participate in the decision calculation. The solution channels and calculation measures can avoid the influence of extreme values and make effective evaluation decisions. The CINM operator provides new ideas and methods for evaluating and decision making and has important practical guiding significance for organizational quality specific immune maturity evaluation and decision making.

2.2.1. Prerequisite Knowledge

1. OWA operator

Theorem 1 [23,29]: Assuming $f : R^n \to R$, if

$$f_\omega(a_1, a_2, \cdots, a_n) = \sum_{j=1}^{n} \omega_j b_j \tag{1}$$

Among of them, $\omega = (\omega_1, \omega_2, \cdots, \omega_n)^T$, $\omega_j \in [0, 1]$, $\sum_{j=1}^{n} \omega_j = 1$, and the weight represented by ω is only related to the position of a_i. Arranging the data $(a_1, a_2, \cdots, a_n)$ in descending order, b_j represents the elements of the jth position after the arrangement, and the function f_ω is the OWA operator.

2. COWA operator

Theorem 2 [23,29]: Assuming $F_Q([a, b])$($[a, b]$ is the interval number), and

$$F_Q([a, b]) = \int_0^1 \frac{dQ(y)}{dy}[b - y(b - a)]dy \tag{2}$$

The function Q satisfies the following conditions:

- The value of the definition field and the value field are respectively $[0, 1]$;
- $Q(0) = 0, Q(1) = 1$;
- When $x > y$, $Q(x) > Q(y)$, then $F_Q([a, b])$ is called COWA operator.

3. CINM operator

Theorem 3 [29]: Assuming $L_Q([a,b])$, and

$$L_Q = ([a,b]) = b - Q^{-1}(1/2)(b-a) \tag{3}$$

Setting $L_Q([a,b])$ as the continuous interval number median operator [29] Where $Q(x)$ is the basic interval monotonic function, the $Q(x)$ function determination depends on the preference of decision maker.

2.2.2. Model Principles and Construction Steps

The model principles and model construction steps are as follows [21–24,29–33]:

Setting the decision maker set as $D = \{d_1, d_2, \cdots d_t\}$, the weight vector corresponding to the decision maker is $G = (g_1, g_2, \cdots, g_t)^T$, $G_k \in [0,1]$, $\sum_{k=1}^{t} G_k = 1$. The attribute value under each scenario is $u_j (j = 1, 2, \cdots, m)$, the attribute weight vector is $W = (w_1, w_2, \cdots w_m)^T$, $W_j \in [0,1]$, $\sum_{j=1}^{m} W_j = 1$. Setting the program set as $X = \{x_1, \ldots, x_n\}$, decision-maker $d_k \in D$, for each scenario $x_i \in X$, the evaluation value given under different attributes is $a_{ij}^{(l)}$, $a_{ij}^{(l)} = \left[(a_{ij}^L)^{(l)}, (a_{ji}^U)^{(l)} \right]$. $a_{ij}^{(l)}$ belongs to the continuous interval number which has an interval range of [0, 100], and the scoring and assignment scopes fluctuate from 0 to 100. Hereby, $(a_{ij}^L)^{(l)}$ is the minimum value of the continuous interval number (the lower limits), and $(a_{ji}^U)^{(l)}$ is the maximum value of the continuous interval number (the upper limits).

Step 1: The decision matrix A is normalized to eliminate the impact on the decision results due to the different dimensions. The CINM operator is used to aggregate the attribute values under the decision information, and the decision matrix after normalization is recorded as R, $R = (r_{ij}^{(l)})_{m \times n}$. Among them, $r_{ij}^{(l)} = \left[(r_{ij}^L)^{(l)}, (r_{ij}^U)^{(l)} \right]$, $i = 1, 2, \cdots, m$, j $= 1 \cdots, n$, $l = 1, 2, \cdots, t$.

Step 2: The weighted integration of attribute values $r_{ij}^{(l)} (i = 1, 2, \cdots, n; j = 1, 2, \cdots, m)$ under attribute u_j under different schemes given by the decision maker is carried out. Thus, the population attribute value $h_{ij}^{(l)} (i = 1, 2, \cdots, n; j = 1, 2, \cdots, m)$ of the scheme x_i under the attribute is obtained and

$$h_{ij} = \sum_{l=1}^{t} G_l L_Q(r_{ij}^{(l)}) \tag{4}$$

In the equation, $G = (g_1, g_2, \cdots, g_t)^T$ is the weight vector corresponding to the decision maker, further obtaining the group decision matrix $H = (h_{ij})_{n \times m}$ with the help of $L_Q(r_{ij}^{(l)}) (i = 1, 2, \cdots, n; j = 1, 2, \cdots, m; l = 1, 2, \cdots t)$.

