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ARTICLE

Effect Evaluation and Intelligent Prediction of Power Substation Project Considering New Energy

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ABSTRACT

The evaluation of the implementation effect of the power substation project can find out the problems of the project more comprehensively, which has important practical significance for the further development of the power substation project. To ensure accuracy and real-time evaluation, this paper proposes a novel hybrid intelligent evaluation and prediction model based on improved TOPSIS and Long Short-Term Memory (LSTM) optimized by a Sperm Whale Algorithm (SWA). Firstly, under the background of considering the development of new energy, the influencing factors of power substation project implementation effect are analyzed from three aspects of technology, economy and society. Moreover, an evaluation model based on improved TOPSIS is constructed. Then, an intelligent prediction model based on SWA optimized LSTM is designed. Finally, the scientificity and accuracy of the proposed model are verified by empirical analysis, and the important factors affecting the implementation effect of power substation projects are pointed out.

KEYWORDS

New energy; substation; implementation effect; evaluation and intelligent prediction; improved topsis; LSTM; SWA

Nomenclature

LSTM	Long Short-Term Memory
SWA	Sperm Whale Algorithm
PSP	Power Substation Project
RNN	Recurrent Neural Network
FOA	Fruit Fly Optimization Algorithm
TOPSIS	Technique for Order Preference by Similarity to an Ideal Solution

1 Introduction

In recent years, with the continuous increase of new energy installed capacity, the construction of Power Substation Project (PSP) supporting new energy power sources has also been accelerated. How to ensure that the substation not only has sufficient capacity to consume new energy, but also can provide high-quality power supply for regional economic and social development and people's living standards, is the main task of substation construction [1]. The construction of PSP can promote regional new energy consumption and improve living standards, which has a significant role in promoting the development of new energy [2]. However, with more and more PSP, the problem faced by project managers is how to evaluate and predict the implementation effect of a PSP, so as to timely and effectively judge whether the construction and operation effect can reach the expectation. In consequence, the implementation effect evaluation and prediction research of PSP has become an important research topic.

The research on the evaluation of PSP implementation effect is not common, but there are some evaluations on other aspects of the substation, which can provide ideas for this study. Reference [3] comprehensively evaluated the real-time status of substation equipment. By collecting the state information of all equipment, the fuzzy evaluation matrix of equipment influencing factors is obtained by applying the relative degradation theory and fuzzy theory. The subjective analytic hierarchy process and objective entropy weight method are combined to calculate the comprehensive weight of equipment influencing factors. Finally, the fuzzy comprehensive evaluation method is used to obtain the equipment condition evaluation results. Reference [4] proposed a statistical method based on Monte Carlo technology, and used the ability of simulation tools to evaluate the lightning performance of a complete air-insulated substation. There have been many evaluations on the implementation effect of other types of projects. As for the evaluation research on the implementation effect, the evaluation research on the implementation effect of PSP has many similarities with the evaluation of the implementation effect of other types of projects. For example, the factors affecting the implementation effect of projects have certain similarities. So, combing and analyzing the research references of the implementation effect evaluation of other types of projects has reference value for the study of the implementation effect evaluation of PSP. Reference [5] took a green building project in Nanchang as an example, the implementation effect of green building project was evaluated by using the extension matter element theory and entropy method. Reference [6] evaluated the implementation effect of waste heat power generation system from economic angle. Reference [7] based on fuzzy Borda method and synergy theory, considering the synergy effect of PPP project, and carried out evaluation research on the implementation effect of PPP project from the perspective of risk and return. Although the above research does not specifically carry out evaluation research on the implementation effect of PSP, its research content has certain reference value for the construction of evaluation index system and the selection of evaluation methods in this paper.

As for the evaluation method, the existing research provides an important reference for the evaluation of the implementation effect of PSP in this paper. By combing and analyzing the relevant comprehensive evaluation methods, it can be found that the evaluation methods mainly include traditional evaluation methods and modern intelligent evaluation methods. Evaluation methods include subjective evaluation method and objective evaluation method [8]. Subjective evaluation methods include expert evaluation method, fuzzy analytic hierarchy process and network analytic hierarchy process [9]. Objective evaluation methods include entropy weight method, principal component analysis, grey correlation analysis, the ideal solution, matter element extension, etc. [10]. Modern intelligent evaluation methods mainly include artificial neural network evaluation method and support vector machine evaluation method [11]. In view of the traditional evaluation method theory is more mature, the calculation results are more accurate, the calculation process is more complex, and the modern intelligent evaluation method can accurately deal with massive real-time data, so as to realize fast intelligent prediction [12]. This paper intends to combine the traditional evaluation method and modern intelligent algorithm for PSP implementation effect evaluation and prediction research.

Firstly, based on the traditional evaluation method, the index weight is determined by the widely used entropy weight method, and TOPSIS. A widely used objective evaluation method is used to reduce the deviation caused by the interference of human factors and quantify the evaluation, thus making the evaluation results more objective [13]. However, the use of TOPSIS method for evaluation has a flaw, which can only rank the level of each program, but cannot judge the level of each program [14]. This paper considers using the idea of matter-element extension to improve it to make up for the limitation of the TOPSIS method that cannot determine the evaluation level. Secondly, modern intelligent prediction methods use the Long Short-Term Memory model (LSTM). The main reason is that the LSTM neural network is based on the Recurrent Neural Network (RNN), which effectively solves the problem of gradient explosion and gradient disappearance by adding forget gates, input gates and output gates [15]. In the field of prediction, LSTM neural network has achieved certain results [16]. However, considering that LSTM prediction performance is affected by the number of hidden layer neurons, block size, maximum number of training cycles and learning rate. This paper uses intelligent algorithm to optimize LSTM to solve the blind selection of key parameters [17]. Common intelligent algorithms include genetic algorithm, Fruit Fly Optimization Algorithm (FOA), particle swarm algorithm, wolf swarm algorithm, cuckoo optimization algorithm, etc. Although the above algorithms have their own advantages, they also have corresponding shortcomings. For example, the FOA algorithm cannot guarantee the convergence to the optimal solution, and it is easy to low efficiency and local optimum, resulting in the decrease of prediction accuracy [18]. Wolf swarm algorithm in different cases will appear premature convergence [19]. Cuckoo search algorithm has low search efficiency, long calculation time and low local search accuracy, which cannot fully meet the needs of LSTM parameter optimization problem [20]. Therefore, this paper uses the whale algorithm to optimize LSTM parameters. The sperm whale algorithm avoids premature convergence and local optimization by creating different subgroups [21]. The worst result is transferred to the desired space through the reflection of the center of the search space, which greatly reduces the calculation time of the algorithm and improves the search efficiency [22].

