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Retraction

Retracted: Application of TOPSIS Method Combined with Grey Relational Degree in the Selection of Snow-Melting Agent Use Plan

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This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

1. Discrepancies in scope
2. Discrepancies in the description of the research reported
3. Discrepancies between the availability of data and the research described
4. Inappropriate citations
5. Incoherent, meaningless and/or irrelevant content included in the article
6. Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

[1] H. Yang, M. Huang, G. Zhou, X. Chen, and R. Ming, "Application of TOPSIS Method Combined with Grey Relational Degree in the Selection of Snow-Melting Agent Use Plan," *Journal of Nanomaterials*, vol. 2022, Article ID 3882031, 8 pages, 2022.

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Research Article

Application of TOPSIS Method Combined with Grey Relational Degree in the Selection of Snow-Melting Agent Use Plan

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With the rapid development of China's ice and snow industry, the use of snow-melting agents as a nonpoint source pollution source is increasing, and the impact on the environment cannot be ignored. This paper expounds the agent, purpose, mechanism, and current situation of snow-melting agents at home and abroad and analyzes the national standards, industry standards, and technical indicators of various provinces and cities. This paper puts forward the standard of snow-melting agents, standardizes the production management and detection method of snow-melting agents, improves the quality of snow-melting agent products, and solves the adverse effects of environmental pollution of snow-melting agents. In order to select an economical, effective, and environmentally friendly snow-melting agent application plan that is suitable for cold mountainous areas, the article proposes a TOPSIS method evaluation model with the purpose of source control combined with grey correlation. Calcium, magnesium chloride, chloride salt mixed snow-melting agent (1 : 1 : 1 ratio), and calcium and magnesium acetate are used to melt snow in four specific environments (high cold and high sensitivity, high cold and low sensitivity, low cold and high sensitivity, and low cold and low sensitivity). The pros and cons of the dosage regimen are evaluated. The combined weighting method is used to overcome the shortcomings of the individual subjective and objective weighting methods, and it is concluded that calcium and magnesium acetate is the optimal solution in high-cold and high-sensitivity areas, calcium chloride is the optimal solution in high-cold and low-sensitivity areas, and magnesium chloride is the optimal solution in low-cold and high-sensitivity areas. As the optimal solution, calcium chloride with low cold and low sensitivity is the optimal solution.

1. Introduction

In order to ensure road safety and vehicle mobility in winter, in some cold climate regions such as the north, a large amount of snow-melting agent and sand is applied on the road [1]. The 2022 Winter Olympics will be held in Beijing and Zhangjiakou, which will stimulate the development of my country's ice and snow industry and will also lead to an increase in the amount of snow-melting agents [2]. The increasing use of snow-melting agents has made people worry about the adverse environmental impact of various snow-melting agents and actively change the snow and ice control strategy model [3]. While the snow-melting agent brings convenience and benefits, its wide use will also damage urban infrastructure such as road surface, pipe network, and metal structure and will have adverse effects on vegetation, soil, water, and other environments [4]. The snow-melting agent is widely used in road snow removal due to its high efficiency of snow melting and ice melting [5], but there are many kinds of snow-melting agents with complex and changeable components. Its main component is inorganic salt, and the price of sodium chloride is relatively cheap, so sodium chloride is widely used as a snow-melting agent [6–9].

In addition to the nature of the snowmelt agent itself, the use of the snowmelt agent lacks rationality, and the impact of the binding criteria on the environment is also related. Ski resorts are generally located in the northern mountainous area, with low temperature, high environmental impact, high risk of roads leading to the ski resort, and dense crowds. For these reasons, there is a high demand for snowmelt agents in winter. Therefore, it is necessary to study and provide a decision-making method and provide a scientific basis for the selection of snow-melting agents in cold mountainous areas. For this multiobjective decision-making problem, in order to obtain credible results in a concise and easy-to-use method, the TOPSIS method can be used to evaluate the optimization. In the evaluation, it can comprehensively carry out evaluation optimization, which has great advantages in multiobjective decision-making [10].

In winter, snow and dark ice will reduce the skid performance, thus affecting the safety and capacity of the road. Compared with the use of mechanical and heat and other snow and ice removal methods, snow-melting agents have the advantages of low cost and efficiently and effectively destroying the bonding force between ice and the road surface. It is widely used to remove snow and ice in winter but will corrode the structure along the road and its ancillary facilities and poison animals and plants.

