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A TODIM-PROMETHEE II Based Multi-Criteria Group Decision Making Method for Risk Evaluation of Water Resource Carrying Capacity under Probabilistic Linguistic Z-Number Circumstances

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Abstract: With the development of the urbanization process, the demand for water resources has increased significantly, but the pollution of water resources has caused serious problems. These changes pose a potential threat to water resource carrying capacity in many regions. However, how to determine the areas of highest risk in water resource carrying capacity is an urgent problem which remains to be solved. Resounding to these circumstances, this study establishes a TODIM-PROMETHEE II (An acronym in Portuguese for interactive and multiple attribute decision making- preference ranking organization method for enrichment evaluation II) based decision support framework to address this issue for the regions of intensive governance, thereby providing support. In this framework, a novel theoretical concept, namely probabilistic linguistic Z-numbers, is proposed to describe group decision information. The related knowledge of probabilistic linguistic Z-numbers is developed, including a comparison method, distance, and operational rules. Subsequently, a case study involving the evaluation of water resource carrying capacity is conducted to demonstrate the feasibility of the decision support model, followed by sensitivity analysis, comparison analysis, and discussion. The findings demonstrate that the constructed framework demonstrates great performance to address this issue.

Keywords: PLZNs; TODIM-PROMETHEE II; Multi-criteria group decision making; WRCC; Risk evaluation issues

1. Introduction

Water resources are the most essential natural resource for biological survivals [1]. With the rapid development of contemporary society, water resources are of increasing importance to our socio-economic development [2]. Sustainable development is facing potential threats due to the excessive consumption and pollution of water resources [3]. Therefore, it is of significance for the concerned authorities to acquire the related information about water resource carrying capacity (WRCC) and then to implement effective governance in specific regions.

WRCC provides the greatest support of water resources for regional social and economic development in a specific historical stage. Based on the principles of sustainable development, WRCC maintains a virtuous cycle of ecological environmental development. In a specific stage of water resources development and utilization, the available water resources can be rationally optimized to maintain the maximum socio-economic scale under the limited development targets [1]. With the continuous progress of urbanization, some issues have emerged in the majority of regions, namely water resource shortage and water resource pollution. These issues have become a threat to environmental protection, sustainable development, and even human health [4]. According to geographic areas and regional conditions, negative effects exist with respect to large differences among regions. Meanwhile, it is increasingly recognized that water resource consumption and pollution should not exceed the local WRCC in many countries, and related policies have been introduced to prevent and improve the water environment.

In the WRCC risk evaluation process, expert assessment is a common and practical method to investigate regional WRCC. Numerous researchers have integrated expert evaluation with multi-criteria group decision making (MCGDM) methods to evaluate the potential risk of WRCC. However, although the related studies have improved a little for WRCC risk evaluation, three defects still exist in these studies which are mentioned below. (1) The expert evaluation information is given crisp values or fuzzy numbers. Considering the difference of expertise and professional background of experts, the reliability of information provided by experts may be different. However, the representation of the mentioned information makes it difficult to describe the reliability of expert evaluation. (2) In the evaluation process, the weight of criteria is determined via experts. This weight determining method is excessively subjective such that it is not rational. For different experts, the final outcome may be different. (3) Some MCGDM methods are entirely rational, but they cannot be suitable for a practical decision-making process. In addition, some MCGDM methods have some inherent limitations so they have some negative effects on evaluation outcomes.

To overcome the above-mentioned defects, the related works are conducted in this paper. To that point, the motivations of this paper are summarized below. (1) We attempt to find an effective information representation to depict a collective view of an expert group. Probabilistic linguistic term sets (PLTSs) have significant advantages in representing group information, while Z-numbers can represent fuzzy restrictions of objects and describe the reliability of the fuzzy restrictions. Thus, by combining the advantages of these two information representations, the above limitations can be well resolved. (2) We attempt to find an objective weight determining method for criteria. The maximum deviation method is an objective weight determining method for criteria which utilizes the deviation of alternatives as a whole under each criterion to determine criteria weights, fully considering the inner relationship for each piece of evaluation information. Thus, we plan to extend maximum deviation method, which makes it suitable for our decision circumstances, to replace the subjective criteria weight determining method. (3) We attempt to develop a MCGDM method to address WRCC risk evaluation issues. The MCGDM methods of bounded rationality are more suitable for practical decision process than that of entirely rational methods. The TODIM (An acronym in Portuguese for interactive and multiple attribute decision making) method is based on prospect theory and thus it is a MCGDM method of bounded rationality. However, the TODIM method has some inherent limitations. Therefore, we plan to overcome the limitations of the TODIM method and utilize an extended TODIM method to address risk evaluation issues of WRCC.

Under the current circumstances, this research establishes a decision support framework to evaluate WRCC among different regions. Through this framework, a ranking of WRCC can be acquired among regions and a region with the worst WRCC can be determined. According to the ranking results, the concerned authorities can give priority to governance in poor areas of WRCC.

The contributions of this research are summarized below:

1. An information representation, namely probabilistic linguistic Z-numbers (PLZNs), is proposed to describe complex group preferences. Z-numbers constitute a good representation to depict vague and imprecise information. Due to the complexity of group decision-making circumstances, Z-numbers and their extensions make it difficult to meet the requirements of information expression. Considering the advantages of PLTSs for the description of group decision making information, PLTSs are utilized to depict the fuzzy restriction of Z-numbers. This extension of

Z-numbers is referred to PLZNs. PLZNs can help decision-makers to express their opinions and preferences more easily and correctly during group decision making.

2. A TODIM-PROMETHEE II based decision support framework is developed to address MCGDM issues, involving the risk evaluation of WRCC. The TODIM method and PROMETHEE (preference ranking organization method for enrichment evaluation) II method are common MCGDM methods. However, the TODIM method has the compensation problem, while the PROMETHEE II method cannot distribute the weights of related importance to the criteria in an effective way. Considering their complementarity, TODIM and PROMETHEE II methods are combined to overcome their respective restrictions, and the combined method is referred to as the TODIM-PROMETHEE II method. The TODIM-PROMETHEE II method utilizes the value function of prospect theory as its preference function, which provides a good description for decision behaviors of bounded rationality. It can well reflect decision makers' preferences in practical decision conditions.

The rest of this paper is organized as follows. The related literature is reviewed in Section 2. Section 3 introduces some basic concepts. In Section 4, PLZNs and their knowledge contributions are presented, containing the comparison method, distance, and operational rules. Section 5 includes a decision support framework and Section 6 introduces a case study, followed by sensitivity analysis, comparison analysis, and discussion. The conclusions, limitations, and future works are presented in Section 7.

2. Literature Review

2.1. Fuzzy Sets

On the basis of fuzzy set theory, Zadeh [5] introduced linguistic term sets (LTSs), which can expressly describe the preferences of decision makers via one or more linguistic terms. Since LTSs are consistent with the expression of natural language, many scholars have paid more attention to them and conducted some extended studies [6–8] involving a two-tuple linguistic model [9], continuous language structure, uncertain language structure [10], and unbalanced uncertain linguistic information [11].

As the complexity of linguistic expression increases, original information modelling tools are not able to depict the decision makers' preferences effectively and accurately in a practical decision process. To address this issue, Pang et al. [12] introduced PLTSs, which exploit probabilities to prevent information distortion for each linguistic term. PLTSs are an excellent expression to describe group decision information. PLTSs have developed rapidly and a series of research achievements have been acquired in recent years [13–17]. Peng et al. [18] proposed four kinds of novel binary relations for PLTSs, and developed an innovative multi criteria outranking method. Han et al. [19] defined the concept of the probabilistic unbalanced linguistic term set and constructed a novel computational model to handle the probabilistic unbalanced linguistic information.

Although the above linguistic models can express decision-making information well, they do not consider the reliability of relevant information. Zadeh [20] developed the Z-number to overcome this restriction. A Z-number is an ordered pair of fuzzy numbers, $Z = (A, B)$, and has a straightforward structure: fuzzy restriction A and reliability B. Recently, some extended studies of Z-number have been completed [21–24], such as discrete Z-numbers [25], Z*-number [26], normal Z-numbers [27], and Z-advanced numbers [28].

Considering the widespread application of Z-numbers and the effective representation of PLTSs for group decision making, PLZNs are proposed in this paper and can be considered as a subclass of Z-numbers. The first component of Z-numbers is fuzzy restriction which is described via uncertain linguistic variables. At present, Z-numbers and their extensions usually utilize a single linguistic term, several linguistic terms, and interval linguistic terms to depict fuzzy restriction, but their description is not applicable to group decision information. In group decision making, the mentioned forms to describe group decision information lead to a strict information loss. Hence, utilizing PLTSs to denote fuzzy restriction is more appropriate to depict group decision information than Z-numbers and their current extensions, and is more effective in presenting incomplete information and providing richer expression. PLZNs are thus appropriate to group decision making information in practical conditions.

2.2. MCGDM Methods

MCGDM methods are a significant development during the past few decades, because the variety of practical issues can be solved using these methodologies. The common MCGDM methods includes TOPSIS (techniques for order preference by similarity to ideal solution), VIKOR (visekriterijumska optimizacija i kompromisno resenje, a Serbian name), TODIM, PROMETHEE, ELECTRE (elimination et choix traduisant la realité, in French, which means elimination and choice expressing reality), and so on. Considering the complexity of practical conditions, scholars combined MCGDM methods with fuzzy set theory and then proposed fuzzy-MCGDM methods to solve practical issues [29–35], involving energy security evaluation [36], doctor ranking [37], hotel selection [38], and sustainable supplier selection [39].

The TODIM method was proposed by Gomes and Lima [40]. It is a well-known MCGDM method based on prospect theory [41,42] that considers a human's psychological behavior under risk and uncertain circumstances. On the basis of the TODIM method, scholars have made a series of achievements [43–45]. Wu et al. [46] developed a DENATEL-TODIM method for photovoltaic power generation project in expressway service area under an intuitionistic fuzzy environment. Tian and Peng [47] proposed an ANP-TODIM method in tourism attraction recommendation under a picture fuzzy environment.

The PROMETHEE method was proposed by Brans and Vincke [48] and is based on pairwise comparison of alternatives for criteria. Its intrinsic relationship is significantly different from other MCGDM methods. The PROMETHEE II method is membership of PROMETHEE family and it has two advantages. Firstly, it is a user-friendly outranking method and can acquire the completeness of ranking. Secondly, it has a high level of flexibility when defining preference thresholds for criteria [49]. Thus, scholars utilized the PROMETHEE II method to conduct many applications [50–52].

The classical TODIM method has two limitations. On the one hand, it is only applicable for the problems in which attribute values are crisp numbers [53]. On the other hand, the compensation issue also has in this method [54]. Moreover, the PROMETHEE II method cannot distribute the weights of relative importance to the criteria in an organized way. Traditional preference functions of the PROMETHEE II method do not well represent the practical situations. To overcome the limitations mentioned above, the TODIM method is used in conjunction with PROMETHEE II in this paper. The TODIM method is utilized to work out overall appraisal values of alternatives, and the value function of prospect theory is employed as a preference function to get ranking outcomes.

2.3. WRCC

Water resources constitute an irreplaceable basis of socio-economic development and one of the most significant natural resources for biological survival. The carrying capacity is a concept in ecology which is exploited to represent the maximum amount of individual species that a habitat can support. The WRCC is an extended form of the carrying capacity in the area of water resources and was firstly put forward via the Research Panel of Water Resource Soft Science in Xinjiang, China [55]. After this concept was put forward, many scholars conducted related research and had a heated discussion. Some scholars were convinced that the WRCC is a concept that reflects sustainable socio-economic development within a specific region and basin, while others considered it as the maximum threshold of water resources that can maintain human activities. In this research, the understanding of WRCC is to achieve the sustainably maximum socio-economic scale in relation to the healthy water environment and the available water resources. At present, the majority of scholars incorporate the concept of WRCC into the theory of sustainable development rather than regarding it as a separate research topic [56]. Thus, WRCC is contained by a large theoretical background with respect to sustainable development and water resource management.

Nowadays, many researchers have conducted research related to WRCC evaluation via different methods, including fuzzy comprehensive evaluation methods [57], traditional tendency methods [58], multiple objective analysis methods [59], ecological footprint methods [60], system dynamics methods [61], and principal component analysis methods [62]. Considering the fact that each method has its own advantages, some researchers attempted to combine several methods to improve evaluation performance for WRCC [63]. With the rapid development of information science, some advanced technologies are involved in the WRCC evaluation, such as the artificial neural network algorithm, the matter element analysis method, and the grid search method based on a geographic information system [64].

However, these methods are more or less limited due to the lack of systematic analysis of the coupled relationship among different elements, while the traditional trend analysis methods remain challenging for attempt to objectively reflect the actual situation of WRCC. Due to a lack of an appropriate method to obtain the optimal solution, multiple objective analysis methods are to be applied in the practical evaluation. Although the artificial neural network method has excellent performances in terms of nonlinear pattern recognition, it is not easy to quantify the assessment results in practical applications. Considering the reasons above, this research attempts to evaluate WRCC from the perspective of MCGDM to improve the above limitations.

3. Preliminaries

3.1. The Basic Concept of PLTSs

Definition 1. *[9]. Let $S = \left\{ s_i \middle| i = 0, 1, 2, \cdots, 2g, g \in N^+ \right\}$ be a linguistic term set (LTS) with odd cardinality, where s_i represents a possible value for linguistic variables, and the following conditions need to be satisfied as*

1. *The set is ordered: $\alpha > \beta \Leftrightarrow s_\alpha > s_\beta$, and*
2. *A negation operator exists: $neg(s_\alpha) = s_{2g-\alpha}$.*

To better preserve the all given information, the continuous LTS $\hat{S} = \left\{ s_k \middle| k \in [0, l] \right\}$ is defined, where $s_i > s_j$ if $i > j$, and l $(l > 2g)$ is a sufficiently large positive integer [65].

Definition 2. *[12]. Let $S = \left\{ s_i \middle| i = 0, 1, \cdots, 2g, g \epsilon N^+ \right\}$ be an LTS, then PLTSs are defined in the following:*

$$L(p) = \{h_i(p_i)|h_i \in S, p_i \geq 0, i = 0, 1, \cdots, \#L(p), \sum_{i=1}^{\#L(p)} p_i \leq 1\},$$

where $h_i(p_i)$ represents the linguistic variable h_i and its related probability p_i, and $\#L(p)$ is the number of linguistic variables in $L(p)$.

3.2. The Basic Concept of Linguistic Scale Functions (LSFs)

Mapping is always an important process to transform linguistic terms into numerical values, because it has a significant influence on the accuracy and reliability of the final outcomes. In accordance with the previous research [66], Wang et al. [67] proposed three kinds of LSFs which are suitable for different conditions.

Definition 3. *[67]. Let $S = \left\{ s_i \middle| i = 0, 1, \cdots, 2g, g \in N^+ \right\}$ be an LTS and $s_i \in S$ is a linguistic variable. The LSF f conducts the mapping from s_i to θ_i and the mapping is defined below,*

$$f : s_i \to \theta_i \ (i = 0, 1, 2, \cdots 2g),$$

where $0 \leq \theta_0 \leq \theta_1 \leq \cdots \leq \theta_{2g} \leq 1$. Clearly, LSF f is absolutely monotonically increasing function in relation to subscript i.

***LSF 1**: $f_1(s_i) = \theta_i$*

$$\theta_i = i/2g \ (i = 0, 1, 2, \cdots, 2g).$$

The LSF 1 is defined on the basis of the subscript function $I(s_i) = i$ and its assessment scale is divided on average.

***LSF2:** $f_2(s_i) = \theta_i$*

$$\theta_i = \begin{cases} \frac{a^g - a^{g-i}}{2a^g - 2} \ (i = 0, 1, 2, \cdots, g), \\ \frac{a^g + a^{i-g} - 2}{2a^g - 2} \ (i = g+1, g+2, \cdots, 2g). \end{cases}$$

According to the numerous experimental studies, parameter a is demonstrated belonging to the interval $[1.36, 1.4]$ [66].

***LSF3:** $f_3(s_i) = \theta_i$*

$$\theta_i = \begin{cases} \frac{g^\alpha - (g-i)^\alpha}{2g^\alpha} \ (i = 0, 1, 2, \cdots, g), \\ \frac{g^\beta + (i-g)^\beta}{2g^\beta} \ (i = g+1, g+2, \cdots, 2g). \end{cases}$$

where α and β denote the subjective curvature values of gain and loss functions, respectively. With a mass of experimental data, $\alpha = \beta = 0.88$ is determined [42].

3.3. The Basic Concept of Linguistic Z-Numbers

Definition 4. *[20]. A Z-number is an ordered pair of fuzzy numbers, denoted as $Z = (A, B)$. It is related to a real valued uncertain variable X, where the first component A is a fuzzy restriction on the values that X can take, and the second component B is a measure of reliability of the first component A. Typically, A and B are described via a natural language, such as (excellent, likely).*

Definition 5. *[68]. Let X be a universe of discourse, $S_1 = \{s_0, s_1, \cdots, s_{2m}\}$ and $S_2 = \left\{s'_0, s'_1, \cdots, s'_{2n}\right\}$ be two ordered discrete LTSs, where m and n are nonnegative integers. When $A_{\phi(x)} \in S_1$ and $B_{\varphi(x)} \in S_2$, a linguistic Z-number set Z in X can be denoted by the following form:*

$$Z = \left\{\left(x, A_{\phi(x)}, B_{\psi(x)}\right) | x \in X\right\}.$$

When X only includes one element, the linguistic Z-number set is reduced to $\left(A_{\phi(\alpha)}, B_{\varphi(\alpha)}\right)$. For convenience, $z_\alpha = \left(A_{\phi(\alpha)}, B_{\varphi(\alpha)}\right)$. is called a linguistic Z-number.

