An analysis model of urban water supply quality based on extension classification method

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Abstract

Directing at the multiple factors and levels in the complex problem of water consumption, this paper studied and analysed the quality of urban water supply and put forward an analysis model of urban water supply quality based on Extension classification method. Based on the Extension Theory, it modelled relative factors of analysis of urban water supply quality by matter-element method. Than classical domain and joint domain of relative factors of analysis of urban water supply quality were established. Via extension correlation function, the mapping relation between the water supply condition of the urban as research subject and the existing grades of urban water supply condition was established. Based on extension correlation, the grade of water supply condition of the present urban could be obtained. Thus, this grade can offer guidance for water supply of the urban and support for water supply strategy. Finally, by a case study, the model and algorithm were tested and proved feasible and operable.

Keywords: urban water supply, water consumption, extension theory, extension classification, model

1 Introduction

Water supply is important for city life, industrial production, city greening, etc., and is a basic factor in maintaining the normal operation of the urban. Thus, in order to maintain the security and reliability, the current water supply condition of the city is needed to be analysed for the study of dynamic regulation in urban water consumption. It will offer support for the prediction of the future development of urban water consumption and the accurate prediction of water consumption can provide data support or the optimal operation and management of urban water supply system [1, 2]. However, urban water consumption is a complex system of multiple factors and levels, and is related to urban population, industrial development, living standard of the people, energy-saving technique improvement, etc. In the system, there are both given information and unknown or unascertained information, so the analysis of the grade of water supply is a decision-making process with uncertain information [3-5]. In recent years, the imbalance between supply and demand in the water supply system in many large and medium-size cities has been becoming prominent. And urban water shortage has become a common phenomenon. Thus, the analysis and prediction of the quality condition of urban water supply is very important. By far, there have been some studies focusing on condition analysis and prediction of urban water supply quality from different aspects and with different analysis method [6-9]. However, there are some limitations in the present condition analysis and the prediction model and method in the processing with uncertain information, and cannot process the positional relation in uncertain information effectively. In this way, the reliability of the analysis and prediction is not high enough. For that, based on the existing studies, this study analysed the grade of quality condition of urban water supply based on extension classification. By applying matter-element model, relative decision-making factors of decision of grade of urban water supply quality conditions were modelled in formal method, and classical domain and joint domain of different grades of quality conditions of urban water supply were established. Then based on extension correlation function, the grade of quality condition of water supply of the current urban was obtained. Finally, the reliability and operability of the model and algorithm were checked via a case study.

2 Basic concept of extenics

2.1 BASIC CONCEPT

Extenics is an intelligent design discipline that focuses on the designation of possibility and feasibility of extension of objects, and studies the general rules and methods of innovative extension designation. It describes design objects with formalized and modelled knowledge modelling. Its logical cell is matter-element. And by

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combining qualitative analysis and quantitative analysis, it considers comprehensively the quantitative and qualitative changes of the objects, and establishes the extension model that can solve contradictor issues including incompatible problems and antagonistic problems. By far, the relative theory and framework of extenics has got preliminary development, and is widely applied in engineering application, and has obtained corresponding achievements [10-14]. Thus, an applied technology that based on the Extention Theory has formed, namely the extension engineering.

Matter-element model: in extension model, it is one of the logical cells of extenics and also a formalization tool for formalized knowledge modelling. Model-element applied a sequential triad $R=(O, c, v)$ as the basic element in description object. In the formula, O stands for the name of each object, c stands for the characteristics of the object, v stands for the value of the object O on the characteristic c.

Extension distance: in extenics, stipulates the distance between the point x and the interval $X=[a, b]$ is stipulated. Set x as any point in real axis, $X=[a, b]$ as any interval in real domain, then name:

$$\rho(x, X) = \left| x - \frac{a+b}{2} \right| - \frac{b-a}{2}, \quad (1)$$

as the extension distance between point x and the interval $X=[a, b]$.