In summary, based on the scientific principle, comprehensiveness and practical feasibility, this paper constructs the evaluation index system of PSP implementation effect, and proposes a comprehensive evaluation and intelligent prediction model based on improved TOPSIS and SWA-LSTM. The rest of the paper is arranged as follows. In the second part, on the basis of clarifying the basic principles of the evaluation index system, the evaluation indexes of the implementation effect of the PSP are selected, and various indexes are explained. The third part explains the basic theory of improving TOPSIS, SWA algorithm and LSTM. The fourth part designs the evaluation and prediction process based on improved TOPSIS and SWA-LSTM. The fifth part verifies the scientificity and effectiveness of the model through examples, and analyzes and discusses the results of examples. The sixth part summarizes the research results.

2 Evaluation Index System

On the basis of implementing the principles of scientificity, systematic comprehensiveness, and practical feasibility and carefully combing the relevant theories of substation project implementation effect evaluation [23], combined with the background of high proportion of new energy access and the actual situation of substation projects, this paper constructs the evaluation index system of PSP implementation effect from the three perspectives of PSP technical level, PSP economy and PSP social benefit. The evaluation index system of PSP is composed of three first-level indexes and 15 s-level indexes, as shown in Table 1.

Table 1: Evaluation index system of PSP implementation effect

General objective	First-level index	Secondary- level index
Evaluation Index System of PSP Implementation Effect	Technical level of PSP	Scientific decision-making in project design stage Technical scheme quality of PSP Implementation conditions of external environment Construction transition measures Progress control level of PSP Personnel arrangement of PSP implementation Safety management level of PSP Quality management level of PSP
	Economy level of PSP	Cost control level of PSP Financial net present value of PSP Internal rate of return of PSP Investment payback period of PSP
	Social benefits of PSP	Influence of PSP on regional economic development Influence of PSP on regional power grid operation Influence of PSP on regional environment

2.1 Selection of PSP Technical Level Evaluation Index

The evaluation index of PSP technical level selects eight subindexes, including scientific decision-making in project design stage, technical scheme quality of PSP, implementation conditions of external environment, construction transition measures, progress control level of PSP, personnel arrangement of PSP, safety management level of PSP and quality management level of PSP.

(1) Scientific decision-making in project design stage

The scientificity of technical scheme comparison and selection in design stage mainly refers to whether the technical scheme comparison and selection is scientific and reasonable in the researchable design stage of PSP, and whether the comprehensive comparison and selection are carried out in terms of safety, efficiency and equipment life cycle cost. The reason and comparison basis of the scheme selection are sufficient, and the goal and purpose are clear, which can show that the project decision-making is scientific and effective.

(2) Quality of PSP technical scheme

The quality of technical scheme of PSP refers to whether the content of the technical scheme is comprehensive, whether the scheme is in place, whether the content of the scheme has sufficient depth, whether the main demolition equipment materials and the new main equipment materials are fully considered, and whether it can provide sufficient basis for controlling the construction cost of the project.

(3) Implementation conditions of external environment

The implementation conditions of the external environment mainly refer to whether the organizational measures, on-site safety measures, and on-site risk point control and preventive measures of the PSP are implemented in place, whether the construction conditions are met, and whether the construction of the PSP has played a sufficient guarantee role.

(4) Construction transition measures

Construction transition measures refer to whether the transformation of the entire station, load switching, and possible power accidents have been considered in advance in the PSP, and whether corresponding emergency plans have been formulated for these situations. And during the construction of the project, whether the operation of the power grid is closely monitored, and whether the safety and reliability of power supply are fully guaranteed.

(5) Progress control level of PSP

The progress control of PSP refers to that the relevant construction units should complete on schedule according to the milestone progress plan of the project phase, and complete all the agreed work contents according to the contract content.

(6) Arrangement of PSP implementation personnel

The personnel arrangement of PSP implementation refers to whether the specific responsibility arrangement and management of project implementation personnel such as team leader, project safety officer, project technician, work leader, material officer, reference officer and work team member are appropriate.

(7) PSP safety management level

PSP safety management refers to the project management should be able to do a good job in advance, in and after the whole process of safety management, investigation of various security risks, safety education and protection measures for construction personnel. The whole project does not appear personal casualties, equipment failure events, safety risk management, hidden trouble investigation and management, emergency planning and other key work to meet the requirements of the company, safety management in place, must conform to the relevant safety production management measures.

(8) PSP quality management level

The quality management of PSP refers to the proper control and management of PSP in the main links of cabinet installation, cable laying and production, secondary wiring and protection debugging.

2.2 Selection of Economic Evaluation Indexes for PSP

The economic evaluation index of substation project includes 4 sub-indexes, namely, the cost control level of PSP, the financial net present value of PSP, the internal rate of return of PSP and the investment payback period of PSP.

(1) Cost control level of PSP

The cost control of PSP refers to a series of activities to predict, calculate, manage and monitor the cost of PSP in the process of decision-making, design and implementation of PSP in order to achieve the expected goal of PSP investment. The cost control in the PSP is an important part of the complete PSP management process. It is interdependent with other control work of the PSP, and the cost control of the PSP will run through the whole investment process of the project, which plays a very important role. Therefore, this paper takes the cost control level of PSP as an index to evaluate the economy of the project, and judges the cost control level of PSP through comparative analysis of project investment estimation and project final accounts.

(2) The financial net present value of the PSP

Under the premise of calculating the benchmark discount rate of the entire power industry, the PSP is divided into multiple stages according to time, and the net cash flow of each stage is converted to the initial period of the PSP. The value obtained is the financial net present value. If the financial net present value is not less than 0, the return rate of this project will not be less than the benchmark interest rate of the whole industry. Therefore, this project has good economy and good investment construction and operation effect. If the financial net present value of this project is smaller than 0, the return rate of this project is bound to be lower than the benchmark interest rate of the entire industry. Therefore, the economy of this project is poor, and its investment and operation effect are not very good from an economic point of view.

(3) Internal rate of return of PSP

The discount rate obtained when the sum of net cash flow in each stage of substation construction project is zero that is the internal rate of return of PSP. The internal rate of return of the PSP can be compared with the benchmark rate of return of the entire industry to determine the economic advantages and disadvantages of the PSP. If the internal rate of return of the PSP is higher than the benchmark rate of return of the entire industry, the economy of the PSP is good and the investment implementation effect is excellent. If the internal rate of return of the PSP is lower than the benchmark rate of return of the whole industry, the economy of the project is poor, and its investment and operation effect is poor from an economic point of view.

(4) Investment payback period of PSP

The payback period of PSP investment refers to the time that the net income of PSP can compensate for the total investment in the early stage of project construction. The main evaluation is the investment recovery level of PSP in finance.

2.3 Selection of Social Benefit Evaluation Index of PSP

The social benefit evaluation index of PSP mainly selects three indexes: the influence of PSP on regional economic development, the influence of PSP on regional power grid operation, and the influence of PSP on regional environment.