4. PLZNs and Their Knowledge

4.1. The Concept of PLZNs

Definition 6. *Let X. be a universe of discourse, $L(p) = \{h_0(p_0), h_1(p_1), \cdots, h_{2m}(p_{2m})\}$ be a ordered discrete PLTS and $L = \{l_0, l_1, \cdots, l_{2n}\}$ be a ordered discrete LTS, where h_i, l_j are linguistic terms, p_i is probability and $m, n \in g$. A PLZN on X can be defined below:*

$$Z = \{(x, A_z(x), B_z(x)) | x \in X\},$$

where $A_z(x)$ is a subset from $L(p)$ and $B_z(x)$ is an element from L. The first component $A_z(x)$ is a fuzzy restriction on the values that X can take, and the second component $B_z(x)$ is a measure of reliability of the first component $A_z(x)$. For a specific variable α, the PLZN is represented by $z_\alpha = (A_z(\alpha), B_z(\alpha))$.

4.2. The Comparison Method of PLZNs

Definition 7. *Let $z_\alpha = (A_z(\alpha), B_z(\alpha)) = \left(\left(h_0^\alpha\left(p_0^\alpha\right), h_1^\alpha\left(p_1^\alpha\right), \cdots, h_k^\alpha\left(p_k^\alpha\right)\right), l_t^\alpha\right)$ be a PLZN, $k \in 2m$ and $t \in 2n$. The score of z_α and the deviation degree of z_α are, respective, given as*

$$E(z_\alpha) = \sum_{i=1}^{\#A_z(\alpha)} f\left(h_i^\alpha\right) \cdot p_i^\alpha \cdot g\left(l_t^\alpha\right) \Big/ \sum_{i=1}^{\#A_z(\alpha)} p_i^\alpha,$$

$$\sigma(z_\alpha) = \left(\sum_{i=1}^{\#A_z(\alpha)} \left(p_i^\alpha\left(f\left(h_i^\alpha\right) \cdot g\left(l_t^\alpha\right) - E(Z_\alpha)\right)\right)\right)^{1/2} \Big/ \sum_{i=1}^{\#A_z(\alpha)} p_i^\alpha$$

where $f(*)$ and $g(*)$ are LSFs, h_i^α and l_t^α are linguistic terms, p_i^α is related probability, $\#A_z(\alpha)$ is the number of elements in $A_z(\alpha)$, $E(z_\alpha)$ is the score of z_α and $\sigma(z_\alpha)$ is the deviation degree of z_α.

Definition 8. *Let z_α and z_β be two PLZNs, and the comparison method is defined as follow:*

(1) *When $E(z_\alpha) > E\left(z_\beta\right)$, $z_\alpha \succ z_\beta$*
(2) *When $E(z_\alpha) = E\left(z_\beta\right)$,*

if $\sigma(z_\alpha) < \sigma\left(z_\beta\right)$, then $z_\alpha \succ z_\beta$;
if $\sigma(z_\alpha) = \sigma\left(z_\beta\right)$, then $z_\alpha \sim z_\beta$.
$E(*)(* = \alpha, \beta)$ is the score function and $\sigma(*)(* = \alpha, \beta)$ is the deviation degree function.

4.3. The Distance of PLZNs

Definition 9. *Let $z_\alpha = (A_z(\alpha), B_z(\alpha)) = \left(\left(h_0^\alpha\left(p_0^\alpha\right), h_1^\alpha\left(p_1^\alpha\right), \cdots, h_k^\alpha\left(p_k^\alpha\right)\right), l_t^\alpha\right)$ be a PLZN, $k \in 2m$, and $\widetilde{z} = (h_{2m}(1), l_{2n})$ be the largest PLZN. The distance between z_α and $\widetilde{z}$ is defined as*

$$d(z_\alpha) = (1 - \left(\sum_{i=1}^{k} \left|f(h_{2m}) - f\left(h_i^\alpha\right)\right|^r \cdot p_i^r)\right)^{1/r}) \cdot g\left(l_t^\alpha\right),$$

where $f(*)$ and $g(*)$ are the LSFs, and r is a positive integer.

Definition 10. *Let z_α and z_β be two PLZNs, the distance between z_α and z_β is defined as*

$$D\left(z_\alpha, z_\beta\right) = \left|d(z_\alpha) - d\left(z_\beta\right)\right|.$$

Theorem 1. *Let z_α, z_β and z_γ be three PLZNs, the proposed distance equation satisfies the following properties:*

(1) $D\left(z_\alpha, z_\beta\right) \geq 0$,
(2) $D\left(z_\alpha, z_\beta\right) = D\left(z_\beta, z_\alpha\right)$, *and*
(3) $D\left(z_\alpha, z_\beta\right) \leq D\left(z_\alpha, z_\gamma\right) + D\left(z_\gamma, z_\beta\right)$.

Proof.

(1) $D\left(z_\alpha, z_\beta\right) = \left|d(z_\alpha) - d\left(z_\beta\right)\right| \geq 0$.
(2) $D\left(z_\alpha, z_\beta\right) = \left|d(z_\alpha) - d\left(z_\beta\right)\right| = \left|d\left(z_\beta\right) - d(z_\alpha)\right| = D\left(z_\beta, z_\alpha\right)$.
(3) $D\left(z_\alpha, z_\beta\right) = \left|d(z_\alpha) - d\left(z_\gamma\right) + d\left(z_\gamma\right) - d\left(z_\beta\right)\right| \leq \left|d(z_\alpha) - d\left(z_\gamma\right)\right| + \left|d\left(z_\gamma\right) - d\left(z_\beta\right)\right| \leq D\left(z_\alpha, z_\gamma\right) + D\left(z_\gamma, z_\beta\right)$. □

4.4. The Operations of PLZNs

Definition 11. *Let* $z_\alpha = (A_z(\alpha), B_z(\alpha))\Big(\Big(h_0^\alpha\big(p_0^\alpha\big), h_1^\alpha\big(p_1^\alpha\big), \cdots, h_{k_1}^\alpha(p_{k_1}^\alpha)\Big), l_{t_1}^\alpha\Big)$ *and* $z_\beta = (A_z(\beta), B_z(\beta)) = \Big(\Big(h_0^\beta(p_0^\beta), h_1^\beta(p_1^\beta), \cdots, h_{k_2}^\beta(p_{k_2}^\beta)\Big), l_{t_2}^\beta\Big)$ *be two PLZNs, the operation of PLZNs can be defined below.*

$$\lambda_1 z_\alpha \oplus \lambda_2 z_\beta = \Big(\Big(h_0^\alpha\big(\lambda_1 p_0^\alpha\big), \cdots, h_{k_1}^\alpha(\lambda_1 p_{k_1}^\alpha), \cdots, h_{k_2}^\beta(\lambda_2 p_{k_2}^\beta)\Big), g^{-1}\Big(\lambda_1 g(l_{t_1}^\alpha) + \lambda_2 g(l_{t_2}^\beta)\Big)\Big),$$

where $\lambda_1 + \lambda_2 = 1$, $g(*)$ *is LSF and* $g^{-1}(*)$ *is the inverse function of* $g(*)$.

Example 1. *Assuming* $S_1 = \{s_0 : \textit{extremely poor}, s_1 : \textit{poor}, s_2 : \textit{slightly poor}, s_3 : \textit{fair}, s_4 : \textit{slightly good}, s_5 : \textit{good}, s_6 : \textit{extremely good}\}$ *represents a LTS to depict the fuzzy restriction on evaluation objects,* $S_2 = \Big\{s_0' : \textit{strongly uncetain}, s_1' : \textit{uncertain}, s_2' : \textit{neutral}, s_3' : \textit{certain}, s_4' : \textit{strongly certain}\Big\}$ *denotes another LSF to describe reliability of the fuzzy restriction. Let* $z_\alpha = \Big((s_5(0.3), s_4(0.5), s_3(0.2)), s_3'\Big)$ *and* $z_\beta = \Big((s_4(0.6), s_3(0.2), s_2(0.2)), s_2'\Big)$ *be two PLZNs, and* $g(s_i) = i/6\ (i = 0, 1, \cdots, 6)$. *Then, the following outcome can be calculated below,*

$$0.5z_\alpha \oplus 0.5z_\beta = \Big((s_5(0.15), s_4(0.55), s_3(0.2), s_2(0.1)), s_{2.5}'\Big).$$

Definition 12. *Let* $z_1, z_2, \cdots, z_n$ *be* n *PLZNs and* Ω *be the set of all given values. Then, the probabilistic linguistic Z-number weighted average (PLZNWA) operator is the mapping:* $\Omega^n \to \Omega$, *and is defined below:*

$$PLZNWA(z_1, z_2, \cdots, z_n) = \frac{(1 + d(z_1))}{\sum_{i=1}^n (1 + d(z_i))} z_1 \oplus \frac{(1 + d(z_2))}{\sum_{i=1}^n (1 + d(z_i))} z_2 \oplus \cdots \oplus \frac{(1 + d(z_n))}{\sum_{i=1}^n (1 + d(z_i))} z_n,$$

where $d(z_i)$ *is distance between* z_i *and* $\widetilde{z}$. $\widetilde{z} = (h_{2m}(1), l_{2n})$ *is the largest PLZN.*

5. Decision Support Framework

This decision support framework is constructed to solve MCGDM problems. The related knowledge is explained below. The evaluation objects are represented by $A = \{a_1, a_2, \cdots, a_n\}$, where each object is evaluated by means of m denoted criteria by $C = \{c_1, c_2, \cdots, c_m\}$. The weight vector in relation to each criterion is shown as $w = (w_1, w_2, \cdots, w_m)$, where $\sum_{j=1}^m w_j = 1$. The evaluation of a_i under c_j is denoted PLZNs $z_{ij} = \Big(A_z\big(x_{ij}\big), B_z\big(x_{ij}\big)\Big)$. The component $A_z\big(x_{ij}\big)$ is the evaluation for object x_{ij} and the component $B_z\big(x_{ij}\big)$ is the reliability of $A_z\big(x_{ij}\big)$.

On the basis of the related knowledge in Section 4, the decision support framework is established, and the specific procedure is shown in Figure 1.

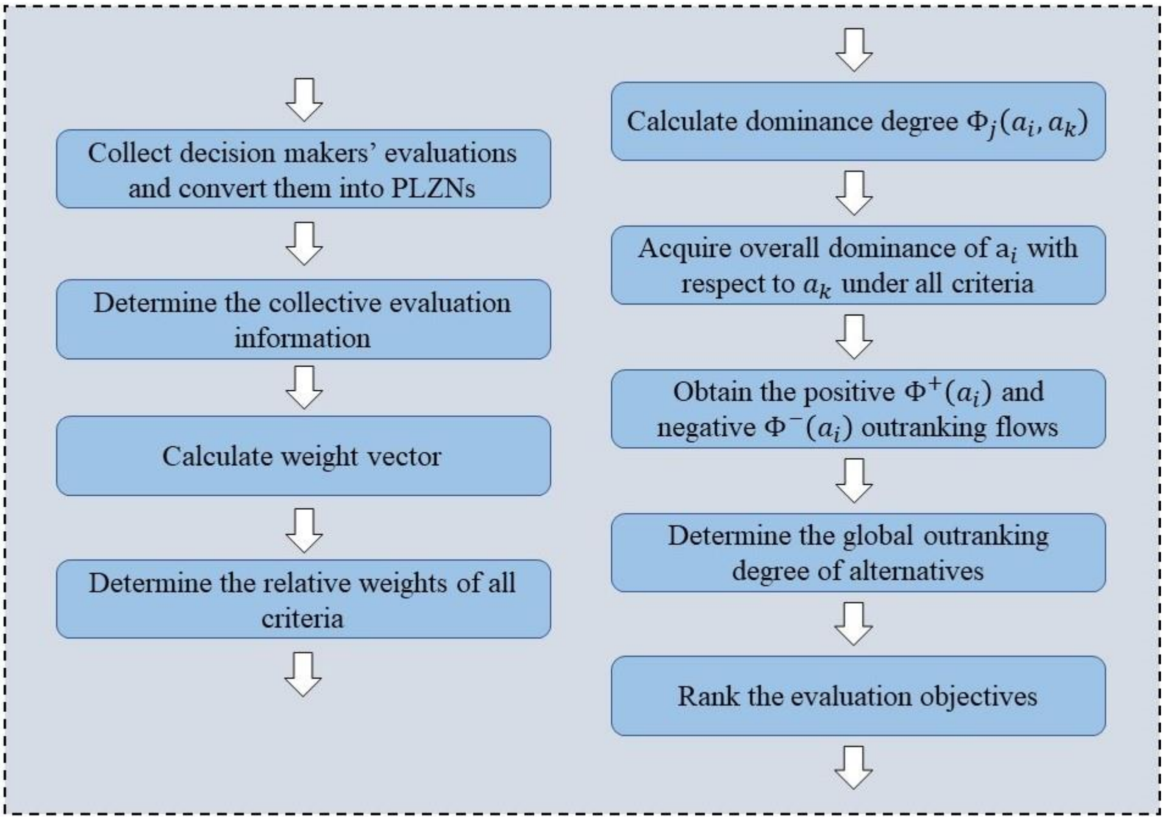

Figure 1. Flow chart of the decision support framework.

Step 1. Collect decision makers' evaluations and convert them into PLZNs.

In accordance with cognition degree of decision makers, the reliability of their evaluations is divided into k levels. For each level, the evaluations of decision makers are converted into PLTSs with statistical methods. Considering that combination of evaluations and their reliability, PLZNs are used to depict these two components, denoted by z_{ij}. The component $A_z\left(x_{ij}\right)$ is the evaluations of decision makers and the component $B_z\left(x_{ij}\right)$ denotes the reliability of their evaluations.

Step 2. Determine the collective evaluation information.

Under c_j criterion, the evaluation of object a_i is described via several PLZNs. According to Definition 12, the PLZNWA operator is utilized to aggregate these PLZNs, shown a

$$PLZNWA(z_1, z_2, \cdots, z_n) = \frac{(1+d(z_1))}{\sum_{i=1}^{n}(1+d(z_i))} z_1 \oplus \frac{(1+d(z_2))}{\sum_{i=1}^{n}(1+d(z_i))} z_2 \oplus \cdots \oplus \frac{(1+d(z_n))}{\sum_{i=1}^{n}(1+d(z_i))} z_n, \tag{1}$$

where $d(z_i)$ is distance between z_i and $\widetilde{z}$. $\widetilde{z} = (h_{2m}(1), l_{2n})$ is the largest PLZN.

Step 3. Calculate weight vector.

In this decision support framework, an extended maximum deviation method [69,70] is exploited to calculate the weight vector. Compared with other weight determining methods, the extended maximum deviation method utilizes the deviation of alternatives as a whole under each criterion to determine criteria weights, which fully considers the inner relationship for each piece of evaluation information. This is an excellent objective method to determine criteria weights. The specific procedures are shown below.

$$Max\ F\left(w_j\right) = \sum_{j=1}^{m} w_j \sum_{i=1}^{n} \sum_{k=1, k\neq i}^{n} \left|D\left(z_{ij}, z_{kj}\right)\right|$$

$$s.t\begin{cases} \sum\limits_{j=1}^{m} w_j^2 = 1 \\ w_j \geq 0, j = 1, 2, \cdots, m \end{cases}, \tag{2}$$

where $D\left(z_{ij}, z_{kj}\right)$ denotes the distance between PLZNs z_{ij} and z_{kj}.

To manage this model, the Lagrange function is constructed as follow,

$$F\left(w_j, \lambda\right) = \sum\nolimits_{j=1}^{m} w_j \sum\nolimits_{i=1}^{n} \sum\nolimits_{k=1, k\neq i}^{n} \left| D\left(z_{ij}, z_{kj}\right) \right| + \frac{\lambda}{2}\left(\sum_{j=1}^{m} w_j^2 - 1\right), \tag{3}$$

where λ is the Lagrange multiplier. Subsequently, the partial derivatives of $F\left(w_j, \lambda\right)$ can be calculated via the following formulas,

$$\begin{cases} \frac{\partial F\left(w_j,\lambda\right)}{\partial w_j} = \sum_{i=1}^{n} \sum_{k=1,k\neq i}^{n} \left| D\left(z_{ij}, z_{kj}\right) \right| + \lambda w_j = 0 \\ \frac{\partial F\left(w_j,\lambda\right)}{\partial \lambda} = \sum_{j=1}^{m} w_j^2 - 1 = 0 \end{cases}. \tag{4}$$

By solving the formulas above, the optimal weights of the criteria can be obtained below:

$$w_j^* = \frac{\sum_{i=1}^{n} \sum_{k=1,k\neq i}^{n} \left| D\left(z_{ij}, z_{kj}\right) \right|}{\sqrt{\sum_{j=1}^{m} \left(\sum_{i=1}^{n} \sum_{k=1,k\neq i}^{n} \left| D\left(z_{ij}, z_{kj}\right) \right|\right)^2}}. \tag{5}$$

To normalise w_j as a unit, the normalised weights of the criteria can be calculated as:

$$w_j = \frac{w_j^*}{\sum_{j=1}^{m} w_j^*} = \frac{\sum_{i=1}^{n} \sum_{k=1,k\neq i}^{n} \left| D\left(z_{ij}, z_{kj}\right) \right|}{\sum_{j=1}^{m} \left(\sum_{i=1}^{n} \sum_{k=1,k\neq i}^{n} \left| D\left(z_{ij}, z_{kj}\right) \right|\right)}. \tag{6}$$

Step 4. Determine the relative weights of all criteria.

