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Sustainability Evaluation of Renewable Energy Incubators Using Interval Type-II Fuzzy AHP-TOPSIS with MEA-MLSSVM

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Abstract: With the development of renewable energy, renewable energy incubators have emerged continuously. However, these incubators present a crude development model of low-level replication and large-scale expansion, which has triggered a series of urgent problems including unbalanced regional development, low incubation efficiency, low resource utilization, and vicious competition for resources. There are huge challenges for the sustainable development of incubators in the future. A scientific and accurate evaluation approach is of great significance for improving the sustainability of renewable energy incubators. Therefore, this paper proposes a novel method combining an interval type-II fuzzy analytic hierarchy process (AHP) with mind evolutionary algorithm-modified least-squares support vector machine (MEA-MLSSVM). The indicator system is established from two aspects: service capability and operational efficiency. TOPSIS integrated with an interval type-II fuzzy AHP is employed for index weighting and assessment. In the least-squares support vector machine (LSSVM), the traditional radial basis function is replaced with the wavelet transform function (WT), and the parameters are fine-tuned by the mind evolutionary algorithm (MEA). Accordingly, the establishment of a comprehensive sustainability evaluation model for renewable energy incubators is accomplished in this paper. The experimental study reveals that this novel technique has the advantages of scientificity and precision and provides a decision-making basis for renewable energy incubators to realize sustainable operation.

Keywords: renewable energy incubator; sustainability evaluation; interval type-II fuzzy number; AHP; TOPSIS; MEA; MLSSVM

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1. Introduction

The renewable energy incubator, as an efficacious tool of renewable energy achievement in industrialization, has aroused wide public concern. It is a kind of business incubator, the concept of which came from the Betevia industrial center under the leadership of Mancuso in 1956 [1]. The role of small start-ups in economic growth has been generally accepted since 1980, and numerous business incubators have emerged and achieved success in developed countries such as Europe and America [2]. With the burgeoning development of renewable energy, there is an incessant springing up of renewable energy incubators [3]. However, the sustainable development of incubators is faced with great challenges, due to their extensive growth, of low-level replication and large-scale expansion, which has caused a series of problems including unbalanced regional development, low incubation efficiency, low resource utilization rate, and vicious resource competition [4]. In order to describe the status, identify the bottleneck, and address the problems in sustainable growth, it is necessary to evaluate the sustainable development capacity of renewable energy incubators.

The existing literature has mainly focused on the operation performance and evaluation of incubators, while few studies have paid attention to renewable energy incubators and their sustainable development [5]. In light of the performance assessment of science and technology incubators, Reference [6] introduced a multi-level extension model for empirical analysis based on the index system of relevant enterprises in Jiangsu, China, from the perspectives of incubator construction, serviceability, incubation performance, and social contribution. Reference [7] comprehensively took the incubation infrastructure, service, benefit, and effect into account in terms of a performance assessment indicator system of cultural industry incubators. Four samples were estimated in Zibo City in accordance with the corresponding determined index weight and scoring standard. Data envelopment analysis (DEA) was employed to estimate the technical efficiency, pure technical efficiency, and scale efficiency of the Chinese provincial incubator industry in Reference [8]. Few scholars concentrate on the sustainable growth ability of incubators. Quantitative approaches are mostly applied to assess operational efficiency and performance, while qualitative methods are chiefly used for sustainability evaluation. Reference [9] designed an integrated mechanism to achieve the sustainable development of cultural business incubators including multi-level screening, comprehensive service, virtual and reality combination, and joint investment mechanisms. Reference [10] proposed that different revenue strategies and support modes had a great impact on incubator income, the number of incubated enterprises, and graduated companies. Nevertheless, research on the sustainable development ability of incubators mainly stays in the stage of qualitative description and, therefore, lacks systematic and in-depth multi-dimensional quantitative assessment. Hence, this paper intends to combine qualitative means with quantitative techniques in the sustainable development capability evaluation of renewable energy incubators. Thus, appropriate models and an index system are established to conduct this experiment from the perspectives of serviceability and operation efficiency.

The existing evaluation methods, which chiefly include traditional assessment approaches and modern intelligent algorithms, are of great significance for the sustainable development estimation of renewable energy incubators [11]. Traditional assessment models can be separated into subjective and objective modes. For example, expert evaluation, the fuzzy analytic hierarchy process, and the network analytic hierarchy process are exploited for subjective judgment, while entropy weight method, principal component analysis, gray correlation analysis, matter-element extension model, and ideal solution are utilized for objective estimation [12–14]. In recent years, some improved solutions for these traditional evaluation methods have also emerged with excellent results. For example, Reference [15] proposed a novel method to support decision-making in an uncertain environment based on normalized interval-valued triangular fuzzy numbers and the comet technique. Modern intelligent techniques principally consist of an artificial neural network (ANN), a support vector machine (SVM), the least-squares support vector machine (LSSVM), and so on [16]. Due to the mature theory and accurate calculation of traditional evaluation methods and the quick processing capability of intelligent algorithms [17–19], this study has established a combined assessment approach where interval type-II fuzzy integrated with the analytic hierarchy process (AHP) is employed for index weight determination, and technique for order preference by similarity to an ideal solution (TOPSIS) is applied for comprehensive estimation and ranking. With regard to intelligent evaluation techniques, an ANN is confronted with slow convergence speed and easily falls into a local optimum [20]. As a valid alternative, an SVM overcomes the defects of an ANN by converting the solving process into quadratic programming based on kernel function transformation [21]. Considering the low efficiency and not ideal convergence accuracy of an SVM, an LSSVM makes use of the least-squares linear system as the loss function, which avoids the process of quadratic programming [22]. Simultaneously, the improvement in evaluation precision and speed can be achieved via transforming inequality constraints into equality ones [23]. It is worth noting that the traditional Gaussian kernel function in the LSSVM model is correlated, even redundant, and presents poor nonlinear processing ability. Owing to the orthogonal property, the wavelet transform function (WT) is able to gradually describe data information and make multi-resolution analysis on wavelet signal. Additionally, the nonlinear processing capability is superior to the Gaussian kernel function [24]. Therefore, in our study, WT is employed to improve LSSVM for comprehensive evaluation. Nevertheless, two parameters, namely penalty coefficient and kernel parameter, are commonly decided by experience [25]. Thus, it is necessary to select an appropriate heuristic algorithm to determine the values. As a modified optimization approach based on a genetic algorithm (GA), the mind evolutionary algorithm (MEA) is founded on group search and mind imitation [26]. This method not only retains the merits of GA [27], but it also proposes novel core contents of convergence and alienation, which replaces the central ideal of crossover and mutation [28]. The improvement in MEA plays a satisfactory effect on global search and the possibility reduction of trapping into local optimum [29]. Hence, this paper exploits MEA to automatically determine the two parameters in the LSSVM model.

To sum up, this paper establishes the sustainable development evaluation index system of renewable energy incubators and puts forward a hybrid technique that combines interval Type-II fuzzy AHP-TOPSIS with MEA-MLSSVM for assessment. The rest of the paper is organized as follows: Section 2 designs the indicator system including service capability and operational efficiency. Section 3 shows a brief description of the methodology. In Section 4, a comprehensive evaluation technique is analyzed. Section 5 provides a case study to validate the proposed model, and Section 6 summarizes this study.

2. Index System

2.1. Index Selection

In light of the existing research on sustainable development of incubators, this paper carried out the study in two perspectives, that is, service capability and operation efficiency [30,31]. The former refers to the ability to provide various services and enhance the success rate of renewable energy start-ups. Operation efficiency represents the comparative relationship between the incubation benefits and total input, such as human resources and capital. It reflects the ability of self-reliance and independent operation, which offers a guarantee for the sustainable growth of incubators. As it can be seen, service capability ensures renewable energy incubators to realize their responsibilities including incubation and cultivation of enterprises and entrepreneurs and promotion of sustainable development. Operation efficiency reveals whether the incubator can achieve independent running without external support with respect to input–output.

In brief, service capability and operational efficiencies are the core requirement and necessary guarantees for the sustainable development of renewable energy incubators. Thus, the indicator system is established from these two perspectives on the principles of scientificity, comprehensiveness, importance, and operability.

2.1.1. Indexes of Service Capability

Service offered by renewable energy incubators not only comprises basic modes, such as hardware facilities, administrative service, network service, and management training, but also incorporates value-added types including technological innovation, entrepreneurship guidance, as well as a financial and legal consultation. As a result, this study evaluates the service capability of renewable energy incubators from four aspects: management team, basic service, value-added service, and performance indicators.

The management team acts as the functional support for serviceability. In this paper, five indexes are selected: management system, number of administrators in per incubated enterprise, the proportion of administrators with a bachelor degree or above, the proportion of administrators receiving professional training, and entrepreneurship cultivation.

Basic service is made up of hardware facilities, administrative service, and network service level provided by renewable energy incubators.

