mathematics

Article

Identifying Qualified Public Safety Education Venues Using the Dempster–Shafer Theory-Based PROMETHEE Method under Linguistic Environments

Yiqian Zhang [1], Yutong Dai [1] and Bo Liu [2,*]

[1] School of Economics and Management, Northeast Forestry University, Harbin 150040, China
[2] Department of Sociology, Northeast Forestry University, Harbin 150040, China
* Correspondence: liubo1596@nefu.edu.cn

Abstract: How to improve safety awareness is an important topic, and it is of great significance for the public to reduce losses in the face of disasters and crises. A public safety education venue is an important carrier to realize safety education, as it has the characteristics of professionalism, comprehensiveness, experience, interest, participation, and so on, arousing the enthusiasm of the public for learning. As a meaningful supplement to "formal safety education", venue education has many advantages. However, there are problems in the current venue construction such as imperfect infrastructure, weak professionalism, poor service level, chaotic organizational structure, and low safety, which affect the effect of safety education. To evaluate safety education venues effectively, this study proposes an evidential PROMETHEE method under linguistic environments. The innovation of this study lies in the integration of various linguistic expressions into the Dempster–Shafer theory (DST) framework, realizing the free expression and choice of evaluation information. The results and contributions of this study are summarized as follows. First, a two-tier evaluation index system of public safety education venues including 18 sub-standards is constructed. Secondly, it sets up four levels of quality evaluation for public safety education venues. Third, the belief function is used to represent all kinds of linguistic information, so as to maximize the effect of linguistic information fusion. Fourthly, an evidential PROMETHEE model is proposed to rank the venues. Fifthly, a case study is presented to demonstrate the usage of the proposed method in detail, and the evaluation results are fully analyzed and discussed. The implications of this study are as follows. First of all, to enhance public safety education, people need to face the significance of experiential education venues. Second, experiential education venues can increase learners' enthusiasm for learning. Thirdly, the evaluation index system provided in this paper can be used to guide the construction of appropriate education venues in cities. Fourthly, the method of linguistic information transformation based on DST is also applicable to other decision-making and evaluation problems. Finally, the evidential PROMETHEE method can not only evaluate the quality of education venues, but also be used to rank a group of alternative venues.

Keywords: Dempster–Shafer theory; PROMETHEE method; linguistic decision-making; public safety education; venues evaluation

MSC: 90B50

Citation: Zhang, Y.; Dai, Y.; Liu, B. Identifying Qualified Public Safety Education Venues Using the Dempster–Shafer Theory-Based PROMETHEE Method under Linguistic Environments. *Mathematics* **2023**, *11*, 1011. https://doi.org/10.3390/math11041011

Academic Editor: Ignacio Javier Perez Galvez

Received: 28 December 2022
Revised: 24 January 2023
Accepted: 14 February 2023
Published: 16 February 2023

1. Introduction

With the development of economy and the innovation of science and technology, people's awareness of social development and human happiness is further sublimated. Of these factors, cognition and perception of public safety are the most important [1]. Human beings have an inherent need for knowledge acquisition, especially considering the current wealth of available material. These days, the public is rarely troubled by the problem of overall survival, paying more attention to their personal safety [2]. As part of a society, human beings cannot avoid risks from all sides, and the pursuit of public safety is everyone's right and need. So-called public safety refers to the stable external environment and order needed by society and individual citizens for normal life, work, study, entertainment, and communication [3]. To maintain the public safety of the masses, it is necessary to improve public safety consciousness. One important way to achieve this is through public safety education [4]. Public safety education—also known as safety science popularization or emergency science popularization—is aimed at improving the safety awareness of everyone in the big safety category [5]. This includes methods and skills relevant to most people, helping to avoid or reduce personal injury resulting from various emergencies [6,7]. Public safety education originally originated from countries or regions that face frequent disasters in order to deal with complicated natural environments and efforts to fight disasters. In practice, people living in these regions have accumulated plenty of experience in disaster prevention and mitigation [8], and in conveying the knowledge of these methods and skills via national education provides the public with safety consciousness and skills [9,10].

In today's world, various crises occur frequently, and disasters have led to great losses for mankind. One reason for this is the lack of knowledge of disaster prevention and the serious lack of emergency ability to resist risks and crises [10]. China is a country with a large population which experiences frequent disasters, so it is necessary to strengthen the cultivation and expansion of citizens' safety quality [11]. However, there are still many problems in public safety education, such as an imperfect education system, a low level of education, lack of attention, etc. [12]. The positive aspect is that China has begun to pay attention to the importance of safety education. The country has launched a series of policies and measures to strengthen public safety education, gradually brought safety education into primary and secondary school education, and started to carry out popular science education for children [13].

At present, most countries attach great importance to public safety education [14]. For example, Russia has identified safety education as a "compulsory course" in schools, the United States regards safety education as a "national cause", and Japan's safety education covers all children in kindergarten, primary school, and middle school. However, it is not enough to use the traditional and formal education system, such as primary and secondary school education and publishing books. It is necessary to combine various mixed methods to carry out education, such as multimedia [15]. Stadium education is one such method, which has been widely adopted because of its many advantages [16,17]. (1) The establishment of public safety education venues allows the education department to set up regular education institutions and personnel to carry out education activities. (2) Fixed venues can integrate various education resources together to carry out public safety education activities, assisting with the formation of the local public safety education network, (3) the venue can increase its focus on experiential training links, mainly to guide public safety and emergency evacuation skills, improving the efficiency of training, (4) venues can provide more diversified forms of education to stimulate the public's interest in and enthusiasm for learning.

Public safety education venues are of great significance, so the quality of venues must be strictly controlled to ensure that safety education can achieve the desired effect [17,18]. Investigations of several public safety education venues in Chinese cities identified problems such as imperfect infrastructure, poor professionalism, poor service level, disorganized organization structure, and low safety [19]. Therefore, to provide targeted, effective, and comprehensive safety knowledge services to the whole society, to effectively enhance the safety awareness and safety literacy of its people and to promote the resilience development of cities, it is necessary to conduct a comprehensive evaluation of safety education venues to identify the qualified venues [20].

In the process of evaluation, experts need to use some form of information expression to describe their subjective judgment. Uncertain linguistic expression is one way to describe the qualitative evaluation information [21,22], which is widely used because it can flexibly and appropriately express the decision maker's real opinion on realistic decision-making problems [23,24]. Since Zadeh proposed linguistic variables [25], linguistic expressions have been constantly updated with the development of decision making [26], and scholars have constantly proposed new methods with applicability, such as Fuzzy Linguistic Variable (FLV) [25], 2-Tuple Linguistic Representation (2TLR) [27], Proportional 2-Tuple Linguistic Representation (P2TLR) [28], Hesitant Fuzzy Linguistic Term Set (HFLTS) [29], Linguistic Distribution Assessments (LDA) [30,31], Probabilistic Linguistic Term Set (PLTS) [32], Intuitionistic Linguistic Set (ILS) [33], and Intuitionistic Uncertain Linguistic Set (IULS) [34].

Developments in linguistic decision information improve the accuracy of the information description, enrich the linguistic variable values and enhance the reliability of the decision results and interpretability. However, they also create a number of problems at the same time. For example, in a specific decision problem, only a certain form of information expression can be used, which restricts the DMs' choice [26]. To solve this problem, this paper—with the advantage of the Dempster–Shafer (D-S) theory in expressing uncertain information—proposes transforming all kinds of linguistic information into evidence representation so that DMs can flexibly choose appropriate information expression. In addition, PROMETHEE method is a useful MADM (multiple attribute decision-making) method, but it has some shortcomings in the expression and processing of uncertain information. The advantages of DST provide opportunities for further development of the PROMETHEE method. Therefore, the DS-PROMETHEE method is proposed in this study to enrich the uncertain decision-making method in theory and to help the evaluation of public safety education venues in practice.

The subsequent arrangement of the paper is as follows. Section 2 is a literature review. Section 3 constructs the evaluation index system and the grading standard of public safety education venues. Section 4 presents the evidential PROMETHEE method for the comprehensive evaluation of education venues. Section 5 provides a case study to demonstrate and validate the proposed approach. Finally, the conclusion of this study is stated.

2. Literature Review

In this section, the relevant literature of this study is reviewed, including public safety education and the application of PROMETHEE method and D-S theory in emergency decision-making and evaluation. Finally, the relevant comments are made.

2.1. Public Safety Education

Public safety education refers to the activities or processes that systematically influence the moral character, intelligence, physique, and skills of citizens in accordance with the purpose and requirements of maintaining social public safety [14,20]. Through publicity and education, it aims to cultivate good safety awareness, prevention capacity, and social safety responsibility, helping residents understand the relevant laws and regulations knowledge, correctly deal with daily life and emergencies, prevent the occurrence of safety accidents, and reduce damage incidence, ensuring that residents maintain a normal, orderly, and healthy life [15]. Public safety education can be divided into the following categories: fire safety, food safety, traffic safety, earthquake safety, building safety, and national defense safety, etc. [19]. Chen et al. [35] studied food safety education attitudes and practices among health professionals in China, Peru, and the United States. Smith et al. [36] assessed consumer food safety education needs in Washington state. Chen and Feng [37] analyzed the research results of food safety education over the past 20 years to provide a basis for formulating more effective food safety education interventions in China. Ref. [38] proposed an implementation mechanism and plan for public fire safety education measures, aiming to provide guidance for the reform of the management and education measures of urban public fire safety education in China. Ref. [39] aims to promote safety education policies through standardized manuals and fire safety educators led by fire departments on the front lines responsible for public safety. VuHong [40] selected four primary schools in Vietnam in which to conduct a practical investigation of administrators and teachers, and emphatically analyzed the current situation, necessity, and existing problems of traffic safety education management activities in primary schools. Chen et al. [41] studied the traffic safety publicity and education websites of major cities at home and abroad, and subsequently suggested that China should accelerate the identification of key education groups and establish systematic, professional, and multi-form traffic safety publicity and education content.

2.2. Application of the PROMETHEE Method in Emergency Problems

PROMETHEE is a type of MADM method that does not need dimensionless and standardized treatment of the evaluation index, avoids missing information and deviation of the results, and makes evaluation results more objective and scientific. As a result, it is widely used in decision making and evaluation problems and has played an important role in recent emergency problems. Caliskan et al. [42] used a combination of AHP and PROMETHEE methods based on Likert scales for risk analysis and selection of consequences modeling software. Ghandi et al. [43] proposed a fuzzy PROMTHEE decision-making method to help DMs select a set of possible drinking water supply management options to avoid urban water supply crises. Liu [44] developed an integrated cloud model and a PROMETHEE framework for the management of group behavior in FMEA and applied it to the emergency department. Nassereddine et al. [45] proposed a MADM approach to evaluate emergency response systems that take interaction synergies into account, and the effectiveness and applicability of this approach was demonstrated in a real case in Lebanon. Esmaelian et al. [46] established a multi-criteria spatial decision support system based on the PROMETHEE method to determine shelter and emergency service locations in urban evacuation planning. Celik and Gumus [47] proposed a hybrid method consisting of interval type 2 fuzzy sets, AHP, and PROMETHEE to evaluate the emergency preparedness and response capabilities of NGOs. Rezaei-Malek et al. [48] used the PROMETHEE method to establish a multi-objective, two-stage stochastic, non-linear, and mixed-integer mathematical model for disaster management rescue prelocation. They also proposed a new hybrid fuzzy PROMETHEE method to rank the vulnerability of earthquake-prone areas [49].