In accordance with the maximum deviation method, the weight vector is determined. Then, the related weight of each criterion is calculated via the subsequent formula.

$$w_j' = \frac{w_j}{w_r}\ (j = 1, 2, \cdots, m), \tag{7}$$

where $w_r = max\left\{w_j \middle| j = 1, 2, \cdots, m\right\}$.

Step 5. Calculate dominance degree $\Phi_j(a_i, a_k)$ about criteria c_j in relation to evaluation objects a_i and a_k.

$$\Phi_j(a_i, a_k) = \begin{cases} \sqrt[\lambda]{\frac{w_j'}{\sum_{j=1}^{m} w_j'}} \cdot D\left(z_{ij}, z_{kj}\right)\ if\ z_{ij} \succ z_{kj} \\ 0\ if\ z_{ij} \sim z_{kj} \\ -\frac{1}{\theta} \cdot \sqrt[\lambda]{\frac{\sum_{j=1}^{m} w_j'}{w_j'}} \cdot D\left(z_{ij}, z_{kj}\right)\ if\ z_{ij} \prec z_{kj} \end{cases} \tag{8}$$

where $D\left(z_{ij}, z_{kj}\right)$ is the distance between z_{ij} and z_{kj} $(i, k = 1, 2, \cdots, n;\ j = 1, 2, \cdots,\ m)$. θ represents the loss of the attenuation coefficient. Without loss of normalization, $\theta = 1$ is exploited in the calculation process.

Step 6. Acquire overall dominance of a_i with respect to a_k under all criteria.

On the basis of the results of Step 5, the overall dominance $\Phi(a_i, a_k)$ can be calculated via the following formula.

$$\Phi(a_i, a_k) = \sum\nolimits_{j=1}^{m} w_j \Phi_j(a_i, a_k)\ (i, k = 1, 2, \cdots, n; i \neq k) \tag{9}$$

Step 7. Obtain the positive $\Phi^{+}(a_i)$ and negative $\Phi^{-}(a_i)$ outranking flows.

The positive and negative outranking flows are calculated below.

$$\Phi^{+}(a_i) = \sum\nolimits_{k=1}^{m} \Phi(a_i, a_k), \tag{10}$$

$$\Phi^{-}(a_i) = \sum\nolimits_{k=1}^{m} \Phi(a_k, a_i). \tag{11}$$

Step 8. Determine the global outranking degree of alternatives.

The global outranking degree is acquired below.

$$\Phi(a_i) = \Phi^{+}(a_i) - \Phi^{-}(a_i), \tag{12}$$

where $i = 1, 2, \cdots, n$.

Step 9. Rank the evaluation objectives.

According to the judgment rules, the value of $\Phi(a_i)$ is large and the evaluation object a_i is optimal.

6. Case Study

Hunan province is a place with abundant water resources. With the increasing use of industrial and domestic water, water resources are subject to serious shortage in some regions. Considering this situation, the concerned authorities invited some experts to investigate local WRCC conditions. According to expert evaluations, the region with the lowest WRCC should be given priority for intensive governance.

In accordance with the collected information, the concerned authorities select six counties as pilot regions, containing Shuangfeng county (a_1), Pingjiang county (a_2), Yanling county (a_3), Cili county (a_4), Dao county (a_5), and Yuanling county (a_6), as shown in Figure 2. On the basis of evaluation criteria [1], shown in Table 1, each expert needs to give his/her own assessments for each criterion. Their evaluations include s_0 : extremely low, s_1 : low, s_2 : slightly low, s_3 : fair, s_4 : slightly high, s_5 : high and s_6 : extremely high. Considering that the cognition degree of experts has some differences, the reliability of their evaluations is divided into five level, including s'_0: impossible, s'_1: doubtful, s'_2: fair, s'_3: acceptable and s'_4: credible. Utilizing the evaluations of the expert group, comprehensive evaluation and ranking are acquired for local WRCC in six regions, and the region of prioritized governance is determined.

Table 1. The evaluation indexes of WRCC.

Main Criteria	Sub-Criteria	Indicator Description
Water resources	Water consumption per 10,000 RMB of gross domestic product (GDP) c_1	Reflects the regional water consumption
	Total available water resources c_2	Reflects the amount of total available water resources
	Recycling rate of industrial wastewater c_3	Reflects the water consumption of regional industry
	Ratio of water supply to water demand c_4	Reflects the level of water supply capacity
Society	Urbanization rate c_5	Reflects the level of urbanization
	Total population c_6	Reflects the regional population
	Coverage of green areas in developed areas c_7	Reflects the level of regional greening
	Cultivated areas c_8	Reflects the regional development of agriculture
Economy	Industrial water consumption c_9	Reflects the water consumption of regional industry
	Irrigation water consumption c_{10}	Reflects the water consumption of regional irrigation
	Urban domestic water demand c_{11}	Reflects the water consumption of regional residents
	GDP c_{12}	Reflects the level of regional economic development
Water environment	The amount of water pollution c_{13}	Reflects the pollution status of water environment
	Treatment rate for sewage c_{14}	Reflects the level of sewage treatment in the area
	The volume of chemical oxygen demand (COD) emissions c_{15}	Reflects the pollution status of the water environment
	Investment in environmental protection c_{16}	Reflects the investment in regional environmental protection

Figure 2. The maps of pilot regions.

6.1. Calculation Process and Results

Step 1. Collect decision makers' evaluations and convert them into PLZNs.

Due to the fact that cost and benefit criteria simultaneously exist in the evaluation process, expert evaluations under cost criteria need to be converted via the formula $\mathrm{neg}(s_\alpha) = s_{2g-\alpha}$. In accordance with the cognition degree of experts, the reliability of evaluations is divided into five portions. Utilizing statistical methods, evaluations of each portion are converted into PLTSs. Considering the combination of cognition degree and evaluations, PLZNs are utilized to denotes these assessments, shown in Appendix A.

Step 2. Determine the collective evaluation information.

Then, according to the Formula (1), a PLZNWA operator is utilized to obtain the comprehensive PLZNs, shown in Appendix B.

Step 3. Calculate weight vector.

According to Formulas (2)–(6), the weights of criteria are determined via the maximum deviation method, shown in Figure 3.

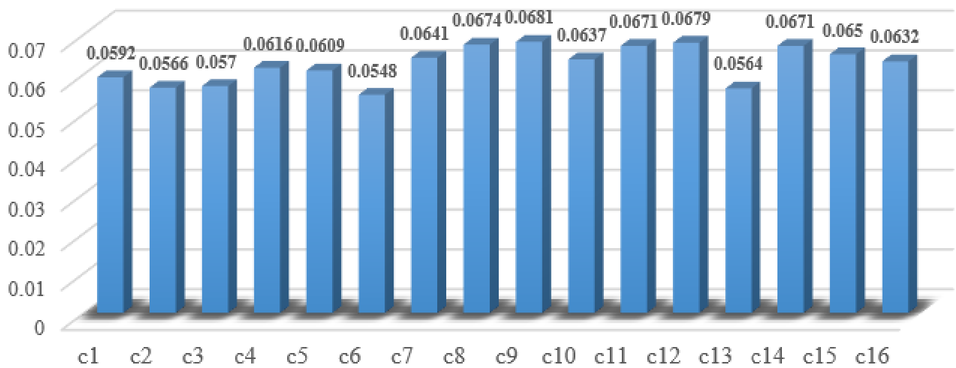

Figure 3. The weight comparison among sixteen sub-criteria.

Step 4. Determine the relative weights of all criteria.

The related weight of each criterion is calculated via the Formula (7), shown in Table 2.

Table 2. The related weight of each criterion.

c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8
0.8693	0.8311	0.8370	0.9046	0.8943	0.8047	0.9413	0.9897
c_9	c_{10}	c_{11}	c_{12}	c_{13}	c_{14}	c_{15}	c_{16}
1.0000	0.9354	0.9853	0.9971	0.8282	0.9853	0.9545	0.9280

Step 5. Calculate dominance degree $\Phi_j(a_i, a_k)$ with respect to criterion c_j in relation to evaluation objects a_i and a_k.

Utilizing the Formula (8), the dominance degree $\Phi_j(a_i, a_k)$ is calculated, as shown in Appendix C.

Step 6. Acquire overall dominance of a_i with respect to a_k under all criteria.

In the light of Formula (9), the overall dominance is calculated and shown below.

$$\Phi(a_i, a_k) = \begin{pmatrix} 0, -0.0644, 0.0129, 0.0144, 0.0020, 0.0010 \\ 0.0038, 0, 0.0167, 0.0182, 0.0058, 0.0048 \\ -0.2187, -0.2832, 0, 0.0014, -0.1851, -0.2025 \\ -0.2432, -0.3076, -0.0245, 0, -0.2096, -0.2269 \\ -0.0336, -0.0980, 0.0110, 0.0124, 0, -0.0173 \\ -0.0162, -0.0807, 0.0120, 0.0134, 0.0010, 0 \end{pmatrix}$$

Step 7. Obtain the positive $\Phi^+(a_i)$ and negative $\Phi^-(a_i)$ outranking flows.

According to the calculation by Formulas (10) and (11), the positive and negative outranking flows are acquired, as shown in Table 3 and Figure 4.

Table 3. The positive and negative outranking flows.

	a_1	a_2	a_3	a_4	a_5	a_6
$\Phi^+(a_i)$	−0.0342	0.0493	−0.8880	−1.0118	−0.1256	−0.0705
$\Phi^-(a_i)$	−0.5079	−0.8339	0.0282	0.0598	−0.3859	−0.4410

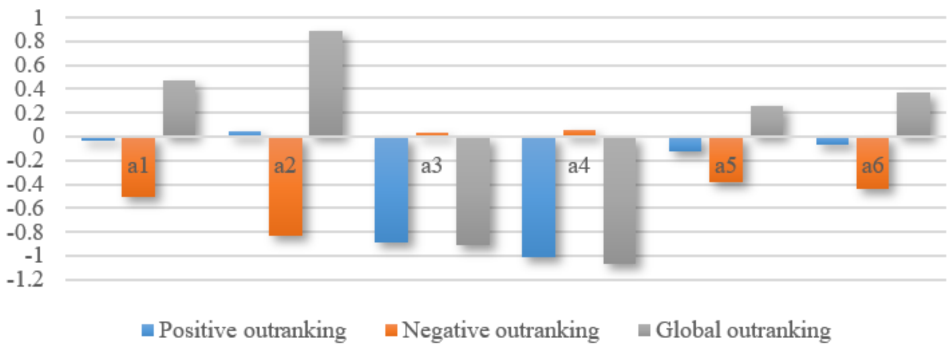

Figure 4. The outcome of positive, negative and global outranking.

Step 8. Determine the global outranking degree of alternatives.

Using Formula (12), the global outranking degree is determined, as shown in Table 4 and Figure 5.

Table 4. The global outranking flows.

	a_1	a_2	a_3	a_4	a_5	a_6
$\Phi(a_i)$	0.4737	0.8832	−0.9162	−1.0716	0.2603	0.3706

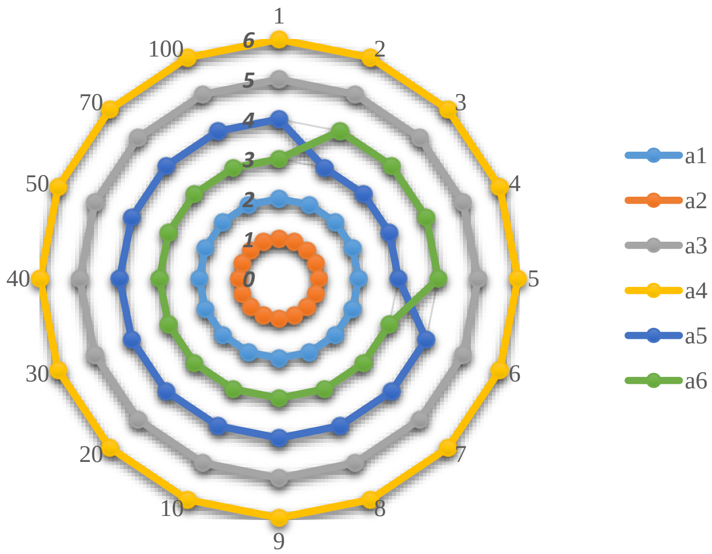

Figure 5. Ranking outcomes of different parameter λ.

Step 9. Rank the evaluation objectives.

The final outcome of alternatives is $a_2 \succ a_1 \succ a_6 \succ a_5 \succ a_3 \succ a_4$. Therefore, the WRCC of Pingjiang county has the lowest risk and that of Cili county (a_1) has the highest risk in these six regions.

6.2. Sensitivity Analysis

In this study, a distance-based decision support framework is used to solve WRCC evaluation problems. According to Definition 10, a variable parameter λ has in the distance formula. In the calculation process, $\lambda = 1$ is utilized to simplify the computational complexity. However, this condition possibly results in some deviations for the final outcome. To demonstrate the influence of parameter λ, a different parameter λ is used to calculate ranking outcome, which is based on the same evaluation data. The ranking outcomes are shown in Figure 5.

In accordance with representation of Figure 5, the ranking outcomes have some differences but are acceptable. Obviously, the ranking of alternatives a_1, a_2, a_3, and a_4 has not any change with increase of parameter λ. The ranking of alternatives a_5 and a_6 shows some changes, but that goes back to the original ranking after $\lambda = 6$. In general, the distance-based decision support framework demonstrates great robustness.

6.3. Comparison Analysis

To confirm the feasibility of PLZNs and the decision support framework, a comparison is conducted with two existing studies, namely those of Pang et al. [12] and Qiao et al. [71]. The comparison with Pang et al. [12] is performed to validate whether PLZNs have some advantages with PLTSs, while the comparison with Qiao et al. [71] is performed to demonstrate the superiority of our decision support framework. The adopted methods are introduced as Case 1 and Case 2.

Case 1. Comparison with the extended TOPSIS method [12].

To ensure that the ranking outcomes are comparable, the evaluation information in Appendix A is taken as the same data source. Utilizing arithmetic average operators, the representation of evaluation data is converted into PLTSs, shown in Appendix D. To obtain a comparative ranking result, three additional steps are conducted below. Firstly, criteria weights are determined by the maximizing deviation method. Secondly, positive and negative ideal solutions of alternatives are acquired via the related definitions. Thirdly, the closeness coefficient of each alternative is calculated. The ranking outcome is $a_1 \succ a_2 \succ a_3 \sim a_5 \sim a_6 \succ a_4$.

Case 2. Comparison with Z-PROMETHEE method [71].

To ensure that the ranking outcomes are comparable, the evaluation information in Appendix A is taken as the same data source. According to their conversion rules, the representation of evaluation data is transformed into Z-numbers. The components A and B are donated by triangular fuzzy numbers. The transformed evaluation data are shown in Appendix E. To acquire the ranking outcome, four additional steps are conducted as follow. Firstly, criteria weights are calculated. Secondly, the priority index of alternatives is determined. Thirdly, outgoing flow, incoming flow, and net flow are obtained. Finally, the ranking is determined via net flow. The ranking outcome is $a_2 \succ a_5 \succ a_6 \succ a_1 \succ a_3 \succ a_4$ $(\omega = 0.1)$.

Table 5 shows the ranking results generated by the proposed decision support framework and another two cases, and some differences are observed in the ranking outcomes among these three methods. This is acceptable, because these methods are based on different theories.

Table 5. The list of ranking outcomes.

Method	The Ranking Outcome
Pang et al. [14]	$a_1 \succ a_2 \succ a_3 \sim a_5 \sim a_6 \succ a_4$
Qiao et al. [71]	$a_6 \succ a_2 \succ a_1 \succ a_5 \succ a_3 \succ a_4$
The proposed method	$a_2 \succ a_1 \succ a_6 \succ a_5 \succ a_3 \succ a_4$

A comparison between our ranking results and those of the extended TOPSIS method demonstrates that the trend of ranking is similar. There is a change between the locations of the first and second alternatives in the sequence. In the extended TOPSIS method, due to the fact that closeness coefficients are absolutely the same, it is difficult to acquire an order for alternatives a_3, a_5, and a_6. The difference of ranking outcome can be explained according to the following reasons. Firstly, information representations show a significant difference between two methods. PLZNs have a component to describe the reliability of fuzzy restriction, which PLTSs do not. Thus, compared with PLTSs, PLZNs can well describe group evaluation information, and simultaneously reflect reliability of group evaluation information. Secondly, the conversion method of linguistic terms has a significant difference between these two methods. Our conversion method is based on LSFs, while the conversion method of Pang et al. [12] is based on subscript calculation. Thirdly, the related knowledge of PLTSs and PLZNs involves distance, information method, operational rules, and comparison method. Finally, the theoretical basis of these two methods are different. The TOPSIS method is an entirely rational method, while the TODIM-PROMETHEE II method is a bounded rationality method.