2.2 MATTER-ELEMENT MODELING OF ANALYSIS OF URBAN WATER SUPPLY QUALITY

The analysis of urban water supply is a complex problem with multiple factors and levels. Establishing the matter-element model of analysis of city water supply quality in formalization and modelling method is the basis of the analysis of the grade of quality condition of city water supply. If there are n characters $c_1, c_2, \ldots, c_n$ and corresponding values $v_1, v_2, \ldots, v_n$ in the matter-element model of analysis of city water supply quality, its rectangular array formed by the corresponding matter-element model forms is a matter-element of n dimensions. It can be expressed as:

$$R(O,C,V) = \begin{bmatrix} O & c_1 & v_1 \\ & c_2 & v_2 \\ & \cdots & \cdots \\ & c_n & v_n \end{bmatrix}, \quad (2)$$

where $C = (c_1, c_2, \ldots, c_n)^{\mathrm{T}}$, $V = (v_1, v_2, \ldots, v_n)^{\mathrm{T}}$. $v_i (1 \le i \le n)$ can be certain values or fuzzy interval values. In the process of analyzing the city water supply quality, via conduct element-matter modelling to influence factors in different categories, it provides the computer with formalization tool for intelligent implementation in analysis of city water supply quality.

3 Analysis model and algorithm of urban water supply quality based on extension classification analysis method

3.1 CLASSICAL AND JOINT DOMAINS

Assume that there are m grades of the quality condition of city water supply, and the i-th grade has n condition characteristics. So the classical domain matter-element model $R_i^{dom-cla}$ can be expressed as

$$R_i^{dom-cla} = [O_i, C, V] = \begin{bmatrix} O_i & c_{i1} & v_{i1} \\ & c_{i2} & v_{i2} \\ & \cdots\cdots & \\ & c_{in} & v_{in} \end{bmatrix} = \begin{bmatrix} O_i & c_{i1} & \langle v_{i1}^a, v_{i1}^b \rangle \\ & c_{i2} & \langle v_{i2}^a, v_{i2}^b \rangle \\ & \cdots & \cdots \\ & c_{in} & \langle v_{in}^a, v_{in}^b \rangle \end{bmatrix}, \quad (3)$$

where $c_{i1}, c_{i2}, \ldots, c_{in}$ are the quality condition characters of water supply of the city in the i-th grade, $v_{i1}, v_{i2}, \ldots, v_{in}$ are respectively the values of quality condition of city water supply of the city in the i-th grade on the characteristics of n different influence factors. It can be accurate information of point value or fuzzy interval information, namely the classical domain of the i-th grade of the quality condition of the urban water supply satisfies $v_{ij} = \langle v_{ij}^a, v_{ij}^b \rangle, v_{ij}^a \le v_{ij}^b$ ($i=1,2,\ldots, m$; $j=1,2,\ldots, n$).

On the basis of the establishment of classical domain matter-element of grades of quality condition of water supply of m cities, the joint domain matter-element $R_0^{dom-joi}$ of quality condition of water supply can be formed:

$$R_0^{dom-joi} = [O_0, C, V] = \begin{bmatrix} O_0 & c_{01} & v_{01} \\ & c_{02} & v_{02} \\ & \cdots\cdots & \\ & c_{0n} & v_{0n} \end{bmatrix} = \begin{bmatrix} O_0 & c_{01} & \langle v_{01}^a, v_{01}^b \rangle \\ & c_{02} & \langle v_{02}^a, v_{02}^b \rangle \\ & \cdots & \cdots \\ & c_{0n} & \langle v_{0n}^a, v_{0n}^b \rangle \end{bmatrix}, \quad (4)$$

where $c_{01}, c_{02}, \ldots, c_{0n}$ are n characters of different influence factors of O_0, $v_{01}, v_{02}, \ldots, v_{0n}$ are the value of O_0 on n characters of different influence factors $c_{01}, c_{02}, \ldots, c_{0n}$. It can be accurate information of point value or fuzzy interval information, namely the joint domain of O_0. It satisfies $v_{0j} = \langle v_{0j}^a, v_{0j}^b \rangle, v_{0j}^a \le v_{0j}^b$. Obviously, $v_{ij} \subseteq v_{0j}$, and $v_{0j}^a = \min_{1 \le i \le m} v_{ij}^a, v_{0j}^b = \max_{1 \le i \le m} v_{ij}^b$.