Although PROMETHEE method has been widely applied in emergency management, along with the aggravation of risks, the decision-making problem is becoming more and more complex, and the uncertainty is also growing, which requires in-depth research on the basis of traditional PROMETHEE method. This study will make use of the advantages of D-S theory in uncertainty expression and treatment to develop the PROMETHEE method, with the purpose of expanding the uncertainty decision theory and completing the evaluation of public safety education venues.

2.3. Application of the Dempster–Shafer Theory in Emergency/Disaster Management

The D-S theory is widely used in emergency management and disaster management. Deng et al. have carried out extensive work identifying critical success factors in emergency systems, proposing an evidential DEMATEL method [50] and a hybrid intelligent model [51], respectively. Fei et al. conducted extensive exploration in the field of emergency decision-making. Based on the D-S theory, they proposed a heterogeneous multi-attribute emergency decision-making method [52], a rescuers dispatch and allocation model [53], and a disaster reduction education strategy evaluation method based on the evidential MULTI-MOORA method [26]. Ref. [54] systematically evaluated the feasibility of an offshore oil spill contingency plan from the perspective of information availability and accuracy. Then, the researchers presented a new method for assessing the percentage of building collapses using timely disaster information and geographical location. Milaghardan et al. [55] used slope, elevation, geomorphic conditions, earth curvature, proximity to rivers, and proximity to faults, among other parameters, to prepare a landslide hazard map using an entropy index and used D-S theory to calculate the confidence value. Ref. [56] proposed a framework for assessing the resilience of housing infrastructure by combining D-S theory and the best–worst method. Ref. [57] proposed a multi-source information fusion analysis method for tunnel water inrush disaster based on the improved D-S theory. Shahraki et al. [58] used D-S theory and combined user profiles, tweets, and location attachments to estimate where accidents occurred. Ref. [59] proposed a hybrid information fusion method integrating D-S theory and cluster analysis to evaluate the regional resilience in early earthquake.

2.4. Analysis

The following conclusions can be drawn from the above survey of the literature related to this study, which also drives the development of this study. (1) In terms of public safety education, the current research mainly focuses on the investigation and suggestions of the status quo of safety education. It also pays attention to the research on campus safety education. However, the research of experiential safety education, which has innate advantages in propagating knowledge and guiding the public, is rarely involved. (2) Experiential safety education has only just begun, and there are still many problems to be solved in the construction process of education venues, such as the lack of administrative guidance and incentive, the single display and experience content, and the operation of experience venues. However, there is no relevant research to guide the construction of qualified public safety education venues. (3) The PROMETHEE method and D-S theory have been effectively applied in emergency and disaster management, and have made considerable contributions, but their joint application has not been explored in the field of safety, so the evaluation of public safety education venues based on the PROMETHEE method and D-S theory is worthy of study.

3. Evaluation Criteria of Qualified Public Safety Education Venues

The evaluation of public safety education venues depends on a series of criteria, and the construction of these criteria can be used to guide the evaluation. Therefore, it is necessary to start with the significance of the construction of the venues, deeply analyze the essential requirements for the public education venues and thus develop the evaluation index system. This section will first construct the evaluation criteria and then provide the grade division to make it easier to distinguish different levels of venues.

3.1. Construction of the Evaluation Index System

This study begins with the practice of public safety education and combines many relevant standards from China to formulate an evaluation index system. We visited and inspected the public safety education venues in different cities in China, experienced the content and services they provided and further identified the key factors. From this, we identified five major dimensions as the most important assessment criteria: infrastructure, specialty, service, organization, and safety [60].

The four main aspects of infrastructure to be investigated are (1) the building area of public safety education venues, which determines whether there is enough space to carry out activities and arrange training, (2) the rationality of the layout of the venue (a good layout can extend the existing basis), (3) the coverage of the education theme (the courses, training, and education theme of the venue should comprehensively cover all fields) and (4) the pertinence of the education content. A good venue should reasonably set up relevant learning content for different industries and regions.

Specialty also includes four aspects. The first is to investigate whether the publicity and education methods are diversified, including whether to use a combination of online and offline methods. The second investigates the enthusiasm of the venue in the competition, as well as the awards through the competition, etc. The third aspect considers cooperation with the outside world: a good venue should constantly strengthen exchanges and cooperation with different fields, exercising its business ability and improving its service level. The fourth aspect is social influence: good venues should play a demonstrative role and should have a good social influence.

In terms of the service level, three aspects can be examined. The first is the number of visitors and training, the second is the level of convenient services provided to the masses, and the third is the quality of services, including the overall level of explanation, training, teaching, service, management, and other aspects. In terms of organization, three aspects must be considered: First, whether the organization structure of the venue is reasonable, whether the system is perfect, and whether the operation is smooth. Second, the construction of professional staff. The third consideration is the management of the various supporting resources.

Safety refers to whether the venue has safety measures in place, whether it has a mature emergency plan to deal with emergencies, whether it has conducted emergency drills, whether there have been accidents, etc. Specifically, it is necessary to examine whether the venue's pre-plan system is perfect, whether the level of safety is adequate, whether there are enough safety personnel and whether they are professional, how often emergency drills are conducted and, finally, whether there have been major accidents and how they were handled.

Following the above analysis, 11 experts in the field of emergency management and safety science were invited to jointly build a 2-layer evaluation index system for assessing public safety education venues with 18 sub-criteria, as shown in Table 1.

Table 1. The comprehensive index system for assessing public safety education venues.

Dimension	Indicator	Meaning	References
Infrastructure (C_{in})			
Venue area	C_1	The building area of the venue, which is an important indicator for determining the construction scale	[60]
Spatial planning	C_2	The layout of venues is required to be reasonable and make full use of space	[12]
Topic coverage	C_3	It is required to cover different topics of public safety publicity and education	Proposed in this study
Content pertinence	C_4	It is required that the contents of publicity and education should be targeted to specific objects, industries, and regions	[12,60]
Specialty (C_{sp})			
Diversity of means	C_5	Diversified publicity and education methods are required, such as various online platforms, offline visits, etc	[38]
Competition and awards	C_6	Investigate the enthusiasm of participating in various selection and safety knowledge publicity and education competitions, as well as the awards	Proposed in this study
Cooperation	C_7	It is required to strengthen communication and cooperation with venues in different fields, exercise the team's business ability, and improve the service level	[60]
Social influence	C_8	Social influence and popularity of venues	[38,60]
Service (C_{se})			
The number of reception	C_9	Including the number of people who visit the experience, attend activities, attend training courses, etc	[38,60]
Convenient service	C_{10}	Services provided to the public, such as training visits, learning safety knowledge and skills, etc	[38]
Service quality	C_{11}	Visitors' overall evaluation of the venue in terms of presentation quality, service, and experience	[9]
Organization (C_{or})			
Structure and institution	C_{12}	The rationality of the organization structure, the perfection of the system, and the smoothness of operation	[60]
Professional guidance	C_{13}	Including professional explanation team building, use of various equipment, and guidance team	Proposed in this study
Supporting management	C_{14}	Various supporting resource management, such as internal operation management system, equipment and facilities maintenance, various archives management, etc	[60]
Safety (C_{sa})			
Emergency plan	C_{15}	Complete emergency plans are required to deal with various emergencies	[60]
Safety level	C_{16}	Sufficient safety personnel are required to ensure the safety of visitors and learners	[13]
Emergency drill	C_{17}	It is required to carry out emergency drills regularly	[2,3]
Accident rate	C_{18}	The less frequent accidents, the better	Proposed in this study

3.2. Setting of the Qualification Level

Grading the evaluation results can make it easier to judge the level of a public safety education venue and achieve a visual effect. This study conducts evaluation based on linguistic information, and the linguistic term set used is defined as $S = \{s_0, s_1, s_2, s_3, s_4, s_5, s_6\}$, where s_0 represents the worst and s_6 represents the best. It should be noted that in this study, the assessment information given by the experts is based on discrete linguistic terms, while the result of grading is continuous linguistic information. This paper divides the evaluation results of public safety education venues into four levels: unqualified (0–3), one-star (3–4), two-star (4–5), and three-star (5–6). Table 2 shows the performance of venues at different levels in five dimensions.

Table 2. Performance of different levels of public safety education venues in five dimensions.

	Infrastructure	Specialty	Service	Organization	Safety
Unqualified	The venue area is small, the space planning is not reasonable, the theme coverage is poor, the content is chaotic	Single way of propaganda and education, no competition, no cooperation, poor social influence	The number of visitors is very small, no convenient services are provided, the service quality is poor	The organization structure is chaotic, there is no professional guidance team, no supporting management	No emergency plan, not enough safety personnel, no emergency drills, major accidents
One-star	The venue area is general, the space planning is general, the theme coverage is not comprehensive, the content is biased	More ways of propaganda and education, participating in competitions, but not winning awards, less cooperation, general social influence	The number of visitors is large, providing limited convenience services, service quality is average	The organization structure is clear, lacks the professional guidance team, does not provide the supporting management	With emergency plan, there are certain safety personnel, no emergency drill, accident
Two-star	The venue area is large, the space planning is reasonable, the theme coverage is slightly less comprehensive, the content is slightly less targeted	More ways of propaganda and education, participating in competitions, less awards, more cooperation, better social influence	The number of visitors, provide more convenient services, service quality is better	Clear organizational structure, professional guidance team, supporting management is not good enough	With emergency plans, adequate safety personnel, emergency drills, minor accidents
Three-star	The venue area is large enough, the space planning is very reasonable, the theme coverage is comprehensive, the content is targeted	Various ways of propaganda and education, many competitions, and more awards, more cooperation, strong social influence	The number of visitors is very large, providing good convenience service, service quality is good	Clear organizational structure, professional guidance team, supporting good management	With emergency plan, there are sufficient safety personnel, regular emergency drill, no accident

4. Evidential PROMETHEE Method for Identifying Qualified Public Safety Education Venues

4.1. Evidential Representations of Different Linguistic Information

Since the concept of linguistic variables [25] was proposed, research on its expansion has been carried out gradually. Decision making based on linguistic variables is a method used to qualitatively express uncertain decision information in a non-numerical way. Although it is not as accurate as numerical variables, it is closer to human cognitive habits and expression habits in real life, so it is also popular [26,53]. However, the current variety of linguistic information leads to certain invariability, which has been clearly analyzed in the previous section. The solution of this study is to use th belief function to uniformly represent multiple linguistic information sources, maximizing the integration of linguistic decision information.