(1) Influence of PSP on regional economic development

The impact of the project on the local economic development mainly depends on the pulling effect of the project on the local economy and whether it can promote employment. It includes the following aspects: First, the impact on local residents' income, including analyzing and predicting the scope, extent and reasons of the increase or decrease in residents' income, and analyzing the equity of income distribution, whether to expand the income gap between rich and poor and how to achieve equitable income distribution policy recommendations. Second, the impact on the living standards and quality of residents in the project area, mainly analyzing the changes in residents' living level, consumption level, consumption structure, life expectancy, and the reasons for these changes. Third, the impact on employment of residents in the project area, mainly analyzing the positive and negative effects of the construction and operation of the project on the employment structure and employment opportunities of local residents. Fourth, the impact on different interest groups in the region, mainly analyzing of the project construction and operation of which people benefit, who are damaged and compensation measures and ways for the damaged groups.

(2) Influence of PSP on regional power grid operation

The social influence of the project can be judged by analyzing the influence of PSP on power grid operation. If the construction and operation of the PSP can bring about the improvement of the operation effect of the power grid, and if the construction technology advances, it can bring about the improvement of the power supply capacity and quality and the improvement of the reliability of the power grid, so as to determine whether to meet the electricity demand of enterprises and residents in the region, and then determine whether the investment and operation of the PSP can promote the sustainable development of regional enterprises and ensure the stable development of regional social economy. In addition, it can also judge the influence of PSP on power grid line loss, whether it can reduce the consumption of energy and other related energy, and whether it has achieved the effect of energy saving and loss reduction. If the investment and operation of PSP have a favorable impact on the operation of regional power grids, to a certain extent, it can enhance the degree of social security, improve urban infrastructure construction, and also conform to the national macro strategy of expanding domestic demand and stimulating economic growth.

(3) Influence of PSP on regional environment

The impact of PSP on the regional environment mainly refers to whether the PSP have a leading role in the development of regional new energy, the environmental protection measures adopted in the implementation process, the governance of pollutants, and whether there are short-term or long-term negative impacts on the natural environment. The specific evaluation indexes include the following two aspects. Firstly, the pollution impact of the project on the natural environment mainly refers to the main pollution that may occur in the PSP and the corresponding preventive measures. The main pollution sources include air, waste water, noise and so on. Secondly, the impact of PSP on the development of new energy and the quality of natural environment. Nature is the material basis for the survival of mankind and all kinds of organisms. According to the characteristics of PSP, the impact of PSP on regional environment is evaluated mainly from the aspects of regional new energy consumption level, the improvement of environmental quality and natural landscape.

3 Methodology

3.1 Improved TOPSIS

TOPSIS method, also known as technique for order preference by similarity to an ideal solution, has the following main idea. Firstly, a scheme is virtualized, and each attribute value in this scheme is the best. The set of these attribute values is called positive ideal solution. At the same time, another scheme is virtualized, and each attribute value in this scheme is the worst. The set of these attribute values is called negative ideal solution. Then, each scheme in the scheme set is compared with the positive ideal solution and the negative ideal solution, respectively. The best scheme is those schemes which are close to the positive ideal solution and far away from the negative ideal solution [24]. There is a defect in TOPSIS to evaluate, which can only sort the level of each scheme, but cannot judge the level of each scheme. Matter-element extension evaluation method is a method for quantitative evaluation of things based on matter-element theory, extension set and correlation degree [25]. Its main idea is to divide the data interval of the evaluation object into several grades, and then determine the corresponding level of each data interval, and then substitute the data value of each scheme into the data interval of each grade to determine its correlation degree. The greater the correlation degree is, the higher the membership degree is. The grade of the data interval with the highest membership degree is the level of the rating object. Taking into account the limitations of TOPSIS method, this paper uses the idea of matter-element extension to improve it to make up for the limitations of TOPSIS method that cannot determine the evaluation level. Therefore, the specific idea of using matter-element extension to improve TOPSIS in this paper is as follows. Firstly, the positive ideal solution and the negative ideal solution of the evaluation scheme are determined by the ideal solution method. The interval equidistant composed of the negative ideal solution and the positive ideal solution is divided into several grades, and the corresponding evaluation grade level of each grade is determined, and the corresponding comment is given. Then, the correlation degree between the scheme and the interval of each grade is calculated, and the evaluation grade of the scheme can be determined. In this paper, matter-element extension-TOPSIS method is used to evaluate the implementation effect of PSP, which can make full use of the original information and truly reflect the actual situation of the evaluation object. It has the advantages of scientific and objectivity.

This section will build an evaluation model based on matter-element extension-TOPSIS method, and the specific steps are as follows.

(1) Construction of standard index matrix

Assuming that the scheme set involved in the evaluation is $M = (M_1, M_2, \cdots, M_m)$, n evaluation indexes are included. and the evaluation index set is $D = (D_1, D_2, \cdots, D_n)$, the original index value is consistent and dimensionless, and the standard index matrix C is:

$$C = \left(c_{ij}\right)_{m\times n} = \begin{bmatrix} c_{11} & c_{12} & \cdots & c_{1n} \\ c_{21} & c_{22} & \cdots & c_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ c_{m1} & c_{m2} & \cdots & c_{mn} \end{bmatrix} \tag{1}$$

where, $c_{ij} = (i = 1, 2, \cdots, m; j = 1, 2, \cdots, n)$ is the standard index value of scheme M_i to index D_j.

(2) Construction of weighted standardized matrix

The entropy weight method is used to calculate the weight of each evaluation index w_i. The specific operation steps of the entropy weight method are referred to reference [26], which is not repeated here. The weighted standardized matrix is obtained by weighting x_{ij} according to formula $X_{ij} = w_i c_{ij}$:

$$X = \left(x_{ij}\right)_{m\times n} = \begin{bmatrix} w_1 c_{11} & w_2 c_{12} & \cdots & w_n c_{1n} \\ w_1 c_{21} & w_2 c_{22} & \cdots & w_n c_{2n} \\ \cdots & \cdots & \cdots & \cdots \\ w_1 c_{m1} & w_2 c_{m2} & \cdots & w_n c_{mn} \end{bmatrix} \tag{2}$$

(3) Determination of positive and negative ideal solutions for schemes

The positive ideal solution and the negative ideal solution are as follows:

$$X^{+} = \left\{ \max_{1 \le i \le m} x_i(j) \left| j \in J^{+}, \min_{1 \le i \le m} x_i(j) \right| j \in J^{-} \right\} \tag{3}$$

$$X^{-} = \left\{ \min_{1 \le i \le m} x_i(j) \left| j \in J^{+}, \max_{1 \le i \le m} x_i(j) \right| j \in J^{-} \right\} \tag{4}$$

(4) Divide the extreme value interval and calculate the closeness between each index and each comment interval.

(5) The extremal intervals of elements composed of negative and positive ideal solutions are divided into N layers, and the intervals of each layer are $H_{it} = (h_{it}^{1}, h_{it}^{2}), i = 1, 2 \cdots, n;\ t = 1, 2, \cdots, N$. in which $x_i^{-} \le h_{it}^{1} \le x_i^{+}, x_i^{-} \le h_{it}^{2} \le x_i^{+}$, h_{it}^{1}, h_{it}^{2} together constitute the interval $[x_i^{-}, x_i^{+}]$.