3.2 STANDARDIZATION OF INFLUENCE FACATORS

In the process of choosing the characteristics of influence factors in the analysis of the quality condition of city water supply, some characteristics of influence factors can be described quantitatively and their values are accurate point values. While other characteristics of influence factors are not certain values and are usually fuzzy and uncertain, and their values are described with an interval. On the other hand, in the analysis of quality condition of city water supply, some characteristics of influence factors are positive indexes, while others are negative indexes. Thus, the characteristics of influence factors in the analysis of quality condition of city water supply are complex and are of multiple levels, attributes and types. Thus, it needs to be standardized.

If the characteristic of influence factor of water supply v_{ij} is a positive index and its value $v_{ij} = \left\langle v_{ij}^a, v_{ij}^b \right\rangle$, its corresponding standardized index is:

$$v_{ij}^{\odot} = \left\langle v_{ij}^{\odot a}, v_{ij}^{\odot b} \right\rangle = \left\langle \frac{v_{ij}^a}{v_{0j}^b}, \frac{v_{ij}^b}{v_{0j}^b} \right\rangle, \tag{5}$$

where v_{0j}^b is the maximum value of grade joint domain of quality condition of water supply on the interval of characteristic of influence factors v_{ij}.

If the characteristic of influence factor of urban water supply quality v_{ij} is a negative index, its value $v_{ij} = \left\langle v_{ij}^a, v_{ij}^b \right\rangle$, the corresponding standardized index is:

$$v_{ij}^{\odot} = \left\langle v_{ij}^{\odot a}, v_{ij}^{\odot b} \right\rangle = \left\langle \frac{v_{0j}^a}{v_{ij}^a}, \frac{v_{0j}^a}{v_{ij}^b} \right\rangle, \tag{6}$$

where v_{0j}^a is the minimum value of grade joint domain of quality condition of water supply on the interval of characteristic of influence factors v_{ij}.

Thus, via the above-mentioned standardization of characteristics of influence factors of city water supply, all the characteristics of influence factors are in a unified measure standard and the differentiation among different types of characteristics of influence factors are removed. In this way, the accuracy of the analysis of quality condition of urban water supply will be improved.

3.3 ESTABLISHMENT OF EXTENSION CORRELATION FUNCTION

Assume that the analysed quality condition of urban water supply is P. Then the analytic object is described with matter-element model, and its matter-element model is R_P:

$$R_P = \begin{bmatrix} O_P & c_{P1} & v_{P1} \\ & c_{P2} & v_{P2} \\ & \cdots\cdots & \\ & c_{Pn} & v_{Pn} \end{bmatrix} = \begin{bmatrix} O_P & c_{P1} & \left\langle v_{P1}^a, v_{P1}^b \right\rangle \\ & c_{P2} & \left\langle v_{P2}^a, v_{P2}^b \right\rangle \\ & \cdots & \cdots \\ & c_{Pn} & \left\langle v_{Pn}^a, v_{Pn}^b \right\rangle \end{bmatrix}, \tag{7}$$

where c_{P1}, c_{P2}, …, c_{Pn} are the n different design characteristics of the matter-element of quality condition of water supply R_P, v_{P1}, v_{P2}, …, v_{Pn} are relatively n values of matter-element of quality condition of water supply R_P on different design characteristics c_{P1}, c_{P2}, …, c_{Pn}. If the characteristic of the matter-element of quality condition of water supply R_P is the characteristic of influence factors that can be described accurately, its corresponding value of matter-element characteristic is an accurate point value. If the characteristic of the matter-element of quality condition of water supply R_P is not a characteristic of influence factors that can be described accurately, its corresponding value of matter-element characteristic is an interval value. Thus, $v_{Pj} = \left\langle v_{Pj}^a, v_{Pj}^b \right\rangle$.