2. Research Method

2.1. Application Plan and Evaluation Index of Snow-Melting Agent in Cold Mountain Area

2.1.1. Application Plan of Snow-Melting Agent in Cold Mountain Area. Snow-melting agents are mainly divided into two categories, namely, chloride-based snow-melting agents and organic-based environmentally friendly snow-melting agents [11]. Chloride-based snow-melting agents include sodium chloride (NaCl), calcium chloride ($CaCl_2$), magnesium chloride ($MgCl_2$), potassium chloride (KCl_2), and chloride salt mixed snow-melting agents. Organic environmental protection snow-melting agents include acetic acid, formic acid, urea, and alcohol, among which acetic acid is the most important. Acetic acid snow-melting agents include calcium magnesium acetate (CMA), potassium acetate (KAc), sodium acetate (NAAC), and CMAK (CMA and KAc). According to the difference of the common use of snow-melting agent, sodium chloride, calcium chloride, magnesium chloride, magnesium chloride salt mixed snow-melting agent (1 : 1 : 1 : 1:1 ratio), and magnesium acetate are selected. There are five programs, p1, p2, p3, p4, and p5. Considering the characteristics of cold degree, environmental sensitivity, and economic differences in each ski resort, temperatures below -10°C were defined as high temperatures, and temperatures above -10°C and below 0°C were defined as low temperatures. The optimal use of snowmelt agents was studied using A_1, A_2, A_3, and A_4 in four environments, both cold and low-cold low-sensitivity land.

2.1.2. Evaluation Indicators. The evaluation is based on a selection of five snowmelts that vary in price, performance, and degree of environmental impact. The five kinds of snow-melting agents have relatively big differences in price, ranging from several hundred to tens of thousands. In terms of performance, there are also different snow-melting speeds, 30 min deicing rates, and different suitable temperatures. In terms of environmental impact, they have different effects on the soil, water body, vegetation, road, metal, etc. The evaluation indicators are shown in Table 1.

2.2. TOPSIS Evaluation Model Combined with Grey Correlation Degree

2.2.1. TOPSIS. The TOPSIS method was proposed by Hwang and Yoon in 1981 who published the monograph "Multi-Attribute Decision Making" [12]. In 2003, Liao proposed the TOPSIS method based on the signal-to-noise ratio-based process capability index. Yanrui studied the index weight determination method and the comprehensive evaluation method, obtained the G1 method based on the index scale to determine the index weight, and improved the TOPSIS method for the service quality evaluation of this paper, to determine the positive and negative ideal values of the index [13]. The TOPSIS method first determines the positive and negative ideal solutions of the problem and compares the distances between the feasible solutions to the positive ideal solution and the negative ideal solution [14]. The traditional TOPSIS method does not consider the similarity in shape, and the TOPSIS method may not obtain correct decision results when the amount of data information is small, but the grey relational analysis method can fully mine the internal information of the data and analyze the reference data. It is similar to the geometric curve of each group of data to determine the pros and cons of the program, and it does not require a large amount of data, which just forms a complementary relationship with the TOPSIS method [15].

2.3. The Basic Steps

2.3.1. Create a Matrix. There are m schemes, $p_1, p_2, p_3 \cdots, p_m$, denoted as $p = \{p_1, p_2, p_3 \cdots, p_m\}$, and the n indicators of each scheme are $I_1, I_2, I_3 \cdots, I_n$, recorded as $I = \{I_1, I_2, I_3 \cdots, I_n\}$. I_{ij} refers to the j-th index of the scheme p_i. Create an initial evaluation matrix E:

$$E = \left[I_{ij}\right]_{m\times n}. \tag{1}$$

2.3.2. Cochemotropic Treatment. In the evaluation index I_n, the level of the index value represents the different pros and cons of the plan. In order to facilitate the calculation, the index should be treated with homotaxis, and the indexes in the evaluation matrix should be classified into one category. The conversion methods usually include the reciprocal method and the difference method [10]. The evaluation matrix after homotaxis is $E = [I'_{ij}]_{m\times n}$, and the transformation method is as follows:

$$I'_{ij} = \frac{1}{I_{ij}}, \tag{2}$$

$$I'_{ij} = 1 - I_{ij} \text{ or } I'_{ij} = 100 - I_{ij}. \tag{3}$$

2.3.3. Normalization Processing. In order to eliminate the influence of dimension and order of magnitude between the

Table 1: Evaluation index table.