Value-added service means the higher requirements for incubators advanced by incubated renewable energy enterprises, which mainly includes professional business guidance and related policy consultation. Thus, seven indicators are picked in this study to judge the value-added serviceability, that is, the number of entrepreneurial mentors and the quantities of experts in accounting, finance, law, human resource, marketing, and renewable energy in per incubated enterprises.

Performance indicators are the result-oriented embodiment of the serviceability. The merits of incubators can be shown in light of economic benefits, innovation performance, and social effects. Limited by the availability of the index "the number of approved intellectual property", this paper selects "proportion of high-tech renewable energy enterprises" as an alternative to measure the innovation benefits.

In this study, twenty indicators are displayed in Table 1 to judge the service capability of incubators.

Table 1. Evaluation indexes of service capability for renewable energy incubators.

First-Grade	Second-Grade	Third-Grade
Service capability	Management team	Management system
		Number of administrators in per incubated enterprise
		The proportion of administrators with a bachelor degree or above
		The proportion of administrators receiving professional training
		Entrepreneurship cultivation
	Basic service	Hard facilities
		Administrative service
		Network service level
	Value-added service	Number of entrepreneurial mentors of per incubated enterprise
		Number of experts in the accounting of per incubated enterprise
		Number of experts in finance of per incubated enterprise
		Number of experts in the law of per incubated enterprise
		Number of experts in human resource of per incubated enterprise
		Number of experts in the marketing of per incubated enterprise
		Number of experts in renewable energy of per incubated enterprise
	Performance indicators	Rate of enterprises graduated in the current year
		The average income of incubated enterprises (k yuan)
		The proportion of high-tech renewable energy enterprises
		The impact of incubated enterprises on local renewable energy development
		Incubated enterprise satisfaction

2.1.2. Indexes of Operation Efficiency

Operation efficiency expresses the relationship between input and output. For example, human involvement such as administrators and guidance specialists, incubation fund, capital, and site investment in pubic technology service platform all belong to the input of incubators, while the output mostly consists of economic benefits derived from incubated enterprises and the incubator itself, incubation achievement, as well as employment opportunity. The specific indexes aiming at operation efficiency are presented in Table 2.

Table 2. Evaluation indexes of operation efficiency for renewable energy incubators.

First-Grade	**Second-Grade**	**Third-Grade**
Operation efficiency	Input indexes	Number of administrators
		Number of guidance specialists
		Investment in public technology service platform (k yuan)
		The total amount of incubation fund (k yuan)
		Site area (m^2)
		Total income of the incubator (k yuan)
	Output indexes	Number of enterprises that acquire financing
		Number of enterprises that successfully graduate
		Number of employees in the incubator and incubating enterprises

2.2. Index Description

Based on the existing research literature regarding the sustainability of business incubators and the sustainability of other micro-entities, the foregoing indicators are selected in this paper. For a better understanding of the established evaluation index system, the specific meaning of each indicator is explained as follows:

(1) Management system identifies whether there are clear standards for enterprises to enter and graduate, meanwhile judging if a personnel training system is complete.
(2) The number of administrators per incubated enterprise refers to the average number of executives in each incubating company.
(3) The proportion of administrators with a bachelor's degree or above stands for the educational background of managers.
(4) The proportion of administrators receiving professional training reflects the expertise of executives to a certain degree.
(5) Entrepreneurship cultivation is a momentous part of high-quality development for incubators.
(6) Hard facilities incorporate working site, network, property management (water, electricity, heating, security, greening, and cleaning), and so on.
(7) Administrative service judges the ability of incubators in the coordination of government and enterprises, the co-operation of industrial and commercial tax, as well as science and technology applications.
(8) Network service level is employed to measure whether the incubator can form a valid network platform that can connect the incubating enterprises and social network resources as well as provide service more quickly and conveniently.
(9) The number of entrepreneurial mentors per incubated enterprise refers to the average number of entrepreneurial mentors owned by each company, which represents the corresponding training resource used by each incubated enterprise.
(10) The number of experts in the accounting of per incubated enterprise refers to the average number of accounting specialists owned by each company, which represents the corresponding accounting consultation resource used by each incubated enterprise.
(11) The number of experts in finance per incubated enterprise refers to the average number of financial specialists owned by each company, which represents the corresponding resource used by each incubated enterprise.
(12) The number of experts in the law of per incubated enterprise refers to the average number of legal specialists owned by each company, which represents the corresponding consultation resource used by each incubated enterprise.

(13) The number of experts in human resources per incubated enterprise refers to the average number of human specialists owned by each company, which represents the corresponding consultation resource used by each incubated enterprise.
(14) The number of experts in the marketing of per incubated enterprise refers to the average number of marketing specialists owned by each company, which represents the corresponding consultation resource used by each incubated enterprise.
(15) The number of experts in renewable energy per incubated enterprise refers to the average number of specialists owned by each company, which represents the corresponding consultation resource used by each incubated enterprise.
(16) The rate of enterprises graduated in the current year stands for the proportion of successfully hatched companies in an incubator.
(17) The average income of incubated enterprises is taken as the representative of economic benefits in the incubation period.
(18) The proportion of high-tech renewable energy enterprises can reflect both the technical level of incubating business and service quality offered by the incubator.
(19) The impact of incubated enterprises on local renewable energy development illustrates the effectiveness of incubator support.
(20) Incubated enterprise satisfaction is equivalent to the ratio of incubating companies that are satisfied with the service.
(21) The number of administrators is perceived as the manpower input of incubators.
(22) The number of guidance specialists in accounting, finance, law, human resource, marketing, and renewable energy can be regarded as manpower input of incubators.
(23) Investment in public technology service platforms refers to the funds devoted to improving the service capability of the incubator itself.
(24) The total amount of incubation fund provides capital investment for incubating enterprises.
(25) Site area equals complete construction space of the incubator for work, service, and so on.
(26) The total income of the incubator includes the operation revenue of the incubators itself together with the whole economic output derived from incubating enterprises.
(27) The number of enterprises that acquire financing stands for the companies that obtain financing with the help of incubators.
(28) The number of enterprises that successfully graduate can be treated as one of the primary incubation achievements in the current year.
(29) The number of employees in the incubator and incubating enterprises represents the total quantity of jobs offered by the incubator, which acts as an indicator of social benefits.

3. Methodology

3.1. Interval Type-II Fuzzy AHP-TOPSIS

3.1.1. Interval Type-II Fuzzy Numbers

Considering the influence of complex factors, the sustainable development evaluation of renewable energy incubators is complicated and uncertain. Interval type-II fuzzy number plays a momentous role in coping with indefinite factors and deriving robust results [32]. This technique has been widely used in many fields, such as air quality evaluation, supplier assessment, etc. [33]. The detailed introduction is described as follows [34,35].

Definition 1. *Set type-II fuzzy number as* $\widetilde{A} = \{((x,\mu),\mu_{\lambda}(x,\mu))|\forall\mu\in J_x\subseteq[0,1],\ 0\le\mu_{\lambda}(x,\mu)\le1\}$*, where* X *is the type-II membership function of* $\widetilde{A}$*,* $J_x\subseteq[0,1]$*.* $\widetilde{A}$ *can be also expressed as Equation (1):*

$$\widetilde{A}=\oint_{x\in X}\int_{\mu\in J_x}\mu_{\widetilde{A}}(x,\mu)/(x,\mu) \tag{1}$$

Definition 2. *If $\mu_\lambda(x,\mu) = 1$, $\widetilde{A}$ can be called as interval type-II fuzzy number as shown in Equation (2):*

$$\widetilde{A} = \oint_{x \in X} \int_{\mu \in J_x} 1/(x,\mu) \tag{2}$$

where $J_x \subseteq [0,1]$.

Definition 3. *Type-II fuzzy numbers $\widetilde{A}$ can give a description of the uncertainty with the help of a bounded region graph. The projection area of $\widetilde{A}$ on x and μ, also named as footprint uncertainty, is represented by $FOU\left(\widetilde{A}\right)$. $\overline{FOU\left(\widetilde{A}\right)}$ and $\underline{FOU\left(\widetilde{A}\right)}$ stand for the upper and lower bound membership functions, respectively.*

$$FOU\left(\widetilde{A}\right) = \left[\overline{FOU\left(\widetilde{A}\right)}, \underline{FOU\left(\widetilde{A}\right)}\right] \tag{3}$$

Definition 4. *If the aforementioned upper and lower bound membership functions both belong to trapezoidal fuzzy numbers, it can be perceived as interval trapezoidal fuzzy numbers, as presented in Equation (4):*

$$\widetilde{\widetilde{A}} = \left(\widetilde{A}_i^U, \widetilde{A}_i^L\right) = \begin{bmatrix} \left(a_{i1}^U, a_{i2}^U, a_{i3}^U, a_{i4}^U; H_1\left(\widetilde{A}_i^U\right), H_2\left(\widetilde{A}_i^U\right)\right) \\ \left(a_{i1}^L, a_{i2}^L, a_{i3}^L, a_{i4}^L; H_1\left(\widetilde{A}_i^L\right), H_2\left(\widetilde{A}_i^L\right)\right) \end{bmatrix} \tag{4}$$

where $\widetilde{A}_i^U$ and $\widetilde{A}_i^L$ are type-I fuzzy sets. a_{i1}^U, a_{i2}^U, a_{i3}^U, a_{i4}^U, a_{i1}^L, a_{i2}^L, a_{i3}^L, a_{i4}^L are reference points of $\widetilde{\widetilde{A}}$. $H_j\left(\widetilde{A}_i^U\right)$ and $H_j\left(\widetilde{A}_i^L\right)$ represent the membership degree of $a_{i(j+1)}^U$ and $a_{i(j+1)}^L$ in the upper and lower bound membership functions, respectively. $1 \le j \le 2$.