Comparing the sequence of our own and the Z-PROMETHEE method, the location of alternative a_6 changes, while other alternatives remain of the same order. There are some reasons to explain why ranking outcomes have some differences. Firstly, information expressions are different between these two methods. The fuzzy restriction of Z-number is one or several linguistic terms, which is suitable for the representation of individual information. The fuzzy restriction of PLZNs is PLTSs, which is suitable for the expression of group information. Secondly, the transformation method of linguistic terms also has some differences between these two methods. The transformation method of Qiao et al. [71] is based on triangular fuzzy numbers. Thirdly, operational rules and measures have some differences between the two methods. The measure of our research is distance, while that of Qiao et al. [71] is the possibility degree. Finally, the Z-PROMETHEE and TODIM-PROMETHEE II methods have some differences. Compared with the Z-PROMETHEE method, the TODIM-PROMETHEE II method utilizes the value function of prospect theory, which makes it more suitable for a practical decision process. In addition, some limitations are present in the Z-PROMETHEE method. On the one hand, the weight determination method cannot handle this condition that the number of criteria is larger than that of alternatives. On the other hand, the possibility degree they proposed is highly subjective. In addition, the possibility degree contains a parameter ω, and when parameter ω changes, the ranking results of alternatives are significantly different.

Compared with extended TOPSIS and Z-PROMETHEE methods, there are some advantages in our research. Firstly, a novel information representation, PLZNs, is used to depict group evaluation information. PLZNs combine the advantages of PLTSs and Z-numbers, which can describe group evaluation information well and simultaneously reflect its reliability. Secondly, our research utilizes the extended maximum deviation method to determine criteria weights. As an objective criteria weight determining method, the maximum deviation method can effectively consider the inner relationship of each evaluation information. Compared with those subjective criteria weight determining methods, it is more rational and effective. Thirdly, a TODIM-PROMETHEE II based MCGDM method is developed to address WRCC risk evaluation issues. In our method, the value function of prospect theory is used as a preference function, which makes our method more suitable for practical decision-making conditions. Moreover, the TODIM and PROMETHEE II methods are combined to overcome their inherent limitations, which endows the combined method with excellent performance.

6.4. Discussion

In this study, the maximum deviation method is used to determine the weight. This method calculates criterion weights by the difference of evaluations under each criterion. The difference is greater and the weight is larger. According to criteria weights, it is easy to find the shortcomings of specific aspects for WRCC among these six regions.

Referring to Figure 3, these are six criteria, namely c_8, c_9, c_{11}, c_{12}, c_{14}, and c_{15}, which are significantly larger than others. This means that some regions have obvious deviations compared with the average level of these six regions under these criteria. Criterion c_8 is cultivated areas which reflect the regional development of agriculture, which can be considered as the scale of primary industries. Criterion c_9 is industrial water consumption which reflects the water consumption of regional industry, that can be deemed as the scale of secondary industries. Criterion c_{11} is urban domestic water demand which reflects the water consumption of regional residents and service industries, that is regarded as the scale of tertiary industries. In these six regions, due to differences of urbanization, some regions focus on the development of primary and secondary industries, while some areas pay more attention to the development of tertiary industries. For instance, region a_5 has a poor development and it has low expert evaluations under criteria c_8, c_9 and c_{11}. Region a_6 has a good development and it has high expert evaluations under criterion c_{11}. Thus, expert evaluations have noticeable differences under criteria c_8, c_9, and c_{11}. Criterion c_{12} is GDP which reflects the level of regional economic development. It has a close correlation with criteria c_8, c_9, and c_{11}, that is, the scale of primary, secondary, and tertiary industries. Obviously, GDP also has dramatical differences in six regions.

Criterion c_{14} is treatment rate for sewage which reflects the level of sewage treatment in the area. Criterion c_{15} is the volume of COD emissions which reflects the pollution status of the water environment. Both of them can represent the current condition of regional sustainable development. They have a positive correlation with regional economic development c_{12}. A developed area pays more attention to sustainable development and environmental protection, while a developing area focuses on economic development and neglects environmental issues to some extent. Additionally, a region's emphasis on environmental issues is closely related to its developing industries. For example, as an area strives to develop tourism, it must consider environmental issues to maintain the sustainable development of natural tourist attractions. In contrast, if an area fully develops secondary industries, then the environmental protection awareness of the region will be reduced. Considering the different development degree and directions of these six regions, the practical conditions under criteria c_{14} and c_{15} have some differences.

Referring to Figure 3, these are two criteria, c_6 and c_{13}, which are significantly smaller than other criteria. Criterion c_6 is total population and it reflects the number of regional dwellers. Criterion c_{13} is the amount of water pollution and it reflects the pollution status of water environment. Compared with other criteria, the practical conditions do not have such significant deviations under these two criteria among six regions. Despite the fact that criteria c_6 and c_{11} have some correlations, their correlations are not absolute. The water consumption of residents not only involves the total population, but also contains residents' awareness of water conservation, government strategies and other factors. Hence, there is a situation wherein the total population has minor deviations, while the water consumption of residents demonstrates major differences among these six regions. Additionally, although both criteria c_{13} and c_{15} can reflect the regional pollution status of a water environment, their emphases have differences. Criterion c_{13} denotes the number and scale of water pollution, while criteria c_{15} represents the volume of COD emissions. Thus, it is reasonable that expert evaluations of these six regions have minor deviations under criterion c_{13} and major differences under criterion c_{15}.

In accordance with the analysis and discussion above, it is easy to understand why there is a major evaluation deviation among some associated criteria and why there is a minor evaluation difference among some associated criteria. Furthermore, on the basis of criteria weights, it is easy to find the criterion that has the largest weight. Under this criterion, it is not difficult to find the regions with poor evaluations. Prioritizing governance in this aspect, it is an effective way to improve the comprehensive WRCC.

7. Conclusions, Limitation and Future Work

In our research, a TODIM-PROMETHEE II based MCGDM method is developed to address WRCC risk evaluation issues under probabilistic linguistic Z-number circumstances. The related findings can enrich the theoretical foundation of fuzzy MCGDM methods and provide a novel viewpoint of WRCC risk evaluation.

Our research has some theoretical contributions. Firstly, a novel information representation, namely PLZNs, is proposed to express the group decision information. In contrast with other information expressions, PLZNs integrate advantages of PLTSs and Z-numbers, which can well depict the group decision information and simultaneously describe the reliability of the group decision information. Secondly, some related knowledge of PLZNs is developed. The contents contain comparison method, distance, and operational rules. Thirdly, a TODIM-PROMETHEE II based MCGDM method is presented to address evaluation issues involving WRCC potential risk. The method overcome inherent limitations of TODIM method and PROMETHEE II method. Meanwhile, it is based on the behavioral principles of reference dependence and loss aversion, and considers the bounded rationality of behaviors for decision makers.

Our research also has some practical implications. The method is able to determine the regions of high risk in WRCC among several areas. According to ranking outcomes, concerned authorities can understand which areas need to be governed with a priority and which regions can be managed later. Meanwhile, the findings can also reflect the differences among several regions in a specific aspect via the size of criteria weights. Such differences can help concerned authorities to acquire the most urgent issue that should be quickly resolved in high risk areas. Concerned authorities can take effective measures to improve local WRCC quickly. In accordance with our research, some suggestions and implications can be acquired for the improvement and management of WRCC in regions.

Although our research has some theoretical contributions and practical implications, it also has some limitations. On the one hand, some theoretical research needs to be improved. As a novel concept, PLZNs need to be enriched with related knowledge. On the other hand, evaluation criteria need to be improved too. These criteria are summarized via the existing literature, and thus they can be universally utilized to evaluate WRCC in many regions. However, considering conditions in different areas, some indicators need to be increased or decreased to make the evaluation criteria more suitable for practical conditions. In short, the improved evaluation criteria reflect local practical conditions more accurately than before.

In the future, we will attempt to improve the related knowledge of PLZNs, involving distance and operational rules, to make PLZNs suitable for most situations. Then, we would like to conduct a deep research regarding information representation and develop more extensions to suit different conditions. Finally, we also plan to extend our method to more scenarios, such as medical services, industrial wastewater management, and energy selections.

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Appendix A

Table A1. The original evaluation information.

	c_1	c_2	c_3
a_1	$((s_5(0.3),s_4(0.3),s_2(0.3),s_1(0.3)),s_4)$ $((s_4(0.6),s_3(0.1),s_1(0.3)),s_3)$ $((s_4(0.3),s_3(0.3),s_2(0.3),s_1(0.1)),s_2)$ $((s_5(0.3),s_4(0.3),s_2(0.4)),s_1)$	$((s_4(0.3),s_3(0.3),s_2(0.1),s_1(0.3)),s_4)$ $((s_5(0.2),s_4(0.4),s_3(0.1),s_2(0.3)),s_3)$ $((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_2)$ $((s_4(0.4),s_3(0.4),s_1(0.2)),s_1)$	$((s_5(0.2),s_4(0.1),s_3(0.3),s_2(0.4)),s_4)$ $((s_5(0.1),s_4(0.3),s_3(0.1),s_2(0.5)),s_3)$ $((s_4(0.3),s_3(0.4),s_2(0.1),s_1(0.2)),s_2)$ $((s_4(0.3),s_3(0.1),s_2(0.2),s_1(0.4)),s_1)$
a_2	$((s_5(0.4),s_3(0.4),s_1(0.2)),s_4)$ $((s_5(0.2),s_4(0.1),s_2(0.3),s_1(0.4)),s_3)$ $((s_5(0.2),s_4(0.4),s_3(0.1),s_2(0.3)),s_2)$ $((s_5(0.2),s_4(0.3),s_3(0.3),s_2(0.2)),s_1)$	$((s_5(0.2),s_4(0.2),s_3(0.2),s_1(0.4)),s_4)$ $((s_4(0.4),s_3(0.3),s_2(0.2),s_1(0.1)),s_3)$ $((s_5(0.2),s_4(0.4),s_2(0.2),s_2(0.2)),s_2)$ $((s_5(0.2),s_4(0.3),s_3(0.1),s_2(0.4)),s_1)$	$((s_5(0.1),s_4(0.1),s_3(0.4),s_2(0.4)),s_4)$ $((s_4(0.3),s_3(0.2),s_2(0.1),s_1(0.4)),s_3)$ $((s_4(0.3),s_2(0.2),s_1(0.5)),s_2)$ $((s_4(0.3),s_3(0.2),s_2(0.1),s_1(0.4)),s_1)$
a_3	$((s_4(0.3),s_3(0.3),s_2(0.1),s_1(0.3)),s_4)$ $((s_4(0.4),s_3(0.3),s_1(0.3)),s_3)$ $((s_4(0.3),s_3(0.3),s_2(0.3),s_1(0.1)),s_2)$ $((s_5(0.1),s_4(0.4),s_3(0.3),s_2(0.2)),s_1)$	$((s_4(0.3),s_3(0.4),s_2(0.2),s_1(0.1)),s_4)$ $((s_4(0.4),s_3(0.3),s_1(0.3)),s_3)$ $((s_5(0.1),s_4(0.4),s_3(0.1),s_2(0.4)),s_2)$ $((s_4(0.3),s_3(0.3),s_2(0.3),s_1(0.1)),s_1)$	$((s_5(0.2),s_3(0.6),s_2(0.2)),s_4)$ $((s_5(0.1),s_4(0.3),s_3(0.4),s_2(0.2)),s_3)$ $((s_4(0.3),s_2(0.1),s_1(0.6)),s_2)$ $((s_5(0.1),s_4(0.6),s_2(0.3)),s_1)$
a_4	$((s_4(0.4),s_3(0.1),s_2(0.1),s_1(0.4)),s_4)$ $((s_4(0.3),s_2(0.4),s_1(0.3)),s_3)$ $((s_5(0.2),s_4(0.3),s_3(0.2),s_2(0.3)),s_2)$ $((s_5(0.1),s_4(0.5),s_3(0.3),s_2(0.1)),s_1)$	$((s_5(0.1),s_4(0.1),s_3(0.4),s_2(0.4)),s_4)$ $((s_5(0.1),s_4(0.4),s_3(0.2),s_2(0.3)),s_3)$ $((s_4(0.4),s_2(0.4),s_1(0.2)),s_2)$ $((s_5(0.2),s_4(0.3),s_3(0.2),s_2(0.3)),s_1)$	$((s_5(0.1),s_4(0.3),s_3(0.5),s_2(0.1)),s_4)$ $((s_5(0.2),s_4(0.1),s_3(0.2),s_1(0.5)),s_3)$ $((s_4(0.4),s_2(0.3),s_1(0.3)),s_2)$ $((s_4(0.3),s_3(0.3),s_1(0.4)),s_1)$
a_5	$((s_5(0.1),s_4(0.2),s_3(0.4),s_2(0.3)),s_4)$ $((s_5(0.1),s_4(0.2),s_3(0.5),s_2(0.2)),s_3)$ $((s_5(0.1),s_4(0.1),s_3(0.4),s_2(0.4)),s_2)$ $((s_4(0.3),s_2(0.6),s_1(0.1)),s_1)$	$((s_4(0.6),s_3(0.2),s_2(0.1),s_1(0.1)),s_4)$ $((s_5(0.2),s_4(0.3),s_3(0.2),s_2(0.3)),s_3)$ $((s_5(0.2),s_2(0.8)),s_2)$ $((s_4(0.3),s_2(0.3),s_1(0.4)),s_1)$	$((s_4(0.5),s_3(0.2),s_2(0.2),s_1(0.1)),s_4)$ $((s_4(0.4),s_3(0.2),s_2(0.2),s_1(0.2)),s_3)$ $((s_5(0.1),s_4(0.4),s_3(0.2),s_2(0.3)),s_2)$ $((s_5(0.1),s_4(0.4),s_3(0.2),s_2(0.3)),s_1)$
a_6	$((s_5(0.1),s_4(0.3),s_3(0.4),s_2(0.2)),s_4)$ $((s_5(0.2),s_4(0.1),s_3(0.3),s_2(0.4)),s_3)$ $((s_4(0.3),s_3(0.1),s_2(0.3),s_1(0.3)),s_2)$ $((s_5(0.1),s_4(0.3),s_3(0.3),s_2(0.3)),s_1)$	$((s_5(0.1),s_4(0.2),s_3(0.3),s_2(0.4)),s_4)$ $((s_5(0.2),s_3(0.7),s_2(0.1)),s_3)$ $((s_4(0.3),s_2(0.4),s_1(0.3)),s_2)$ $((s_5(0.1),s_4(0.5),s_2(0.4)),s_1)$	$((s_5(0.2),s_4(0.3),s_3(0.2),s_2(0.3)),s_4)$ $((s_4(0.3),s_3(0.3),s_2(0.3),s_1(0.1)),s_3)$ $((s_4(0.3),s_3(0.2),s_2(0.2),s_1(0.3)),s_2)$ $((s_5(0.2),s_4(0.4),s_2(0.4)),s_1)$