In essence, the belief function is an expression method of uncertain information [61,62], which is a generalization of probability theory and has been widely used in the field of decision making [63,64]. The two contributors to the theory of belief function are Dempster [65] and Shafer [66], hence also known as Dempster–Shafer theory, or evidence theory. The basis of the theory is the frame of discernment (FOD), which is a set of mutually exclusive elements, and can be expressed as $\tilde{\Omega} = \{\phi, \tilde{\omega}_1, \tilde{\omega}_2, \ldots, \tilde{\omega}_n\}$. In the belief function, $\tilde{\Omega}$ is extended to its power set, which is expressed as $2^{\tilde{\Omega}} = \{\tilde{\omega}_1, \ldots, \tilde{\omega}_n, \{\tilde{\omega}_1, \tilde{\omega}_2\}, \ldots, \tilde{\Omega}\}$. There are $2^{\tilde{\Omega}-1}$ propositions in total (except for the empty set), and the mass of belief 1 is assigned to these propositions, indicating the degree of trust in the propositions. The belief function, also known as the basic probability assignment (BPA) is defined as $m: 2^{\tilde{\Omega}} \to [0,1]$ satisfying $m(\phi) = 0$ and $\sum_{A \in 2^{\tilde{\Omega}}} m(A) = 1$. In fact, the belief function can represent linguistic information to a large extent [53,67], as long as the linguistic term set can be regarded as the FOD. In the following, the transformation ideas and implementation of various kinds of linguistic information (including fuzzy linguistic variable, 2-tuple linguistic representation, proportional 2-tuple linguistic representation, hesitant fuzzy linguistic term set, linguistic distribution assessment, probabilistic linguistic term set, intuitionistic linguistic set, and intuitionistic uncertain linguistic set) to belief functions are introduced. Note that the linguistic information in this section is defined on LTS $S = \{s_k | k = 0, 1, \ldots, 2\tau\}$.

Evidential representation of FLV. The conversion from the fuzzy linguistic variable to belief function is obvious, and the variable in the former can be regarded as a proposition in the latter, which is a single set and has the mass of belief of 1, so that: $\{s_k\} \mapsto m(s_k) = 1$.

Evidential representation of $2FLR$. Here, $2FLR$ is represented as a binary, the former element is a linguistic variable, the latter one is the corresponding mass of belief, so it can be easily converted into a belief function as $< s_k, \alpha > \mapsto m(s_k) = \alpha, m(S) = 1 - \alpha$, where the incomplete mass of belief is assigned to LTS S.

Evidential representation of $P2FLR$. $P2FLR$ allocates the remaining mass of belief to a higher level proposition (one of term in S) of s_k on the basis of $2FLR$, so it is easy to define the transformation from $P2FLR$ to the belief function as: $\{(\alpha s_k, (1-\alpha)s_{k+1})\} \mapsto m(s_k) = \alpha$, $m(s_{k+1}) = 1 - \alpha$.

Evidential representation of $HFLTS$. The $HFLTS$ allows the evaluator to hesitate among several linguistic terms. Therefore, the selected linguistic terms are the proposition in the belief function, and the mass of belief is 1. Therefore, $\{s_{\delta_k}\} \mapsto m(s_{\delta_k}) = 1$.

Evidential representation of LDA. LDA is to assign the mass of belief to each linguistic term, which is actually a natural belief function, so it has: $\{< s_k, \beta_k >\} \mapsto m(s_k) = \beta_k (\beta_k \neq 0)$.

Evidential representation of $PLTS$. $PLTS$ is actually an extension of LDA. It allows the sum of mass of belief of all probabilities to be less than 1, and only needs to allocate the remaining mass of belief to LTS S. Therefore, $\{L^{(k)}(p^{(k)})\} \mapsto m(L^{(k)}) = p^{(k)}$ when $\sum_{k=1}^{\#L(p)} p^{(k)} = 1$, and $m(L^{(k)}) = p^{(k)}, m(S) = 1 - \sum_{k=1}^{\#L(p)} p^{(k)}$ when $\sum_{k=1}^{\#L(p)} p^{(k)} \leq 1$.

Evidential representation of ILS. ILS allows the evaluator to select a linguistic term and provides an intuitionistic fuzzy set to indicate the reliability of the selection. The degree of membership represents the positive part, while the non degree of membership represents the negative part, which is equivalent to the affirmation of the inverse of the selected linguistic term, so it has: $< s_k, (\mu(s_k), \nu(s_k)) > \mapsto m(s_k) = \mu(s_k), m(neg(s_k)) = \nu(s_k), m(S) = 1 - \mu(s_k) - \nu(s_k)$, where $s_i = neg(s_j) \Leftrightarrow N(s_i) + N(s_j) = 2\tau$.

Evidential representation of $IULS$. $IULS$ is an extension of ILS. The membership means that all linguistic terms in the interval are positive, while non membership means that the inverse of elements in the interval is positive, so we have: $< [s_L, s_U], (\mu(s_{[s_L, s_U]}), \nu(s_{[s_L, s_U]})) > \mapsto m(\{s_L, \ldots, s_U\}) = \mu(s_{[s_L, s_U]}), m(\{neg(s_L), \ldots, neg(s_U)\}) = \nu(s_{[s_L, s_U]}), m(S) = 1 - \mu(s_{[s_L, s_U]}) - \nu(s_{[s_L, s_U]})$.

4.2. Evidential PROMETHEE Assessment Model

4.2.1. Problem Description of Public Safety Education Venues Assessment

In order to evaluate public safety education venues, a total of x experts (denoted as $\tilde{\mathbf{E}} = \tilde{e}_k, k = 1, \ldots, x$) are required. Due to different professional backgrounds and specialities, their weight is expressed as $\tilde{\mathbf{W}} = \tilde{w}_k, k = 1, \ldots, x$. There are a total of y venues to be evaluated, expressed as $\tilde{\mathbf{A}} = \tilde{a}_i, i = 1, \ldots, y$. In this study, in addition to rating each venue, these venues should also be compared. Assume that there are z evaluation indicators, expressed as $\tilde{\mathbf{C}} = \tilde{c}_j, j = 1, \ldots, z$, and the corresponding weight is $\tilde{\mathbf{\Omega}} = \tilde{\omega}_j, j = 1, \ldots, z$, in this study, $z = 18$.

This study allows the use of different linguistic information to express the evaluation according to the preference of decision-makers or the applicability of real problems, and then uses the method proposed in Section 4.1 to uniformly convert the evaluation information into belief functions. The original data includes x evaluation matrices from experts, where the kth evaluation matrix is represented by $EM^k = [LIN^k_{ij}]_{y \times z}$, and LIN^k_{ij} represents the evaluation from expert $\tilde{e}_k$ for venues $\tilde{a}_i$ under $\tilde{c}_j$.

4.2.2. The Weights of the Experts

There is heterogeneity among the experts, especially for different problems, so it is necessary to calculate the weight of different experts. This study seeks consistency among experts, so a deviation minimization method [68] is used to meet the following requirements:

$$min \quad \mathcal{D} = \frac{1}{y \times z} \sum_{k=1}^{x} \tilde{w}_k \sum_{i=1}^{y} \sum_{j=1}^{z} (|\mathcal{M}^k_{ij} - \mathcal{M}_{ij}|)$$
$$s.t. \begin{cases} \mathcal{M}_{ij} = \sum_{k=1}^{x} \tilde{w}_k \mathcal{M}^k_{ij} \\ \tilde{w}_k \in [0,1] \\ \sum_{k=1}^{x} \tilde{w}_k = 1 \end{cases} \tag{1}$$

where $\mathcal{D}$ represents the deviation of all experts' assessment information, $\tilde{w}_k$ represents the weight of expert $\tilde{e}_k$, $\mathcal{M}^k_{ij}$ is the clear version of the belief functions m^k_{ij} of LIN^k_{ij}, and $\mathcal{M}_{ij}$ is the group assessment on $\tilde{a}_i$ under $\tilde{c}_j$.

The clarity method of the belief function is given below. If the belief function of the evaluation information of venue $\tilde{a}_i$ under indicator $\tilde{c}_j$ is expressed as LIN_{ij}, then $\mathcal{M}_{ij}$ is defined as:

$$\mathcal{M}_{ij} = \sum_{\varrho=0}^{6} \zeta_{ij}(s_\varrho)\varrho, \tag{2}$$

where ζ_{ij} is defined as:

$$\zeta_{ij}(s_\varphi) = \sum_{s_\varrho \subseteq S} ((|s_\varphi \cap s_\varrho|)/|s_\varrho|) \cdot (m_{ij}(s_\varrho)/(1 - m_{ij}(\phi))), \forall s_\varphi \subseteq S \tag{3}$$

where $|s_\varphi|$ is the cardinality of focal element s_φ, $\zeta_{ij}(s_\varphi)$ indicates the belief of linguistic term s_φ.

4.2.3. Aggregation of the Experts' Evaluation Matrices

In order to comprehensively evaluate public safety education venues, it is necessary to aggregate the evaluation results of all experts. The weights of experts were obtained in the previous section, and the evaluation matrix of experts will be weighted and integrated in this section. The elements in the decision matrix are transformed belief functions, so the fusion uses Dempster's fusion rules, which are expanded on this basis. The specific definitions are as follows.

Let the belief function corresponding to linguistic information LIN^k_{ij} be m^k_{ij}, then the fusion result of evaluation matrix $\tilde{e}_k, k = 1, \ldots, x$ is:

$$\widetilde{m}_{ij} = \bigoplus_{x} \{m_{ij}\}, m_{ij}(s_\varphi) = \sum_{k=1}^{x} \tilde{w}_k \cdot m^k_{ij}(s_\varphi), \forall s_\varphi \subseteq S, \tag{4}$$

where $\oplus$ denotes the fusion rule of Dempster, $m_1 \oplus m_2$ is defined as:

$$m(A) = \frac{\sum_{B \cap C = A} m_1(B) m_2(C)}{1 - K}, K = \sum_{B \cap C = \phi} m_1(B) m_2(C) \tag{5}$$

Note that the Dempster's rule can only be employed for m_1 and m_2 when $K < 1$.

4.2.4. The Evidential Fusion Method for Venue Rating

To rate the different venues, this section further aggregates the criteria based on the aggregated experts' evaluation matrix obtained in the previous section, again using Dempster's fusion rule. The advantage of this approach is that the principle of focusing of Dempster's fusion rule is utilized, which can aggregate the mass of belief in the direction agreed by most criteria, facilitating the mining of the real intention of decision makers regarding complex problems.

Step 1: Calculate criteria weights

Different criteria have different importance in the rating of public safety education venues. This study uses the entropy weight method to calculate the weight of criteria. The essence of the entropy weight method is to give more weight to the criteria with a more discriminative degree.

Firstly, the entropy of each criterion is calculated according to the clear values obtained by using Equation (2):

$$\ell_j = -\kappa \sum_{i=1}^{y} \mathcal{M}_{ij}^* \ln(\mathcal{M}_{ij}^*), \kappa = 1/\ln(y). \tag{6}$$

Then, the weight of the criteria is defined as:

$$\tilde{\omega}_j = (1-\ell_j) / \sum_{j=1}^{z} (1-\ell_j) \tag{7}$$

Step 2: Aggregate criteria values

After the criteria weights are obtained, for each venue to be evaluated, all its criteria values are aggregated, and the method in Section 4.2.3 is still used. Let the belief function of $\tilde{a}_i$ under $\tilde{c}_j$ be m_{ij}, for venue $\tilde{a}_i$, the fusion result of criteria values $\{m_{i1}, m_{i1}, \ldots, m_{iz}\}$ is defined as:

$$\widetilde{m}_i = \bigoplus_{z} \{m_i\}, m_i(s_\varphi) = \sum_{j=1}^{z} \tilde{\omega}_j \cdot m_{ij}(s_\varphi), \forall s_\varphi \subseteq S \tag{8}$$

Step 3: Rating venues

The criteria fusion result of the previous step is still the belief functions, in other words, each venue corresponds to a belief function based on the linguistic term set as the FOD. To facilitate the rating, the belief function is further numerically manipulated as:

$$\zeta_i(s_\varphi) = \sum_{s_\varrho \subseteq S} (|s_\varphi \cap s_\varrho| / |s_\varrho|) \cdot (m_i(s_\varrho)/(1 - m_i(\phi))), \forall s_\varphi \subseteq S \tag{9}$$

where $|s_\varphi|$ is the cardinality of focal element s_φ, $\zeta_i(s_\varphi)$ indicates the belief of linguistic term s_φ. Then, the score for venue $\tilde{a}_i$ is calculated as:

$$\mathcal{M}_i = \sum_{\varrho=0}^{6} \zeta_i(s_\varrho)\varrho \tag{10}$$

Finally, the level of venue $\tilde{a}_i$ is obtained. If $\mathcal{M}_i \in [0, 3]$, then $\tilde{a}_i$ is unqualified, if $\mathcal{M}_i \in [3, 4]$, then venue $\tilde{a}_i$ is one-star, if $\mathcal{M}_i \in [4, 5]$, then $\tilde{a}_i$ is two-star, if $\mathcal{M}_i \in [5, 6]$, then $\tilde{a}_i$ is three-star.