Definition 5. *Randomly select two-interval fuzzy numbers, namely $a = \left[a^L, a^U\right]$ and $b = \left[b^L, b^U\right]$. Equations (5)–(7) can calculate the probability $a \ge b$, that is $P(a \ge b)$.*

$$P(a \ge b) = \max\left\{1 - \max\left\{\frac{b^u - a^l}{L(a) + L(b)}, 0\right\}, 0\right\} \tag{5}$$

$$L(a) = a^u - a^l \tag{6}$$

$$L(b) = b^u - b^l \tag{7}$$

Convert p trapezoidal interval type-II fuzzy numbers in $\widetilde{A}$ into the interval ones via integral calculation. The probability of pairwise comparison of these fuzzy numbers can be obtained on the basis of Equations (5)–(7). The ranking results are acquired in accordance with Equation (8).

$$R_U\left(A^i\right) = \frac{1}{q(q-1)}\left(\sum_{j=1}^{q} P\left(\widetilde{A}_i \ge \widetilde{A}_j + \frac{q}{2} - 1\right)\right) \tag{8}$$

Randomly select two-interval type-II fuzzy numbers $\widetilde{A}_1$ and $\widetilde{A}_2$. The calculation system between them consists of four forms as shown in Equations (9)–(12) [36].

(1) Addition

$$A\tilde{}\tilde{}1 \oplus A\tilde{}\tilde{}1 \;= (A\tilde{}1U, A\ \tilde{}1L) \oplus (A\tilde{}2U, A\ \tilde{}2L) = \begin{pmatrix} a11U + a21U, a\ 12U + a22U, a\ 13U + a23U, a\ 14U + a24U; \\ min(H1(A\tilde{}1U), H\ 1(A\tilde{}2U), H\ 2(A\tilde{}1U), H\ 2(A\tilde{}2U)), \\ a\ 11L + a21L, a\ 12L + a22L, a\ 13L + a23L, a\ 14L + a24L; \\ min\ (H1(A\tilde{}1L), H\ 1(A\tilde{}2L), H\ 2(A\tilde{}1L), H\ 2(A\tilde{}2L)) \end{pmatrix} \tag{9}$$

(2) Multiplication

$$A\tilde{}\tilde{}1 \otimes A\tilde{}\tilde{}2 \;= (A\tilde{}1U, A\ \tilde{}1L) \otimes (A\tilde{}2U, A\ \tilde{}2L) = \begin{pmatrix} a11U \times a21U, a\ 12U \times a22U, a\ 13U \times a23U, a\ 14U \times a24U; \\ min(H1(A\tilde{}1U), H\ 1(A\tilde{}2U), H\ 2(A\tilde{}1U), H\ 2(A\tilde{}2U)), \\ a\ 11L \times a21L, a\ 12L \times a22L, a\ 13L \times a23L, a\ 14L \times a24L; \\ min\ (H1(A\tilde{}1L), H\ 1(A\tilde{}2L), H\ 2(A\tilde{}1L), H\ 2(A\tilde{}2L)) \end{pmatrix} \tag{10}$$

(3) Scalar multiplication

$$k \otimes \tilde{\tilde{A}}_1 == \begin{pmatrix} \left(ka_{11}^U, ka_{12}^U, ka_{13}^U, ka_{14}^U; H_1\left(\tilde{A}_1^U\right), H_2\left(\tilde{A}_1^U\right)\right), \\ \left(ka_{11}^L, ka_{12}^L, ka_{13}^L, ka_{14}^L; H_1\left(\tilde{A}_1^L\right), H_2\left(\tilde{A}_1^L\right)\right) \end{pmatrix} \tag{11}$$

(4) Exponentiation

$$\sqrt[\frac{1}{k}]{\tilde{\tilde{A}}_1} == \begin{pmatrix} \left(\sqrt[\frac{1}{k}]{a_{11}^U}, \sqrt[\frac{1}{k}]{a_{12}^U}, \sqrt[\frac{1}{k}]{a_{13}^U}, \sqrt[\frac{1}{k}]{a_{14}^U}; H_1\left(\tilde{A}_1^U\right), H_2\left(\tilde{A}_1^U\right)\right), \\ \left(\sqrt[\frac{1}{k}]{a_{11}^L}, \sqrt[\frac{1}{k}]{a_{12}^L}, \sqrt[\frac{1}{k}]{a_{13}^L}, \sqrt[\frac{1}{k}]{a_{14}^L}; H_1\left(\tilde{A}_1^L\right), H_2\left(\tilde{A}_1^L\right)\right) \end{pmatrix} \tag{12}$$

3.1.2. Interval Type-II Fuzzy AHP Model

AHP is a multi-criteria analysis method that can deal with qualitative problems quantitatively. The scientific hierarchy establishment and clear logical structure make this approach one of the most commonly used multi-criteria decision-making techniques [37]. AHP in combination with fuzzy set theory can resolve the uncertainty and achieve pairwise comparison so as to ensure the consistency of the ranking made by decision-makers. Therefore, the interval type-II fuzzy AHP model is employed in this paper to determine the index weight

The procedures are expressed here in detail:

(1) Establish a pairwise comparison matrix for distinct levels and categories based on interval type-II fuzzy number theory. Decision-makers generally employ linguistic mode in evaluation; thus, it is difficult to define interval type-II fuzzy numbers directly. Five grades of the assessment set are put forward in this study: absolutely strong (AS), very strong (VS), fairly strong (ES), slightly strong (SS), and equal (E). The interval type-II fuzzy numbers corresponding to each comment set are listed in Table 3.

(2) Determine whether the consistency of the comparison matrix is acceptable. If not, the relevant elements in the matrix need to be adjusted.

(3) Integrate the interval type-II fuzzy number contrast matrix via geometrical average method according to Equation (13).

$$\tilde{\tilde{A}}_{ij} = \left[\tilde{\tilde{A}}^1 \otimes \tilde{\tilde{A}}^2 \otimes \cdots \otimes \tilde{\tilde{A}}^n\right]^{\frac{1}{n}} \tag{13}$$

(4) Calculate the fuzzy weights based on Equation (14).

$$\tilde{\tilde{w}}_i = \tilde{\tilde{r}}_i \otimes \left(\tilde{\tilde{r}}_1 \oplus \tilde{\tilde{r}}_2 \oplus \cdots \oplus \tilde{\tilde{r}}_m\right)^{-1} \tag{14}$$

where $\tilde{\tilde{r}}_i$ is the geometric mean of the integrated comparison matrix in each row.

(5) Obtain the defuzzification weight in line with DTraT.

$$DTraT = \frac{\frac{(u_U - l_U)+(\beta_U \cdot m_{1U} - l_U)+(\alpha_U \cdot m_{2U} - l_U)}{4} + l_U + \left[\frac{(u_L - l_L)+(\beta_L \cdot m_{1L} - l_L)+(\alpha_L \cdot m_{2L} - l_L)}{4} + l_L\right]}{2} \tag{15}$$

where α_U, β_U and α_L, β_L are the maximum membership degree of upper and lower membership functions, respectively. u_U, l_U and u_L, l_L equal the maximum and minimum, while m_{1U}, m_{2U} and m_{1L}, m_{2L} represent the second and third parameter of upper as well as lower membership functions, respectively.

Table 3. Linguistic variables for criteria weights.