Step 3: The attribute value of the i row in the group decision matrix $H = (h_{ij})_{n \times m}$ obtained in the above step according to the weight vector of different attributes is weighted and integrated, and the group's comprehensive attribute value $Z_i(w) (i = 1, 2, \cdots, n)$ under the scheme x_i is obtained.

$$Z_i(w) = \sum_{j=1}^{m} w_j r_{ij} \tag{5}$$

Among them, $W = (w_1, w_2, \cdots w_m)^T$ is the attribute weight vector, and $w_j \in [0,1]$, $\sum_{j=1}^{m} w_j = 1$.

Step 4: The decision scheme $x_i (i = 1, 2, \cdots, n)$ according to the $Z_i(w) (i = 1, 2, \cdots, n)$ calculation results is sorted and prioritized.

3. Data Analysis and Results

The effective combination of immune theory and organizational quality management can efficiently discover problems in the quality management, production, and operation of enterprises, especially for equipment manufacturing enterprises. Quality is the life of every enterprise. As the core link of the supply chain of the equipment manufacturing industry, quality management maturity is the key factor in determining the core competitiveness of equipment manufacturing enterprise. The challenge of how to evaluate and conduct decision making in organizational quality specific immune maturity of equipment manufacturing enterprises in quality management scope and range has become the core appeal.

One large-sized equipment manufacturing enterprise seeks for long-term and close partnerships. The typical and representative enterprise will determine the sorting orders of partnerships in the field of quality management, production, and operation management in the supply chain of the equipment manufacturing industry. The enterprise lies in the eastern region (established in year 2002), passes the quality management system certification, and belongs to the directory of top 100 Chinese equipment manufacturing enterprises.

This study selected five large-sized equipment manufacturing enterprises in the eastern and western regions as target objects, schemes, and sample. The selected enterprises are good at constructing immune mechanisms to deal with quality risk events with quality management capabilities and levels and quality performances that were representative. The corresponding corporate assets, profits, sizes, scales, market shares, and reputations were typical. The corporate ages of five enterprises were all more than fifteen years, and they all belonged to the directory of the top 100 Chinese equipment manufacturing enterprises. Through the continuous interval number median operator method, the organizational quality specific immune maturity of the five enterprises (decision schemes) $x_i(i = 1, 2, \cdots, 5)$ were evaluated, ranked, and selected. We invited four experts ($D_t(t = 1, 2, 3, 4)$) by distributing questionnaires in the field, and we conducted field and spot interviews to evaluate each enterprise separately, and the weight G_t of each expert was 0.4, 0.2, 0.3, and 0.1 respectively. The four experts were middle and senior managers of four large-sized equipment manufacturing enterprises. The four large-sized equipment manufacturing enterprises were all at the high-quality management level and performance, had excellent corporate operation management experience in the eastern and western regions. The four large-sized equipment manufacturing enterprises where the experts worked had typical corporate assets, profits, sizes, scales, market shares, and reputations. The corporate ages of the four enterprises where the experts were located were all more than fifteen years old and were attached to the directory of the top 100 Chinese equipment manufacturing enterprises. The four experts had undergraduate and master's degrees, and all had working experience of more than 15 years.

Combined with the immune response process, the six aspects and construction dimensions of genetic replication (c_1), crossovers and mutations (organizational quality defense soft elements (c_2)), variations (organizational quality defense basic practice (c_3)), adaptations (organizational quality defense hard elements (c_4)), selection (organizational quality defense core practice (c_5)), coordinating corrections (preventing bottlenecks (c_6)) were used as evaluation indicators (attributes) of the five enterprises by the four experts to evaluate organizational quality specific immune maturity and to conduct decision making. The attribute weight (W) of each evaluation index was 0.1, 0.2, 0.1, 0.2, 0.1, and 0.3, respectively. The evaluation and decision-making experts evaluated the above six attributes (evaluation indicators) in the format of a continuous interval number. The left number value of a continuous interval number is the minimum value (the lower limits) given by experts, the right number value of continuous interval number is the maximum value (the upper limits) given by experts. The scoring and assignment ranges fluctuate in the continuous interval number of [0, 100]. The evaluation and decision-making results in the form of decision matrix are given as shown from Tables 2–5.