Since the matter-element characteristics of the matter-element of water supply condition R_P can be either accurate point value or interval value, thus the establishments of the correlation functions are different. Thus, these two conditions need to be discussed separately.

a) When the matter-element characteristic of the matter-element of water supply condition R_P is an accurate point value, the extension distance $\rho_{R_i^{dom-cla}}^{R_P}(ij)$ between the matter-element of quality condition of water supply R_P and the classical domain $R_i^{dom-cla}$ of the i-th quality condition of urban water supply on the j-th matter-element characteristics is:

$$\rho_{R_I^{dom-cla}}^{R_P}(ij) = \left| v_{Pj} - \frac{v_{ij}^a + v_{ij}^b}{2} \right| - \frac{v_{ij}^b - v_{ij}^a}{2}. \tag{8}$$

Meanwhile, the extension distance $\rho_{R_0^{dom-joi}}^{R_P}(ij)$ between the matter-element of quality condition of water supply R_P and the joint domain matter-element $R_0^{dom-joi}$ of the i-th quality condition of urban water supply on the j-th matter-element characteristics is:

$$\rho_{R_0^{dom-joi}}^{R_P}(ij) = \left| v_{Pj} - \frac{v_{0j}^a + v_{0j}^b}{2} \right| - \frac{v_{0j}^b - v_{0j}^a}{2}. \tag{9}$$

The value of the extension correlation function $K_{R_i^{dom-cla}}^{R_P}(ij)$ of the matter-element of quality condition of water supply R_P and the classical domain matter-element $R_i^{dom-cla}$ of the i-th quality condition of city water supply on the j-th matter-element characteristics is:

$$K_{R_i^{dom-cla}}^{R_P}(ij) = \begin{cases} -\rho_{R_i^{dom-cla}}^{R_P}(ij) / \left| v_{ij} \right|, v_{Pj} \in v_{ij} \\ \rho_{R_i^{dom-joi}}^{R_P}(ij) / (\rho_{R_0^{dom-cla}}^{R_P}(ij) - \rho_{R_i^{dom-cla}}^{R_P}(ij)), v_{Pj} \notin v_{ij} \end{cases}. \tag{10}$$

b) When the matter-element characteristic of the matter-element of water supply condition R_P is an interval value, the extension distance $\rho^{R_P}_{R_i^{dom-cla}}(ij)$ between the matter-element of quality condition of water supply R_P and the classical domain $R_i^{dom-cla}$ of the i-th quality condition of city water supply on the j-th matter-element characteristics is:

$$\rho^{R_P}_{R_i^{dom-cla}}(ij)=\frac{\left[\left|v^a_{Pj}-\frac{v^a_{ij}+v^b_{ij}}{2}\right|+\left|v^b_{Pj}-\frac{v^a_{ij}+v^b_{ij}}{2}\right|-(v^b_{ij}-v^a_{ij})\right]}{2}. \quad (11)$$

Meanwhile, the extension distance $\rho^{R_P}_{R_0^{dom-joi}}(ij)$ between the matter-element of quality condition of water supply R_P and the joint domain matter-element $R_0^{dom-joi}$ of the i-th quality condition of city water supply on the j-th matter-element characteristics is:

$$\rho^{R_P}_{R_0^{dom-joi}}(ij)=\frac{\left[\left|v^a_{Pj}-\frac{v^a_{0j}+v^b_{0j}}{2}\right|+\left|v^b_{Pj}-\frac{v^a_{0j}+v^b_{0j}}{2}\right|-(v^b_{0j}-v^a_{0j})\right]}{2}. \quad (12)$$