Linguistic Variables	Interval Type-II Fuzzy Numbers	Reciprocal of Interval Type-II Fuzzy Numbers
AS	((7,8,9,9;1,1), (7.2,8.2,8.8,9;0.8,0.8))	((0.11,0.11,0.12,0.14;1,1), (0.11,0.11,0.12,0.14;0.8,0.8))
VS	((5,6,8,9;1,1), (5.2,6.2,7.8,8.8;0.8,0.8))	((0.11,0.12,0.17,0.2;1,1), (0.11,0.13,0.16,0.19;0.8,0.8))
FS	((3,4,6,7;1,1), (3.2,4.2,5.8,6.8;0.8,0.8))	((0.14,0.17,0.25,0.33;1,1), (0.15,0.17,0.24,0.31;0.8,0.8))
SS	((1,2,4,5;1,1), (1.2,2.2,3.8,4.8;0.8,0.8))	((0.2,0.25,0.5,1;1,1), (0.21,0.26,0.45,0.83;0.8,0.8))
E	((1,1,1,1;1,1),(1,1,1,1;1,1))	((1,1,1,1;1,1),(1,1,1,1;1,1))

3.1.3. TOPSIS

TOPSIS, proposed in the early 1980s, is a multi-objective decision-making method that approximates the ideal solution. The basic principle of this approach is exhibited as follows: firstly determine the distance between the evaluation object and the positive as well as negative ideal solutions. Then, the ranking results can be obtained in accordance with the above distance [38]. It is noteworthy that the positive and negative ideal solutions are not objective existence, but fictitious optimal and worst values, respectively. Sometimes even all of these may dissolve into nothingness. The foundation of this approach is the entropy weight method.

The evaluation results of TOPSIS are not affected by the number of assessment indexes and objects. Simultaneously, the vertical and horizontal comparison can be executed for each estimation target. This superiority is most obvious in the projects with a large number of indexes as well a small evaluation scale. The prime advantage of TOPSIS is the valid utilization of the original data. In this way, this technique can acquire the evaluation results in line with the actual situation of the project. In light of few applications in practical projects, it is of great necessity to constantly improve the performance of TOPSIS for more scientific and reasonable assessment [39].

3.1.4. Comprehensive Evaluation Based on Interval Type-II Fuzzy AHP-TOPSIS

In accordance with the index weights derived from interval type-II fuzzy AHP, the research on sustainable development estimation of renewable energy incubators can be put into practice via TOPSIS.

(1) Implement weighted operation on initial data

In Equation (16), a weighted normalized matrix is obtained, where m and n represent the level and number of assessment indicators, respectively.

$$R = \begin{pmatrix} P_{11}w_1 & \cdots & P_{1n}w_n \\ \vdots & \ddots & \vdots \\ P_{m1}w_1 & \cdots & P_{mn}w_n \end{pmatrix} = \begin{pmatrix} r_{11} & \cdots & r_{1n} \\ \vdots & \ddots & \vdots \\ r_{m1} & \cdots & r_{mn} \end{pmatrix} \tag{16}$$

(2) Calculate positive and negative ideal solutions

The assumption is proposed here that the positive and negative ideal solutions equal the optimal and worst values correspondingly, as described in Equations (17) and (18).

$$r_j{}^+ = \left\{ \left(\max_{1 \le j \le m} r_{ij} | j \in J_1 \right), \left(\min_{1 \le j \le m} r_{ij} | j \in J_2 \right) | i = 1, 2, \ldots, m \right\} \tag{17}$$

$$r_j{}^- = \left\{ \left(\min_{1 \le j \le m} r_{ij} | j \in J_1 \right), \left(\max_{1 \le j \le m} r_{ij} | j \in J_2 \right) | i = 1, 2, \ldots, m \right\} \tag{18}$$

where J_1 and J_2 are the cost indexes and profit indicators, respectively. V^+ and V^- represent the positive and negative ideal solutions of J_1 and J_2.

The Euclidean distance is calculated as Equations (19) and (20):

$$d_1^+ = \sqrt{\sum_{j=1}^{n} \left(r_{ij} - r_j{}^+ \right)^2} (i = 1, 2, \ldots, m) \tag{19}$$

$$d_1^- = \sqrt{\sum_{j=1}^{n} \left(r_{ij} - r_j{}^- \right)^2} (i = 1, 2, \ldots, m) \tag{20}$$

(3) Determine the relative closeness degree

On the basis of Equation (21), the relative closeness degree is acquired:

$$C_i = \frac{d_i^+}{d_i^+ + d_i^-} (i = 1, 2, \ldots, m) \tag{21}$$

In the aforementioned calculation, the distance between each index and the positive as well as the negative ideal solution is obtained, and the homologous Euclidean distance indicates the closeness degree. The nearer the distance is, the more closely the evaluation object approximates the ideal level, which also corresponds to a higher ranking.

3.2. MEA-MLSSVM

3.2.1. MEA

MEA is an evolutionary algorithm directed against the limitations of GA [40]. It retains a few ideas in GA, such as "population", "individual", "environment", and "evolution", but different from "crossover" and "mutation", MEA puts forward new concepts, namely "convergence" and "alienation". Compared with GA-LSSVM, LSSVM optimized by MEA has the advantages of global optimization and low possibility of falling into local optimum. In MEA, the selection of individuals in subgroups can be achieved through convergence. The mature subgroups compete globally via alienation. The structure of MEA is illustrated in Figure 1.

The basic idea and steps of MEA are presented as follows:

(1) Randomly generate a series of individuals and calculate the reciprocal of the mean square error as the corresponding score. Several individuals with relatively high scores are deemed as the superior ones and temporary ones.
(2) In the center of selected individuals, generate new ones and obtain superior and temporary subgroups, separately.
(3) Implement convergence on each subgroup, that is, individuals compete for the winner. When the winner no longer changes, it demonstrates that the subgroup is mature. Thus, the score of the winner is perceived as the points of the subgroup and posted on the global bulletin board.

(4) Implement alienation on all subgroups in the global space after convergence. The replacement, abandonment, and individual release of the superior subgroup and temporary subgroup are completed by comparing the scores. Accordingly, the optimal individual and its score in the global scope can be obtained.
(5) The individuals released from the subgroup generate new temporary subgroups in the solution space. The total number of temporary subgroups should be unchanged. Judge whether the accuracy is satisfied. If not, repeat Step (3) and Step (4) until the end of an iteration or the optimal score does not change. Finally, output the optimal individual.

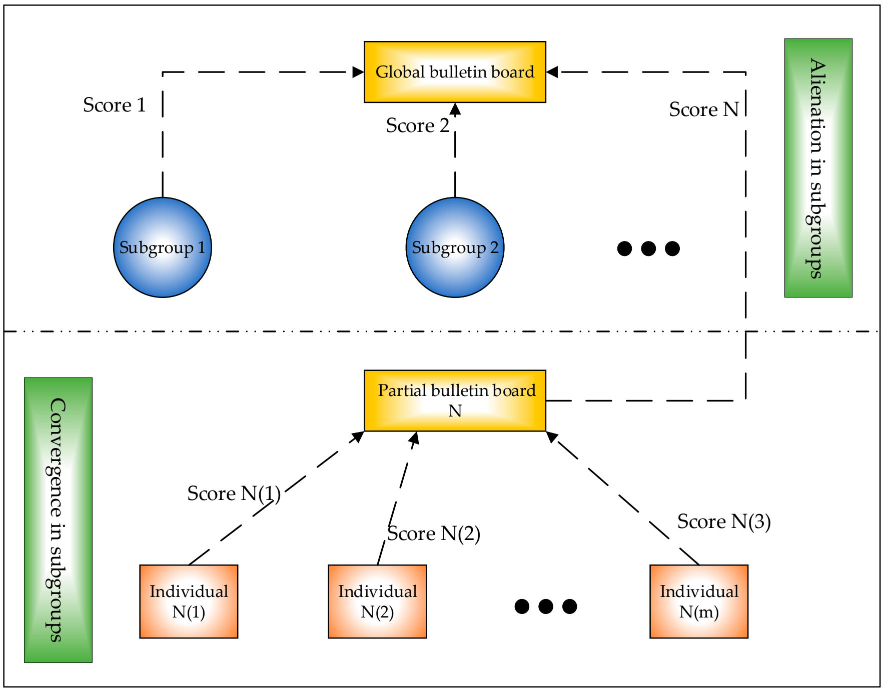

Figure 1. The framework of MEA.

3.2.2. Modified LSSVM (MLSSVM)

As an extension of SVM, there exist two main differences in LSSVM: (i) LSSVM establishes the optimal decision platform through transferring the input into higher-dimensional space. (ii) LSSVM applies the principle of risk minimization to transform the inequality constraints into equality ones. These two parts are conducive to reducing the calculation complexity and promoting the operation speed [41].

In LSSVM, set the training sample as $T = \{(x_i, y_i)\}_{i=1}^{N}$, where N represents the total number. The regression model is described as Equation (22):

$$y(x) = w^T \cdot \varphi(x) + b \tag{22}$$

where $\varphi(*)$ maps the training data into a much higher dimensional space; w and b are the weight vector and bias, respectively.

The optimization problem can be transformed as follows:

$$\min \frac{1}{2} w^T w + \frac{1}{2} \gamma \sum_{i=1}^{N} \xi_i^2 \tag{23}$$

$$s \cdot t\ y_i = w^T \varphi(x_i) + b + \xi_i, i = 1, 2, 3, \cdots N; \tag{24}$$

where the regularization parameter γ is exploited to balance the complexity and precision in the model; ξ_i equals the error.