Target	Sodium chloride, calcium chloride, magnesium chloride, chloride mixed type, calcium magnesium acetate								
Guidelines	Price	Performance			Environmental impact				
Index	Price	Snow-melting speed	Deicing rate	Suitable temperature	Road damage	Metal corrosion	Soil impact	Water impact	Vegetation impact
Indicator meaning	Snow-melting agent price per ton	Snow-melting speed at the same dose	Snow removal amount of the same concentration of snow-melting agent in 30 min	Normal temperature range for snow removal	Corrosion measurement for roads	Corrosiveness to metal measurement	Degree of influence on soil properties	Degree of influence on water properties	Degree of damage to plants
Nature	Cost	Benefit	Benefit	Cost	Cost	Cost	Cost	Cost	Cost

evaluation indicators, the matrix after homotaxis is normalized. After normalization, $E = [g_{ij}]_{m\times n}$; the method is as follows:

$$g_{ij} = \frac{I'_{ij}}{\sqrt{\sum_{i=1}^{n}\left(I'_{ij}\right)^2}}. \quad (4)$$

2.3.4. Weighted Processing. Due to the different purposes and requirements of the scheme, the importance of each element of the criterion layer and the index layer will be different, so the matrix should be weighted as follows:

$$E = [Z_{ij}]_{m\times n} = \left[g_{ij}\right]_{m\times n} \operatorname{diag}\left(\omega_j\right)_{n\times n}, \quad (5)$$

where ω_j represents the weight of the j-th index and satisfies $\sum_{j=1}^{n}\omega_j = 1$.

2.3.5. Positive and Negative Ideal Solution Distances. In the TOPSIS square, p_i has n indicators and there are n feasible solutions $Z_j = (Z_{i1}, Z_{i2}, Z_{i3} \cdots, Z_{\text{in}})(j = 1, 2, 3 \cdots, n)$; the positive ideal solution assumes Z^+, $Z_j^+ = (Z_1^+, Z_2^+, Z_3^+ \cdots, Z_n^+)$, the distance from the feasible solution Z_j to Z_j^+ is [16]

$$S_i^{\ +} = \sqrt{\sum_{j-1}^{m}\left(Z_{ij} - Z_j^{\ +}\right)^2 (i = 1, 2, 3 \cdots, m)}. \quad (6)$$

In the same way, let $Z_j^- = (Z_1^-, Z_2^-, Z_3^+ \cdots, Z_n^-)$ be the negative ideal solution of the index, and the distance between the feasible solution Z_j and the negative ideal solution Z_j^- is [17]

$$S_i^{\ -} = \sqrt{\sum_{j=1}^{m}\left(Z_{ij} - Z_j^{\ -}\right)^2 (i = 1, 2, 2 \cdots, m)}. \quad (7)$$

2.3.6. Calculation of Grey Relational Degree. The i-th sample positive ideal solution is the j-th index grey correlation coefficient:

$$\xi_{ij}^{\ +} = \frac{\Delta_{\min} + \rho\Delta_{\max}}{\Delta_{ij} + \rho\Delta_{\max}}. \quad (8)$$

In formula (10) $\Delta_{ij} = |Z_j{+}{-}Z_{ij}|$, $\Delta_{\min} = \min_i \min_j \Delta z_{ij}$ is the minimum difference, $\Delta_{\max} = \max_i \max_j \Delta z_{ij}$ is the maximum difference, and ρ is the resolution coefficient, generally 0.5.

The grey relational degree of the positive ideal solution of the i-th sample is

$$\xi_i^{\ +} = \frac{1}{n}\sum_{i=1}^{n}\xi_{ij}^{\ +}. \quad (9)$$

The grey correlation coefficient of the j-th index of the negative ideal solution of the i-th sample is

$$\xi_{ij}^{\ -} = \frac{\Delta_{\min} + \rho\Delta_{\max}}{\Delta_{ij} + \rho\Delta_{\max}}. \quad (10)$$

The grey relational degree of the negative ideal solution of the i-th sample is

$$\xi_i^{\ -} = \frac{1}{n}\sum_{i=1}^{n}\xi_{ij}^{\ +}. \quad (11)$$

2.3.7. The Pros and Cons of the Plan. Positive and negative ideal solutions and grey relational degree dimensionless processing are

$$R_i^{\ *} = \frac{R_i}{\max\limits_{1\le i\le m}(R_i)}. \quad (12)$$

R_i represents S^+, S^-, ξ_j^+, and ξ_j^-; R_i^* represents the

Table 2: Table of evaluation index weights.