The value of the extension correlation function $K^{R_P}_{R_i^{dom-cla}}(ij)$ of the matter-element of quality condition of water supply R_P and the classical domain matter-element $R_i^{dom-cla}$ of the i-th quality condition of urban water supply on the j-th matter-element characteristics is:

$$K^{R_P}_{R_i^{dom-cla}}(ij)=\begin{cases}-\rho^{R_P}_{R_i^{dom-cla}}(ij)/\left|v_{ij}\right|, \left\langle v^a_{Pj},v^b_{Pj}\right\rangle\in\left\langle v^a_{0j},v^b_{0j}\right\rangle\\ \rho^{R_P}_{R_i^{dom-joi}}(ij)/(\rho^{R_P}_{R_0^{dom-cla}}(ij)-\rho^{R_P}_{R_i^{dom-cla}}(ij)).\\ \left\langle v^a_{Pj},v^b_{Pj}\right\rangle\notin\left\langle v^a_{0j},v^b_{0j}\right\rangle\end{cases} \quad (13)$$

Directing at the extension correlation functions of different matter-element characteristics obtained in the two methods mentioned above and considering the weight w_j of corresponding matter-element characteristic, comprehensive extension correlation $K(i)$ between the matter-element of quality condition of water supply R_P and the classical domain matter-element $R_i^{dom-cla}$ of the i-th quality condition of the urban water supply is:

$$K(i)=\sum_{j=1}^{n}(w_j\times K^{R_P}_{R_i^{dom-cla}}(ij)). \quad (14)$$

3.4 REALIZATION OF MODEL AND ALGORITHM OF ANALYSIS OF URBAN WATER SUPPLY BASED ON EXTENSION CLASSIFICATION METHOD

In the above-mentioned analysis of quality condition of city water supply, via constructing the classical domain matter-element $R_i^{dom-cla}$ and the joint domain element $R_0^{dom-joi}$ of corresponding different grades of urban water supply quality, the extension correlation classification between the matter-element of the quality condition of water supply of the current city and the classical domain matter-element can be conducted. After the comprehensive extension correlation between the matter-element of the quality condition of water supply of the current city R_P and the classical domain matter-element $R_i^{dom-cla}$ is obtained, the extension correlation sequence **K** between the matter-element of quality condition of urban water supply of the current city R_P and the classical domain matter-element $R_i^{dom-cla}$ can be obtained, namely:

$$\mathbf{K}=\max(K(1),K(2),\ldots,K(n))=K(t). \quad (15)$$

Thus, the grade of quality condition of city water supply correspondent to the classical domain matter-element $R_i^{dom-cla}$ is the quality condition of water supply of the current city. Thus, the subsequent water supply plans can be adjusted based on the quality condition of city water supply.

In conclusion, the concrete steps of implementation of quality analysis model of city water supply based on extension classification analysis method are as below:

Step 1 Divide the grades of quality condition of city water supply based on design experience and knowledge of this field, and extract the key characteristics of influence factors;

Step 2 Directing at the obtained characteristics of influence factors, conduct matter-element modelling to the classical and joint domain of different grades of quality condition of city water supply based on Equations (3) and (4);

Step 3 Directing at the water supply condition of the current city, extract the corresponding characteristics of influence factors and values of the factors and construct the matter-element model of the water supply condition of the current city based on Equation (7);

Step 4 Standardize different types of characteristics of influence factors based on Equations (5) and (6);

Step 5 If the characteristics of the value is point value information, obtain the extension distance and the extension correlation function of the water supply condition of the current city based on the Equations (8-10);

Step 6 If the characteristics of the value are fuzzy internal information, obtain the extension distance and the extension correlation function of the water supply condition of the current city based on the Equations (11-13);

Step 7 Considering the importance of different characteristics of matter-element, namely the weight, the comprehensive extension correlation between the quality condition of water supply and the classical domain matter-element of the quality condition of water supply can be obtained via Equation (14);

Step 8 Based on the obtained comprehensive extension correlation sequence of quality condition of city water supply, the grade of the quality condition of water supply of the current city can be obtained via Equation (15).