4.2.5. The Evidential PROMETHEE Method for Venue Ranking

The PROMETHEE method is a kind of ranking method that constructs a higher level than relation, which was first proposed by Brans et al. [69]. It uses the preference function, criteria value, and criteria weight provided by decision makers to determine the ranking of alternatives with priority relation. The main steps of the evidential PROMETHEE method are given below.

Step 1: Construct the preference function

The priority function refers to the degree to which venue $\tilde{a}_i$ is superior to $\tilde{a}_k$ under criteria $\tilde{c}_j$. The priority function $p_j(\tilde{a}_i, \tilde{a}_k)$ is defined by the decision-makers considering each attribute $\tilde{c}_j$ as:

$$p_j(\tilde{a}_i, \tilde{a}_k) = f(d_j(\tilde{a}_i, \tilde{a}_k)) \tag{11}$$

where $d_j(\tilde{a}_i, \tilde{a}_k) = \mathcal{M}_{ij} - \mathcal{M}_{kj}$ is the difference (or distance) between two venues under the same criterion.

When $d_j(\tilde{a}_i, \tilde{a}_k) = 0$, then $p_j(\tilde{a}_i, \tilde{a}_k) = 0$, that is, there is no difference between venue $\tilde{a}_i$ and $\tilde{a}_k$. When $p_j(\tilde{a}_i, \tilde{a}_k) = 1$, there is a strict priority relationship between the two venues, indicating the correct degree of considering the proposition "venue $\tilde{a}_i$ is better than $\tilde{a}_k$" from the perspective of criterion $\tilde{c}_j$. p is a non-decreasing function, i.e., when $d_j(\tilde{a}_i, \tilde{a}_k) < 0$, $p_j(\tilde{a}_i, \tilde{a}_k) = 0$.

Step 2: Selected Gaussian preference function

In the actual construction of preference function, Brans recommended six common general criteria. Since the Gauss criterion has shown good performance in practice, it is selected to construct preference function, which is defined as:

$$p_j(\tilde{a}_i, \tilde{a}_k) = \begin{cases} 1 - e^{(-d^2/2\delta^2)}, & d > 0 \\ 0, & d \leq 0 \end{cases} \tag{12}$$

where δ is the distance from the origin to the inflection point of the curve.

Step 3: Calculate the overall preference

For each pair of venues $(\tilde{a}_i, \tilde{a}_k)$, the criterion weight is $\tilde{\omega}_j$, and its overall preference degree is defined as:

$$\pi(\tilde{a}_i, \tilde{a}_k) = \sum_{j=1}^{z} \tilde{\omega}_j p_j(\tilde{a}_i, \tilde{a}_k) \tag{13}$$

Step 4: Calculate the traffic

The positive flow, negative flow, and net flow of venue $\tilde{a}_i$ can be defined as:

$$\begin{cases} \Phi^+(\tilde{a}_i) = \dfrac{1}{y-1} \displaystyle\sum_{k=1,k\neq i}^{z} \pi(\tilde{a}_i, \tilde{a}_k), \\ \Phi^-(\tilde{a}_i) = \dfrac{1}{y-1} \displaystyle\sum_{k=1,k\neq i}^{z} \pi(\tilde{a}_K, \tilde{a}_i), \\ \Phi(\tilde{a}_i) = \Phi^+(\tilde{a}_i) - \Phi^-(\tilde{a}_i) \end{cases} \tag{14}$$

where, $\Phi^+(\tilde{a}_i)$ is the traffic of venue $\tilde{a}_i$ prior to all other venues, $\Phi^-(\tilde{a}_i)$ is the traffic of all other venues prior to Plan venue $\tilde{a}_i$, and $\Phi(\tilde{a}_i)$ is the reflection of the priority degree of venue $\tilde{a}_i$. The larger the value of $\Phi(\tilde{a}_i)$, the higher the priority level of $\tilde{a}_i$.

Step 5: Venue ranking

The corresponding priority can be determined according to the net flow value of each venue. The priority of venues is defined as:

$$\begin{cases} \tilde{a}_i P \tilde{a}_k \Leftrightarrow \Phi(\tilde{a}_i) > \Phi(\tilde{a}_k), \tilde{a}_i \succeq \tilde{a}_k \\ \tilde{a}_i I \tilde{a}_k \Leftrightarrow \Phi(\tilde{a}_i) = \Phi(\tilde{a}_k), \tilde{a}_i \sim \tilde{a}_k \end{cases} \tag{15}$$

where $\succeq$ stands for better and $\sim$ for equivalent.

4.2.6. The Framework of the Assessment Model

The above section completed the description of the main method of this study. Next, it is summarized through a flow chart, which is shown in Figure 1. The evaluation method described in this paper can be divided into three stages: the preparation stage, the evaluation stage, and the decision stage. In the preparation stage, experts in related fields are invited to form a team according to specific evaluation problems (the evaluation problem of public safety education venues in this study), so that the experts can choose appropriate linguistic representations to judge the evaluation objects based on their personal preferences. In the evaluation stage, the evaluation matrices are obtained according to the experts' opinions; various linguistic information is converted into belief function representations based on the methods in Section 4.1; the expert weight is calculated by using the methods in Section 4.2.2; and the multi-expert evaluation matrices are further weighted and fused to obtain the integrated evaluation matrix. The decision stage is divided into two parts, namely rating and ranking. For rating, criteria values continue to be fused on the basis of the integrated evaluation matrix, and then, the belief function corresponding to each alternative (public safety education venue) can be obtained. The score of the alternative can be further numerically obtained, and finally, the level can be obtained according to the score. For ranking, this study uses the PROMETHEE method to determine the priority order of alternatives by using preference function, criteria value, and weight. Finally, it obtains the ranking of the alternatives.

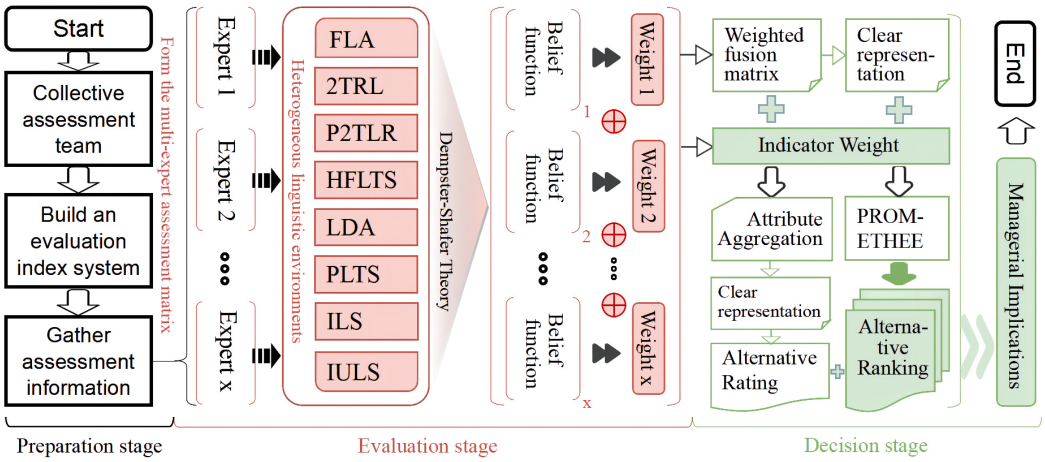

Figure 1. The process for identifying qualified public safety education by using the evidential PROMETHEE method.

5. Identifying Qualified Public Safety Education Venues

This section will demonstrate the whole process of the proposed method through a case and perform in-depth analysis of the evaluation results to obtain meaningful enlightenment.

5.1. Case Description

To cultivate a social public safety sense of responsibility, a gradual formation of public safety awareness is crucial [1,2]. In recent years, China has vigorously carried out public safety education [3] in order to help the public master the knowledge and skills necessary for safety behavior, understand the relevant laws and regulations knowledge, and develop a habitual safe emergency response in daily life [4]. Thus, accidents can be prevented and injuries caused by safety incidents can be reduced to a minimum [5,7].

Public safety education venues are important educational carriers, which have been widely adopted due to their exhibition of interesting scientific information and their interactivity, among other advantages [10]. In China, many cities (such as Beijing, Shanghai, Shenzhen, etc.) have taken the lead in establishing public safety education bases, which have played an important role in popularizing safety knowledge and cultivating public safety awareness.

To develop the cause of public safety education, *Q* city in East China is preparing to build a demonstration public safety education venue (also known as an education base). After preliminary assessment, three alternative venues have been selected from the venues with a certain scale in the city, which are expressed as $\tilde{\mathbf{A}} = \tilde{a}_i, i = 1, 2, 3$. At present, the three venues need to be comprehensively inspected and evaluated. The evaluation is based on the indicator system referred to Section 3.1, with a total of 18 indicators, denoted as $\tilde{\mathbf{C}} = \tilde{c}_j, j = 1, \ldots, 18$.

5.2. Assessment Process

To evaluate the three alternative venues for public safety education, Q city invited three experts from the field of public safety, denoted $\tilde{\mathbf{E}} = \tilde{e}_k, k = 1, 2, 3$. To facilitate the evaluation, the experts are allowed to choose linguistic information to express subjective judgments according to their preferences. The evaluation matrices of the three experts are shown in Table 3. Next, the method proposed in Section 4.1 is used to convert the linguistic information into belief function expression, as shown in Table 4. Then, the obtained belief function needs to be numerized using Equations (2) and (3), as shown in Table 5. The deviation minimization method proposed in Section 4.2.2 is employed to calculate the expert weight as $\tilde{w}_1 = 0.3535, \tilde{w}_2 = 0.4141, \tilde{w}_3 = 0.2324$. For the final decision operation, the experts' evaluation matrices need to be aggregated using the method proposed in Section 4.2.3, and the results are shown in Table 6.