Target		Sodium chloride, calcium chloride, magnesium chloride, chloride mixed type, calcium magnesium acetate								
Guidelines		Price		Performance				Environmental impact		
Subjective weight	A_1	0.050		0.300				0.650		
	A_2	0.300		0.300				0.400		
	A_3	0.150		0.200				0.650		
	A_4	0.350		0.200				0.450		
Index		Price	Snow-melting speed	Deicing rate	Suitable temperature	Road damage	Metal corrosion	Soil impact	Water impact	Vegetation impact
Objective weight		0.456	0.069	0.001	0.179	0.066	0.063	0.050	0.066	0.050
Combined weights	A_1	0.153	0.070	0.001	0.180	0.134	0.127	0.101	0.133	0.101
	A_2	0.415	0.063	0.001	0.163	0.080	0.077	0.061	0.080	0.061
	A_3	0.220	0.045	0.001	0.115	0.139	0.132	0.105	0.138	0.105
	A_4	0.466	0.040	0.001	0.105	0.087	0.083	0.066	0.087	0.066

parameter values after dimensionless processing and integrates the positive and negative ideal solutions and grey correlation degree after dimensionless processing:

$$T_i^{+} = fS_i^{-} + (1-f)\xi_i^{+}, \quad (13)$$

$$T_i^{-} = fS_i^{+} + (1-f)\xi_i^{-}. \quad (14)$$

f is the preference coefficient, which can be adjusted according to the preference degree of the decision-maker.

C_i represents the relative proximity; the more the relative proximity is equal to 1, the better the solution, and the optimal solution can be obtained by sorting C_i [18]:

$$C_i = \frac{T_i^{+}}{T_i^{+} + T_i^{-}} 0 \le C_i \le 1, \quad (i = 1, 2, 3 \cdots, m). \quad (15)$$

2.4. Weight Determination. In order to reduce the limitation of individual weighting, the combined weighting method is adopted in this paper. To reduce the limitations of individual weighting, a combined weighting approach is used. Subjective weights were determined by expert scoring based on the four environmental specificities of low-temperature sensitivity, low-temperature sensitivity, low-temperature sensitivity, and low-temperature sensitivity. Target weights were determined using the entropy weight method. The entropy weight method is the weighting method based on the amount of information in each index. The smaller the entropy of the exponent, the greater the degree of the exponential and the greater the role it plays in the comprehensive evaluation. The weight of this index should also be large [19], and the calculation steps of the entropy weight method are shown in equations (16) and (17). The subjective weight mainly refers to the expert scores on the price, performance, and pollution degree of the snow agent in the research of Yin [20] in 2013. According to the characteristics of cold mountainous areas, the weights of the evaluation schemes for the use of snow-melting agents are shown in Table 2.

According to the definition of entropy, the entropy value b_j of the j-th index is

$$b_j = -\frac{\sum_{i=1}^{m} g_{ij} ln g_{ij}}{1nm} \quad j = 1, 2, \cdots n. \quad (16)$$

In formula (3), $0 \le b_j \le 1$, when specifying $g_{ij} = 0$, $g_{ij} ln\, g_{ij} = 0$.

$$w_j = \frac{1 - b_j}{n - \sum_{j=1}^{m} b_j} \quad j = 1, 2, \cdots n. \quad (17)$$

3. Results and Analysis

3.1. Scheme Calculation

3.1.1. Matrix Creation and Calculation. There are a total of 9 indicators for each of the 5 snow-melting agent schemes, and the index evaluation data are shown in Table 3.

And the initial evaluation matrix E is established from the above evaluation data and formula (1), using formulas (2) and (3) to carry out the same chemotaxis matrix as shown in Table 4.

According to formula (4), the normalization process is performed as shown in Table 5.

The evaluation matrix is weighted according to formula (5), and the distance values are obtained according to formulas (6) and (7): the optimal distance S^{+} and the worst distance S^{-} are shown in Table 6.