	c_4	c_5	c_6
a_1	$((s_5(0.3),s_4(0.4),s_2(0.3)),s_4)$ $((s_4(0.5),s_2(0.3),s_1(0.2)),s_3)$ $((s_5(0.1),s_4(0.2),s_3(0.4),s_2(0.3)),s_2)$ $((s_4(0.7),s_1(0.3)),s_1)$	$((s_5(0.2),s_4(0.2),s_3(0.3),s_2(0.3)),s_4)$ $((s_5(0.2),s_4(0.2),s_3(0.3),s_2(0.3)),s_3)$ $((s_5(0.1),s_4(0.4),s_3(0.1),s_2(0.4)),s_2)$ $((s_5(0.2),s_4(0.3),s_3(0.2),s_2(0.3)),s_1)$	$((s_5(0.1),s_3(0.6),s_2(0.3)),s_4)$ $((s_4(0.6),s_2(0.2),s_1(0.2)),s_3)$ $((s_4(0.4),s_2(0.2),s_1(0.4)),s_2)$ $((s_5(0.3),s_4(0.2),s_3(0.2),s_2(0.3)),s_1)$
a_2	$((s_5(0.3),s_4(0.3),s_3(0.1),s_2(0.3)),s_4)$ $((s_5(0.3),s_4(0.3),s_3(0.1),s_2(0.3)),s_3)$ $((s_5(0.3),s_4(0.2),s_3(0.3),s_2(0.2)),s_2)$ $((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_1)$	$((s_5(0.3),s_4(0.3),s_3(0.1),s_2(0.3)),s_4)$ $((s_5(0.1),s_4(0.1),s_3(0.4),s_2(0.4)),s_3)$ $((s_5(0.1),s_4(0.4),s_3(0.3),s_2(0.2)),s_2)$ $((s_5(0.1),s_4(0.3),s_3(0.1),s_2(0.5)),s_1)$	$((s_5(0.2),s_4(0.3),s_2(0.5)),s_4)$ $((s_4(0.4),s_3(0.4),s_2(0.2)),s_3)$ $((s_4(0.5),s_2(0.2),s_1(0.3)),s_2)$ $((s_5(0.3),s_3(0.2),s_2(0.5)),s_1)$
a_3	$((s_5(0.2),s_4(0.4),s_3(0.2),s_2(0.2)),s_4)$ $((s_5(0.3),s_4(0.4),s_2(0.3)),s_3)$ $((s_5(0.3),s_4(0.5),s_2(0.2)),s_2)$ $((s_5(0.3),s_4(0.3),s_3(0.1),s_2(0.3)),s_1)$	$((s_4(0.5),s_3(0.2),s_1(0.3)),s_4)$ $((s_4(0.5),s_1(0.5)),s_3)$ $((s_5(0.3),s_4(0.1),s_2(0.6)),s_2)$ $((s_5(0.1),s_4(0.1),s_3(0.3),s_2(0.5)),s_1)$	$((s_5(0.3),s_4(0.3),s_2(0.4)),s_4)$ $((s_4(0.4),s_3(0.5),s_1(0.1)),s_3)$ $((s_5(0.3),s_4(0.1),s_2(0.6)),s_2)$ $((s_5(0.3),s_3(0.1),s_2(0.6)),s_1)$
a_4	$((s_5(0.3),s_4(0.1),s_3(0.4),s_2(0.2)),s_4)$ $((s_4(0.6),s_2(0.2),s_1(0.2)),s_3)$ $((s_5(0.3),s_4(0.4),s_3(0.1),s_2(0.2)),s_2)$ $((s_5(0.1),s_4(0.5),s_3(0.1),s_2(0.3)),s_1)$	$((s_4(0.5),s_3(0.1),s_1(0.4)),s_4)$ $((s_5(0.2),s_4(0.4),s_2(0.4)),s_3)$ $((s_4(0.5),s_3(0.1),s_2(0.3),s_1(0.1)),s_2)$ $((s_5(0.2),s_4(0.4),s_3(0.1),s_2(0.3)),s_1)$	$((s_5(0.1),s_4(0.1),s_3(0.2),s_2(0.6)),s_4)$ $((s_5(0.1),s_4(0.4),s_3(0.2),s_2(0.3)),s_3)$ $((s_5(0.1),s_4(0.4),s_3(0.2),s_2(0.3)),s_2)$ $((s_5(0.3),s_3(0.5),s_2(0.2)),s_1)$
a_5	$((s_5(0.2),s_3(0.8)),s_4)$ $((s_5(0.2),s_4(0.4),s_2(0.4)),s_3)$ $((s_5(0.2),s_4(0.3),s_3(0.1),s_2(0.3)),s_2)$ $((s_5(0.2),s_4(0.4),s_2(0.4)),s_1)$	$((s_5(0.2),s_4(0.5),s_2(0.3)),s_4)$ $((s_5(0.3),s_4(0.3),s_3(0.2),s_2(0.2)),s_3)$ $((s_5(0.2),s_4(0.6),s_2(0.2)),s_2)$ $((s_5(0.2),s_4(0.4),s_2(0.4)),s_1)$	$((s_5(0.1),s_3(0.3),s_2(0.6)),s_4)$ $((s_5(0.1),s_3(0.2),s_2(0.7)),s_3)$ $((s_5(0.2),s_4(0.4),s_3(0.2),s_2(0.2)),s_2)$ $((s_5(0.1),s_4(0.5),s_3(0.3),s_2(0.1)),s_1)$
a_6	$((s_5(0.3),s_4(0.4),s_3(0.1),s_2(0.2)),s_4)$ $((s_5(0.3),s_3(0.3),s_2(0.4)),s_3)$ $((s_5(0.4),s_2(0.6)),s_2)$ $((s_5(0.1),s_4(0.4),s_3(0.2),s_2(0.3)),s_1)$	$((s_5(0.4),s_4(0.3),s_3(0.1),s_2(0.2)),s_4)$ $((s_5(0.1),s_4(0.2),s_3(0.3),s_2(0.4)),s_3)$ $((s_5(0.3),s_4(0.3),s_3(0.3),s_2(0.1)),s_2)$ $((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_1)$	$((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_4)$ $((s_4(0.5),s_3(0.1),s_2(0.4)),s_3)$ $((s_5(0.3),s_4(0.3),s_3(0.3),s_2(0.1)),s_2)$ $((s_5(0.2),s_4(0.1),s_3(0.4),s_2(0.3)),s_1)$

Table A1. *Cont.*

	c_7	c_8	c_9
a_1	$((s_5(0.3),s_4(0.3),s_2(0.4)),s_4)$ $((s_5(0.3),s_4(0.1),s_3(0.1),s_2(0.4)),s_3)$ $((s_5(0.2),s_3(0.2),s_2(0.6)),s_2)$ $((s_5(0.2),s_4(0.2),s_3(0.2),s_2(0.4)),s_1)$	$((s_5(0.4),s_4(0.4),s_2(0.2)),s_4)$ $((s_5(0.2),s_4(0.2),s_3(0.2),s_2(0.4)),s_3)$ $((s_5(0.4),s_4(0.1),s_3(0.3),s_2(0.2)),s_2)$ $((s_5(0.3),s_4(0.3),s_3(0.1),s_2(0.3)),s_1)$	$((s_5(0.3),s_4(0.3),s_3(0.1),s_2(0.3)),s_4)$ $((s_5(0.4),s_4(0.5),s_2(0.1)),s_3)$ $((s_5(0.2),s_4(0.3),s_3(0.2),s_2(0.3)),s_2)$ $((s_5(0.2),s_4(0.3),s_3(0.3),s_2(0.2)),s_1)$
a_2	$((s_5(0.2),s_4(0.3),s_3(0.3),s_2(0.2)),s_4)$ $((,s_4(0.2),s_3(0.2),s_2(0.3)),s_3)$ $((s_4(0.6),s_3(0.2),s_1(0.2)),s_2)$ $((s_5(0.3),s_3(0.4),s_2(0.3)),s_1)$	$((s_5(0.4),s_4(0.4),s_2(0.2)),s_4)$ $((s_5(0.3),s_4(0.5),s_3(0.1),s_2(0.1)),s_3)$ $((s_5(0.2),s_4(0.2),s_3(0.2),s_2(0.4)),s_2)$ $((s_5(0.3),s_4(0.2),s_3(0.2),s_2(0.3)),s_1)$	$((s_5(0.3),s_4(0.1),s_3(0.1),s_2(0.5)),s_4)$ $((s_5(0.1),s_4(0.3),s_3(0.3),s_2(0.3)),s_3)$ $((s_5(0.3),s_4(0.2),s_2(0.5)),s_2)$ $((s_5(0.1),s_4(0.4),s_3(0.1),s_2(0.4)),s_1)$
a_3	$((s_4(0.5),s_3(0.3),s_2(0.2)),s_4)$ $((s_5(0.2),s_4(0.3),s_3(0.2),s_2(0.3)),s_3)$ $((s_5(0.1),s_4(0.3),s_3(0.3),s_2(0.3)),s_2)$ $((s_5(0.2),s_4(0.2),s_3(0.2),s_2(0.4)),s_1)$	$((s_5(0.1),s_4(0.5),s_3(0.3),s_2(0.1)),s_4)$ $((s_5(0.3),s_4(0.2),s_3(0.3),s_2(0.2)),s_3)$ $((s_5(0.3),s_4(0.3),s_2(0.4)),s_2)$ $((s_4(0.8),s_2(0.2)),s_1)$	$((s_5(0.3),s_3(0.4),s_2(0.3)),s_4)$ $((s_5(0.2),s_4(0.1),s_3(0.5),s_2(0.2)),s_3)$ $((s_5(0.3),s_4(0.1),s_3(0.1),s_2(0.5)),s_2)$ $((s_5\ (0.1),s_4(0.3),s_2(0.6)),s_1)$
a_4	$((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_4)$ $((s_5(0.2),s_4(0.4),s_2(0.4)),s_3)$ $((s_5(0.4),s_3(0.2),s_2(0.4)),s_2)$ $((s_5(0.3),s_4(0.3),s_3(0.3),s_2(0.1)),s_1)$	$((s_5(0.1),s_4(0.1),s_3(0.4),s_2(0.4)),s_4)$ $((s_5(0.2),s_4(0.4),s_3(0.3),s_2(0.1)),s_3)$ $((s_5(0.1),s_4(0.4),s_3(0.2),s_2(0.3)),s_2)$ $((s_5(0.1),s_4(0.1),s_3(0.5),s_2(0.3)),s_1)$	$((s_5(0.2),s_4(0.2),s_2(0.6)),s_4)$ $((s_5(0.4),s_4(0.5),s_2(0.1)),s_3)$ $((s_5(0.3),s_4(0.3),s_2(0.4)),s_2)$ $((s_5(0.3),s_4(0.3),s_3(0.1),s_2(0.3)),s_1)$
a_5	$((s_5(0.1),s_4(0.4),s_3(0.2),s_2(0.3)),s_4)$ $((s_5(0.2),s_4(0.4),s_2(0.4)),s_3)$ $((s_5(0.2),s_4(0.3),s_3(0.3),s_2(0.2)),s_2)$ $((s_5(0.2),s_4(0.5),s_3(0.1),s_2(0.2)),s_1)$	$((s_5(0.2),s_4(0.3),s_2(0.5)),s_4)$ $((s_5(0.2),s_4(0.4),s_2(0.4)),s_3)$ $((s_5(0.1),s_4(0.2),s_3(0.3),s_2(0.4)),s_2)$ $((s_5(0.3),s_4(0.3),s_3(0.2),s_2(0.2)),s_1)$	$((s_5(0.2),s_4(0.5),s_3(0.2),s_2(0.1)),s_4)$ $((s_5(0.3),s_4(0.2),s_3(0.2),s_2(0.3)),s_3)$ $((s_5(0.2),s_4(0.3),s_2(0.5)),s_2)$ $((s_5(0.3),s_4(0.5),s_2(0.2)),s_1)$
a_6	$((s_5(0.2),s_4(0.4),s_3(0.1),s_2(0.3)),s_4)$ $((s_5(0.4),s_4(0.4),s_2(0.2)),s_3)$ $((s_5(0.3),s_3(0.3),s_2(0.4)),s_2)$ $((s_5(0.2),s_4(0.3),s_3(0.1),s_2(0.4)),s_1)$	$((s_5(0.4),s_2(0.6)),s_4)$ $((s_5(0.3),s_4(0.4),s_2(0.3)),s_3).$ $((s_5(0.1),s_4(0.4),s_2(0.5)),s_2)$ $((s_5(0.3),s_4(0.1),s_3(0.4),s_2(0.2)),s_1)$	$((s_5(0.4),s_3(0.4),s_2(0.2)),s_4)$ $((s_5(0.1),s_3(0.3),s_2(0.6)),s_3)$ $((s_5(0.1),s_4(0.6),s_3(0.1),s_2(0.2)),s_2)$ $((s_5(0.4),s_4(0.1),s_3(0.3),s_2(0.2)),s_1)$
	c_{10}	c_{11}	c_{12}
a_1	$((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_4)$ $((s_5(0.3),s_3(0.2),s_2(0.5)),s_3)$ $((s_5(0.4),s_4(0.5),s_2(0.1)),s_2)$ $((s_5(0.3),s_4(0.4),s_3(0.1),s_2(0.2)),s_1)$	$((s_5(0.4),s_4(0.3),s_3(0.2),s_2(0.1)),s_4)$ $((s_5(0.2),s_4(0.2),s_3(0.2),s_2(0.4)),s_3)$ $((s_5(0.3),s_4(0.3),s_3(0.1),s_2(0.3)),s_2)$ $((s_5(0.3),s_4(0.1),s_3(0.4),s_2(0.2)),s_1)$	$((s_5(0.3),s_4(0.3),s_3(0.3),s_2(0.1)),s_4)$ $((s_5(0.3),s_4(0.5),s_2(0.2)),s_3)$ $((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_2)$ $((s_5(0.1),s_4(0.6),s_3(0.1),s_2(0.2)),s_1)$
a_2	$((s_5(0.1),s_3(0.6),s_2(0.3)),s_4)$ $((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_3)$ $((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_2)$ $((s_5(0.2),s_4(0.2),s_3(0.4),s_2(0.2)),s_1)$	$((s_5(0.3),s_4(0.3),s_3(0.3),s_2(0.1)),s_4)$ $((s_5(0.3),s_3(0.1),s_2(0.6)),s_3)$ $((s_5(0.1),s_4(0.5),s_3(0.1),s_2(0.3)),s_2)$ $((s_5(0.2),s_4(0.3),s_3(0.2),s_2(0.3)),s_1)$	$((s_5(0.2),s_4(0.4),s_3(0.2),s_2(0.2)),s_4)$ $((s_5(0.3),s_4(0.4),s_3(0.2),s_2(0.1)),s_3)$ $((s_5(0.1),s_3(0.4),s_2(0.5)),s_2)$ $((s_5(0.1),s_4(0.2),s_3(0.1),s_2(0.6)),s_1)$
a_3	$((s_5(0.4),s_4(0.3),s_2(0.3)),s_4)$ $((s_5(0.4),s_4(0.1),s_3(0.1),s_2(0.4)),s_3)$ $((s_5(0.1),s_4(0.1),s_3(0.5),s_2(0.3)),s_2)$ $((s_5(0.3),s_4(0.3),s_2(0.4)),s_1)$	$((s_5(0.3),s_4(0.3),s_3(0.2),s_2(0.2)),s_4)$ $((s_5(0.3),s_4(0.4),s_3(0.1),s_2(0.2)),s_3)$ $((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_2)$ $((s_5(0.3),s_4(0.3),s_2(0.4)),s_1)$	$((s_5(0.3),s_3(0.3),s_2(0.4)),s_4)$ $((s_5(0.1),s_4(0.3),s_3(0.4),s_2(0.2)),s_3)$ $((s_5(0.3),s_4(0.4),s_2(0.3)),s_2)$ $((s_5(0.3),s_4(0.2),s_3(0.3),s_2(0.2)),s_1)$
a_4	$((s_5(0.1),s_4(0.6),s_2(0.4)),s_4)$ $((s_4(0.5),s_3(0.3),s_2(0.2)),s_3)$ $((s_5(0.1),s_4(0.1),s_3(0.3),s_2(0.5)),s_2)$ $((s_5(0.3),s_4(0.1),s_3(0.4),s_2(0.2)),s_1)$	$((s_5(0.1),s_4(0.2),s_3(0.1),s_2(0.6)),s_4)$ $((s_5(0.1),s_4(0.4),s_3(0.1),s_2(0.4)),s_3)$ $((s_5(0.3),s_4(0.2),s_3(0.3),s_2(0.2)),s_2)$ $((s_5(0.3),s_4(0.2),s_3(0.3),s_2(0.2)),s_1)$	$((s_5(0.4),s_4(0.3),s_3(0.2),s_2(0.1)),s_4)$ $((s_5(0.3),s_4(0.4),s_3(0.2),s_2(0.1)),s_3)$ $((s_5(0.4),s_4(0.4),s_3(0.2)),s_2)$ $((s_5(0.4),s_4(0.2),s_2(0.4)),s_1)$
a_5	$((s_5(0.2),s_4(0.4),s_3(0.2),s_2(0.2)),s_4)$ $((s_5(0.2),s_4(0.5),s_3(0.1),s_2(0.2)),s_3)$ $((s_5(0.1),s_4(0.3),s_3(0.1),s_2(0.5)),s_2)$ $((s_4(0.5),s_3(0.3),s_2(0.1),s_1(0.1)),s_1)$	$((s_5(0.2),s_4(0.5),s_3(0.2),s_2(0.1)),s_4)$ $((s_5(0.2),s_4(0.6),s_2(0.2)),s_3)$ $((s_5(0.1),s_4(0.4),s_2(0.5)),s_2)$ $((s_4(0.6),s_2(0.4)),s_1)$	$((s_5(0.2),s_4(0.4),s_3(0.1),s_2(0.3)),s_4)$ $((s_5(0.3),s_4(0.4),s_3(0.1),s_2(0.2)),s_3)$ $((s_5(0.2),s_4(0.4),s_3(0.1),s_2(0.3)),s_2)$ $((s_5(0.2),s_3(0.7),s_2(0.1)),s_1)$
a_6	$((s_5(0.1),s_4(0.4),s_3(0.3),s_2(0.2)),s_4)$ $((s_5(0.3),s_4(0.4),s_2(0.1),s_1(0.2)),s_3)$ $((s_5(0.3),s_4(0.1),s_2(0.6)),s_2)$ $((s_5(0.1),s_4(0.4),s_3(0.3),s_2(0.2)),s_1)$	$((s_5(0.4),s_4(0.4),s_2(0.2)),s_4)$ $((s_5(0.3),s_4(0.4),s_3(0.2),s_2(0.1)),s_3)$ $((s_5(0.3),s_4(0.1),s_3(0.3),s_2(0.3)),s_2)$ $((s_5(0.3),s_4(0.3),s_2(0.4)),s_1)$	$((s_5(0.2),s_4(0.4),s_3(0.1),s_2(0.3)),s_4)$ $((s_5(0.2),s_4(0.4),s_3(0.2),s_2(0.2)),s_3)$ $((s_5(0.1),s_4(0.5),s_3(0.3),s_2(0.1)),s_2)$ $((s_5(0.4),s_4(0.5),s_3(0.1)),s_1)$