4 Case study

In this paper, the model and algorithm was tested and explained via the analysis of quality condition of water supply of a city. Via diagnoses, analysis and consultation to specialists and relative technician in city water supply engineering and designation, influence factors, including personal average amount of water supply, popularization rate of water supply, water supply peak, average values of water supply, etc, were extracted as characteristics of matter-element of analysis of quality condition of city water supply. Thus, the grade of quality condition of city water supply can be established as "excellent", "good", "fair", and "bad". And the corresponding classical domain matter-element model of grades of quality condition of city water supply are $R_1^{dom-cla}$, $R_2^{dom-cla}$, $R_3^{dom-cla}$ and $R_4^{dom-cla}$, respectively.

$$R_1^{dom-cla} = \begin{bmatrix} O_1^{dom-cla} & \text{personal average amount of water supply } (\text{m}^3) & 45-55 \\ & \text{popularization rate of water supply}(\%) & 95-100 \\ & \text{water supply peak}(10^7 \times \text{m}^3) & 5.5\text{-}6.0 \\ & \text{average values of water supply}(10^7 \times \text{m}^3) & 5.0-5.8 \\ & \text{water supply price}(\text{RMB/m}^3) & 0.9-1.1 \\ & \text{water quality}(\%) & 95-100 \end{bmatrix},$$

$$R_2^{dom-cla} = \begin{bmatrix} O_2^{dom-cla} & \text{personal average amount of water supply}(\text{m}^3) & 40-45 \\ & \text{popularization rate of water supply}(\%) & 85-95 \\ & \text{water supply peak}(\text{m}^3) & 4.5-5.5 \\ & \text{average values of water supply}(\text{m}^3) & 4.2-5.0 \\ & \text{water supply price}(\text{RMB/m}^3) & 1.1-1.2 \\ & \text{water quality}(\%) & 85-95 \end{bmatrix},$$

$$R_3^{dom-cla} = \begin{bmatrix} O_3^{dom-cla} & \text{personal average amount of water supply}(\text{m}^3) & 35-40 \\ & \text{popularization rate of water supply}(\%) & 75-85 \\ & \text{water supply peak}(\text{m}^3) & 3.8-4.5 \\ & \text{average values of water supply}(\text{m}^3) & 3.6-4.2 \\ & \text{water supply price}(\text{RMB/m}^3) & 1.2-1.3 \\ & \text{water quality}(\%) & 75-85 \end{bmatrix},$$

$$R_4^{dom-cla} = \begin{bmatrix} O_4^{dom-cla} & \text{personal average amount of water supply}(\text{m}^3) & 25-35 \\ & \text{popularization rate of water supply}(\%) & 60-75 \\ & \text{water supply peak}(\text{m}^3) & 3.4-3.8 \\ & \text{average values of water supply}(\text{m}^3) & 3.0-3.6 \\ & \text{water supply price}(\text{RMB/m}^3) & 1.3-1.5 \\ & \text{water quality}(\%) & 60-75 \end{bmatrix}.$$

Transfer the water supply condition of the current city into the matter-element of city water supply condition R_P:

$$R_P = \begin{bmatrix} O_P & \text{personal average amount of water supply}(\text{m}^3) & 40-45 \\ & \text{popularization rate of water supply}(\%) & 86-91 \\ & \text{water supply peak}(\text{m}^3) & 5.5 \\ & \text{average values of water supply}(\text{m}^3) & 4.8 \\ & \text{water supply price}(\text{RMB/m}^3) & 1.2 \\ & \text{water quality}(\%) & 83-86 \end{bmatrix}.$$

Based on the standardization method of influence factor of quality condition of city water supply in this paper, the extension distance between the water supply condition of the current city R_P and the corresponding classical domain of quality condition of city water supply $R_1^{dom-cla}$, $R_2^{dom-cla}$, $R_3^{dom-cla}$ and $R_4^{dom-cla}$, and that between water supply condition of the current city R_P and the joint domain $R_0^{dom-joi}$ were obtained through relative calculation formula of extension distance. The result is presented in Table 1.