3.2. Calculation of Grey Relational Degree. According to formulas (8), (9), (10), and (11), the grey correlation degree is calculated for the evaluation matrix, and the resolution coefficient is taken as 0.5, as shown in Table 7.

3.3. Relative Proximity. According to formula (12), the positive and negative ideal solutions and the grey relational degree are dimensionless, and the positive and negative ideal

Table 3: Evaluation index data table.

Plan	Sodium chloride	Calcium chloride	Magnesium chloride	Chloride mixed type	Calcium magnesium acetate
Price (yuan/ton)[1]	400	900	1000	766	14000
Snow-melting speed [2]	100%	150%	150%	133%	200%
Deicing rate[3]	100%	102.4%	96.4%	99.6%	95.2%
Suitable working temperature (°C)[4]	-1∼-10	-1∼-30	-1∼-20	-1∼-20	-1∼-30
Road damage [4]	100%	97%	97%	98%	33%
Degree of metal corrosion[4]	100%	89%	87%	91%	26%
Soil impact[5]	100%	96%	81%	92.3%	37%
Water impact[5]	100%	112%	84%	98.6%	40%
Vegetation impact[5]	100%	96%	81%	92.3%	37%

[1]2010 Beijing area recommended list price of snow-melting agent products. [2]Snowmelt velocity defined by NaCl as standard [21]. [3]The deicing rate of 18% concentration snow-melting agent in 30 min is based on NaCl [22]. [4]Summarized from the experiment of Shi et al. and converted to percentage based on NaCl [23]. [5]In 2012, Dai et al. [24] proposed and proved the concept that the effects of different snow-melting agents on soil, water and soil, and plants are significantly different.

Table 4: Homozygous matrix.

Plan	Sodium chloride	Calcium chloride	Magnesium chloride	Chloride mixed type	Calcium magnesium acetate
Price (yuan/ton)	14600	14100	14000	14234.	1000
Snow-melting speed	1.000	1.500	1.500	1.330	2.000
Deicing rate	1.000	1.024	0.964	0.996	0.952
Suitable working temperature (°C)	10.000	30.000	20.000	20.000	30.000
Road damage	1.000	1.030	1.030	1.020	1.670
Degree of metal corrosion	1.000	1.110	1.130	1.090	1.740
Soil impact	1.000	1.040	1.190	1.077	1.630
Water impact	1.000	0.880	1.160	1.014	1.600
Vegetation impact	1.000	1.004	1.190	1.077	1.630

Table 5: Normalized matrix table.

Plan	Sodium chloride	Calcium chloride	Magnesium chloride	Chloride mixed type	Calcium magnesium acetate
Price (yuan/ton)	0.495	0.491	0.500	0.035	0.512
Snow-melting speed	0.447	0.447	0.396	0.596	0.298
Deicing rate	0.464	0.437	0.451	0.431	0.453
Suitable working temperature (°C)	0.577	0.385	0.385	0.577	0.192
Road damage	0.391	0.391	0.387	0.633	0.379
Degree of metal corrosion	0.399	0.407	0.392	0.626	0.360
Soil impact	0.385	0.440	0.398	0.603	0.370
Water impact	0.386	0.368	0.515	0.515	0.907
Vegetation impact	0.372	0.402	0.513	0.531	0.908

solutions and grey relational degree after comprehensive dimensionlessization using formulas (13) and (14) are shown in Table 8.

The relative proximity calculation formula (15) can obtain the proximity as *C*, as shown in Table 9.

4. Alternatives

The relative proximity radar chart is shown in Figure 1. It can be seen that in the high-cold and high-risk environment of A_1, the *C* value of the proximity of the scheme is calcium magnesium acetate > calcium chloride > magnesium chloride > chloride salt mixed type > sodium chloride; the scheme p5 (calcium acetate magnesium (CMA)) is the best solution among the five solutions, mainly because (1) in alpine areas, CMA has a good effect of deicing and melting snow; (2) in high-sensitivity areas, the CMA snow-melting agent is corrosive to metals after the snow melts, resulting in less negative impact on infrastructure, flora and fauna, and the surrounding ecological environment; these reasons make CMA the best solution.

Table 6: Positive and negative ideal solution distance table.