Table A1. *Cont.*

	c_{13}	c_{14}	c_{15}
a_1	$((s_5(0.2), s_4(0.5), s_3(0.3), s_2(0.3)), s_4)$ $((s_5(0.3), s_4(0.1), s_3(0.2), s_2(0.4)), s_3)$ $((s_5(0.3), s_4(0.3), s_3(0.3), s_2(0.1)), s_2)$ $((s_4(0.6), s_2(0.4)), s_1)$	$((s_5(0.3), s_4(0.4), s_3(0.2), s_2(0.1)), s_4)$ $((s_5(0.2), s_4(0.4), s_3(0.3), s_2(0.1)), s_3)$ $((s_5(0.1), s_4(0.2), s_3(0.3), s_2(0.4)), s_2)$ $((s_5(0.3), s_4(0.3), s_3(0.2), s_2(0.2)), s_1)$	$((s_5(0.3), s_4(0.2), s_3(0.3), s_2(0.2)), s_4)$ $((s_5(0.4), s_4(0.2), s_2(0.4)), s_3)$ $((s_5(0.2), s_4(0.2), s_3(0.2), s_2(0.4)), s_2)$ $((s_5(0.2), s_3(0.8)), s_1)$
a_2	$((s_4(0.4), s_3(0.4), s_1(0.2)), s_4)$ $((s_5(0.2), s_4(0.3), s_3(0.3), s_2(0.2)), s_3)$ $((s_5(0.2), s_4(0.2), s_3(0.3), s_2(0.3)), s_2)$ $((s_5(0.2), s_3(0.6), s_2(0.2)), s_1)$	$((s_5(0.3), s_4(0.3), s_3(0.1), s_2(0.3)), s_4)$ $((s_5(0.1), s_4(0.6), s_3(0.2), s_2(0.1)), s_3)$ $((s_5(0.2), s_4(0.3), s_2(0.5)), s_2)$ $((s_4(0.4), s_3(0.1), s_2(0.4), s_1(0.1)), s_1)$	$((s_5(0.1), s_4(0.3), s_3(0.2), s_2(0.4)), s_4)$ $((s_4(0.5), s_2(0.1), s_1(0.4)), s_3)$ $((s_5(0.1), s_4(0.4), s_3(0.1), s_2(0.4)), s_2)$ $((s_4(0.4), s_3(0.3), s_2(0.2), s_1(0.1)), s_1)$
a_3	$((s_5(0.3), s_4(0.2), s_3(0.3), s_2(0.2)), s_4)$ $((s_4(0.4), s_2(0.6)), s_3)$ $((s_5(0.3), s_4(0.3), s_3(0.1), s_2(0.3)), s_2)$ $((s_5(0.1), s_4(0.4), s_3(0.1), s_2(0.4)), s_1)$	$((s_5(0.3), s_4(0.3), s_3(0.1), s_2(0.3)), s_4)$ $((s_5(0.3), s_4(0.1), s_3(0.3), s_2(0.3)), s_3)$ $((s_5(0.2), s_4(0.3), s_3(0.2), s_2(0.3)), s_2)$ $((s_5(0.3), s_3(0.1), s_2(0.6)), s_1)$	$((s_5(0.2), s_4(0.3), s_3(0.2), s_2(0.3)), s_4)$ $((s_4(0.6), s_3(0.2), s_2(0.2)), s_3)$ $((s_5(0.2), s_4(0.4), s_3(0.2), s_2(0.2)), s_2)$ $((s_5(0.3), s_4(0.3), s_2(0.4)), s_1)$
a_4	$((s_4(0.4), s_2(0.4), s_1(0.2)), s_4)$ $((s_5(0.2), s_4(0.4), s_3(0.2), s_2(0.2)), s_3)$ $((s_5(0.2), s_4(0.1), s_3(0.4), s_2(0.3)), s_2)$ $((s_5(0.2), s_4(0.2), s_3(0.1), s_2(0.5)), s_1)$	$((s_5(0.3), s_3(0.3), s_2(0.4)), s_4)$ $((s_5(0.3), s_4(0.2), s_3(0.2), s_2(0.3)), s_3)$ $((s_4(0.4), s_3(0.4), s_1(0.2)), s_2)$ $((s_5(0.3), s_3(0.5), s_2(0.2)), s_1)$	$((s_5(0.3), s_4(0.3), s_2(0.4)), s_4)$ $((s_5(0.1), s_4(0.5), s_3(0.1), s_2(0.3)), s_3)$ $((s_5(0.2), s_4(0.2), s_3(0.3), s_2(0.3)), s_2)$ $((s_5(0.3), s_4(0.6), s_2(0.1)), s_1)$
a_5	$((s_5(0.1), s_4(0.3), s_3(0.4), s_2(0.2)), s_4)$ $((s_5(0.2), s_4(0.2), s_3(0.3), s_2(0.3)), s_3)$ $((s_5(0.1), s_4(0.2), s_3(0.4), s_2(0.3)), s_2)$ $((s_5(0.2), s_4(0.5), s_3(0.3)), s_1)$	$((s_5(0.2), s_4(0.3), s_3(0.4), s_2(0.1)), s_4)$ $((s_5(0.2), s_4(0.3), s_3(0.2), s_2(0.3)), s_3)$ $((s_5(0.2), s_4(0.3), s_3(0.3), s_2(0.2)), s_2)$ $((s_5(0.2), s_4(0.3), s_3(0.2), s_2(0.3)), s_1)$	$((s_5(0.2), s_4(0.3), s_3(0.2), s_2(0.3)), s_4)$ $((s_5(0.2), s_4(0.2), s_2(0.6)), s_3)$ $((s_5(0.2), s_2(0.8)), s_2)$ $((s_5(0.3), s_4(0.3), s_3(0.1), s_2(0.3)), s_1)$
a_6	$((s_4(0.4), s_3(0.4), s_1(0.2)), s_4)$ $((s_4(0.4), s_3(0.3), s_2(0.1), s_1(0.2)), s_3)$ $((s_4(0.5), s_2(0.5)), s_2)$ $((s_5(0.2), s_4(0.4), s_3(0.1), s_2(0.3)), s_1)$	$((s_5(0.3), s_4(0.6), s_2(0.1)), s_4)$ $((s_5(0.2), s_4(0.5), s_2(0.3)), s_3)$ $((s_5(0.2), s_4(0.3), s_3(0.2), s_2(0.3)), s_2)$ $((s_5(0.3), s_4(0.2), s_3(0.2), s_2(0.3)), s_1)$	$((s_5(0.3), s_4(0.3), s_3(0.2), s_2(0.2)), s_4)$ $((s_5(0.3), s_4(0.3), s_3(0.2), s_2(0.2)), s_3)$ $((s_5(0.1), s_4(0.1), s_3(0.7), s_2(0.1)), s_2)$ $((s_4(0.4), s_3(0.4), s_2(0.2)), s_1)$

	c_{16}
a_1	$((s_5(0.2), s_4(0.4), s_2(0.4)), s_4)$ $((s_5(0.3), s_4(0.2), s_3(0.1), s_2(0.4)), s_3)$ $((s_5(0.2), s_4(0.5), s_3(0.1), s_2(0.2)), s_2)$ $((s_5(0.3), s_4(0.1), s_3(0.3), s_2(0.3)), s_1)$
a_2	$((s_5(0.3), s_4(0.3), s_3(0.3), s_2(0.1)), s_4)$ $((s_5(0.1), s_4(0.3), s_2(0.6)), s_3)$ $((s_5(0.3), s_4(0.3), s_2(0.4)), s_2)$ $((s_4(0.4), s_3(0.6)), s_1)$
a_3	$((s_5(0.2), s_4(0.3), s_3(0.2), s_2(0.3)), s_4)$ $((s_5(0.3), s_4(0.1), s_3(0.3), s_2(0.3)), s_3)$ $((s_5(0.2), s_4(0.3), s_3(0.3), s_2(0.2)), s_2)$ $((s_5(0.1), s_4(0.1), s_3(0.4), s_2(0.4)), s_1)$
a_4	$((s_5(0.3), s_4(0.1), s_3(0.1), s_2(0.5)), s_4)$ $((s_5(0.2), s_4(0.3), s_3(0.3), s_2(0.2)), s_3)$ $((s_5(0.3), s_4(0.3), s_3(0.1), s_2(0.3)), s_2)$ $((s_5(0.3), s_3(0.2), s_2(0.5)), s_1)$
a_5	$((s_5(0.2), s_4(0.5), s_3(0.1), s_2(0.2)), s_4)$ $((s_5(0.3), s_4(0.2), s_3(0.2), s_2(0.3)), s_3)$ $((s_4(0.6), s_2(0.4)), s_2)$ $((s_5(0.1), s_4(0.1), s_3(0.4), s_2(0.4)), s_1)$
a_6	$((s_5(0.2), s_4(0.3), s_3(0.2), s_2(0.3)), s_4)$ $((s_5(0.3), s_4(0.2), s_3(0.3), s_2(0.2)), s_3)$ $((s_4(0.4), s_3(0.4), s_2(0.1), s_1(0.1)), s_2)$ $((s_5(0.1), s_4(0.3), s_3(0.3), s_2(0.3)), s_1)$

Appendix B

Table A2. The converted evaluation information.

	c_1	c_2
a_1	$((s_5(0.1586), s_4(0.3868), s_3(0.0835), s_2(0.2232), s_1(0.1478)), s_{2.9737})$	$((s_5(0.1351), s_4(0.2992), s_3(0.2399), s_2(0.2042), s_1(0.1216)), s_{2.8803})$
a_2	$((s_5(0.2811), s_4(0.1405), s_3(0.2991), s_2(0.1982), s_1(0.0811)), s_{2.9374})$	$((s_5(0.2715), s_4(0.2870), s_3(0.1909), s_2(0.1142), s_1(0.1364)), s_{2.8808})$
a_3	$((s_5(0.0109), s_4(0.3417), s_3(0.3000), s_2(0.1207), s_1(0.2267)), s_{2.8850})$	$((s_5(0.0218), s_4(0.3512), s_3(0.2964), s_2(0.1934), s_1(0.1372)), s_{2.9320})$
a_4	$((s_5(0.0600), s_4(0.3599), s_3(0.1199), s_2(0.2303), s_1(0.2298)), s_{2.8192})$	$((s_5(0.0924), s_4(0.2724), s_3(0.2430), s_2(0.3568), s_1(0.0353)), s_{2.9443})$
a_5	$((s_5(0.0921), s_4(0.1885), s_3(0.4007), s_2(0.3017), s_1(0.0079)), s_{2.9893})$	$((s_5(0.1031), s_4(0.3704), s_3(0.1501), s_2(0.3072), s_1(0.0692)), s_{3.0339})$
a_6	$((s_5(0.1152), s_4(0.2367), s_3(0.3097), s_2(0.2891), s_1(0.0492)), s_{3.0039})$	$((s_5(0.1174), s_4(0.1786), s_3(0.3562), s_2(0.2992), s_1(0.0486)), s_{2.9775})$
	c_3	c_4
a_1	$((s_5(0.1158), s_4(0.2157), s_3(0.2411), s_2(0.3599), s_1(0.0675)), s_{3.0192})$	$((s_5(0.1539), s_4(0.4140), s_3(0.0777), s_2(0.2743), s_1(0.0801)), s_{3.0126})$
a_2	$((s_5(0.0452), s_4(0.2097), s_3(0.2562), s_2(0.2526), s_1(0.2364)), s_{3.0415})$	$((s_5(0.3000), s_4(0.2623), s_3(0.1577), s_2(0.2799)), s_{2.9555})$
a_3	$((s_5(0.1282), s_4(0.2035), s_3(0.3871), s_2(0.1961), s_1(0.0851)), s_{3.0109})$	$((s_5(0.2609), s_4(0.4119), s_3(0.0872), s_2(0.2400)), s_{2.9319})$
a_4	$((s_5(0.1016), s_4(0.2625), s_3(0.3109), s_2(0.1001), s_1(0.2248)), s_{3.0535})$	$((s_5(0.1988), s_4(0.3311), s_3(0.1962), s_2(0.2097), s_1(0.0546)), s_{2.9249})$
a_5	$((s_5(0.0312), s_4(0.4402), s_3(0.2000), s_2(0.2312), s_1(0.0975)), s_{2.9195})$	$((s_5(0.2000), s_4(0.2407), s_3(0.3390), s_2(0.2203)), s_{2.9428})$
a_6	$((s_5(0.1083), s_4(0.3101), s_3(0.2088), s_2(0.2931), s_1(0.0798)), s_{2.9994})$	$((s_5(0.3017), s_4(0.2065), s_3(0.1481), s_2(0.3437)), s_{2.9947})$
	c_5	c_6
a_1	$((s_5(0.1805), s_4(0.2483), s_3(0.2517), s_2(0.3195)), s_{2.9494})$	$((s_5(0.0732), s_4(0.2781), s_3(0.2662), s_2(0.2516), s_1(0.1309)), s_{2.9502})$
a_2	$((s_5(0.1862), s_4(0.2642), s_3(0.2249), s_2(0.3247)), s_{2.9870})$	$((s_5(0.1111), s_4(0.3387), s_3(0.1448), s_2(0.3526), s_1(0.0528)), s_{2.9839})$
a_3	$((s_5(0.0766), s_4(0.3729), s_3(0.1093), s_2(0.1813), s_1(0.2599)), s_{2.9202})$	$((s_5(0.2111), s_4(0.2648), s_3(0.1568), s_2(0.3376), s_1(0.0296)), s_{2.9865})$
a_4	$((s_5(0.0891), s_4(0.4554), s_3(0.0658), s_2(0.2272), s_1(0.1625)), s_{2.8820})$	$((s_5(0.1199), s_4(0.2505), s_3(0.2299), s_2(0.3997)), s_{2.8845})$
a_5	$((s_5(0.2313), s_4(0.4493), s_3(0.0626), s_2(0.2568)), s_{2.9472})$	$((s_5(0.1237), s_4(0.1485), s_3(0.2482), s_2(0.4796)), s_{2.8454})$
a_6	$((s_5(0.2893), s_4(0.2553), s_3(0.2137), s_2(0.2417)), s_{2.9721})$	$((s_5(0.2054), s_4(0.2585), s_3(0.2516), s_2(0.2846)), s_{2.9378})$
	c_7	c_8
a_1	$((s_5(0.2740), s_4(0.1732), s_3(0.0851), s_2(0.4347)), s_{2.9960})$	$((s_5(0.3354), s_4(0.2746), s_3(0.1254), s_2(0.2646)), s_{2.9749})$
a_2	$((s_5(0.2336), s_4(0.1876), s_3(0.2077), s_2(0.3528)), s_{3.0217})$	$((s_5(0.3354), s_4(0.2746), s_3(0.1254), s_2(0.2646)), s_{2.9749})$
a_3	$((s_5(0.1011), s_4(0.3703), s_3(0.2592), s_2(0.2693)), s_{2.9521})$	$((s_5(0.1931), s_4(0.3937), s_3(0.2134), s_2(0.1998)), s_{2.9503})$
a_4	$((s_5(0.2896), s_4(0.1909), s_3(0.1887), s_2(0.3308)), s_{2.9288})$	$((s_5(0.1342), s_4(0.2633), s_3(0.3340), s_2(0.2685)), s_{2.9269})$
a_5	$((s_5(0.1611), s_4(0.3893), s_3(0.1489), s_2(0.3007)), s_{2.9184})$	$((s_5(0.1914), s_4(0.3131), s_3(0.0762), s_2(0.4193)), s_{2.9356})$
a_6	$((s_5(0.2861), s_4(0.3174), s_3(0.1032), s_2(0.2933)), s_{2.9689})$	$((s_5(0.3018), s_4(0.2160), s_3(0.0376), s_2(0.4446)), s_{2.9474})$
	c_9	c_{10}
a_1	$((s_5(0.3067), s_4(0.3678), s_3(0.1019), s_2(0.2236)), s_{2.9648})$	$((s_5(0.3230), s_4(0.1927), s_3(0.1835), s_2(0.3009)), s_{2.8930})$
a_2	$((s_5(0.3067), s_4(0.3678), s_3(0.1019), s_2(0.2236)), s_{2.9648})$	$((s_5(0.2165), s_4(0.0725), s_3(0.4205), s_2(0.2905)), s_{2.8984})$
a_3	$((s_5(0.2522), s_4(0.0760), s_3(0.3381), s_2(0.3337)), s_{2.9728})$	$((s_5(0.3481), s_4(0.2251), s_3(0.1169), s_2(0.3099)), s_{2.9697})$
a_4	$((s_5(0.3000), s_4(0.3354), s_3(0.0093), s_2(0.3554)), s_{2.9017})$	$((s_5(0.0882), s_4(0.4236), s_3(0.1931), s_2(0.3341)), s_{2.9295})$
a_5	$((s_5(0.2401), s_4(0.3721), s_3(0.1439), s_2(0.2439)), s_{2.9671})$	$((s_5(0.1652), s_4(0.4229), s_3(0.1581), s_2(0.2454), s_1(0.0084)), s_{2.9881})$
a_6	$((s_5(0.2593), s_4(0.1364), s_3(0.3010), s_2(0.3034)), s_{2.9443})$	$((s_5(0.2014), s_4(0.3427), s_3(0.1478), s_2(0.2448), s_1(0.0632)), s_{2.9581})$
	c_{11}	c_{12}
a_1	$((s_5(0.3153), s_4(0.2542), s_3(0.1979), s_2(0.2326)), s_{2.9851})$	$((s_5(0.2825), s_4(0.3527), s_3(0.1867), s_2(0.1781)), s_{2.9755})$
a_2	$((s_5(0.2517), s_4(0.2547), s_3(0.1954), s_2(0.2981)), s_{2.9845})$	$((s_5(0.2095), s_4(0.3174), s_3(0.2256), s_2(0.2475)), s_{3.0267})$
a_3	$((s_5(0.3000), s_4(0.2938), s_3(0.1695), s_2(0.2367)), s_{2.9686})$	$((s_5(0.2398), s_4(0.1956), s_3(0.2656), s_2(0.2991)), s_{2.9075})$
a_4	$((s_5(0.1647), s_4(0.2620), s_3(0.1647), s_2(0.4085)), s_{2.8676})$	$((s_5(0.3697), s_4(0.3427), s_3(0.1830), s_2(0.1047)), s_{2.9539})$
a_5	$((s_5(0.1656), s_4(0.5226), s_3(0.0834), s_2(0.2284)), s_{3.0075})$	$((s_5(0.2324), s_4(0.3656), s_3(0.1516), s_2(0.2504)), s_{2.9567})$
a_6	$((s_5(0.3417), s_4(0.3363), s_3(0.1179), s_2(0.2042)), s_{2.9944})$	$((s_5(0.2013), s_4(0.4303), s_3(0.1702), s_2(0.1982)), s_{2.9094})$
	c_{13}	c_{14}
a_1	$((s_5(0.2382), s_4(0.3291), s_3(0.2387), s_2(0.2949)), s_{2.8397})$	$((s_5(0.2344), s_4(0.3562), s_3(0.2484), s_2(0.1610)), s_{2.9970})$
a_2	$((s_5(0.1572), s_4(0.2242), s_3(0.3331), s_2(0.2104), s_1(0.0751)), s_{2.9117})$	$((s_5(0.1940), s_4(0.4040), s_3(0.1132), s_2(0.2812), s_1(0.0076)), s_{3.0071})$
a_3	$((s_5(0.2014), s_4(0.2930), s_3(0.1586), s_2(0.3469)), s_{2.9648})$	$((s_5(0.2803), s_4(0.2138), s_3(0.1810), s_2(0.3249)), s_{2.9826})$
a_4	$((s_5(0.1304), s_4(0.3188), s_3(0.1628), s_2(0.3184), s_1(0.0696)), s_{2.8847})$	$((s_5(0.2455), s_4(0.1380), s_3(0.3044), s_2(0.2757), s_1(0.0364)), s_{2.9577})$
a_5	$((s_5(0.1413), s_4(0.2707), s_3(0.3587), s_2(0.2293)), s_{2.9290})$	$((s_5(0.2000), s_4(0.3000), s_3(0.3017), s_2(0.1983)), s_{2.9595})$
a_6	$((s_5(0.0209), s_4(0.4201), s_3(0.2583), s_2(0.1619), s_1(0.1388)), s_{2.9123})$	$((s_5(0.2516), s_4(0.4796), s_3(0.0545), s_2(0.2142)), s_{3.0007})$
	c_{15}	c_{16}
a_1	$((s_5(0.3042), s_4(0.1823), s_3(0.2306), s_2(0.2829)), s_{2.9767})$	$((s_5(0.2397), s_4(0.3325), s_3(0.0787), s_2(0.3491)), s_{2.9325})$
a_2	$((s_5(0.0635), s_4(0.3854), s_3(0.1331), s_2(0.2996), s_1(0.1186)), s_{2.9479})$	$((s_5(0.2188), s_4(0.3089), s_3(0.1839), s_2(0.2884)), s_{2.9794})$
a_3	$((s_5(0.1490), s_4(0.4113), s_3(0.1813), s_2(0.2584)), s_{2.9322})$	$((s_5(0.2231), s_4(0.2213), s_3(0.2680), s_2(0.2876)), s_{2.9659})$
a_4	$((s_5(0.2207), s_4(0.3720), s_3(0.0877), s_2(0.3197)), s_{2.9323})$	$((s_5(0.2684), s_4(0.1967), s_3(0.1718), s_2(0.3631)), s_{2.9343})$
a_5	$((s_5(0.2102), s_4(0.2173), s_3(0.0948), s_2(0.4777)), s_{2.9739})$	$((s_5(0.1862), s_4(0.3925), s_3(0.1368), s_2(0.2846)), s_{3.0082})$
a_6	$((s_5(0.2384), s_4(0.2716), s_3(0.3084), s_2(0.1817)), s_{2.9980})$	$((s_5(0.1871), s_4(0.2857), s_3(0.2781), s_2(0.2306), s_1(0.0184)), s_{2.9773})$