The closeness between each index of the standardized decision matrix and each comment interval is:

$$K(N_i) = \left| x_{ij} - \frac{h_{jt}^{1} + h_{jt}^{2}}{2} \right| \tag{5}$$

Based on the closeness of each index, the weighted closeness of each evaluation scheme is calculated as:

$$T_j(N_i) = 1 - \sum_{j=1}^{n} w_j K(N_i) \tag{6}$$

(6) Classifying the evaluation schemes

According to the maximum level of $T_j(N_i)$ is the evaluation object belongs to the rating level.

3.2 SWA

As a multi-objective optimization algorithm based on multi-population search, the SWA searches the optimal position by imitating the life operation program of sperm whale in nature, and constantly moves to the region, so as to gather to the optimal position and realize the function of searching the optimal solution. In SWA, each answer represents a sperm whale unit, and the search process is based on the common search of multiple populations.

First, at the initial stage of the algorithm, individuals need to be created and designed as candidate populations. Then, the candidate population should be divided into Temporary Sub-Group (TSG), each of which contains individuals. Finally, new groups are obtained by regrouping temporary sub-groups. The specific operation is as follows. A unit is randomly selected from each TSG to form a new Main Sub-Group (MSG) until main sub-groups are generated for iterative optimization. At this time, each MSG contains individuals, as shown in Fig. 1. The creation of the above temporary subgroups and the principal subgroups can effectively prevent the algorithm from stopping prematurely and preventing it from falling into local optimum. In SWA, the following operations are mainly performed for the MSG created [27].

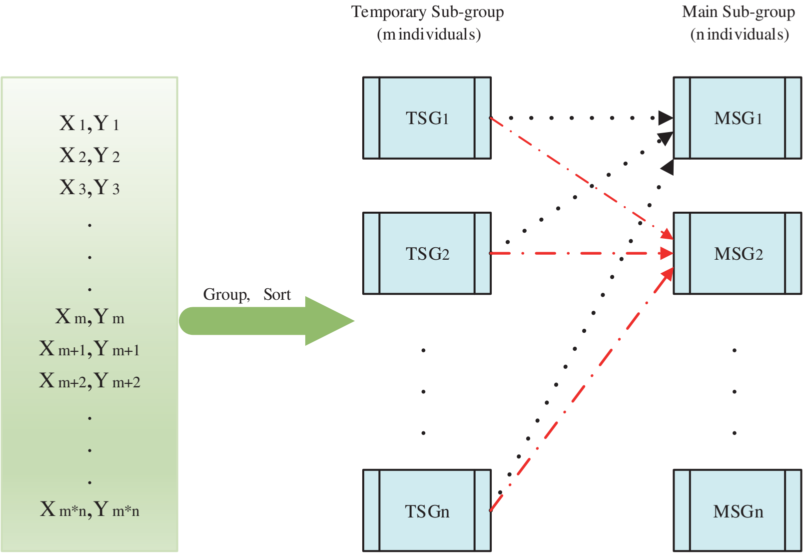

Figure 1: The grouping process in SWA

(1) Calculate the results of the objective function. Given the whales habit of eating on the seabed and breathing on the sea, each individual constantly breathes and feeds in two places. When calculating the objective function results of each sperm whale unit, it should be considered in two positions (current position and relative position). However, since the mirror reflection of the best answer cannot obtain the optimal solution, it can only increase the calculation time of the algorithm, and only the worst result in the relative position of the individual will be calculated and reflected. For the above reasons, considering the information exchange between whales, we can transfer the worst result position to the expected space through the reflection of the center of the search space. The connection between the two points is just connected to the worst whale individual and the optimal whale individual, as shown in Fig. 2. Assuming that the worst individual and the optimal individual in the population are S_{worst} and S_{best}, respectively, then

$$S_{center} = S_{worst} + \alpha \times S_{best} \tag{7}$$

$$S_{reflex} = S_{worst} + 2 \times (S_{center} - S_{worst}) = 2S_{center} - S_{worst} \tag{8}$$

where S_{center} is the reflection center, S_{reflex} is the calculation result between the worst individual whale S_{worst} and the reflection center S_{center}; α is the reflection center factor. In addition, if S_{reflex} is outside the search space, α should be contracted according to $\alpha = \rho \times \alpha_i$, α_i represents the initial center factor, ρ is the contraction factor, and $\rho \leq 1$. In global optimization problems, the choice of parameter α cannot make S_{reflex} exceed the search space boundary. Assuming that A is the vector of order $1 \times n$ and n is the number of decision variables, then: $for\ i = 1:n$.

$$
\begin{aligned}
& S_{\min}(i) \le S_{reflex}(i) \le S_{\max}(i) \\
& \xrightarrow[Equation(2)]{} S_{\min}(i) \le 2S_{center(i)} - S_{worst}(i) \le S_{\max}(i) \\
& \xrightarrow[Equation(1)]{} S_{\min}(i) \le 2 \times (S_{worst}(i) + A(i) \times S_{best}(i)) - S_{worst}(i) \le S_{\max}(i) \\
& \rightarrow S_{\min}(i) \le S_{worst}(i) + 2A(i) \times S_{best}(i) \le S_{\max}(i) \\
& \rightarrow \frac{S_{\min}(i) - S_{worst}(i)}{2S_{best}(i)} \le A(i) \le \frac{S_{\max}(i) - S_{worst}(i)}{2S_{best}(i)} \\
& \alpha = rand \times Min(A)
\end{aligned}
$$

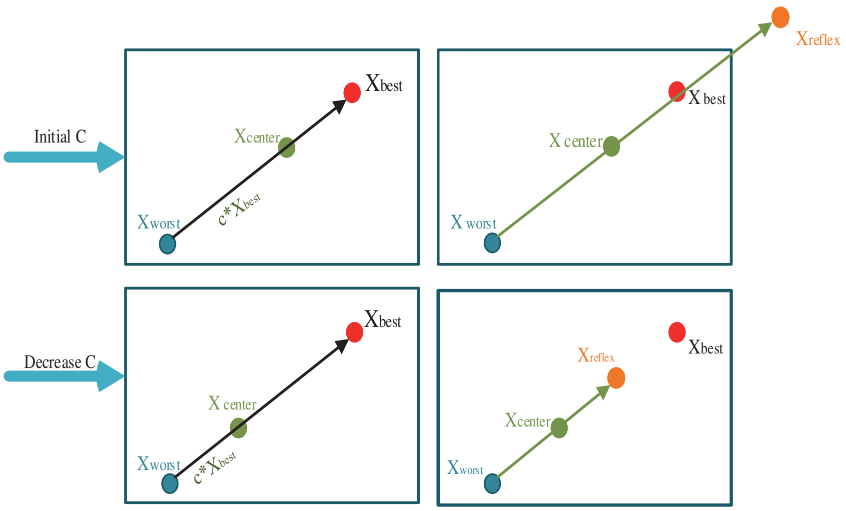

Figure 2: Reflection of worse answer in SWA

The above calculation process shows that the algorithm does not need to determine whether S_{reflex} exceeds the search space, which is equivalent to increasing the calculation speed of the algorithm to a certain extent, reducing the algorithm parameters and the operation dimension, and it is not necessary to deliberately set the parameters ρ and α.