We first rated the public safety education venues. Based on the numerical form of fused assessment matrix in Table 5, the entropy weight method proposed in Equations (6) and (7) can be used to obtain the criteria weight as $\omega_1 = 0.0114, \omega_2 = 0.0078, \omega_3 = 0.0897, \omega_4 = 0.0568, \omega_5 = 0.0208, \omega_6 = 0.0268, \omega_7 = 0.0103, \omega_8 = 0.0450, \omega_9 = 0.0100, \omega_{10} = 0.0036, \omega_{11} = 0.0204, \omega_{12} = 0.0532, \omega_{13} = 0.0847, \omega_{14} = 0.1565, \omega_{15} = 0.2573, \omega_{16} = 0.0516, \omega_{17} = 0.0435, \omega_{18} = 0.0505$. In the next step, Equation (8) is used to complete the aggregation of the criteria values, and the results are $\widetilde{m}_1 = \{('s'_0, 0.0108), ('s'_2, 0.9887), ('s'_4, 0.0003), ('s_2, s'_4, 0.0001)\}$, $\widetilde{m}_2 = \{(('s'_2, 1)\}$, and $\widetilde{m}_3 = \{('s'_4, 0.0553), ('s'_5, 0.9447)\}$. The clear value of the above belief functions can be calculated, so that the scores of the three venues are 1.9789, 2 and 4.93. By referring to the rating criteria set in Section 3.2, we can get the ratings of three public education base venues, *venue* 1 is "unqualified", *venue* 2 is also "unqualified", and *venue* 3 is "two-star". Because its value is close to 5, it is close to the lowest level of "three-star".

The following uses the evidential PROMETHEE method of Section 4.2.5 to rank the alternative public safety education venues. This part is based on the numerical fusion matrix data in Table 6. Firstly, the distance between different venues is calculated, as shown in Table 7. On this basis, the preference relationship between the venues is calculated. The value of δ in the selected Gaussian preference function is set as 5 to obtain the preference relationship as shown in Table 8. Equation (13) is then used to calculate the overall preference indices as $\pi(\tilde{a}_1, \tilde{a}_2) = 0.0057$, $\pi(\tilde{a}_1, \tilde{a}_3) = 0.0209$, $\pi(\tilde{a}_2, \tilde{a}_1) = 0.0094$, $\pi(\tilde{a}_2, \tilde{a}_3) = 0.0112$, $\pi(\tilde{a}_3, \tilde{a}_1) = 0.0977$, $\pi(\tilde{a}_3, \tilde{a}_2) = 0.0832$. According to Equation (14), the positive flow, negative flow, and net flow of the alternative venues can be calculated as $\Phi^+(\tilde{a}_1) = 0.0266$, $\Phi^+(\tilde{a}_2) = 0.0206$, $\Phi^+(\tilde{a}_3) = 0.1809$, $\Phi^-(\tilde{a}_1) = 0.1071$, $\Phi^-(\tilde{a}_2) = 0.0889$, $\Phi^-(\tilde{a}_3) = 0.0321$ and $\Phi(\tilde{a}_1) = -0.0805$, $\Phi(\tilde{a}_2) = -0.0683$, $\Phi(\tilde{a}_3) = 0.1488$, respectively. Finally, the order of net flow of each alternative venue can be obtained as $\tilde{a}_3 \succeq \tilde{a}_2 \succeq \tilde{a}_1$.

All the calculation tasks have been completed above. The results of the evaluation will be analyzed below. Firstly, the rating results of public safety education venues were analyzed. As shown in Figure 2, venues $\tilde{a}_1$ and $\tilde{a}_2$ were rated as unqualified, and venue $\tilde{a}_3$ was identified as a two-star. From this result, it can be concluded that Q city should choose the education venue $\tilde{a}_3$. Second, we analyze the ranking results of public safety education venues. Based on the evidential PROMETHEE method, it is easy to get that the ranking of the three venues is $\tilde{a}_3 \succeq \tilde{a}_2 \succeq \tilde{a}_1$, which is consistent with the rating result. In addition, this paper conducts sensitivity analysis on Gaussian preference function, changes the value of δ, and finds that the conclusion consistent with the above is still obtained when δ takes different parameters.

Table 3. The assessment information for public safety education venues.

Experts	**Venues**	**Criteria**								
		C_1	C_2	C_3	C_4	C_5	C_6	C_7	$\cdots$	C_{18}
$\tilde{e}_1$	$\tilde{a}_1$	$\{(s_3,0.8)$ $(s_4,0.2)\}$	$< s_3,(0.8,0) >$	$< s_3,0.8 >$	$< s_3,(0.9,0.1) >$	$\{(s_5,0.2)$ $(s_6,0.8)\}$	$\{s_2\}$	$< s_1,0.9 >$	$\cdots$	$\{(s_1,0.5)$ $(s_2,0.5)\}$
	$\tilde{a}_2$	$\{(s_2,0.5)$ $(s_3,0.5)\}$	$\{(s_2,0.8)$ $(s_3,0.2)\}$	$\{s_3\}$	$\{(s_4,0.6)$ $(s_5,0.4)\}$	$\{s_4\}$	$\{s_2\}$	$\{(s_2,0.7)$ $(s_3,0.3)\}$	$\cdots$	$< s_2,(0.7,0) >$
	$\tilde{a}_3$	$\{s_4\}$	$< s_2,0.9 >$	$\{(s_1,0.9)$ $(s_2,0.1)\}$	$< s_1,(0.8,0) >$	$\{s_2\}$	$< s_3,0.9 >$	$\{s_2,s_3\}$	$\cdots$	$\{s_3\}$
$\tilde{e}_2$	$\tilde{a}_1$	$\{s_4\}$	$< s_2,0.9 >$	$< s_4,(1,0) >$	$\{s_3\}$	$\{(s_4,0.3)$ $(s_5,0.7)\}$	$\{(s_1,0.6)$ $(s_2,0.4)\}$	$\{s_2\}$	$\cdots$	$\{(s_1,0.4)$ $(s_2,0.3)\}$
	$\tilde{a}_2$	$< s_3,(1,0) >$	$\{s_3\}$	$\{(s_1,0.6)$ $(s_2,0.3)\}$	$\{s_2\}$	$< s_4,0.8 >$	$< s_2,0.9 >$	$< s_2,0.8 >$	$\cdots$	$\{s_1\}$
	$\tilde{a}_3$	$\{(s_4,0.3)$ $(s_5,0.6)\}$	$\{s_2,s_3\}$	$\{(s_0,0.5)$ $(s_1,0.5)\}$	$< s_1,(0.8,0.1) >$	$\{s_4\}$	$< s_3,(1,0) >$	$\{s_2\}$	$\cdots$	$\{s_5\}$
$\tilde{e}_3$	$\tilde{a}_1$	$\{s_4\}$	$< s_2,0.9 >$	$\{s_2\}$	$\{(s_1,0.5)$ $(s_2,0.5)\}$	$\{(s_4,0.9)$ $(s_6,0.1)\}$	$\{s_1\}$	$\{s_0\}$	$\cdots$	$< s_2,0.9 >$
	$\tilde{a}_2$	$\{(s_1,0.3)$ $(s_2,0.7)\}$	$\{s_3\}$	$< s_3,0.9 >$	$\{s_4\}$	$< s_5,0.9 >$	$\{(s_1,0.9)$ $(s_2,0.1)\}$	$\{(s_2,0.9)$ $(s_3,0.1)\}$	$\cdots$	$\{s_3\}$
	$\tilde{a}_3$	$\{(s_5,0.7)$ $(s_6,0.3)\}$	$\{s_2,s_3\}$	$\{s_1\}$	$< s_2,(1,0) >$	$\{s_2\}$	$< s_3,0.9 >$	$\{(s_3,0.6)$ $(s_4,0.4)\}$	$\cdots$	$\{(s_3,0.9)$ $(s_4,0.1)\}$

Table 4. Evidential representations of different linguistic evaluation information.

Experts	**Venues**	**Criteria**								
		C_1	C_2	C_3	C_4	C_5	C_6	C_7	$\cdots$	C_{18}
$\tilde{e}_1$	$\tilde{a}_1$	$m(\{s_3\}) = 0.8$ $m(\{s_4\}) = 0.2$	$m(\{s_3\}) = 0.8$ $m(\{S\}) = 0.2$	$m(\{s_3\}) = 0.8$ $m(\{S\}) = 0.2$	$m(\{s_3\}) = 1$	$m(\{s_5\}) = 0.2$ $m(\{s_6\}) = 0.8$	$m(\{s_2\}) = 1$	$m(\{s_1\}) = 0.9$ $m(\{S\}) = 0.1$	$\cdots$	$m(\{s_1\}) = 0.5$ $m(\{s_2\}) = 0.5$
	$\tilde{a}_2$	$m(\{s_2\}) = 0.5$ $m(\{s_3\}) = 0.5$	$m(\{s_2\}) = 0.8$ $m(\{s_3\}) = 0.2$	$m(\{s_3\}) = 1$	$m(\{s_4\}) = 0.6$ $m(\{s_5\}) = 0.4$	$m(\{s_4\}) = 1$	$m(\{s_2\}) = 1$	$m(\{s_2\}) = 0.7$ $m(\{s_3\}) = 0.3$	$\cdots$	$m(\{s_2\}) = 0.7$ $m(\{S\}) = 0.3$
	$\tilde{a}_3$	$m(\{s_4\}) = 1$	$m(\{s_2\}) = 0.9$ $m(\{S\}) = 0.1$	$m(\{s_1\}) = 0.9$ $m(\{s_2\}) = 0.1$	$m(\{s_1\}) = 0.8$ $m(\{S\}) = 0.2$	$m(\{s_2\}) = 1$	$m(\{s_3\}) = 0.9$ $m(\{S\}) = 0.1$	$m(\{s_2, s_3\}) = 1$	$\cdots$	$m(\{s_3\}) = 1$
$\tilde{e}_2$	$\tilde{a}_1$	$m(\{s_4\}) = 1$	$m(\{s_2\}) = 0.9$ $m(\{S\}) = 0.1$	$m(\{s_4\}) = 1$	$m(\{s_3\}) = 1$	$m(\{s_4\}) = 0.3$ $m(\{s_5\}) = 0.7$	$m(\{s_1\}) = 0.6$ $m(\{s_2\}) = 0.4$	$m(\{s_2\}) = 1$	$\cdots$	$m(\{s_1\}) = 0.4$ $m(\{s_2\}) = 0.3$ $m(\{S\}) = 0.3$
	$\tilde{a}_2$	$m(\{s_3\}) = 1$	$m(\{s_3\}) = 1$	$m(\{s_1\}) = 0.6$ $m(\{s_2\}) = 0.3$ $m(\{S\}) = 0.1$	$m(\{s_2\}) = 1$	$m(\{s_4\}) = 0.8$ $m(\{S\}) = 0.2$	$m(\{s_2\}) = 0.9$ $m(\{S\}) = 0.1$	$m(\{s_2\}) = 0.8$ $m(\{S\}) = 0.2$	$\cdots$	$m(\{s_1\}) = 1$
	$\tilde{a}_3$	$m(\{s_4\}) = 0.3$ $m(\{s_5\}) = 0.6$ $m(\{S\}) = 0.1$	$m(\{s_2, s_3\}) = 1$	$m(\{s_0\}) = 0.5$ $m(\{s_1\}) = 0.5$	$m(\{s_1\}) = 0.8$ $m(\{s_5\}) = 0.1$ $m(\{S\}) = 0.1$	$m(\{s_4\}) = 1$	$m(\{s_3\}) = 1$	$m(\{s_2\}) = 1$	$\cdots$	$m(\{s_5\}) = 1$
$\tilde{e}_3$	$\tilde{a}_1$	$m(\{s_4\}) = 1$	$m(\{s_2\}) = 0.9$ $m(\{S\}) = 0.1$	$m(\{s_2\}) = 1$	$m(\{s_1\}) = 0.5$ $m(\{s_2\}) = 0.5$	$m(\{s_4\}) = 0.9$ $m(\{s_6\}) = 0.1$	$m(\{s_1\}) = 1$	$m(\{s_0\}) = 1$	$\cdots$	$m(\{s_2\}) = 0.9$ $m(\{S\}) = 0.1$
	$\tilde{a}_2$	$m(\{s_1\}) = 0.3$ $m(\{s_2\}) = 0.7$	$m(\{s_3\}) = 1$	$m(\{s_3\}) = 0.9$ $m(\{S\}) = 0.1$	$m(\{s_4\}) = 1$	$m(\{s_5\}) = 0.9$ $m(\{S\}) = 0.1$	$m(\{s_1\}) = 0.9$ $m(\{s_2\}) = 0.1$	$m(\{s_2\}) = 0.9$ $m(\{s_3\}) = 0.1$	$\cdots$	$m(\{s_3\}) = 1$
	$\tilde{a}_3$	$m(\{s_5\}) = 0.7$ $m(\{s_6\}) = 0.3$	$m(\{s_2, s_3\}) = 1$	$m(\{s_1\}) = 1$	$m(\{s_2\}) = 1$	$m(\{s_2\}) = 1$	$m(\{s_3\}) = 0.9$ $m(\{S\}) = 0.1$	$m(\{s_3\}) = 0.6$ $m(\{s_4\}) = 0.4$	$\cdots$	$m(\{s_3\}) = 0.9$ $m(\{s_4\}) = 0.1$

Table 5. Numerical representation of the assessment information.