Table 2. Decision matrix $Z^{(1)}$. For example, in the continuous interval number (80 86), the left number value 80 of the continuous interval number is the minimum value (the lower limits) given by the experts, and the right number value 86 of continuous interval number is the maximum value (the upper limits) given by experts. The others have the same meaning.

	c_1	c_2	c_3	c_4	c_5	c_6
x_1	(80 86)	(87 91)	(85 93)	(92 97)	(67 73)	(78 81)
x_2	(70 75)	(90 96)	(60 70)	(77 83)	(80 90)	(72 80)
x_3	(90 100)	(66 69)	(78 84)	(83 88)	(70 75)	(90 95)
x_4	(75 83)	(58 67)	(65 75)	(82 85)	(74 80)	(67 71)
x_5	(86 90)	(80 88)	(50 60)	(89 93)	(60 64)	(80 85)

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

	c_1	c_2	c_3	c_4	c_5	c_6
x_1	(63 72)	(77 81)	(80 84)	(83 90)	(70 75)	(85 90)
x_2	(68 75)	(83 93)	(66 70)	(84 88)	(64 70)	(85 89)
x_3	(88 95)	(74 77)	(83 85)	(90 98)	(60 67)	(70 75)
x_4	(95 100)	(70 80)	(78 82)	(90 94)	(76 80)	(77 82)
x_5	(66 70)	(75 81)	(92 95)	(56 60)	(87 93)	(74 84)

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

	c_1	c_2	c_3	c_4	c_5	c_6
x_1	(82 85)	(85 89)	(69 74)	(92 98)	(60 70)	(60 65)
x_2	(92 99)	(64 70)	(80 85)	(80 90)	(77 80)	(85 88)
x_3	(62 69)	(87 96)	(70 80)	(50 55)	(60 70)	(63 66)
x_4	(78 80)	(95 100)	(84 87)	(88 96)	(80 83)	(89 93)
x_5	(75 82)	(76 80)	(90 95)	(75 77)	(84 88)	(78 90)

Table 5. Decision matrix $Z^{(4)}$.

	c_1	c_2	c_3	c_4	c_5	c_6
x_1	(77 83)	(85 92)	(78 84)	(80 90)	(62 72)	(80 85)
x_2	(80 87)	(85 89)	(72 75)	(90 100)	(87 92)	(80 89)
x_3	(90 95)	(75 82)	(86 90)	(88 95)	(72 77)	(76 80)
x_4	(87 93)	(82 90)	(75 85)	(82 84)	(89 91)	(80 85)
x_5	(72 76)	(80 86)	(74 82)	(60 65)	(83 90)	(76 83)

Step 1: The basic interval monotonic function in this study is made $Q(y) = y^r$, $r = 1$. When evaluating the expert risk neutrality, we chose $\lambda = 0.5$. This study calculated the attribute value matrix of each evaluation expert according to Formula (3):

$$L_Q(r_{ij}^{(1)}) = \begin{bmatrix} 83 & 89 & 89 & 94.55 & 70 & 79.5 \\ 72.5 & 93 & 65 & 80 & 85 & 76 \\ 95 & 67.5 & 81 & 85.5 & 72.5 & 92.5 \\ 79 & 62.5 & 70 & 83.5 & 77 & 69 \\ 88 & 84 & 55 & 91 & 62 & 82.5 \end{bmatrix}$$

$$L_Q(r_{ij}^{(2)}) = \begin{bmatrix} 67.5 & 79 & 82 & 86.5 & 72.5 & 87.5 \\ 71.5 & 88 & 68 & 86 & 67 & 87 \\ 91.5 & 75.5 & 84 & 94 & 63.5 & 72.5 \\ 97.5 & 75 & 80 & 92 & 78 & 79.5 \\ 68 & 78 & 93.5 & 58 & 90 & 79 \end{bmatrix}$$