To solve the aforementioned equation, the Lagrange function is listed as Equation (25):

$$\boldsymbol{L}(w,b,\xi_i,\alpha_i)=\frac{1}{2}w^Tw+\frac{1}{2}\gamma\sum_{i=1}^{N}\mu_i\xi_i^2-\sum_{i=1}^{N}\alpha_i\left[w^T\varphi(x_i)+b+\xi_i-y_i\right] \quad (25)$$

where $\alpha_k \in R$ are Lagrange multipliers. According to Equation (26), the derivation result of each variable can be acquired.

$$\begin{cases} \frac{\partial \boldsymbol{L}}{\partial w}=0\rightarrow w=\sum\limits_{i=1}^{N}\alpha_i\varphi(x_i) \\ \frac{\partial \boldsymbol{L}}{\partial b}=0\rightarrow \sum\limits_{i=1}^{N}\alpha_i=0 \\ \frac{\partial \boldsymbol{L}}{\partial \xi}=0\rightarrow \alpha_i=\gamma\mu_i\xi_i \\ \frac{\partial \boldsymbol{L}}{\partial \alpha}=0\rightarrow w^T+b+\xi_i-y_i=0 \end{cases} \quad (26)$$

The optimization problem is transformed into the following equation via the elimination of w and ξ_i.

$$\begin{bmatrix} 0 & \mathbf{e}_n^T \\ \mathbf{e}_n & \boldsymbol{\Omega}+\gamma^{-1}\mu^{-1}\cdot\mathbf{I} \end{bmatrix}\cdot\begin{bmatrix} \mathbf{b} \\ \mathbf{a} \end{bmatrix}=\begin{bmatrix} 0 \\ \mathbf{y} \end{bmatrix} \quad (27)$$

where $\boldsymbol{\Omega}=\varphi^T(x_i)\varphi(x_i)$, $\mathbf{e}_n=[1,1,\ldots,1]^T$, $\alpha=[\alpha_1,\alpha_2,\ldots,\alpha_n]$, $y=[y_1,y_2,\ldots,y_n]^T$.

Hereby, Equation (28) presents the final form of LSSVM:

$$y(x)=\sum_{i=1}^{N}\alpha_iK(x_i,x)+b \quad (28)$$

where $K(x_i,x)$ is the kernel function.

In this paper, the wavelet kernel function $K(x_i,x)=\prod\limits_{i=1}^{N}\psi(\frac{x_i-x'_i}{\sigma_i})$ is selected to substitute the Gaussian kernel function in standard LSSVM, that is

$$y(x)=\sum_{i=1}^{N}\alpha_i\prod_{i=1}^{N}\psi(\frac{x_i-x_i'}{\sigma_i})+b \quad (29)$$

$$\psi(x)=\cos(1.75x)\cdot\exp(\frac{-x^2}{2}) \quad (30)$$

Thus, the modified LSSVM is expressed as Equation (31):

$$y(x)=\sum_{i=1}^{N}\alpha_i\prod_{i=1}^{N}\{\cos[\frac{1.75(x_i-x_i')}{\sigma_i}]\cdot\exp[\frac{-(x_i-x_i')^2}{2}]\}+b \quad (31)$$

The following points give the reason why the traditional radial basis function is replaced with WT: (a) WT is able to describe the data step by step, and LSSVM along with WT can simulate arbitrary function more accurately. (b) WT is orthogonal or nearly orthogonal, while the traditional Gaussian kernel function is correlated or even redundant. (c) The nonlinear processing performance of WT is superior to the Gaussian kernel function on account of multi-resolution ability, which contributes to the improvement of generalization capability and robustness in LSSVM.

4. Evaluation Approach Based on Interval Type-II Fuzzy AHP-TOPSIS and MEA-MLSSVM

A novel hybrid assessment technique incorporating AHP-TOPSIS and MEA-MLSSVM is constructed as presented in Figure 2. Interval type-II fuzzy AHP-TOPSIS is used to obtain traditional estimation results, and the final assessment is accomplished through MLSSVM optimized by MEA. The specific steps are listed as follows:

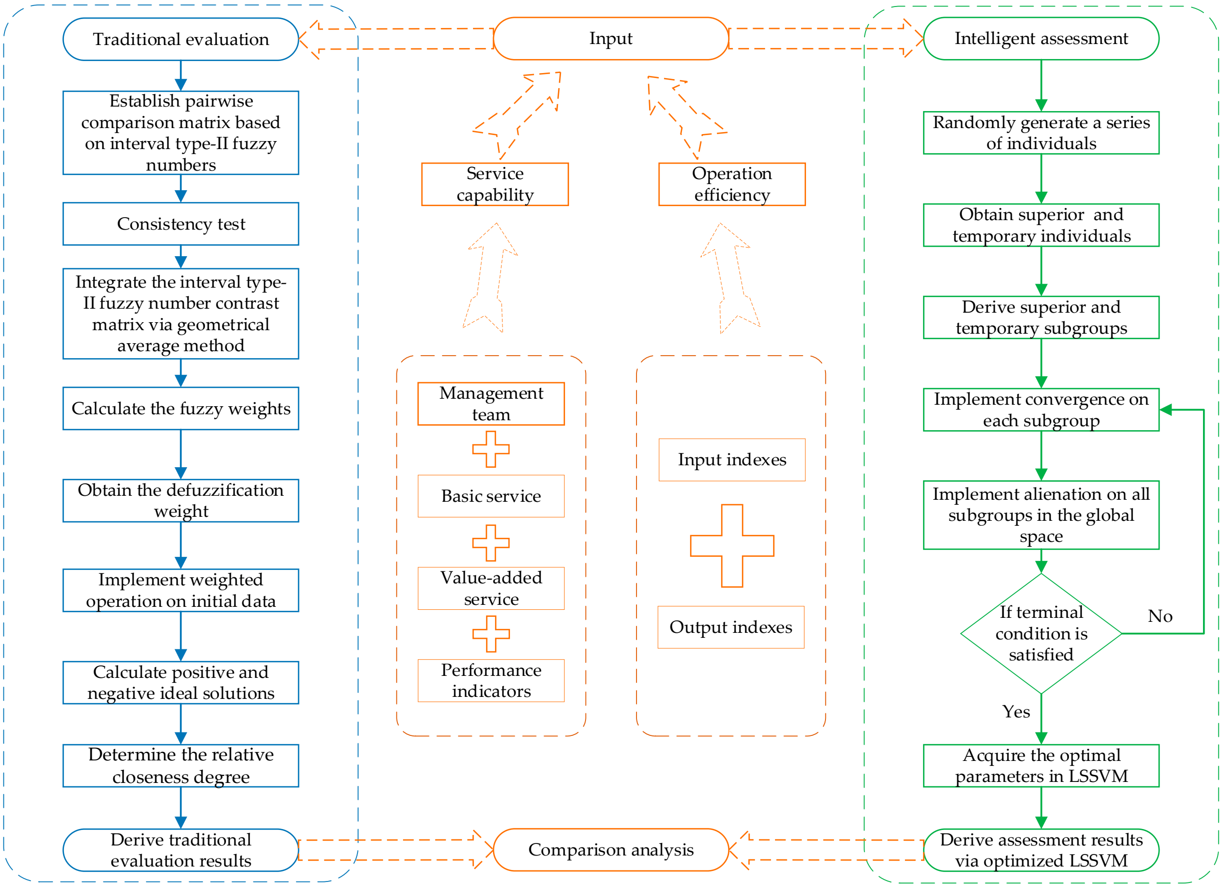

Figure 2. The workflow of the proposed model.

Step 1: Implement input initialization and data preprocessing. On the foundation of the index system, establish the initial input set and put quantification and standardization into practice.

Step 2: Acquire conventional evaluation results based on interval type-II fuzzy AHP TOPSIS.

Step 3: Initialize the parameters in MEA and MLSSVM.

Step 4: Optimize the parameters in MLSSVM via MEA, which are related to evaluation precision of sustainable development for renewable energy incubators. Consequently, this hybrid technique searches for the key parameters by MEA. If the number of iterations reaches the maximum, it demonstrates that the optimal values have been obtained. Otherwise, it is of necessity to rerun this algorithm to acquire the corresponding optimum set. The evaluation approach can be determined through training on test samples.

Step 5: Output the assessment results and make an analysis.

5. Case Study

5.1. Evaluation Based on Interval Type-II Fuzzy AHP-TOPSIS

5.1.1. Determination of Index Weight

In line with the ideas derived from 40 experts, test the consistency of the judgment matrix and attain the linguistic scale values of two first-grade indicators. Table 4 illustrates a few results.

The linguistic values (namely AS, VS, FS, SS, E) are converted into corresponding interval type-II fuzzy numbers according to the comparison relationship in Table 3. The composite values of expert evaluation are computed. Table 5 exhibits the fuzzy weight, deblurred weight, and the standardized weight of the first-grade indexes. Similarly, the indicator weights of second-grade and third-grade are listed in Table 6.