(2) Select the optimal objective function calculation result, iterate continuously and search for better calculation results. According to the calculation results of the objective function, t whale individuals were selected from each MSG to form a Good Gang (GG). In the natural reign, the whale's field of vision is limited. We can only search the limited field of vision of individuals in GG and get the local optimal solution. The search method is as follows: in a division range (determined by visual range or visual radius), better calculation results are continuously searched through algorithm iteration, and the obtained calculation results are the optimal solution, which is used to replace the original member individuals of GG.

(3) Consider crossover and search for the optimal solution. When iterating and searching, it is also necessary to consider the mating behavior of sperm whales in the group (that is, the mating behavior between the strongest male adult whale and several female adult whales). The best individual in GG and the other individuals in MSG will mate with each other to give birth to the next generation. In the next generation, there will be a random member of the offspring to replace the maternal individual. After multiple iterations and reaching the specified number of iterations, all individuals in the subgroup will be replaced and reordered. Repeat the above process until the optimal individual (optimum

solution) is found. Fig. 3 is an optimization flowchart of the sperm whale optimization algorithm. As shown in Fig. 3, in the flow chart of the sperm whale optimization algorithm, it can be seen that because the algorithm uses a heuristic constraint processing method to replace any other constraint conditions. Therefore, the fitness function of the algorithm does not have constraint conditions and cannot Satisfy the constraint nature of the function. A major advantage of the heuristic constraint processing method is that it does not need to set any other specific parameters to meet the performance of the algorithm. The use of heuristic constraint processing method when processing constraints will greatly improve the process ability of the algorithm. When the penalty function technique is used in the sperm whale optimization algorithm, the fitness function of the algorithm will become as follows:

$$H(\overrightarrow{x}) = h(\overrightarrow{x}) + \sum_{i=1}^{N} \beta_i \langle f_i(\overrightarrow{x}) \rangle^2 \tag{9}$$

where, $h(\overrightarrow{x})$ is the objective function, $\langle f_i(\overrightarrow{x}) \rangle$ is the constraint conflict function, β_i is the penalty parameter of the i inequality constraint, and N is the number of penalty parameters. The purpose of β_i is to convert the magnitude of the constraint violation into the objective function values. A large number of constraint conditions will complicate the setting of penalty parameters, but the use of heuristic constraint processing methods can avoid such situations. Considering the above situation, in the SWA, when selecting the optimal solution by comparing the two optimization results with each other, the following principles should be followed: a. When two feasible solutions are compared with each other, the best one is selected; b. When the feasible solution is compared with the infeasible solution, the feasible solution is selected; c. When two infeasible solutions are compared with each other, the one with less constraint violation is selected.

3.3 LSTM

LSTM is an upgraded form of Recurrent Neural Network (RNN), which was proposed by Hochreiter and Schmidhuber in 1996 [28]. LSTM compensates for the poor memory of historical information by adding a long-time delay between input, feedback and gradient explosion of RNN model. In the RNN, the processing procedures for the input data only include simple mapping changes and nonlinear changes. And LSTM is used to realize the conversion of input data by constructing targeted modules. Compared with the RNN structure, the independent module structure in the LSTM framework is more complicated, and the number of adjustable parameters and threshold units is relatively large [29]. The special feature of LSTM lies in the additional setting of cell state, and a three-part structure of input gate, output gate and forget gate [30]. The following is a detailed introduction to the cell state in the LSTM model and the specific operation procedures of the above-mentioned gate structures [31].

(1) Forget gate

The LSTM model obtains the array (h_{t-1}, x_t) by combining the hidden layer output variable h_{t-1} at time $t-1$ and the input variable x_t at time t, and calculates through the forget gate to obtain the judgment vector f_t. The instruction conveyed by f_t is what information should be deleted from the cell state at the previous moment. The control function of the forget gate can be expressed by Eq. (10).

$$f_t = \sigma\left[W_f \bullet (h_{t-1}, x_t) + b_f\right] \tag{10}$$

In Eq. (10), σ represents the sigmod function; W_f represents the weight vector of the previous gate; b_f represents the offset value of the forget gate.

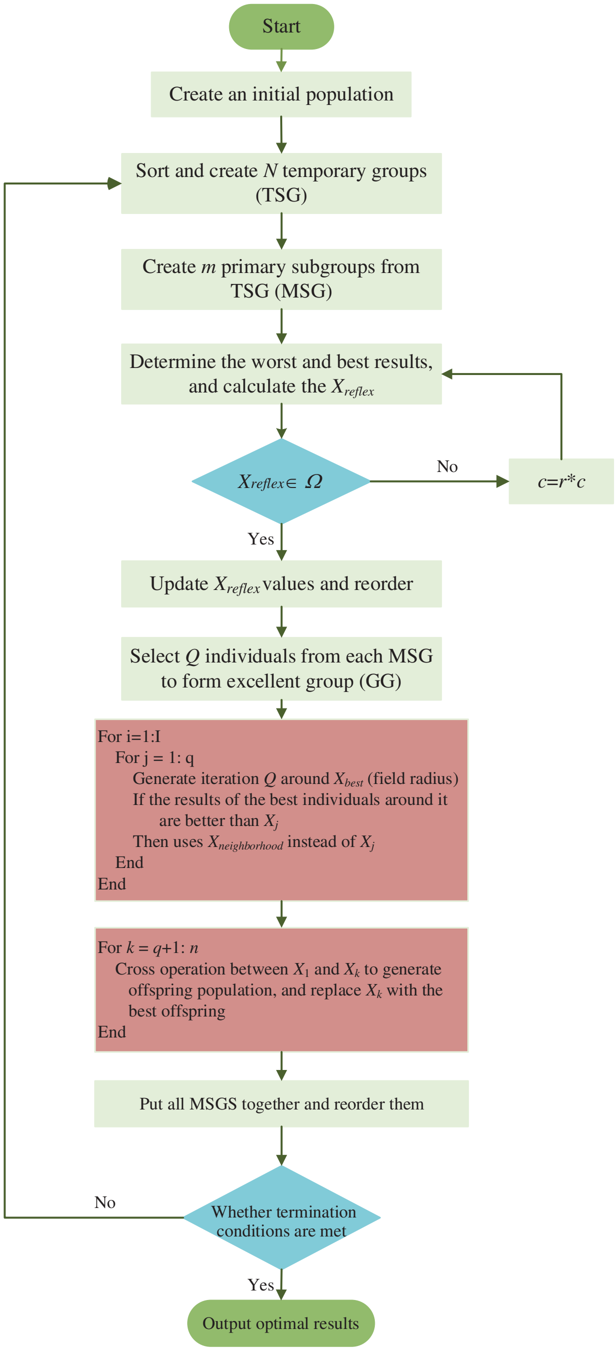

Figure 3: SWA flowchart

(2) Input gate

The function of the input gate is to use the input data (h_{t-1}, x_t) at time t to perform calculations to obtain the cell state $\tilde{C}_f$ to be input and the judgment vector i_t. Among them, the role of i_t is to determine which information can be transferred from the cell state $\tilde{C}_f$ to be input to the cell state. The control function of the input gate can be expressed by Eqs. (11) and (12).