Appendix C

$$\Phi_1(a_i, a_k) = \begin{pmatrix} 0, -0.0644, 0.0129, 0.0144, 0.0020, 0.0010 \\ 0.0038, 0, 0.0167, 0.0182, 0.0058, 0.0048 \\ -0.2187, -0.2832, 0, 0.0014, -0.1851, -0.2025 \\ -0.2432, -0.3076, -0.0245, 0, -0.2096, -0.2269 \\ -0.0336, -0.0980, 0.0110, 0.0124, 0, -0.0173 \\ -0.0162, -0.0807, 0.0120, 0.0134, 0.0010, 0 \end{pmatrix},$$

$$\Phi_2(a_i, a_k) = \begin{pmatrix} 0, -0.1347, 0.0036, -0.0049, -0.0862, -0.0187 \\ 0.0076, 0, 0.0112, 0.0073, 0.0027, 0.0066 \\ -0.0637, -0.1984, 0, -0.0686, -0.1499, -0.0824 \\ 0.0003, -0.1298, 0.0039, 0, -0.0813, -0.0137 \\ 0.0049, -0.0485, 0.0085, 0.0046, 0, 0.0038 \\ 0.0011, -0.1161, 0.0047, 0.0008, -0.0676, 0 \end{pmatrix},$$

$$\Phi_3(a_i, a_k) = \begin{pmatrix} 0, 0.0096, -0.0490, 0.0012, 0.0011, -0.0335 \\ -0.1687, 0, -0.2177, -0.1470, -0.1492, -0.2022 \\ 0.0028, 0.0124, 0, 0.0040, 0.0039, 0.0009, \\ -0.0216, 0.0084, -0.0707, 0, -0.0021, -0.0552 \\ -0.0195, 0.0085, -0.0686, 0.0001, 0, -0, 0530 \\ 0.0019, 0.0115, -0.0155, 0.0031, 0.0030, 0 \end{pmatrix},$$

$$\Phi_4(a_i, a_k) = \begin{pmatrix} 0, -0.1071, -0.1285, 0.0014, -0.0284, -0.0869 \\ 0.0066, 0, -0.0214, 0.0052, 0.0048, 0.0012 \\ 0.0079, 0.0013, 0, 0.0065, 0.0062, 0.0026 \\ -0.0222, -0.0849, -0.1063, 0, -0.0062, -0.0647 \\ 0.0017, -0.0788, -0.1001, 0.0004, 0, -0.0585 \\ 0.0054, -0.0202, -0.0416, 0.0040, 0.0036, 0 \end{pmatrix},$$

$$\Phi_5(a_i, a_k) = \begin{pmatrix} 0, -0.0287, 0.0141, 0.0087, -0.1379, -0.1369 \\ 0.0017, 0, 0.0158, 0.0105, -0.1092, -0.1083 \\ -0.2307, -0.2594, 0, -0.0877, -0.3686, -0.3676 \\ -0.1429, -0.1716, 0.0053, 0, -0.2808, -0.2799 \\ 0.0084, 0.0067, 0.0225, 0.0171, 0, 0.0001 \\ 0.0083, 0.0066, 0.0224, 0.0170, -0.0009, 0 \end{pmatrix},$$

$$\Phi_6(a_i, a_k) = \begin{pmatrix} 0, -0.1075, -0.1990, -0.0588, 0.0014, -0.2111 \\ 0.0059, 0, -0.0915, 0.0027, 0.0073, -0.1037 \\ 0.0109, 0.0050, 0, 0.0077, 0.0123, -0.0122 \\ 0.0032, -0.0486, -0.1402, 0, 0.0046, -0.1523 \\ -0.0260, -0.1335, -0.2250, -0.0848, 0, -0.2372 \\ 0.0116, 0.0057, 0.0007, 0.0083, 0.0130, 0 \end{pmatrix},$$

$$\Phi_7(a_i, a_k) = \begin{pmatrix} 0, -0.0085, -0.0896, -0.0294, -0.0616, -0.0475 \\ 0.0005, 0, 0.0052, -0.0208, -0.0531, -0.0560 \\ 0.0057, -0.0811, 0, -0.0603, -0.0280, -0.1371 \\ 0.0019, 0.0013, 0.0039, 0, 0.0021, -0.0769 \\ 0.0039, 0.0034, 0.0018, -0.0322, 0, -0.1091 \\ 0.0030, 0.0036, 0.0088, 0.0049, 0.0070, 0 \end{pmatrix},$$

$$\Phi_8(a_i,a_k)=\begin{pmatrix} 0,0,0.0045,0.0131,0.0120,0.0084 \\ 0,0,0.0045,0.0131,0.0120,0.0084 \\ -0.0665,-0.0665,0,0.0086,0.0076,0.0039 \\ -0.1948,-0.1948,-0.1283,0,-0.0162,-0.0700 \\ -0.1786,-0.1786,-0.1122,0.0011,0,-0.0538 \\ -0.1248,-0.1248,-0.0583,0.0047,0.0036,0 \end{pmatrix},$$

$$\Phi_9(a_i,a_k)=\begin{pmatrix} 0,0,0.0122,0.0065,0.0040,0.0106 \\ 0,0,0.0122,0.0065,0.0040,0.0106 \\ -0.1789,-0.1789,0,-0.0830,-0.1203,-0.0226 \\ -0.0960,-0.0960,0.0056,0,-0.0373,0.0041 \\ -0.0586,-0.0586,0.0082,0.0025,0,0.0067 \\ -0.1564,-0.1564,0.0015,-0.0604,-0.0977,0 \end{pmatrix},$$

$$\Phi_{10}(a_i,a_k)=\begin{pmatrix} 0,0.0079,-0.0719,0.0105,-0.0190,0.0030 \\ -0.1232,0,-0.1951,-0.0413,-0.1421,-0.0768 \\ 0.0046,0.0124,0,0.0151,0.0034,0.0075 \\ -0.1644,0.0026,-0.2364,0,-0.1834,-0.1181 \\ 0.0012,0.0091,-0.0530,0.0117,0,0.0042 \\ -0.0464,0.0049,-0.1182,0.0075,-0.0653,0 \end{pmatrix},$$

$$\Phi_{11}(a_i,a_k)=\begin{pmatrix} 0,0.0051,0.0006,0.0162,0.0011,-0.0656 \\ -0.0756,0,-0.0663,0.0111,-0.0589,-0.1412 \\ -0.0093,0.0044,0,0.0156,0.0005,-0.0749 \\ -0.2411,-0.1655,-0.2318,0,-0.2244,-0.3067 \\ -0.0167,0.0040,-0.0074,0.0151,0,-0.0823 \\ 0.0044,0.0095,0.0050,0.0206,0.0055,0 \end{pmatrix},$$

$$\Phi_{12}(a_i,a_k)=\begin{pmatrix} 0,0.0047,0.0113,-0.0809,0.0049,0.0056 \\ -0.0694,0,0.0066,-0.1503,0.0001,0.0009 \\ -0.1660,-0.0966,0,-0.2469,-0.0944,-0.0837 \\ 0.0055,0.0102,0.0168,0,0.0104,0.0111 \\ -0.0716,-0.0021,0.0064,-0.1525,0,0.0007 \\ -0.0823,-0.0129,0.0057,-0.1632,-0.0107,0 \end{pmatrix},$$

$$\Phi_{13}(a_i,a_k)=\begin{pmatrix} 0,0.0030,0.0092,0.0008,0.0070,0.0018 \\ -0.0527,0,-0.1096,0.0021,-0.0720,0.0048 \\ -0.1623,0.0062,0,0.0083,0.0021,0.0110 \\ -0.0146,-0.0381,-0.1477,0,-0.1101,0.0027 \\ -0.1247,0.0041,-0.0376,0.0062,0,0.0089 \\ -0.0325,-0.0852,-0.1948,-0.0471,-0.1572,0 \end{pmatrix},$$

$$\Phi_{14}(a_i,a_k)=\begin{pmatrix} 0,0.0040,0.0051,0.0106,0.0054,-0.0410 \\ -0.0599,0,0.0011,0.0065,0.0014,-0.1009 \\ -0.0767,-0.0167,0,0.0054,0.0003,-0.1176 \\ -0.1573,-0.0973,-0.0806,0,-0.0763,-0.1982 \\ -0.0810,-0.0211,-0.0043,0.0051,0,-0.1220 \\ 0.0027,0.0068,0.0079,0.0133,0.0082,0 \end{pmatrix},$$

$$\Phi_{15}(a_i, a_k) = \begin{pmatrix} 0, 0.0162, 0.0042, 0.0026, 0.0089, -0.0237 \\ -0.2488, 0, -0.1848, -0.2091, -0.1120, -0.2725 \\ -0.0640, 0.0120, 0, -0.0243, 0.0047, -0.0877 \\ -0.0398, 0.0136, 0.0016, 0, 0.0063, -0.0635 \\ -0.1368, 0.0073, -0.0728, -0.0971, 0, -0.1605 \\ 0, 0015, 0.0177, 0.0057, 0.0041, 0.0104, 0 \end{pmatrix},$$

$$\Phi_{16}(a_i, a_k) = \begin{pmatrix} 0, -0.0209, 0.0009, 0.0018, -0.0400, 0.0007 \\ 0.0013, 0, 0.0022, 0.0031, -0.0190, 0.0020 \\ -0.0138, -0.0347, 0, 0.0009, -0.0537, -0.0034 \\ -0.0280, -0.0489, -0.0142, 0, -0.0680, -0.0176 \\ 0.0025, 0.0012, 0.0034, 0.0043, 0, 0.0032 \\ -0.0104, -0.0313, 0.0002, 0.0011, -0.0503, 0 \end{pmatrix}.$$

Appendix D

Table A3. The PLTSs-based evaluation information.