Experts	Venues	C_1	C_2	C_3	C_4	C_5	C_6	C_7	⋯	C_{18}
	$\tilde{a}_1$	3.2	3.1	3.1	3	5.8	2	1.25	⋯	1.5
$\tilde{e}_1$	$\tilde{a}_2$	2.5	2.2	3	4.4	4	2	2.3	⋯	2.45
	$\tilde{a}_3$	4	2.15	1.1	1.15	2	3.05	2.5	⋯	3
	$\tilde{a}_1$	4	2.15	4	3	4.7	1.4	2	⋯	2.05
$\tilde{e}_2$	$\tilde{a}_2$	3	3	1.55	2	3.5	2.15	2.3	⋯	1
	$\tilde{a}_3$	4.55	2.5	0.5	1.65	4	3	2	⋯	5
	$\tilde{a}_1$	4	2.15	2	1.5	4.2	1	0	⋯	2.15
$\tilde{e}_3$	$\tilde{a}_2$	1.7	3	3.05	4	4.85	1.1	2.1	⋯	3
	$\tilde{a}_3$	3.3	2.5	1	2	2	3.05	3.4	⋯	3.1

Table 6. Fusion and numerical representation of the expert evaluation matrices.

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	⋯	C_{18}
$\tilde{a}_1$	$m(\{s_3\}) = 0.06$ $m(\{s_4\}) = 0.94$	$m(\{s_2\}) = 0.838$ $m(\{s_3\}) = 0.156$ $m(\{S\}) = 0.006$	$m(\{s_2\}) = 0.161$ $m(\{s_3\}) = 0.233$ $m(\{s_5\}) = 0.604$ $m(\{S\}) = 0.002$	$m(\{s_1\}) = 0.004$ $m(\{s_2\}) = 0.004$ $m(\{s_3\}) = 0.992$	$m(\{s_4\}) = 0.522$ $m(\{s_5\}) = 0.366$ $m(\{s_6\}) = 0.113$	$m(\{s_1\}) = 0.458$ $m(\{s_2\}) = 0.542$	$m(\{s_0\}) = 0.137$ $m(\{s_1\}) = 0.282$ $m(\{s_2\}) = 0.581$	⋯	$m(\{s_1\}) = 0.279$ $m(\{s_2\}) = 0.713$ $m(\{S\}) = 0.008$
$\tilde{a}_2$	$m(\{s_1\}) = 0.002$ $m(\{s_2\}) = 0.168$ $m(\{s_3\}) = 0.831$	$m(\{s_2\}) = 0.056$ $m(\{s_3\}) = 0.944$	$m(\{s_1\}) = 0.104$ $m(\{s_2\}) = 0.022$ $m(\{s_3\}) = 0.873$ $m(\{S\}) = 0.001$	$m(\{s_2\}) = 0.423$ $m(\{s_4\}) = 0.56$ $m(\{s_5\}) = 0.017$	$m(\{s_4\}) = 0.935$ $m(\{s_5\}) = 0.063$ $m(\{S\}) = 0.002$	$m(\{s_1\}) = 0.034$ $m(\{s_2\}) = 0.966$	$m(\{s_2\}) = 0.986$ $m(\{s_3\}) = 0.013$ $m(\{S\}) = 0.001$	⋯	$m(\{s_1\}) = 0.621$ $m(\{s_2\}) = 0.191$ $m(\{s_3\}) = 0.183$ $m(\{S\}) = 0.005$
$\tilde{a}_3$	$m(\{s_4\}) = 0.587$ $m(\{s_5\}) = 0.407$ $m(\{s_6\}) = 0.006$	$m(\{s_2\}) = 0.679$ $m(\{s_2, s_3\}) = 0.321$	$m(\{s_0\}) = 0.019$ $m(\{s_1\}) = 0.981$	$m(\{s_1\}) = 0.891$ $m(\{s_2\}) = 0.101$ $m(\{s_5\}) = 0.005$ $m(\{S\}) = 0.003$	$m(\{s_2\}) = 0.749$ $m(\{s_4\}) = 0.251$	$m(\{s_3\}) = 1$	$m(\{s_2\}) = 0.765$ $\{s_3\}) = 0.15$ $m(\{s_4\}) = 0.002$ $m(\{s_2, s_3\}) = 0.083$	⋯	$m(\{s_2\}) = 0.725$ $m(\{s_5\}) = 0.275$
$\tilde{a}_1$	3.9445	2.1616	4.0464	2.9883	4.5905	1.5419	1.4443	⋯	1.7292
$\tilde{a}_2$	2.8294	2.9445	2.7704	3.1701	4.0603	1.9662	2.0140	⋯	1.5675
$\tilde{a}_3$	4.4185	2.1607	0.9808	1.1279	2.5025	3.0000	2.1949	⋯	3.5509

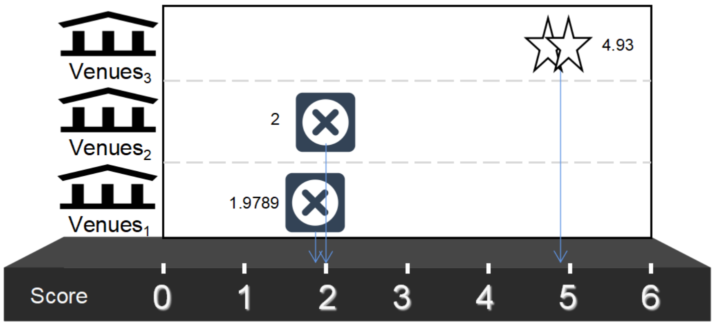

Figure 2. Rating results for the public safety education venues.

Table 7. The distance between the different venues.

Distance	C_1	C_2	C_3	C_4	C_5	C_6	C_7	$\cdots$	C_{18}
$d(\tilde{a}_1, \tilde{a}_2)$	1.1151	−0.7829	1.276	−0.1818	0.5302	−0.424	−0.5697	$\cdots$	0.1617
$d(\tilde{a}_1, \tilde{a}_3)$	−0.474	0.0009	3.0656	1.8604	2.088	−1.4581	−0.7506	$\cdots$	−1.8217
$d(\tilde{a}_2, \tilde{a}_1)$	−1.1151	0.7829	−1.276	0.1818	−0.5302	0.4243	0.5697	$\cdots$	−0.1617
$d(\tilde{a}_2, \tilde{a}_3)$	−1.5891	0.7838	1.7896	2.0422	1.5578	−1.0338	−0.1809	$\cdots$	−1.9834
$d(\tilde{a}_3, \tilde{a}_1)$	0.474	−0.0009	−3.0656	−1.8604	−2.088	1.4581	0.7506	$\cdots$	1.8217
$d(\tilde{a}_3, \tilde{a}_2)$	1.5891	−0.7838	−1.7896	−2.0422	−1.5578	1.0338	0.1809	$\cdots$	1.9834

Table 8. The preference between the different venues when $\delta = 5$.

Preference	C_1	C_2	C_3	C_4	C_5	C_6	C_7	$\cdots$	C_{18}
$p(\tilde{a}_1, \tilde{a}_2)$	0.0246	0	0.0320	0	0.0056	0	0	$\cdots$	0.0005
$p(\tilde{a}_1, \tilde{a}_3)$	0	0.0000	0.1714	0.0669	0.0835	0	0	$\cdots$	0
$p(\tilde{a}_2, \tilde{a}_1)$	0	0.0122	0	0.0007	0	0.0036	0.0065	$\cdots$	0
$p(\tilde{a}_2, \tilde{a}_3)$	0	0.0122	0.0620	0.0800	0.0474	0	0	$\cdots$	0
$p(\tilde{a}_3, \tilde{a}_1)$	0.0045	0	0	0	0	0.0416	0.0112	$\cdots$	0.0642
$p(\tilde{a}_3, \tilde{a}_2)$	0.0493	0	0	0	0	0.0211	0.0007	$\cdots$	0.0757

5.3. Analysis of the Assessment Results

To further verify the effectiveness of the proposed method in determining the venue rating and ranking venues, two comparative analyses are carried out. First of all, the original data (i.e., Table 3) is converted into numerical form, and then the relevant operations are carried out to obtain the scores of each venue. It was found that consistent grade results could be obtained, indicating the effectiveness of the method in this paper. However, compared with such simple numerical calculation, the proposed method has the advantage of improving the flexibility and accuracy of DMs' subjective evaluation. Several other MADM methods are then selected to rank the three venues, all of which ranked $\tilde{a}_3$ first, but for $\tilde{a}_1$ and $\tilde{a}_2$, two results emerged. The reason is that the scores of them are very close, but this difference does not affect the application of this paper, because in the case study, the optimal venue is required to be selected.

To analyze the performance of the three alternative venues under different indicators in more detail, this paper analyzes the performance of each venue under the second-level indicators and first-level indicators, respectively, as shown in Figures 3 and 4. As can be seen from Figure 3, venue $\tilde{a}_1$ performs well in 'Venue area', 'Topic coverage', 'Diversity of means', 'The number of reception', 'Convenient service', and 'Emergency drill', but performs poorly in 'Spatial planning', 'Competition and awards', 'Cooperation', 'Supporting management', 'Emergency plan', and 'Accident rate'. Venue $\tilde{a}_2$ performs well in 'Spatial planning', 'Diversity of means', 'The number of reception', and 'Professional guidance', but poorly in 'Competition and awards', 'Cooperation', 'Service quality', 'Supporting management', 'Emergency plan', and 'Accident rate'. Venue $\tilde{a}_3$ performs well in 'Venue area', 'Competition and awards', 'The number of reception', 'Professional guidance', 'safety level', and 'Emergency drill', but performs poorly in 'Topic coverage', 'Content pertinence', 'Cooperation', 'Service quality', 'Supporting management', and 'Accident rate'.