$$L_Q(r_{ij}^{(3)}) = \begin{bmatrix} 83.5 & 87 & 71.5 & 95 & 65 & 62.5 \\ 95.5 & 67 & 82.5 & 85 & 78.5 & 86.5 \\ 65.5 & 91.5 & 75 & 52.5 & 65 & 64.5 \\ 79 & 97.5 & 85.5 & 92 & 81.5 & 91 \\ 78.5 & 78 & 92.5 & 76 & 86 & 84 \end{bmatrix}$$

$$L_Q(r_{ij}^{(4)}) = \begin{bmatrix} 80 & 88.5 & 81 & 85 & 67 & 82.5 \\ 83.5 & 87 & 73.5 & 95 & 89.5 & 84.5 \\ 92.5 & 78.5 & 88 & 91.5 & 74.5 & 78 \\ 90 & 86 & 80 & 83 & 90 & 82.5 \\ 74 & 83 & 78 & 62.5 & 86.5 & 79.5 \end{bmatrix}$$

Step 2: The comprehensive attribute value of the evaluation expert for each enterprise x_i was calculated according to Formula (4):

$$H = \begin{bmatrix} 79.75 & 86.35 & 81.55 & 92.1 & 68.7 & 76.25 \\ 79.95 & 83.6 & 71.7 & 84.2 & 79.9 & 82.2 \\ 85.2 & 77.4 & 80.5 & 77.9 & 68.65 & 78.65 \\ 83.8 & 77.85 & 77.65 & 87.7 & 79.85 & 79.05 \\ 79.75 & 80.9 & 76.25 & 77.05 & 77.25 & 81.95 \end{bmatrix}$$

Step 3: According to Formula (5), the group comprehensive attribute values of each enterprise x_i was obtained:

$$Z_1(w) = 81.57,\ Z_2(w) = 81.38,\ Z_3(w) = 78.09,\ Z_4(w) = 80.96,\ Z_5(w) = 79.5$$

Step 4: The population comprehensive attribute values and the empirical analysis results were sorted as follows:

$$Z_1 > Z_2 > Z_4 > Z_5 > Z_3$$

In the comprehensive evaluation results of organizational quality specific immune maturity of the five equipment manufacturing enterprises, the equipment manufacturing enterprise 1 had the highest comprehensive score. Followed by the equipment manufacturing enterprise 2, the equipment manufacturing enterprise 4, and the equipment manufacturing enterprise 5, successively. The last one was the equipment manufacturing enterprise 3.

4. Conclusions and Discussion

The immune system is embedded in organizational quality management. This study focused on organizational quality specific immune according to the organizational specific immune response process. Organizational quality specific immune maturity evaluation index systems with diverse dimensions were constructed from the perspectives of immune, organization immune, and organizational quality immune, successively. The continuous interval median operator method was used to construct an organizational quality specific immune maturity evaluation model and conduct decision making. Scientific and dynamic evaluation of immune system maturity is conducive to improving quality management processes and determining the level, grade, and situational stage of organizational quality specific immune. Due to the fact that the organizational quality specific immune system is complex, it is a top priority to be able to scientifically and effectively evaluate maturity. Moreover, experts tend to use the interval method when giving scores to indicators that can reflect the organizational quality specific immune maturity. The phenomenon will make the relative importance of the attributes of the objects and schemes to be evaluated difficult to quantify and susceptible to extreme values of the interval. The continuous interval number median operator can effectively avoid the non-uniform distribution of interval numbers and reduce the error caused by extreme values. The method not only improves the traditional evaluation and decision making, but also has wide applicability in dealing with complex uncertainty. It can effectively identify the defects of the organizational quality specific immune maturity and thus improve the quality management level.

In this study, followed by the maturity evaluation index system and model, the continuous interval number median operator aggregation method was applied to carry out maturity evaluation by specific sample, empirical objects, and schemes. The applicability, effectiveness, and efficiency were further expanded to the theoretical, practical, and applied aspects. The research outcomes can provide new ideas for solving the interval number evaluation problem and render important practical guiding significance for enterprises to determine and enhance organizational quality specific immune maturity and quality performance. However, this study was only a preliminary exploration of the usage of the continuous interval number median operator method to evaluate the organizational quality specific immune maturity of enterprises. The model provides a reference value for self-evaluation within the equipment manufacturing enterprises, and it cannot be used as an organizational quality specific immune maturity evaluation standard for all manufacturing enterprises. The challenge of how to apply the continuous interval number median operator evaluation method to more fields is the focus of future research.

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