Table 4. Linguistic values of indexes in the first-grade.

Indexes	Service Capability				Operation Efficiency			
	Expert 1	Expert 2	···	Expert 40	Expert 1	Expert 2	···	Expert 40
AS	E	E	···	E	1/FS	1/VS	···	VS
VS	FS	VS	···	1/VS	E	E	···	E

Table 5. Index weight of the first-grade.

Indexes	Fuzzy Weight	Deblurred Weight	Standardized Weight
Service capability	(0.12,0.16,0.36,0.56;1,1), (0.15,0.18,0.36,0.58;0.8,0.8)	0.2953	0.5592
Operation efficiency	(0.16,0.19,0.31,0.36;1,1), (0.12,0.16,0.28,0.37;0.8,0.8)	0.2328	0.4408

Table 6. Indicator weight.

First-Grade	Weight	Second-Grade	Weight	Third-Grade	Weight
Service capability	0.5592	Management team	0.1566	Management system	0.0268
				Number of administrators in per incubated enterprise	0.0226
				The proportion of administrators with a bachelor degree or above	0.0201
				The proportion of administrators receiving professional training	0.0210
				Entrepreneurship cultivation	0.0168
		Basic service	0.1826	Hard facilities	0.0276
				Administrative service	0.0267
				Network service level	0.0356
		Value-added service	0.2026	Number of entrepreneurial mentors of per incubated enterprise	0.0396
				Number of experts in the accounting of per incubated enterprise	0.0358
				Number of experts in finance of per incubated enterprise	0.0258
				Number of experts in the law of per incubated enterprise	0.0228
				Number of experts in human resource of per incubated enterprise	0.0256
				Number of experts in the marketing of per incubated enterprise	0.0159
				Number of experts in renewable energy of per incubated enterprise	0.0568
		Performance indicators	0.1588	Rate of enterprises graduated in the current year	0.0368
				The average income of incubated enterprises (k yuan)	0.0585
				The proportion of high-tech renewable energy enterprises	0.0599
				The impact of incubated enterprises on local renewable energy development	0.0258
				Incubated enterprise satisfaction	0.0296
Operation efficiency	0.4408	Input indexes	0.1868	Number of administrators	0.0256
				Number of guidance specialists	0.0258
				Investment in public technology service platform (k yuan)	0.0562
				The total amount of incubation fund (k yuan)	0.0696
				Site area (m^2)	0.0358
				Total income of the incubator (k yuan)	0.0560
		Output indexes	0.1126	Number of enterprises that acquire financing	0.0367
				Number of enterprises that successfully graduate	0.0386
				Number of employees in the incubator and incubating enterprises	0.0256

5.1.2. Evaluation Based on TOPSIS

This paper takes 30 renewable energy incubators for the experiment. The standardized data are listed in Table 7. Table 8 manifests the calculation results of the weighted normalized matrix for the first ten samples. The positive and negative solutions, as well as the Euclidean distance, are shown in Tables 9 and 10, respectively.

Table 7. Standardized evaluation indicators.

No.	Renewable Energy Incubators									
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
1	0.1463	0.1271	0.2255	0.1631	0.2350	0.2350	0.1727	0.1199	0.1607	0.1703
2	0.1696	0.1283	0.1650	0.1215	0.2223	0.2292	0.2154	0.1260	0.2223	0.1192
3	0.1292	0.1527	0.2326	0.2232	0.1903	0.2209	0.1880	0.1950	0.2138	0.1433
4	0.2197	0.2014	0.2037	0.1579	0.2060	0.1396	0.1694	0.1556	0.2174	0.1739
5	0.2186	0.2111	0.2186	0.1391	0.1490	0.2136	0.1689	0.1291	0.2359	0.2260
6	0.1452	0.1679	0.1838	0.2246	0.1566	0.2269	0.2087	0.1702	0.2110	0.1838
7	0.2168	0.1819	0.1495	0.2392	0.1919	0.1819	0.1420	0.1744	0.1669	0.1445
8	0.1543	0.1784	0.1518	0.1976	0.2362	0.1615	0.1711	0.1663	0.2290	0.2314
9	0.1751	0.2359	0.1289	0.1970	0.1484	0.2043	0.1265	0.1338	0.2165	0.1557
10	0.1265	0.1484	0.2238	0.2360	0.1557	0.1873	0.2384	0.1216	0.1824	0.1338
11	0.1737	0.1205	0.1668	0.2293	0.2224	0.1923	0.1668	0.1969	0.1760	0.1784
12	0.2243	0.2014	0.2243	0.1350	0.1144	0.1831	0.1991	0.2197	0.1922	0.1579
13	0.1237	0.1844	0.1892	0.1941	0.2086	0.1480	0.1674	0.1650	0.2038	0.1456
14	0.1532	0.2098	0.1485	0.2145	0.1745	0.2027	0.1792	0.1957	0.1556	0.2216
15	0.1715	0.1903	0.1433	0.1903	0.1785	0.2208	0.1950	0.2325	0.1362	0.1456
16	0.1914	0.1761	0.2016	0.1404	0.1761	0.1353	0.1888	0.1939	0.1276	0.1582
17	0.1764	0.2087	0.1888	0.2062	0.2112	0.1342	0.2385	0.1988	0.2062	0.1342
18	0.1479	0.1947	0.1651	0.1701	0.2070	0.1257	0.2194	0.1479	0.1503	0.1799
19	0.1483	0.1930	0.1789	0.1506	0.1459	0.2212	0.1483	0.2330	0.1600	0.2306
20	0.1989	0.2081	0.2218	0.2103	0.2058	0.2263	0.2149	0.2126	0.2149	0.2103
21	0.1448	0.2312	0.1308	0.1611	0.1541	0.1237	0.1891	0.2055	0.2078	0.1518
22	0.2284	0.1884	0.1318	0.2284	0.1695	0.2025	0.2307	0.1813	0.2119	0.1789
23	0.1826	0.2247	0.2317	0.1662	0.2247	0.1194	0.2060	0.1755	0.1732	0.2177
24	0.1654	0.2190	0.1584	0.2307	0.2143	0.1934	0.2120	0.1375	0.1258	0.1165
25	0.1493	0.1609	0.1726	0.1493	0.2099	0.2029	0.1190	0.1656	0.1773	0.1236
26	0.1917	0.1770	0.2458	0.1426	0.2458	0.1770	0.1770	0.1672	0.1426	0.1794
27	0.1272	0.2237	0.1342	0.1625	0.2143	0.2355	0.1837	0.1790	0.1601	0.2143
28	0.1491	0.1261	0.2087	0.1468	0.1904	0.1697	0.1307	0.1904	0.1697	0.1674
29	0.2057	0.2246	0.1844	0.2222	0.2081	0.2364	0.1489	0.1939	0.1560	0.2151

Table 8. Calculation results of the weighted normalized matrix.

No.	Renewable Energy Incubators									
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
1	0.0039	0.0034	0.0060	0.0044	0.0063	0.0063	0.0046	0.0032	0.0043	0.0046
2	0.0038	0.0029	0.0037	0.0027	0.0050	0.0052	0.0049	0.0028	0.0050	0.0027
3	0.0026	0.0031	0.0047	0.0045	0.0038	0.0044	0.0038	0.0039	0.0043	0.0029
4	0.0046	0.0042	0.0043	0.0033	0.0043	0.0029	0.0036	0.0033	0.0046	0.0037
5	0.0037	0.0035	0.0037	0.0023	0.0025	0.0036	0.0028	0.0022	0.0040	0.0038
6	0.0040	0.0046	0.0051	0.0062	0.0043	0.0063	0.0058	0.0047	0.0058	0.0051
7	0.0058	0.0049	0.0040	0.0064	0.0051	0.0049	0.0038	0.0047	0.0045	0.0039
8	0.0055	0.0063	0.0054	0.0070	0.0084	0.0057	0.0061	0.0059	0.0082	0.0082
9	0.0069	0.0093	0.0051	0.0078	0.0059	0.0081	0.0050	0.0053	0.0086	0.0062
10	0.0045	0.0053	0.0080	0.0084	0.0056	0.0067	0.0085	0.0044	0.0065	0.0048
11	0.0045	0.0031	0.0043	0.0059	0.0057	0.0050	0.0043	0.0051	0.0045	0.0046
12	0.0051	0.0046	0.0051	0.0031	0.0026	0.0042	0.0045	0.0050	0.0044	0.0036
13	0.0032	0.0047	0.0048	0.0050	0.0053	0.0038	0.0043	0.0042	0.0052	0.0037
14	0.0024	0.0033	0.0024	0.0034	0.0028	0.0032	0.0028	0.0031	0.0025	0.0035
15	0.0097	0.0108	0.0081	0.0108	0.0101	0.0125	0.0111	0.0132	0.0077	0.0083
16	0.0070	0.0065	0.0074	0.0052	0.0065	0.0050	0.0069	0.0071	0.0047	0.0058
17	0.0103	0.0122	0.0110	0.0121	0.0124	0.0078	0.0140	0.0116	0.0121	0.0078
18	0.0089	0.0117	0.0099	0.0102	0.0124	0.0075	0.0131	0.0089	0.0090	0.0108
19	0.0038	0.0050	0.0046	0.0039	0.0038	0.0057	0.0038	0.0060	0.0041	0.0060
20	0.0059	0.0062	0.0066	0.0062	0.0061	0.0067	0.0064	0.0063	0.0064	0.0062