	c_1	c_2
a_1	$(s_5(0.150), s_4(0.375), s_3(0.100), s_2(0.250), s_1(0.125))$	$(s_5(0.125), s_4(0.300), s_3(0.275), s_2(0.175), s_1(0.125))$
a_2	$(s_5(0.250), s_4(0.200), s_3(0.275), s_2(0.225), s_1(0.050))$	$(s_5(0.250), s_4(0.300), s_3(0.175), s_2(0.175), s_1(0.100))$
a_3	$(s_5(0.025), s_4(0.350), s_3(0.300), s_2(0.150), s_1(0.175))$	$(s_5(0.025), s_4(0.350), s_3(0.275), s_2(0.225), s_1(0.125))$
a_4	$(s_5(0.075), s_4(0.375), s_3(0.150), s_2(0.225), s_1(0.175))$	$(s_5(0.100), s_4(0.300), s_3(0.200), s_2(0.350), s_1(0.050))$
a_5	$(s_5(0.075), s_4(0.200), s_3(0.325), s_2(0.375), s_1(0.025))$	$(s_5(0.100), s_4(0.300), s_3(0.100), s_2(0.375), s_1(0.125))$
a_6	$(s_5(0.100), s_4(0.250), s_3(0.275), s_2(0.300), s_1(0.075))$	$(s_5(0.100), s_4(0.250), s_3(0.250), s_2(0.325), s_1(0.0075))$
	c_3	c_4
a_1	$(s_5(0.075), s_4(0.250), s_3(0.225), s_2(0.300), s_1(0.150))$	$(s_5(0.100), s_4(0.450), s_3(0.100), s_2(0.225), s_1(0.125))$
a_2	$(s_5(0.025), s_4(0.025), s_3(0.200), s_2(0.200), s_1(0.325))$	$(s_5(0.300), s_4(0.225), s_3(0.200), s_2(0.275))$
a_3	$(s_5(0.100), s_4(0.300), s_3(0.250), s_2(0.200), s_1(0.150))$	$(s_5(0.275), s_4(0.400), s_3(0.075), s_2(0.250))$
a_4	$(s_5(0.075), s_4(0.275), s_3(0.250), s_2(0.100), s_1(0.300))$	$(s_5(0.175), s_4(0.375), s_3(0.150), s_2(0.225), s_1(0.050))$
a_5	$(s_5(0.050), s_4(0.425), s_3(0.200), s_2(0.250), s_1(0.075))$	$(s_5(0.200), s_4(0.300), s_3(0.225), s_2(0.275))$
a_6	$(s_5(0.100), s_4(0.325), s_3(0.175), s_2(0.300), s_1(0.100))$	$(s_5(0.275), s_4(0.200), s_3(0.150), s_2(0.375))$
	c_5	c_6
a_1	$(s_5(0.175), s_4(0.275), s_3(0.225), s_2(0.325))$	$(s_5(0.100), s_4(0.300), s_3(0.200), s_2(0.250), s_1(0.150))$
a_2	$(s_5(0.150), s_4(0.275), s_3(0.225), s_2(0.350))$	$(s_5(0.125), s_4(0.300), s_3(0.150), s_2(0.350), s_1(0.075))$
a_3	$(s_5(0.100), s_4(0.300), s_3(0.125), s_2(0.275), s_1(0.200))$	$(s_5(0.225), s_4(0.200), s_3(0.150), s_2(0.400), s_1(0.025))$
a_4	$(s_5(0.100), s_4(0.450), s_3(0.075), s_2(0.250), s_1(0.125))$	$(s_5(0.150), s_4(0.225), s_3(0.275), s_2(0.350))$
a_5	$(s_5(0.225), s_4(0.450), s_3(0.050), s_2(0.275))$	$(s_5(0.125), s_4(0.225), s_3(0.250), s_2(0.400))$
a_6	$(s_5(0.275), s_4(0.225), s_3(0.250), s_2(0.250))$	$(s_5(0.200), s_4(0.250), s_3(0.275), s_2(0.275))$
	c_7	c_8
a_1	$(s_5(0.250), s_4(0.150), s_3(0.125), s_2(0.450))$	$(s_5(0.325), s_4(0.250), s_3(0.150), s_2(0.275))$
a_2	$(s_5(0.225), s_4(0.200), s_3(0.200), s_2(0.400))$	$(s_5(0.325), s_4(0.250), s_3(0.150), s_2(0.275))$
a_3	$(s_5(0.125), s_4(0.325), s_3(0.250), s_2(0.300))$	$(s_5(0.175), s_4(0.450), s_3(0.150), s_2(0.225))$
a_4	$(s_5(0.300), s_4(0.200), s_3(0.200), s_2(0.300))$	$(s_5(0.125), s_4(0.250), s_3(0.350), s_2(0.275))$
a_5	$(s_5(0.175), s_4(0.400), s_3(0.150), s_2(0.275))$	$(s_5(0.200), s_4(0.300), s_3(0.125), s_2(0.375))$
a_6	$(s_5(0.275), s_4(0.275), s_3(0.125), s_2(0.325))$	$(s_5(0.275), s_4(0.225), s_3(0.100), s_2(0.400))$
	c_9	c_{10}
a_1	$(s_5(0.275), s_4(0.350), s_3(0.150), s_2(0.225))$	$(s_5(0.325), s_4(0.250), s_3(0.150), s_2(0.275))$
a_2	$(s_5(0.275), s_4(0.350), s_3(0.150), s_2(0.225))$	$(s_5(0.225), s_4(0.100), s_3(0.400), s_2(0.275))$
a_3	$(s_5(0.225), s_4(0.125), s_3(0.250), s_2(0.400))$	$(s_5(0.325), s_4(0.250), s_3(0.150), s_2(0.275))$
a_4	$(s_5(0.300), s_4(0.325), s_3(0.025), s_2(0.350))$	$(s_5(0.125), s_4(0.325), s_3(0.250), s_2(0.325))$
a_5	$(s_5(0.250), s_4(0.325), s_3(0.100), s_2(0.275))$	$(s_5(0.125), s_4(0.425), s_3(0.175), s_2(0.250), s_1(0.025))$
a_6	$(s_5(0.250), s_4(0.175), s_3(0.275), s_2(0.300))$	$(s_5(0.200), s_4(0.325), s_3(0.150), s_2(0.275), s_1(0.050))$

Table A3. *Cont.*

	c_{11}	c_{12}
a_1	$(s_5(0.300), s_4(0.225), s_3(0.225), s_2(0.250))$	$(s_5(0.250), s_4(0.375), s_3(0.175), s_2(0.200))$
a_2	$(s_5(0.225), s_4(0.275), s_3(0.175), s_2(0.325))$	$(s_5(0.175), s_4(0.250), s_3(0.225), s_2(0.350))$
a_3	$(s_5(0.300), s_4(0.275), s_3(0.150), s_2(0.275))$	$(s_5(0.250), s_4(0.225), s_3(0.250), s_2(0.275))$
a_4	$(s_5(0.200), s_4(0.250), s_3(0.200), s_2(0.350))$	$(s_5(0.375), s_4(0.325), s_3(0.150), s_2(0.150))$
a_5	$(s_5(0.125), s_4(0.525), s_3(0.050), s_2(0.300))$	$(s_5(0.225), s_4(0.300), s_3(0.250), s_2(0.225))$
a_6	$(s_5(0.325), s_4(0.300), s_3(0.125), s_2(0.250))$	$(s_5(0.225), s_4(0.450), s_3(0.175), s_2(0.150))$
	c_{13}	c_{14}
a_1	$(s_5(0.200), s_4(0.375), s_3(0.200), s_2(0.300))$	$(s_5(0.225), s_4(0.325), s_3(0.250), s_2(0.200))$
a_2	$(s_5(0.175), s_4(0.175), s_3(0.375), s_2(0.225), s_1(0.050))$	$(s_5(0.150), s_4(0.400), s_3(0.100), s_2(0.325), s_1(0.025))$
a_3	$(s_5(0.175), s_4(0.325), s_3(0.125), s_2(0.375))$	$(s_5(0.275), s_4(0.175), s_3(0.175), s_2(0.375))$
a_4	$(s_5(0.150), s_4(0.275), s_3(0.175), s_2(0.350), s_1(0.050))$	$(s_5(0.225), s_4(0.150), s_3(0.350), s_2(0.225), s_1(0.050))$
a_5	$(s_5(0.150), s_4(0.300), s_3(0.350), s_2(0.200))$	$(s_5(0.200), s_4(0.300), s_3(0.275), s_2(0.225))$
a_6	$(s_5(0.050), s_4(0.425), s_3(0.200), s_2(0.225), s_1(0.100))$	$(s_5(0.250), s_4(0.400), s_3(0.100), s_2(0.250))$
	c_{15}	c_{16}
a_1	$(s_5(0.275), s_4(0.150), s_3(0.325), s_2(0.250))$	$(s_5(0.250), s_4(0.300), s_3(0.125), s_2(0.325))$
a_2	$(s_5(0.050), s_4(0.400), s_3(0.150), s_2(0.275), s_1(0.125))$	$(s_5(0.175), s_4(0.325), s_3(0.225), s_2(0.275))$
a_3	$(s_5(0.175), s_4(0.400), s_3(0.150), s_2(0.275))$	$(s_5(0.200), s_4(0.200), s_3(0.300), s_2(0.300))$
a_4	$(s_5(0.225), s_4(0.400), s_3(0.100), s_2(0.275))$	$(s_5(0.275), s_4(0.175), s_3(0.175), s_2(0.375))$
a_5	$(s_5(0.225), s_4(0.200), s_3(0.075), s_2(0.500))$	$(s_5(0.150), s_4(0.350), s_3(0.175), s_2(0.325))$
a_6	$(s_5(0.175), s_4(0.275), s_3(0.375), s_2(0.175))$	$(s_5(0.150), s_4(0.300), s_3(0.300), s_2(0.225), s_1(0.025))$

Appendix E

Table A4. The transformed evaluation information of Z-numbers.

	c_1	c_2
a_1	$((3.1852, 4.1852, 5.1852), (0.5090.0.7090, 0.8662))$	$((3.1221, 4.1221, 5.1221), (0.4898, 0.6898, 0.8552))$
a_2	$((3.3423, 4.3423, 5.3423), (0.5019, 0.7019, 0.8613))$	$((3.4430, 4.4430, 5.4420), (0.4897, 0.6897, 0.8556))$
a_3	$((2.7893, 3.7893, 4.7893), (0.4917, 0.6917, 0.8538))$	$((2.9269, 3.9269, 4.9269), (0.5007, 0.7007, 0.8608))$
a_4	$((2.7900, 3.7900, 4.7900), (0.4796, 0.6796, 0.8426))$	$((3.0299, 4.0299, 5.0299), (0.5027, 0.7027, 0.8625))$
a_5	$((3.0462, 4.0462, 5.0462), (0.5111, 0.7111, 0.8704))$	$((3.1310, 4.1310, 5.1310), (0.5192, 0.7192, 0.8777))$
a_6	$((3.0797, 4.0797, 5.0797), (0.5142, 0.7142, 0.8718))$	$((3.0171, 4.0171, 5.0171), (0.5089, 0.7089, 0.8686))$
	c_3	c_4
a_1	$((2.9525, 3.9525, 4.9525), (0.5168, 0.7168, 0.8747))$	$((3.2874, 4.2874, 5.2874), (0.5165, 0.7165, 0.8717))$
a_2	$((2.5746, 3.5746, 4.5746), (0.5217, 0.7217, 0.8765))$	$((3.5824, 4.5824, 5.5824), (0.5050, 0.7050, 0.8648))$
a_3	$((3.0937, 4.0937, 5.0937), (0.5155, 0.7155, 0.8731))$	$((3.6937, 4.6937, 5.6937), (0.5004, 0.7004, 0.8613))$
a_4	$((2.9162, 3.9162, 4.9162), (0.5241, 0.7241, 0.8779))$	$((3.3807, 4.3710, 5.3613), (0.4999, 0.6999, 0.8587))$
a_5	$((3.0765, 4.0765, 5.0765), (0.4986, 0.6986, 0.8584))$	$((3.4203, 4.4203, 5.4203), (0.5026, 0.7026, 0.8628))$
a_6	$((3.0739, 4.0739, 5.0739), (0.5140, 0.7140, 0.8699))$	$((3.4662, 4.4662, 5.4662), (0.5128, 0.7128, 0.8699))$
	c_5	c_6
a_1	$((3.2899, 4.2899, 5.2899), (0.5039, 0.7039, 0.8637))$	$((2.9110, 3.9110, 4.9110), (0.5042, 0.7042, 0.8634))$
a_2	$((3.3119, 4.3119, 5.3119), (0.5115, 0.7115, 0.8684))$	$((3.1026, 4.1026, 5.1026), (0.5104, 0.7104, 0.8689))$
a_3	$((2.8249, 3.8249, 4.8249), (0.4988, 0.6988, 0.8583))$	$((3.2902, 4.2902, 5.2902), (0.5111, 0.7111, 0.8688))$
a_4	$((3.0815, 4.0815, 5.0815), (0.4905, 0.6905, 0.8548))$	$((3.0907, 4.0907, 5.0907), (0.4912, 0.6912, 0.8546))$
a_5	$((3.6551, 4.6551, 5.6551), (0.5033, 0.7033, 0.8638))$	$((2.9163, 3.9163, 4.9163), (0.4845, 0.6845, 0.8470))$
a_6	$((3.5921, 4.5921, 5.5921), (0.5089, 0.7089, 0.8657))$	$((3.3845, 4.3845, 5.3845), (0.5020, 0.7020, 0.8614))$

Table A4. *Cont.*

	c_7	c_8
a_1	$((3.1873, 4.1542, 5.1212), (0.5123, 0.7123, 0.8714))$	$((3.6810, 4.6810, 5.6810), (0.5093, 0.7093, 0.8663))$
a_2	$((3.2466, 4.2282, 5.2097), (0.5170, 0.7170, 0.8757))$	$((3.6810, 4.6810, 5.6810), (0.5093, 0.7093, 0.8663))$
a_3	$((3.3032, 4.3032, 5.3032), (0.5042, 0.7042, 0.8645))$	$((3.5802, 4.5802, 5.5802), (0.5039, 0.7039, 0.8641))$
a_4	$((3.4393, 4.4393, 5.4393), (0.5001, 0.7001, 0.8604))$	$((3.2632, 4.2632, 5.2632), (0.4989, 0.6989, 0.8619))$
a_5	$((3.4107, 4.4107, 5.4107), (0.4980, 0.6980, 0.8591))$	$((3.2766, 4.2766, 5.2766), (0.5012, 0.7012, 0.8618))$
a_6	$((3.5964, 4.5964, 5.5964), (0.5070, 0.7070, 0.8679))$	$((3.3750, 4.3750, 5.3750), (0.5031, 0.7031, 0.8642))$
	c_9	c_{10}
a_1	$((3.7577, 4.7577, 5.7577), (0.5062, 0.7062, 0.8673))$	$((3.5377, 4.5377, 5.5377), (0.4935, 0.6935, 0.8533))$
a_2	$((3.7577, 4.7577, 5.7577), (0.5062, 0.7062, 0.8673))$	$((3.2151, 4.2151, 5.2151), (0.4938, 0.6938, 0.8568))$
a_3	$((3.2468, 4.2468, 5.2468), (0.5082, 0.7082, 0.8675))$	$((3.6115, 4.6115, 5.6115), (0.5080, 0.7080, 0.8661))$
a_4	$((3.5799, 4.5799, 5.5799), (0.4939, 0.6939, 0.8585))$	$((3.3828, 4.4218, 5.4608), (0.5000, 0.7000, 0.8610))$
a_5	$((3.6085, 4.6085, 5.6085), (0.5075, 0.7075, 0.8659))$	$((3.4911, 4.4911, 5.4911), (0.5128, 0.7128, 0.8716))$
a_6	$((3.3516, 4.3516, 5.3516), (0.5039, 0.7039, 0.8608))$	$((3.3743, 4.3743, 5.3743), (0.5054, 0.7054, 0.8653))$
	c_{11}	c_{12}
a_1	$((3.6522, 4.6522, 5.6522), (0.5112, 0.7112, 0.8679))$	$((3.7395, 4.7395, 5.7395), (0.5086, 0.7086, 0.8681))$
a_2	$((3.4601, 4.4601, 5.4601), (0.5111, 0.7111, 0.8679))$	$((3.4890, 4.4890, 5.4890), (0.5179, 0.7179, 0.8765))$
a_3	$((3.6571, 4.6571, 5.6571), (0.5074, 0.7074, 0.8670))$	$((3.3762, 4.3762, 5.3762), (0.4960, 0.6960, 0.8572))$
a_4	$((3.1830, 4.1830, 5.1830), (0.4882, 0.6882, 0.8516))$	$((3.9774, 4.9774, 5.9774), (0.5047, 0.7047, 0.8644))$
a_5	$((3.6254, 4.6254, 5.6254), (0.5146, 0.7146, 0.8729))$	$((3.5801, 4.5801, 5.5801), (0.5049, 0.7049, 0.8656))$
a_6	$((3.8155, 4.8155, 5.8155), (0.5123, 0.7123, 0.8706))$	$((3.6346, 4.6346, 5.6346), (0.4964, 0.6964, 0.8574))$
	c_{13}	c_{14}
a_1	$((3.8135, 4.9145, 6.0154), (0.4822, 0.6822, 0.8486))$	$((3.6640, 4.6640, 5.6640), (0.5130, 0.7130, 0.8707))$
a_2	$((3.1780, 4.1780, 5.1780), (0.4964, 0.6964, 0.8588))$	$((3.4955, 4.4955, 5.4955), (0.5145, 0.7145, 0.8731))$
a_3	$((3.3490, 4.3490, 5.3490), (0.5075, 0.7075, 0.8647))$	$((3.4495, 4.4495, 5.4495), (0.5101, 0.7101, 0.8688))$
a_4	$((3.1220, 4.1120, 5.1120), (0.4907, 0.6907, 0.8559))$	$((3.2805, 4.2805, 5.2805), (0.5052, 0.7052, 0.8655))$
a_5	$((3.3240, 4.3240, 5.3240), (0.5001, 0.7001, 0.8604))$	$((3.5017, 4.5017, 5.5017), (0.5059, 0.7059, 0.8651))$
a_6	$((3.0224, 4.0224, 5.0224), (0.4971, 0.6971, 0.8575))$	$((3.7686, 4.7686, 5.7686), (0.5138, 0.7138, 0.8709))$
	c_{15}	c_{16}
a_1	$((3.5078, 4.5078, 5.5078), (0.5089, 0.7089, 0.8681))$	$((3.4628, 4.4628, 5.4628), (0.5006, 0.7006, 0.8613))$
a_2	$((2.9756, 3.9756, 4.9756), (0.5042, 0.7042, 0.8622))$	$((3.4582, 4.4582, 5.4582), (0.5102, 0.7102, 0.8668))$
a_3	$((3.4508, 4.4508, 5.4508), (0.5007, 0.7007, 0.8610))$	$((3.3799, 4.3799, 5.3799), (0.5068, 0.7068, 0.8667))$
a_4	$((3.4937, 4.4937, 5.4937), (0.5009, 0.7009, 0.8605))$	$((3.3704, 4.3704, 5.3704), (0.5007, 0.7007, 0.8620))$
a_5	$((3.1600, 4.1600, 5.1600), (0.5089, 0.7089, 0.8666))$	$((3.4802, 4.4802, 5.4802), (0.5148, 0.7148, 0.8728))$
a_6	$((3.5667, 4.5667, 5.5667), (0.5129, 0.7129, 0.8715))$	$((3.3927, 4.3927, 5.3927), (0.5088, 0.7088, 0.8686))$

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