$$\tilde{C}_t = \tanh\left[W_c \bullet (h_{t-1}, x_t) + b_c\right] \tag{11}$$

$$i_t = \sigma\left[W_i \bullet (h_{t-1}, x_t) + b_i\right] \tag{12}$$

In Eqs. (11) and (12), $\tilde{C}_f$, W_c, and b_c respectively represent the cell state to be input, the update weight of the cell state, and the offset of the cell state obtained from the input variable at time t. I_t, W_i, and b_i respectively represent the output vector, weight matrix, and offset of the input gate.

(3) Cell state

The update of the information in the cell state at time t. is determined by two parts. Firstly, the judgment vector f_t obtained after the cell state at the last moment is processed by the forget gate, this vector will determine which information should be deleted from the old cell state; Secondly, according to the input information at time t, the state of the cell to be input determined is processed by the input gate to obtain the judgment vector i_t. This vector determines which information to be input in the cell state can be input into the cell state. The results of the interaction of the two judgment vectors determine the input information in the cell state at the final time t, and the cell state update function can be expressed by Eq. (13).

$$C_t = C_{t-1} \bullet f_t + \tilde{C}_t \bullet i_t \tag{13}$$

In Eq. (13), the symbol "•" represents the multiplication between vectors.

(4) Output gate

The control function of the output gate is calculated to obtain the output result o_t. it is determined by the cell state at this time, and what information in the output results is outputted finally. The control function of the output gate can be expressed by Eqs. (14) and (15).

$$o_t = \sigma\left[W_o \bullet (h_{t-1}, x_t) + b_o\right] \tag{14}$$

$$h_t = o_t \bullet \tanh\left(C_t\right) \tag{15}$$

In Eqs. (14) and (15), o_t, W_o and b_o respectively represent the output vector of the output gate, weight vector and offset. h_t represents the final output result of the long short-term memory model at time t.

4 Evaluation and Prediction Process Based on Improved TOPSIS and SWA-LSTM

Based on the proposed PSP implementation effect evaluation index system, this section proposes the PSP implementation effect evaluation and prediction model based on improved TOPSIS and SWA-LSTM. The improved TOPSIS evaluation method is used to obtain the evaluation results of the implementation effect of the PSP, and the SWA algorithm is used to optimize the LSTM, so as to obtain the optimal values of the important parameters of the LSTM. In the end, the prediction result of the implementation effect of the PSP is obtained and the result analysis is carried out. The proposed PSP implementation effect evaluation and prediction process is shown in Fig. 4. The specific steps are as follows:

Step 1: Initial input variable selection and data preprocessing. The evaluation index of PSP implementation effect selected above is used as the initial input variable set $X = \{x_i,\ i = 1, 2, \cdots, n\}$ and the original data of each input factor x_i are quantified and standardized.

Step 2: Use the entropy method to weight each evaluation index, and obtain the comprehensive evaluation result based on the improved TOPSIS evaluation method constructed above.

Step 3: The parameters in LSTM model and SWA algorithm are initialized. Since the determination of LSTM parameters is the key to affect the model training and learning ability, it directly affects the accuracy of intelligent prediction of PSP implementation effect. Therefore, this model uses the SWA algorithm to search for the key parameters of the LSTM model, and if the termination conditions are met, the optimal parameters are obtained; If the termination condition is not reached, the SWA optimization algorithm is run again until a solution set that satisfies the condition is obtained. Then use the key parameters optimized by the SWA algorithm to apply the LSTM to the test sample set for retraining and testing, and adjust the parameters again to obtain the optimal PSP implementation effect prediction model.

Step 4: Output the intelligent prediction result. The prediction results include evaluation scores and evaluation levels. According to the evaluation level of the implementation effect of the PSP, the PSP category identification is set as *N1*, *N2*, *N3*, *N4*, *N5* and the five types of identification represent the implementation effect of the PSP in turn are better, good, medium, worse and poor.

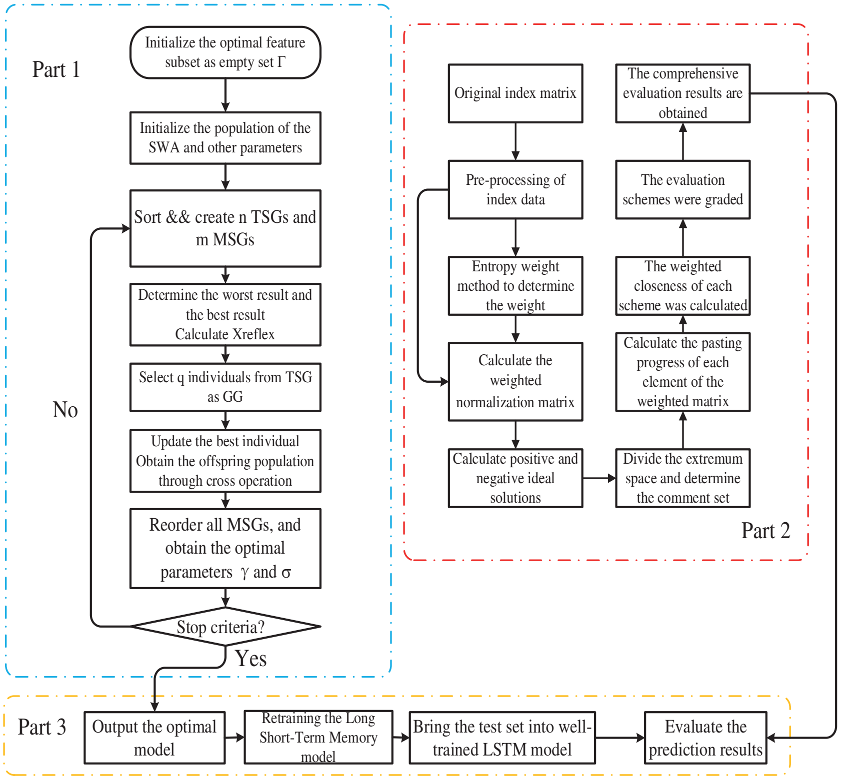

Figure 4: Evaluation and prediction process of PSP implementation effect

5 Results and Discussions

5.1 Data Acquisition and Preprocessing

This paper selects 35 power substation projects in China to conduct empirical analysis. According to the evaluation and prediction model of the implementation effect of the PSP constructed above, the corresponding index values are substituted for calculation, and then obtained the evaluation and prediction results of the implementation effect of the PSP. First, relying on the evaluation index system for the implementation effect of the PSP constructed above, further analysis of the indicators at the index layer was carried out, and obtained the index properties and index attributes as shown in Table 2. Through field research and data collection, the relevant data of 35PSP were collected and sorted out. At the same time, 20 experts were invited to score the qualitative indicators of 35PSP according to the [1,100] interval score. Then these scores are summarized and averaged, and obtained the data value of each qualitative index of 35 power substation projects.