According to the corresponding calculation formula of extension correlation function, the extension correlation function between the water supply condition of the current city R_P and the corresponding classical domain of quality condition of city water supply $R_1^{dom-cla}$, $R_2^{dom-cla}$, $R_3^{dom-cla}$ and $R_4^{dom-cla}$, and that between the water supply condition of the current city R_P and the corresponding joint domain of quality condition of city water supply $R_0^{dom-joi}$. The result is presented in Table 2.

TABLE 1 The extension distance of the water supply condition R_P of the current city

Characteristics	$R_1^{dom-cla}$	$R_2^{dom-cla}$	$R_3^{dom-cla}$	$R_4^{dom-cla}$	$R_0^{dom-joi}$
Personal average amount of water supply	0.046	0	0.046	0.137	-0.228
Popularization rate of water supply	0.065	-0.025	0.035	0.135	-0.115
Water supply peak	0	0	0.167	0.284	0.083
Average values of water supply	0.034	-0.034	0.104	0.206	-0.172
Water supply price	0.068	0	0	0.058	-0.150
Water quality	0.105	0.005	-0.010	0.095	-0.155

TABLE 2 The extension correlation function of the water supply condition of the current city R_P

Characteristics	$R_1^{dom-cla}$	$R_2^{dom-cla}$	$R_3^{dom-cla}$	$R_4^{dom-cla}$
Personal average amount of water supply	-0.168	0	-0.168	-0.375
Popularization rate of water supply	-0.361	0.500	-0.233	-0.540
Water supply peak	0	0	-0.668	-0.774
Average values of water supply	-0.165	0.246	-0.377	-0.545
Water supply price	-0.312	0	0	-0.279
Water quality	-0.404	-0.031	0.333	-0.038

Due to the different weight of different characteristics of influence factors, the weight of each characteristics of influence factors is obtained via the experience of design specialist, namely W=(0.18,0.18,0.13,0.15,0.17,0.19). By using the calculation formula of comprehensive extension correlation, the extension correlation sequence **K** between the water supply condition of the current city R_P and the corresponding classical domain of quality condition of city water supply $R_1^{dom-cla}$, $R_2^{dom-cla}$, $R_3^{dom-cla}$ and $R_4^{dom-cla}$ can be obtained **K**=(-0.235,0.119,-0.186,-0.425). It can be observed that the water supply condition of the current city R_P is the closest to the classical domain of quality condition of city water supply $R_2^{dom-cla}$, namely the city water supply of the current city is in good condition. However, the differentiation between the water supply condition of the current city R_P and quality condition of city water supply $R_3^{dom-cla}$ is smaller than the differentiation between the water supply condition of the current city R_P and quality condition of city water supply $R_1^{dom-cla}$, which indicates that the water supply condition of the current city has a tendency of growing bad. Thus, in order to keep the city water supply in a good condition, corresponding measures should be taken to maintain and adjust the city water supply project.

5 Conclusion

This paper came up with an analysis model and algorithm of city water supply quality based on extension classification analysis method. Via establishing the classical domain matter-element and joint domain matter-element, the extension distances, extension correlation function and the calculation models of extension correlation relatively based on accurate point value and interval value. Based on that, the grade of quality condition of water supply of the current city can be obtained. It offer guide information for the city water supply strategy and can help to improve the reliability of city water supply quality. What's more, it offers a solution to the implementation of intelligent system of city water supply. Finally, in this paper the model and algorithm prove feasible and operable via a case study.

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