Table 8. *Cont.*

No.	Renewable Energy Incubators									
	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
21	0.0037	0.0059	0.0033	0.0041	0.0039	0.0032	0.0048	0.0053	0.0053	0.0039
22	0.0059	0.0049	0.0034	0.0059	0.0044	0.0052	0.0060	0.0047	0.0055	0.0046
23	0.0103	0.0126	0.0130	0.0093	0.0126	0.0067	0.0116	0.0099	0.0097	0.0122
24	0.0115	0.0152	0.0110	0.0161	0.0149	0.0135	0.0148	0.0096	0.0088	0.0081
25	0.0053	0.0058	0.0062	0.0053	0.0075	0.0073	0.0043	0.0059	0.0063	0.0044
26	0.0107	0.0099	0.0138	0.0080	0.0138	0.0099	0.0099	0.0094	0.0080	0.0100
27	0.0047	0.0082	0.0049	0.0060	0.0079	0.0086	0.0067	0.0066	0.0059	0.0079
28	0.0058	0.0049	0.0081	0.0057	0.0073	0.0066	0.0050	0.0073	0.0066	0.0065
29	0.0053	0.0057	0.0047	0.0057	0.0053	0.0061	0.0038	0.0050	0.0040	0.0055

Table 9. Positive and negative solutions.

No.	Positive Solutions	Negative Solutions	No.	Positive Solutions	Negative Solutions
1	0.0064	0.0032	16	0.0093	0.0047
2	0.0052	0.0027	17	0.0140	0.0073
3	0.0047	0.0024	18	0.0140	0.0075
4	0.0048	0.0026	19	0.0061	0.0031
5	0.0042	0.0021	20	0.0067	0.0035
6	0.0063	0.0034	21	0.0059	0.0030
7	0.0065	0.0034	22	0.0060	0.0032
8	0.0084	0.0045	23	0.0130	0.0066
9	0.0096	0.0049	24	0.0162	0.0081
10	0.0085	0.0044	25	0.0083	0.0043
11	0.0059	0.0030	26	0.0138	0.0069
12	0.0052	0.0026	27	0.0086	0.0043
13	0.0061	0.0031	28	0.0086	0.0049
14	0.0036	0.0019	29	0.0061	0.0031
15	0.0132	0.0071			

Table 10. Euclidean distance to positive and negative solutions.

Renewable Energy Incubators	Euclidean Distance to Positive Ideal Solution	Euclidean Distance to Negative Ideal Solution
Sample 1	0.0142	0.0106
Sample 2	0.0105	0.0156
Sample 3	0.0128	0.0142
Sample 4	0.0121	0.0146
Sample 5	0.0089	0.0170
Sample 6	0.0142	0.0137
Sample 7	0.0111	0.0157
Sample 8	0.0142	0.0121
Sample 9	0.0149	0.0116
Sample 10	0.0158	0.0112
Sample 11	0.0152	0.0112
Sample 12	0.0128	0.0126
Sample 13	0.0112	0.0153
Sample 14	0.0138	0.0137
Sample 15	0.0145	0.0127
Sample 16	0.0132	0.0124
Sample 17	0.0116	0.0169
Sample 18	0.0124	0.0146
Sample 19	0.0138	0.0129
Sample 20	0.0125	0.0157

Table 10. *Cont.*

Renewable Energy Incubators	Euclidean Distance to Positive Ideal Solution	Euclidean Distance to Negative Ideal Solution
Sample 21	0.0150	0.0108
Sample 22	0.0151	0.0120
Sample 23	0.0148	0.0125
Sample 24	0.0144	0.0120
Sample 25	0.0112	0.0154
Sample 26	0.0124	0.0155
Sample 27	0.0135	0.0112
Sample 28	0.0131	0.0128
Sample 29	0.0125	0.0123
Sample 30	0.0143	0.0126

The relative closeness degree of each renewable energy incubator is calculated and sorted here. The greater closeness degree means better sustainability of renewable energy incubators. The ranking results of the 30 incubators are exhibited in Table 11 and Figure 3.

Table 11. Relative closeness degree.

Renewable Energy Incubators	Relative Closeness Degree	Ranking	Renewable Energy Incubators	Relative Closeness Degree	Ranking
Sample 1	0.5722	4	Sample 16	0.5148	14
Sample 2	0.4015	29	Sample 17	0.4077	28
Sample 3	0.4731	20	Sample 18	0.4579	21
Sample 4	0.4544	22	Sample 19	0.5184	13
Sample 5	0.3440	30	Sample 20	0.4431	24
Sample 6	0.5094	15	Sample 21	0.5826	2
Sample 7	0.4140	27	Sample 22	0.5578	6
Sample 8	0.5403	10	Sample 23	0.5410	9
Sample 9	0.5637	5	Sample 24	0.5442	8
Sample 10	0.5848	1	Sample 25	0.4215	26
Sample 11	0.5768	3	Sample 26	0.4446	23
Sample 12	0.5034	18	Sample 27	0.5458	7
Sample 13	0.4222	25	Sample 28	0.5057	16
Sample 14	0.5018	19	Sample 29	0.5044	17
Sample 15	0.5339	11	Sample 30	0.5312	12

It can be seen that Sample 10 and Sample 5 present the best and worst sustainability based on interval type-II fuzzy AHP-TOPSIS, respectively.

5.2. MEA-MLSSVM Analysis

The first 20 renewable energy incubators are used as a training set, and the remaining incubators are exploited as a test set. To verify the proposed model, this paper makes the comparison with MEA-LSSVM, GA-MLSSVM, MLSSVM, and LSSVM. Table 12 and Figure 4 display the testing results. The performances of the assessment approaches are measured by relative errors as presented in Table 13 and Figure 5.

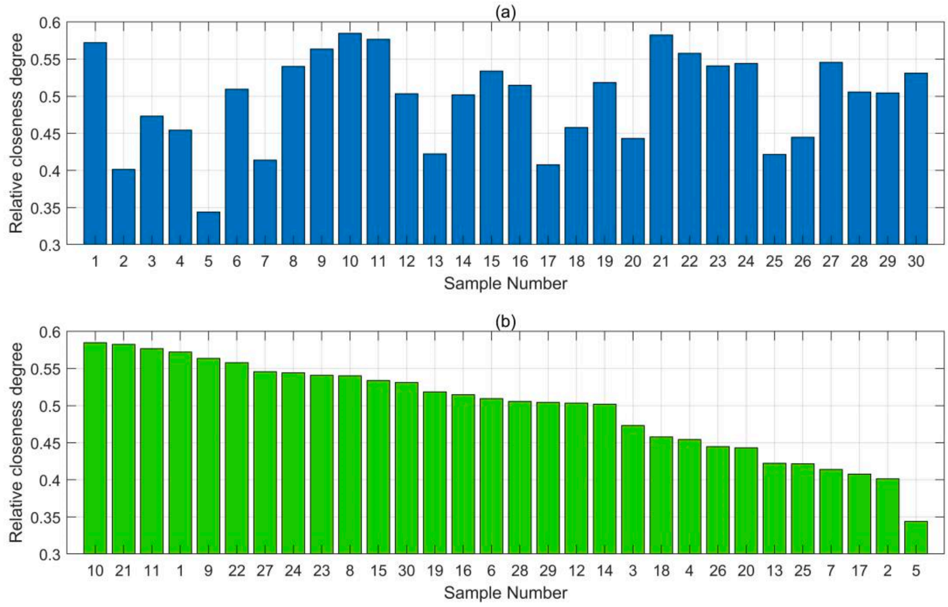

Figure 3. Relative closeness degree of 30 renewable energy incubators. Note: (**a**) sequencing by sample number; (**b**) sequencing by relative closeness degree.

Table 12. Results of the test set.

Renewable Energy Incubators	Evaluation Scores	MEA-MLSSVM	GA-MLSSVM	MLSSVM	LSSVM
Sample 21	0.5826	0.6047	0.5993	0.6239	0.5296
Sample 22	0.5578	0.5462	0.5842	0.5191	0.5986
Sample 23	0.5410	0.5635	0.5767	0.5769	0.5103
Sample 24	0.5442	0.5675	0.5777	0.5095	0.5946
Sample 25	0.4215	0.4418	0.3963	0.4371	0.3816
Sample 26	0.4446	0.4295	0.4610	0.4654	0.4763
Sample 27	0.5458	0.5693	0.5824	0.5874	0.5873
Sample 28	0.5057	0.4867	0.4722	0.5431	0.5501
Sample 29	0.5044	0.4816	0.5292	0.5356	0.4689
Sample 30	0.5312	0.5182	0.5571	0.4905	0.5808

Table 13. Errors of the test set.