Table 2: Nature of evaluation index for implementation effect of PSP

Index number	Name of indicator	The nature of indicators
x_1	Scientific decision-making in project design stage	Qualitative indicators
x_2	Technical scheme quality of PSP	Qualitative indicators
x_3	Implementation conditions of external environment	Qualitative indicators
x_4	Construction transition measures	Qualitative indicators
x_5	Progress control level of PSP	Qualitative indicators
x_6	Personnel arrangement of PSP implementation	Qualitative indicators
x_7	Safety management level of PSP	Qualitative indicators
x_8	Quality management level of PSP	Qualitative indicators
x_9	Cost control level of PSP	Qualitative indicators
x_{10}	Financial net present value of PSP	Qualitative indicators
x_{11}	Internal rate of return of PSP	Qualitative indicators
x_{12}	Investment recovery period of PSP	Qualitative indicators
x_{13}	Influence of PSP on regional economic development	Qualitative indicators
x_{14}	Influence of PSP on regional power grid operation	Qualitative indicators
x_{15}	Influence of PSP on regional environment	Qualitative indicators

Due to the large differences in the attribute and quantity level of the original data, it is necessary to conduct dimensionless processing of each index. Limited by space, this paper shows only some data processing results, as shown in Table 3.

Table 3: Evaluation index data processing results

No.	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
x_1	0.1623	0.1731	0.1645	0.1645	0.1255	0.1839	0.1796	0.1298	0.2164	0.1623	0.1623	0.2013
x_2	0.1276	0.1846	0.1322	0.1914	0.1140	0.1231	0.1778	0.2279	0.2211	0.1436	0.2165	0.1367
x_3	0.1873	0.1388	0.1688	0.1480	0.1920	0.1365	0.1411	0.1526	0.2058	0.1758	0.1966	0.2128
x_4	0.1876	0.1491	0.1921	0.2034	0.1198	0.1424	0.1650	0.1853	0.1401	0.1785	0.1288	0.1717
x_5	0.1380	0.1923	0.1199	0.1765	0.2036	0.2217	0.2014	0.1335	0.1606	0.1403	0.1267	0.1176
x_6	0.1568	0.1848	0.1633	0.1353	0.1654	0.1783	0.1762	0.1826	0.1310	0.1096	0.1654	0.1203
x_7	0.2010	0.2262	0.1165	0.1165	0.1348	0.1873	0.1645	0.1485	0.1531	0.1531	0.1325	0.1576
x_8	0.1352	0.1742	0.1086	0.1946	0.1619	0.1967	0.1926	0.1106	0.1946	0.2028	0.1865	0.1824
x_9	0.1090	0.1342	0.1488	0.1090	0.1195	0.1614	0.1824	0.1446	0.1866	0.1321	0.2075	0.1950
x_{10}	0.1257	0.1918	0.1896	0.1808	0.2051	0.1213	0.1962	0.1103	0.2205	0.1830	0.2007	0.1985
x_{11}	0.1835	0.1988	0.2075	0.1114	0.1769	0.1682	0.1682	0.1726	0.1791	0.1398	0.1158	0.1464
x_{12}	0.1910	0.1654	0.1444	0.1677	0.1468	0.2120	0.1631	0.2097	0.1281	0.1468	0.1351	0.1724
x_{13}	0.2127	0.1074	0.1740	0.1783	0.1160	0.1397	0.1633	0.1504	0.1955	0.1526	0.1397	0.1074
x_{14}	0.1307	0.1352	0.1817	0.2194	0.1884	0.2172	0.1884	0.1330	0.2017	0.2172	0.1994	0.1130
x_{15}	0.2070	0.1334	0.1472	0.2001	0.1863	0.2138	0.1311	0.1380	0.1219	0.1587	0.1472	0.1173

5.2 Analysis of PSP Implementation Effect Evaluation Based on Modified TOPSIS

According to the entropy weight method, the weight of evaluation index of PSP implementation effect can be obtained as shown in Fig. 5.

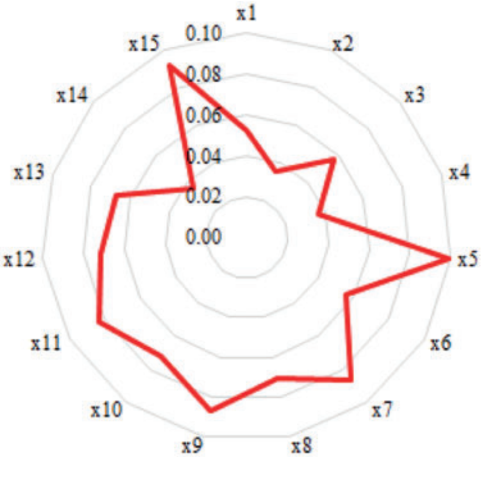

Figure 5: Weight of evaluation index for PSP implementation effect

After getting the weight of each index, the weighted standardization matrix can be further obtained. Some data of the weighted standardization matrix are shown in Table 4.