Figure 4 shows the performance of each venue under the first-level indicators. It can be seen that the order of the three venues in criteria 'Infrastructure', 'Specialty', 'Service', 'Organization', and 'Safety' are $\tilde{a}_1 \succeq \tilde{a}_2 \succeq \tilde{a}_3$, $\tilde{a}_3 \succeq \tilde{a}_2 \succeq \tilde{a}_1$, $\tilde{a}_3 \succeq \tilde{a}_1 \succeq \tilde{a}_2$, $\tilde{a}_3 \succeq \tilde{a}_2 \succeq \tilde{a}_1$, $\tilde{a}_3 \succeq \tilde{a}_1 \succeq \tilde{a}_2$. It can be seen that in the criterion 'Infrastructure', Venue $\tilde{a}_1$ performs best and Venue $\tilde{a}_3$ performs worst, but in the other criteria, Venue $\tilde{a}_3$ performs best, while Venue $\tilde{a}_1$ and Venue $\tilde{a}_2$ perform in a fluctuating manner.

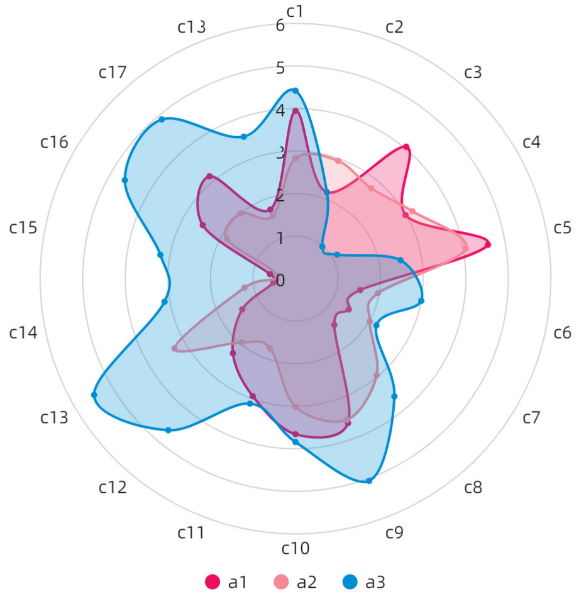

Figure 3. The analysis of the venues under the second-level indicators.

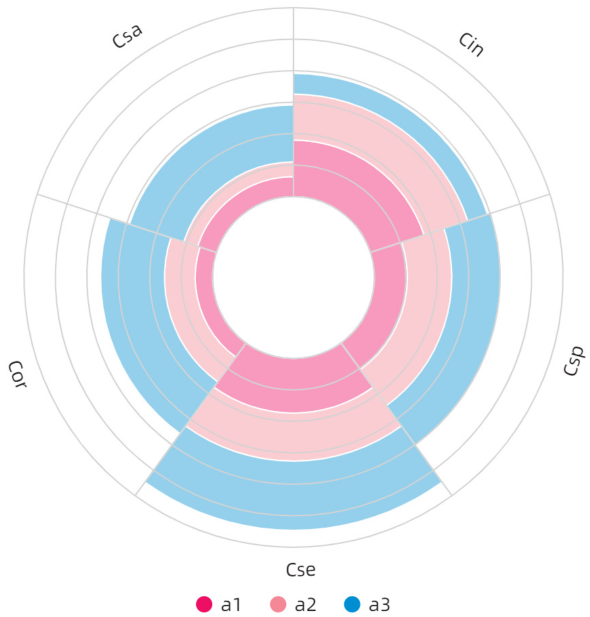

Figure 4. The analysis of the venues under the first-level indicators.

6. Discussion

Public safety is a global issue and one that China has been emphasizing and focusing on recently. At present, under the influence of environmental degradation and other factors, China's public safety situation has greatly improved compared with the past, but it is still grim, which is mainly reflected in the relatively weak foundation of public safety, the unevenness of public safety literacy, the weak safety awareness, and the lack of targeted and systematic safety science education.

To improve the quality of safety education, experiential venue teaching is particularly important. It stores safety knowledge and skills in the mind through interactive training and somatosensory cognition. The quality of venues directly determines the effect of experiential teaching; however, there is a lack of evaluation criteria and methods capable of determining the quality of venues. Therefore, this study firstly provides an evaluation index system, and then a novel method for rating and ranking.

In this paper, the following findings are obtained. First of all, to achieve satisfactory public safety education, we need to face up to the significance of experiential education venues. Experiential education venues can enable learners to cope with various dangerous situations through specific operations in virtual scenes so that learners can gain safety knowledge. Some interactive operations can enrich the learning experience of learners. In addition, practical education is carried out in safety education, in which theory and practice are closely combined and safety science popularization education in a practical sense is realized. Secondly, the evaluation index system of safety education venues constructed in this paper can be used to guide the construction of appropriate education bases in major cities. This study emphasizes that the construction of education venues should focus on five aspects: infrastructure, professionalism, service, organization, and safety, which has become a guiding principle. Thirdly, the linguistic information transformation method based on D-S theory proposed in this paper is suitable for decision making and evaluation problems in multiple linguistic environments, except for the evaluation problem of public safety education venues in this paper. Finally, the evidential PROMETHEE method presented in this paper can be used not only to evaluate the quality of public safety education venues, but also to rank a set of alternative venues.

7. Conclusions

In this study, we propose an evidential PROMETHEE method for identifying qualified public safety education venues under linguistic environments, with the following contributions. (1) Considering the infrastructure, specialty, service, organization and safety of public safety education venues, an evaluation index system including 18 secondary indicators was constructed, which contributed valuable reference criteria for the selection and evaluation of public safety education venues. (2) Combining Dempster–Shafer theory with PROMETHEE method, a comprehensive decision-making method for quality assessment of public safety education venues is proposed, which can be used to analyze public safety education venues from two perspectives: rating and ranking. (3) In view of the problems existing in uncertain linguistic decision-making, such as too many expressions, which are not easy to choose and cannot be used jointly, this study uses the uncertain information expression ability of the Dempster–Shafer theory to transform multiple linguistic information expression into belief function representation without information loss, and solves many key problems in linguistic decision-making. (4) A case study of Q city in China is constructed to demonstrate and verify the usefulness and effectiveness of the proposed method. It then gives a detailed analysis and finally provides insights on the construction and identification of qualified public safety education venues.

The current study has reached several significant conclusions, on which more interesting studies will be developed in the future.

The comprehensive evaluation index system of public safety education venues constructed in this paper only considers limited criteria at present. In the future, new elements will be added with the further research to make the evaluation system more perfect.

The identification method of education venues in this paper will be extended to more cities, and the evidential PROMETHEE method constructed in this study will be used in more evaluation and decision-making fields as an uncertain MADM method.

Author Contributions: Conceptualization, Y.Z. and B.L.; methodology, Y.Z.; software, Y.D.; validation, B.L., Y.Z. and Y.D.; formal analysis, Y.Z.; investigation, Y.D.; resources, B.L.; data curation, B.L.; writing—original draft preparation, Y.Z.; writing—review and editing, B.L.; visualization, Y.D.; supervision, B.L.; project administration, B.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no funding

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Andersson, H.; Levivier, E.; Lindberg, G. Private and public willingness to pay for safety: A validity test. *Accid. Anal. Prev.* **2019**, *123*, 170–175. [CrossRef] [PubMed]
2. Gourevitch, M.N.; Kleiman, N.; Falco, K.B. Public Health and Public Safety: Converging Upstream. *Am. J. Public Health* **2022**, *112*, 716–718. [CrossRef] [PubMed]
3. Yu, D.; Fang, C.; Xue, D.; Yin, J. Assessing urban public safety via indicator-based evaluating method: A systemic view of Shanghai. *Soc. Indic. Res.* **2014**, *117*, 89–104. [CrossRef]
4. Gao, K.; Zhou, K.; Liang, Z. Information-flow-based safety education (IFSE): An indispensable perspective on safety education. *J. Civ. Eng. Manag.* **2021**, *27*, 472–484. [CrossRef]
5. Kong, Q. Research on Safety Education for Children Online Training Safety E-Learning. In Proceedings of the 2015 International conference on Engineering Management, Engineering Education and Information Technology, Guangzhou, China, 24–25 October 2015; Atlantis Press: Amsterdam, The Netherlands, 2015; pp. 479–482.
6. Yue, H.; Lianbo, Z. A Study of the Effect of Safety Education for Construction Personnel Based on Human Factors Engineering. *Ind. Eng. J.* **2016**, *19*, 89.
7. Lee, S.; Dathinten, V.S.; Do, H. Patient safety education in pre-registration nursing programmes in South Korea. *Int. Nurs. Rev.* **2020**, *67*, 512–518. [CrossRef]
8. Chang, Y.H.; Liao, M.Y. The effect of aviation safety education on passenger cabin safety awareness. *Saf. Sci.* **2009**, *47*, 1337–1345. [CrossRef]
9. Ma, C.; Jing, M.; Hou, S.; Jiang, J.; Zhang, B. Current status of safety engineering education in China. *Process Saf. Prog.* **2022**, *41*, 218–225. [CrossRef]
10. Yamamoto, T. Current status and challenges of safety education for children, including those requiring medical care, in Japanese general schools: Focusing on disasters. *Children* **2020**, *7*, 65. [CrossRef]
11. Liu, S.; Chen, L.; Wang, J.; Wang, D.; Jiang, F. Research on mode and system of individualized safety education. *Procedia Eng.* **2012**, *45*, 281–286. [CrossRef]
12. Jun, M.; Zhen, Y.; Xinlong, Z.; Wei, G. Study of DRR Education in Safety Management of Apartments in Universities. In Proceedings of the 2019 4th International Conference on Social Sciences and Economic Development (ICSSED 2019), Wuhan, China, 15–17 March 2019; Atlantis Press: Amsterdam, The Netherlands, 2019; pp. 443–446.
13. Cheng, Y. Research on Public Safety Education of Chinese College Students in Network Multimedia Environment. *AGRO Food Ind. Hi-Tech* **2017**, *28*, 3353–3355.
14. Ryoo, S.; Cheung, C. International students' perceptions of safety level and safety education needs in Korea. *Int. J. Disaster Risk Reduct.* **2021**, *55*, 102068. [CrossRef]
15. Seo, H.J.; Park, G.M.; Son, M.; Hong, A.J. Establishment of virtual-reality-based safety education and training system for safety engagement. *Educ. Sci.* **2021**, *11*, 786. [CrossRef]
16. Hill, R.H., Jr. Undergraduates need a safety education! *J. Chem. Educ.* **2016**, *93*, 1495–1498. [CrossRef]
17. Hapsari, P.W.; Februhartanty, J.; Bardosono, S. Students' interests and learning venues as enablers for school-based nutrition education among adolescents in Jakarta. *Nutr. Food Sci.* **2021**, *51*, 1245–1257. [CrossRef]
18. Gyekye, S.A.; Salminen, S. Educational status and organizational safety climate: Does educational attainment influence workers' perceptions of workplace safety? *Saf. Sci.* **2009**, *47*, 20–28. [CrossRef]
19. Le, Q.T.; Pedro, A.; Park, C.S. A social virtual reality based construction safety education system for experiential learning. *J. Intell. Robot. Syst.* **2015**, *79*, 487–506. [CrossRef]
20. Hill, R.H., Jr. Building Strong Cultures with Chemical Safety Education. *J. Chem. Educ.* **2020**, *98*, 113–117. [CrossRef]
21. Liao, H.; Fang, R.; Yang, J.B.; Xu, D.L. A linguistic belief-based evidential reasoning approach and its application in aiding lung cancer diagnosis. *Knowl.-Based Syst.* **2022**, *253*, 109559. [CrossRef]
22. Wu, X.; Liao, H. Geometric linguistic scale and its application in multi-attribute decision-making for green agricultural product supplier selection. *Fuzzy Sets Syst.* 2022, *in press*. [CrossRef]
23. Li, C.C.; Dong, Y.; Liang, H.; Pedrycz, W.; Herrera, F. Data-driven method to learning personalized individual semantics to support linguistic multi-attribute decision making. *Omega* **2022**, *111*, 102642. [CrossRef]