Name		Sodium chloride	Calcium chloride	Magnesium chloride	Chloride mixed type	Calcium magnesium acetate
Alpine and highly sensitive	Positive ideal solution distance	0.098	0.066	0.065	0.072	0.073
	Negative ideal solution distance	0.073	0.100	0.081	0.080	0.100
Low sensitivity to high and cold	Positive ideal solution distance	0.077	0.041	0.047	0.050	0.198
	Negative ideal solution distance	0.198	0.201	0.192	0.195	0.078
Low cold and high sensitivity	Positive ideal solution distance	0.083	0.068	0.061	0.068	0.105
	Negative ideal solution distance	0.105	0.111	0.105	0.105	0.085
Hyposensitive	Positive ideal solution distance	0.060	0.044	0.042	0.046	0.222
	Negative ideal solution distance	0.223	0.218	0.214	0.218	0.062

Table 7: Grey correlation table of positive and negative ideal solutions.

Name		Sodium chloride	Calcium chloride	Magnesium chloride	Chloride mixed type	Calcium magnesium acetate
Alpine and highly sensitive	Positive ideal solution distance	0.642	0.727	0.701	0.677	0.926
	Negative ideal solution distance	0.910	0.803	0.761	0.807	0.637
Low sensitivity to high and cold	Positive ideal solution distance	0.856	0.901	0.887	0.878	0.926
	Negative ideal solution distance	0.922	0.868	0.868	0.882	0.853
Low cold and high sensitivity	Positive ideal solution distance	0.725	0.782	0.774	0.755	0.926
	Negative ideal solution distance	0.914	0.844	0.815	0.849	0.720
Hyposensitive	Positive ideal solution distance	0.879	0.908	0.902	0.895	0.926
	Negative ideal solution distance	0.922	0.886	0.882	0.894	0.876

Table 8: Proximity table of positive and negative ideal solutions.

Name		Sodium chloride	Calcium chloride	Magnesium chloride	Chloride mixed type	Calcium magnesium acetate
Alpine and highly sensitive	Positive ideal solution proximity	0.713	0.890	0.782	0.765	1.000
	Negative ideal solution proximity	1.000	0.777	0.749	0.809	0.723
Low sensitivity to high and cold	Positive ideal solution proximity	0.955	0.987	0.957	0.960	0.693
	Negative ideal solution proximity	0.693	0.574	0.589	0.605	0.963
Low cold and high sensitivity	Positive ideal solution proximity	0.866	0.922	0.891	0.882	0.885
	Negative ideal solution proximity	0.893	0.785	0.734	0.787	0.894
Hyposensitive	Positive ideal solution proximity	0.975	0.980	0.968	0.972	0.638
	Negative ideal solution proximity	0.635	0.578	0.573	0.588	0.975

Table 9: Table of relative proximity C values.

Name		Sodium chloride	Calcium chloride	Magnesium chloride	Chloride mixed type	Calcium magnesium acetate
Alpine and highly sensitive	Relative proximity	0.416	0.534	0.511	0.486	0.580
Low sensitivity to high and cold	Relative proximity	0.579	0.632	0.619	0.613	0.418
Low cold and high sensitivity	Relative proximity	0.492	0.540	0.548	0.528	0.497
Hyposensitive	Relative proximity	0.605	0.629	0.628	0.623	0.396

In the A_2 high-cold and low-risk environment, the program proximity value C is calcium chloride > magnesium chloride > chloride salt mixed type > sodium chloride > calcium magnesium acetate, and the program p2 (calcium chloride) is the best of the five programs, mainly because (1) in the low-risk environment, the advantages of the CMA snow-melting agent are not so great, the impact of calcium chloride and magnesium chloride on the environment is not too great, and the price is more advantageous than CMA; (2) the environmental impact of sodium chloride is too large in the alpine environment. The performance is not as good as calcium chloride and