Renewable Energy Incubators	MEA-MLSSVM	GA-MLSSVM	MLSSVM	LSSVM
Sample 21	3.80%	2.86%	7.09%	−9.09%
Sample 22	−2.08%	4.73%	−6.94%	7.31%
Sample 23	4.15%	6.59%	6.63%	−5.68%
Sample 24	4.29%	6.15%	−6.37%	9.26%
Sample 25	4.82%	−5.97%	3.69%	−9.46%
Sample 26	−3.40%	3.68%	4.68%	7.13%
Sample 27	4.31%	6.71%	7.63%	7.61%
Sample 28	−3.76%	−6.62%	7.40%	8.78%
Sample 29	−4.53%	4.91%	6.18%	−7.03%
Sample 30	−2.44%	4.87%	−7.67%	9.34%

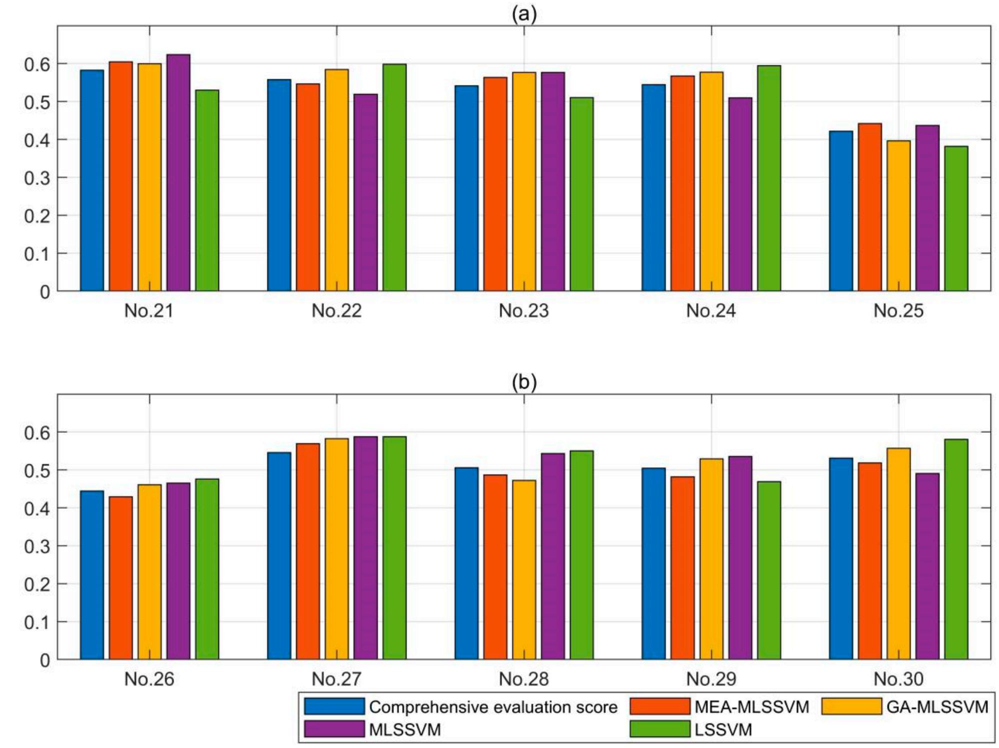

Figure 4. Results of the test set. Note: (**a**) shows the results from sample No.21 to No.25; (**b**) shows the results from sample No.26 to No.30.

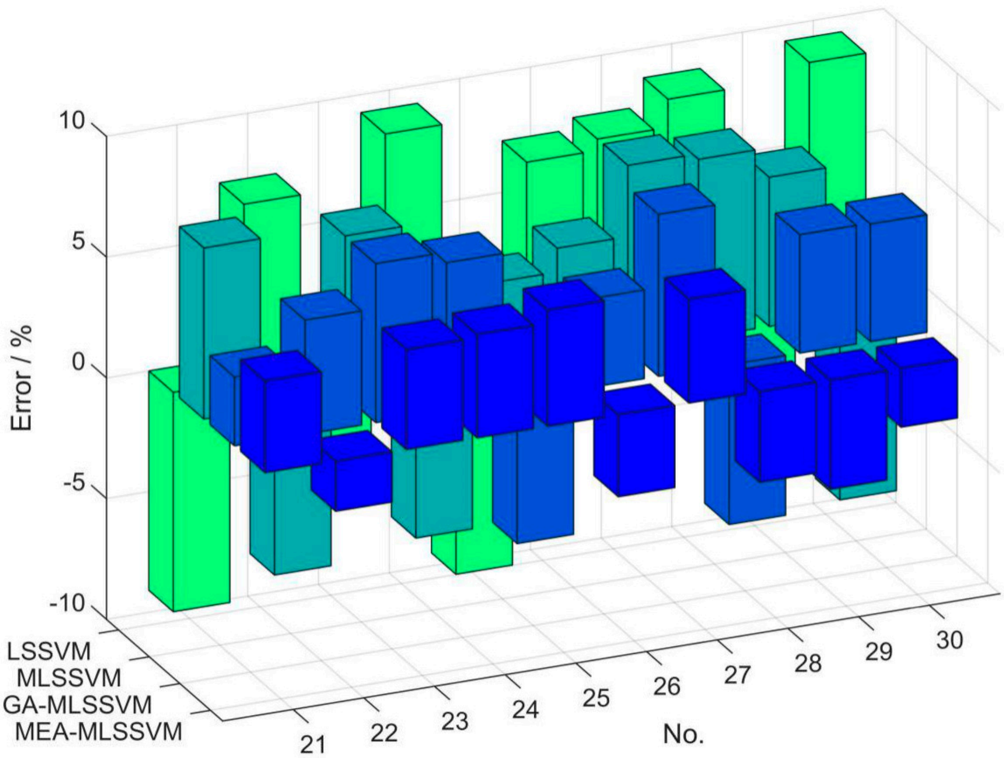

Figure 5. Errors of the test set.

From the above figures and tables, we find that all the relative errors of MEA-MLSSVM are controlled in [−5%, 5%], while the corresponding number of errors within [−5%, 5%] of GA-LSSVM, MLSSVM, and LSSVM equals five (namely Sample 21, Sample 22, Sample 26, Sample 20, and Sample 30), two (namely Sample 25 and Sample 26), and none, respectively. In addition, the error range of MEA-MLSSVM is [2.08%, 4.82%], whereas the evaluation error ranges of GA-LSSVM, MLSSVM, and LSSVM are [2.86%, 6.71%], [3.69%, 7.67%], as well as [5.68%, 9.46%], respectively. Hence, the evaluation accuracy from superior to inferior is ranked as follows: MEA-MLSSVM, GA-LSSVM, MLSSVM, and LSSVM. It is obvious that MEA-MLSSVM has advantages in precision and stability, which proves MEA achieves satisfactory optimization performance with regards to LSSVM.

In this study, MEA-MLSSVM is introduced on the basis of interval type-II fuzzy AHP-TOPSIS for sustainable development of renewable energy incubators so as to simplify the process of expert scoring and realize fast calculation. The intelligent algorithm can flexibly and efficiently study the scoring methods and standards of qualitative indexes through machine training, as well as simulate the expert scoring process, which is conducive to subjectivity reduction and more objective evaluation.

6. Conclusions

This paper designs a comprehensive assessment index system of sustainable development for renewable energy incubators and establishes a hybrid evaluation model incorporating interval type-II fuzzy AHP-TOPSIS and MEA-MLSSVM. Several conclusions can be obtained as follows: (a) the index system is proposed from two perspectives, that is, service capability and operation efficiency, which act as the core requirements and necessary guarantee. Specifically, service capability includes four aspects: management team, basic service, value-added service, and performance indicators; operation efficiency includes two dimensions: input indexes and output indexes. (b) The traditional estimation results are obtained on the foundation of interval type-II fuzzy AHP combined with TOPSIS. It is clarified that the interval type-II fuzzy numbers introduced into the evaluation model can well handle numerous uncertainties and obtain robust results. (c) An intelligent evaluation model based on MEA-MLSSVM is constructed illustrating that the introduction of WT and MEA improves the performance of LSSVM. The case study verifies the scientificity and precision of the established technique. Wherein the traditional assessment approach can acquire scientific and exact results, the modern intelligent algorithm can not only reduce the subjectivity, but also conduce to more objective, accurate, and rapid evaluation. However, more sample data are needed for validation. Simultaneously, leveraging more types of intelligent models to evaluate the sustainability of renewable energy incubators is also a direction for our future research.

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