24. Dong, Y.; Ran, Q.; Chao, X.; Li, C.; Yu, S. Personalized-individual-semantics Learning to Support Large-scale Linguistic Consensus Process. *ACM Trans. Internet Technol.* 2022, *accepted*. [CrossRef]
25. Zadeh, L.A. The concept of a linguistic variable and its application to approximate reasoning—I. *Inf. Sci.* **1975**, *8*, 199–249. [CrossRef]
26. Liu, R.; Fei, L.; Mi, J. An evidential MULTIMOORA approach to assessing disaster risk reduction education strategies under a heterogeneous linguistic environment. *Int. J. Disaster Risk Reduct.* **2022**, *78*, 103114. [CrossRef]
27. Herrera, F.; Martínez, L. A 2-tuple fuzzy linguistic representation model for computing with words. *IEEE Trans. Fuzzy Syst.* **2000**, *8*, 746–752.
28. Wang, J.H.; Hao, J. A new version of 2-tuple fuzzy linguistic representation model for computing with words. *IEEE Trans. Fuzzy Syst.* **2006**, *14*, 435–445. [CrossRef]
29. Rodriguez, R.M.; Martinez, L.; Herrera, F. Hesitant fuzzy linguistic term sets for decision making. *IEEE Trans. Fuzzy Syst.* **2011**, *20*, 109–119. [CrossRef]
30. Zhang, G.; Dong, Y.; Xu, Y. Consistency and consensus measures for linguistic preference relations based on distribution assessments. *Inf. Fusion* **2014**, *17*, 46–55. [CrossRef]
31. Ju, Y.; Liang, Y.; Luis, M.; Wang, A.; Chien, C.F.; Dong, P.; Gonzalez, E.D.S. A new approach for heterogeneous linguistic failure mode and effect analysis with incomplete weight information. *Comput. Ind. Eng.* **2020**, *148*, 106659. [CrossRef]
32. Pang, Q.; Wang, H.; Xu, Z. Probabilistic linguistic term sets in multi-attribute group decision making. *Inf. Sci.* **2016**, *369*, 128–143. [CrossRef]
33. Wang, J.; Li, J. The multi-criteria group decision making method based on multi-granularity intuitionistic two semantics. *Sci. Technol. Inf.* **2009**, *33*, 8–9.
34. Liu, P.; Jin, F. Methods for aggregating intuitionistic uncertain linguistic variables and their application to group decision making. *Inf. Sci.* **2012**, *205*, 58–71. [CrossRef]
35. Chen, H.; Martínez, V.; Feng, Y. Food safety education attitude and practice among health professionals in China, Peru, and the US. *Food Control* **2020**, *109*, 106945. [CrossRef]
36. Smith, S.A.; Rachmat, M.; Beck, R.; Sielaff, A.C. Assessing consumer food safety education needs across the state of Washington: Implications for nationwide extension programming. *J. Food Saf.* **2019**, *39*, e12613. [CrossRef]
37. Chen, H.; Feng, Y. Moving forward to the future: A review of microbial food safety education in China. *Foodborne Pathog. Dis.* **2021**, *18*, 547–566. [CrossRef] [PubMed]
38. Helan, W.; Jiang, Z.; Zheng, Y.; Jun, T. Study on administrative and educational measures of China urban public fire safety education. *Procedia Eng.* **2014**, *84*, 151–165. [CrossRef]
39. JeeEun, K.; Ho, P.S.; Il, R.S. Policy for Promoting Safety Education Designed to Create Safe Society: Focusing on Fire Safety Educator. *J. Saf. Crisis Manag.* **2020**, *10*, 11–16.
40. VuHong, V. Managing traffic safety education activities in primarand y schools: Status, necessity, and influencing factors. *Rev. Line de Política E Gestão Educ.* **2021**, *25*, 2535–2551.
41. Chen, C.; Zhu, M.J.; Hu, X.L. Research on Propaganda and Education of Traffic Safety Based on Network Media. *Zhongguo Anquan Kexue Xuebao* **2011**, *21*, 135–140.
42. Çalişkan, E.; Aksakal, E.; Çetinyokuş, S.; Çetinyokuş, T. Hybrid use of Likert scale-based AHP and PROMETHEE methods for hazard analysis and consequence modeling (HACM) software selection. *Int. J. Inf. Technol. Decis. Mak.* **2019**, *18*, 1689–1715. [CrossRef]
43. Ghandi, M.; Roozbahani, A. Risk management of drinking water supply in critical conditions using fuzzy PROMETHEE V technique. *Water Resour. Manag.* **2020**, *34*, 595–615. [CrossRef]
44. Liu, H.C. FMEA using cloud model and PROMETHEE method and its application to emergency department. In *Improved FMEA Methods for Proactive Healthcare Risk Analysis*; Springer: Berlin/Heidelberg, Germany, 2019; pp. 197–221.
45. Nassereddine, M.; Azar, A.; Rajabzadeh, A.; Afsar, A. Decision making application in collaborative emergency response: A new PROMETHEE preference function. *Int. J. Disaster Risk Reduct.* **2019**, *38*, 101221. [CrossRef]
46. Esmaelian, M.; Tavana, M.; Santos Arteaga, F.J.; Mohammadi, S. A multicriteria spatial decision support system for solving emergency service station location problems. *Int. J. Geogr. Inf. Sci.* **2015**, *29*, 1187–1213. [CrossRef]
47. Celik, E.; Gumus, A.T. An outranking approach based on interval type-2 fuzzy sets to evaluate preparedness and response ability of non-governmental humanitarian relief organizations. *Comput. Ind. Eng.* **2016**, *101*, 21–34. [CrossRef]
48. Rezaei-Malek, M.; Tavakkoli-Moghaddam, R.; Cheikhrouhou, N.; Taheri-Moghaddam, A. An approximation approach to a trade-off among efficiency, efficacy, and balance for relief pre-positioning in disaster management. *Transp. Res. Part Logist. Transp. Rev.* **2016**, *93*, 485–509. [CrossRef]
49. Rezaei-Malek, M.; Torabi, S.A.; Tavakkoli-Moghaddam, R. Prioritizing disaster-prone areas for large-scale earthquakes' preparedness: Methodology and application. *Socio-Econ. Plan. Sci.* **2019**, *67*, 9–25. [CrossRef]
50. Han, Y.; Deng, Y. An enhanced fuzzy evidential DEMATEL method with its application to identify critical success factors. *Soft Comput.* **2018**, *22*, 5073–5090. [CrossRef]
51. Han, Y.; Deng, Y. A hybrid intelligent model for assessment of critical success factors in high-risk emergency system. *J. Ambient. Intell. Humaniz. Comput.* **2018**, *9*, 1933–1953. [CrossRef]

52. Fei, L.; Feng, Y.; Wang, H. Modeling heterogeneous multi-attribute emergency decision-making with dempster-shafer theory. *Comput. Ind. Eng.* **2021**, *161*, 107633. [CrossRef]
53. Fei, L.; Wang, Y. An optimization model for rescuer assignments under an uncertain environment by using Dempster–Shafer theory. *Knowl.-Based Syst.* **2022**, *255*, 109680. [CrossRef]
54. Shi, X.; Wang, Y.; Luo, M.; Zhang, C. Assessing the feasibility of marine oil spill contingency plans from an information perspective. *Saf. Sci.* **2019**, *112*, 38–47. [CrossRef]
55. Hosseinpoor Milaghardan, A.; Ali Abbaspour, R.; Khalesian, M. Evaluation of the effects of uncertainty on the predictions of landslide occurrences using the Shannon entropy theory and Dempster–Shafer theory. *Nat. Hazards* **2020**, *100*, 49–67. [CrossRef]
56. Sen, M.K.; Dutta, S.; Kabir, G. Development of flood resilience framework for housing infrastructure system: Integration of best-worst method with evidence theory. *J. Clean. Prod.* **2021**, *290*, 125197. [CrossRef]
57. Li, S.; Liu, C.; Zhou, Z.; Li, L.; Shi, S.; Yuan, Y. Multi-sources information fusion analysis of water inrush disaster in tunnels based on improved theory of evidence. *Tunn. Undergr. Space Technol.* **2021**, *113*, 103948. [CrossRef]
58. Shahraki, Z.K.; Fatemi, A.; Malazi, H.T. Evidential fine-grained event localization using Twitter. *Inf. Process. Manag.* **2019**, *56*, 102045. [CrossRef]
59. Chen, W.; Zhang, L. Resilience assessment of regional areas against earthquakes using multi-source information fusion. *Reliab. Eng. Syst. Saf.* **2021**, *215*, 107833. [CrossRef]
60. *Shenzhen Safety Education Base Assessment Guidelines*; Technical Report 6; Emergency Management Bureau of Shenzhen Municipality: Shenzhen, China, 2020.
61. Pan, L.; Deng, Y. A new complex evidence theory. *Inf. Sci.* **2022**, *608*, 251–261. [CrossRef]
62. Zhou, Q.; Deng, Y. Higher order information volume of mass function. *Inf. Sci.* **2022**, *586*, 501–513. [CrossRef]
63. Jiang, W.; Liu, Y.; Deng, X. Fuzzy entity alignment via knowledge embedding with awareness of uncertainty measure. *Neurocomputing* **2022**, *468*, 97–110. [CrossRef]
64. Zhou, L.; Cui, H.; Mi, X.; Zhang, J.; Kang, B. A novel conflict management considering the optimal discounting weights using the BWM method in Dempster-Shafer evidence theory. *Inf. Sci.* **2022**, *612*, 536–552. [CrossRef]
65. Dempster, A.P. Upper and lower probabilities induced by a multivalued mapping. *Ann. Math. Stat.* **1967**, *38*, 325–339. [CrossRef]
66. Shafer, G. *A Mathematical Theory of Evidence*; Princeton University Press: Princeton, NJ, USA, 1976.
67. Xiao, F. CaFtR: A fuzzy complex event processing method. *Int. J. Fuzzy Syst.* **2022**, *24*, 1098–1111. [CrossRef]
68. Liu, P.; Wang, X.; Teng, F.; Li, Y.; Wang, F. Distance education quality evaluation based on multigranularity probabilistic linguistic term sets and disappointment theory. *Inf. Sci.* **2022**, *605*, 159–181. [CrossRef]
69. Brans, J.P.; De Smet, Y. PROMETHEE methods. In *Multiple Criteria Decision Analysis*; Springer: Berlin/Heidelberg, Germany, 2016; pp. 187–219.