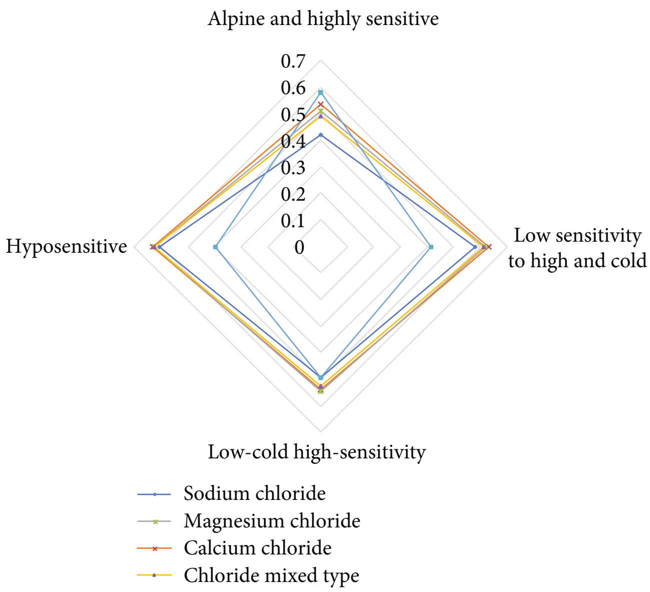

Figure 1: Relative proximity radar.

magnesium chloride. The above reasons make calcium chloride the best solution in high cold and low sensitivity.

In the A_3 low-temperature and high-risk environment, the project close value C for magnesium chloride > calcium chloride > chloride mixture type > magnesium acetate > sodium chloride, plan p3 (magnesium chloride) is the best of the five plans, mainly because (1) in the high-risk environment, the CMA snow-melting agent environmental impact is small, but due to the high price of CMA, it is difficult to achieve large-scale use of the CMA environmental snow-melting agent [9]. Although calcium chloride and magnesium chloride have more environmental impacts than CMA, the price is more favorable than CMA, and magnesium chloride has less effect on the environment than calcium chloride. (2) Calcium chloride and magnesium acetate have little performance advantages in low-cold areas. The best solution to use magnesium chloride at low temperature and with high sensitivity is defined based on the differences between five snowmelt agents, sodium chloride, calcium chloride, magnesium chloride, salt mixed snowmelt, and magnesium acetate.

In the A_4 low-cold and high-risk environment, the program proximity value C is calcium chloride > magnesium chloride > chloride salt mixed type > sodium chloride > calcium and magnesium acetate, and the program p2 (calcium chloride) is the best of the five programs, because in low-risk environments, CMA and magnesium chloride snow-melting agents have little environmental impact and have little advantages and are more expensive; the above reasons make calcium chloride the best solution in low-cold and high-sensitivity areas.

5. Conclusion

In order to select the economic, practical performance, and small environmental impact from the source control, the combined weighting method is used to determine the weight and introduces the TOPSIS evaluation and analysis model combined with grey correlation. Five snow-melting agents (sodium chloride, calcium chloride, magnesium chloride, salt chloride mixed snow-melting agent, and magnesium acetate) respectively adopt cold, high-cold, low-cold, and low-sensitivity areas. The evaluation results show that (1) CMA is the best solution in the A_1 high-cold and high-sensitivity area, (2) calcium chlorine is the best solution in the A_2 high-cold and low-sensitivity area, (3) magnesium chlorine is the best solution in the A_3 low-cold and high-sensitivity area, (4) calcium chlorine is the best solution in the low-cold and low-sensitivity area of A_4. The construction of the model judgment matrix needs to be combined with a specific environment, and the judgment matrix has different habitual constructors. Therefore, using the unique function formula, the process of this model is simple and accurate and the order of the matrix can be adjusted at will to test the matrix and provide the possibility of further expansion. The combination of theory and practice provides a feasible snow-melting agent. Follow-up studies should focus on reducing the harm of using snow-melting agents. Because a model judgment matrix needs to combine a specific environment, and the judgment matrix has different customary constructors, it is necessary to combine theory and practice to provide a feasible snowmelt agent. Follow-up research should focus on reducing the harm of using snowmelt agents. The use of snow-melting agents also has a certain impact on the environment. Therefore, it is necessary to reduce the use of snow-melting agent and gradually develop a new green snow-melting agent [26]. Therefore, it is necessary to strengthen the research and development of an environmentally protective snow-melting agent, improve the use and management system of snow-melting agents, learn from foreign experience, and use scientific decision-making methods to guide the proper use of snow-melting agents.

Data Availability

The data underlying the results presented in the study are available within the manuscript.

Conflicts of Interest

There is no potential conflict of interest in our paper, and all authors have seen the manuscript and approved to submit to your journal.

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