Table 4: Weighted standardized matrix partial data

No.	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
x_1	0.0015	0.0016	0.0015	0.0015	0.0011	0.0017	0.0016	0.0012	0.0020	0.0015	0.0015	0.0018
x_2	0.0008	0.0011	0.0008	0.0012	0.0007	0.0008	0.0011	0.0014	0.0013	0.0009	0.0013	0.0008
x_3	0.0018	0.0014	0.0017	0.0014	0.0019	0.0013	0.0014	0.0015	0.0020	0.0017	0.0019	0.0021
x_4	0.0012	0.0009	0.0012	0.0013	0.0008	0.0009	0.0010	0.0012	0.0009	0.0011	0.0008	0.0011
x_5	0.0024	0.0033	0.0020	0.0030	0.0035	0.0038	0.0034	0.0023	0.0027	0.0024	0.0022	0.0020
x_6	0.0015	0.0018	0.0016	0.0013	0.0016	0.0017	0.0017	0.0018	0.0013	0.0011	0.0016	0.0012
x_7	0.0030	0.0033	0.0017	0.0017	0.0020	0.0028	0.0024	0.0022	0.0023	0.0023	0.0020	0.0023
x_8	0.0016	0.0021	0.0013	0.0023	0.0020	0.0024	0.0023	0.0013	0.0023	0.0024	0.0023	0.0022
x_9	0.0016	0.0020	0.0022	0.0016	0.0018	0.0024	0.0027	0.0021	0.0028	0.0020	0.0031	0.0029
x_{10}	0.0016	0.0024	0.0024	0.0022	0.0025	0.0015	0.0024	0.0014	0.0027	0.0023	0.0025	0.0025
x_{11}	0.0026	0.0028	0.0030	0.0016	0.0025	0.0024	0.0024	0.0025	0.0026	0.0020	0.0017	0.0021
x_{12}	0.0024	0.0020	0.0018	0.0021	0.0018	0.0026	0.0020	0.0026	0.0016	0.0018	0.0017	0.0021
x_{13}	0.0025	0.0012	0.0020	0.0021	0.0013	0.0016	0.0019	0.0017	0.0023	0.0018	0.0016	0.0012
x_{14}	0.0008	0.0008	0.0011	0.0013	0.0012	0.0013	0.0012	0.0008	0.0012	0.0013	0.0012	0.0007
x_{15}	0.0033	0.0021	0.0023	0.0032	0.0030	0.0034	0.0021	0.0022	0.0019	0.0025	0.0023	0.0019

Then, according to Eqs. (3)–(6), the weighted closeness degree of each evaluation scheme (the implementation effect of PSP) is calculated, and the evaluation grade of the evaluation object can be determined according to the grade of the maximum value of $T_j(N_i)$. The calculation results are shown in Table 5.

Table 5: Weighted paste progress and grade of each PSP implementation effect

No.	$Q(\mathrm{N}_1)$	$Q(\mathrm{N}_2)$	$\mathrm{Q}(\mathrm{N}_3)$	$\mathrm{Q}(\mathrm{N}_4)$	$Q(\mathrm{N}_5)$	Maximum	Grade
S1	0.9995	0.9981	0.9984	0.9994	0.9976	0.9995	*N1*
S2	0.9982	0.9993	0.9985	0.9988	0.9991	0.9993	*N2*
S3	0.9992	0.9994	0.9992	0.9993	0.9995	0.9995	*N5*
S4	0.9995	0.9987	0.9988	0.9982	0.9984	0.9995	*N1*
S5	0.9986	0.9988	0.9981	0.9995	0.9989	0.9995	*N4*
S6	0.9982	0.9993	0.9985	0.9990	0.9990	0.9993	*N2*
S7	0.9983	0.9981	0.9993	0.9991	0.9990	0.9993	*N3*
S8	0.9989	0.9992	0.9994	0.9988	0.9987	0.9994	*N3*
S9	0.9989	0.9992	0.9994	0.9974	0.9985	0.9994	*N3*
S10	0.9990	0.9987	0.9988	0.9987	0.9994	0.9994	*N5*
S11	0.9995	0.9984	0.9984	0.9985	0.9993	0.9995	*N1*
S12	0.9995	0.9994	0.9991	0.9991	0.9985	0.9995	*N1*
S13	0.9987	0.9990	0.9992	0.9994	0.9986	0.9994	*N4*
S14	0.9993	0.9984	0.9993	0.9984	0.9995	0.9995	*N5*

(Continued)

Table 5 (continued)

No.	$Q(N_1)$	$Q(N_2)$	$Q(N_3)$	$Q(N_4)$	$Q(N_5)$	Maximum	Grade
S15	0.9986	0.9982	0.9988	0.9986	0.9983	0.9988	*N3*
S16	0.9989	0.9995	0.9989	0.9980	0.9990	0.9995	*N2*
S17	0.9986	0.9981	0.9982	0.9986	0.9995	0.9995	*N5*
S18	0.9995	0.9981	0.9994	0.9992	0.9987	0.9995	*N1*
S19	0.9982	0.9994	0.9985	0.9984	0.9982	0.9994	*N2*
S20	0.9988	0.9993	0.9994	0.9981	0.9987	0.9994	*N3*
S21	0.9989	0.9989	0.9995	0.9994	0.9983	0.9995	*N3*
S22	0.9982	0.9986	0.9994	0.9989	0.9990	0.9994	*N3*
S23	0.9989	0.9995	0.9993	0.9980	0.9981	0.9995	*N2*
S24	0.9994	0.9993	0.9991	0.9981	0.9992	0.9994	*N1*
S25	0.9990	0.9981	0.9985	0.9981	0.9985	0.9990	*N1*
S26	0.9994	0.9988	0.9982	0.9985	0.9987	0.9994	*N1*
S27	0.9995	0.9994	0.9986	0.9993	0.9984	0.9995	*N1*
S28	0.9982	0.9980	0.9985	0.9992	0.9985	0.9992	*N4*
S29	0.9991	0.9980	0.9993	0.9989	0.9987	0.9993	*N3*
S30	0.9990	0.9991	0.9983	0.9984	0.9984	0.9991	*N2*
S31	0.9983	0.9990	0.9983	0.9989	0.9993	0.9993	*N5*
S32	0.9980	0.9984	0.9994	0.9983	0.9990	0.9994	*N3*
S33	0.9984	0.9986	0.9995	0.9981	0.9993	0.9995	*N3*
S34	0.9982	0.9986	0.9987	0.9993	0.9992	0.9993	*N4*
S35	0.9980	0.9987	0.9987	0.9988	0.9985	0.9988	*N4*

According to the analysis of the actual situation, the PSP implementation effect evaluation model based on the improved TOPSIS method constructed in this paper objectively and truly reflects the implementation effect of 35PSP, which also has certain reference significance for the implementation effect evaluation of other PSP in China.

5.3 Intelligent Prediction Analysis of PSP Implementation Effect Based on SWA-LSTM

Through the application of PSP implementation effect evaluation model based on improved TOPSIS method, the objective and accurate evaluation results and grades of 35PSPs are obtained. However, through the calculation process, it can be found that the calculation of the model is complex, the efficiency is low, and the workload is large. When facing the large-scale PSP data, it is inevitable that the method is difficult to quickly and effectively calculate the evaluation results and grades of PSP implementation. Therefore, this paper will further use the constructed intelligent prediction model to predict the implementation effect of these 35PSP and analyze the prediction results. The data of the first 20PSP are selected as training samples, and the remaining 15 PSP are selected as test samples.

The parameters of SWA are set as follows: the initial population number is 100, $m = 12, n = 6$, the initial reflection factor $c = 2.5$, the contraction factor $r = 0.95$, the number of GG individuals $q = 5$, and the visual radius $Q = 10$. In order to verify the performance of the proposed classification prediction model, this paper relies on the test sample data, and uses the unoptimized LSTM model, RNN model and BPNN model for comparative experiments. Bring sample data into the prediction model for training and testing. The prediction results of the test samples are shown in Table 6.

Table 6: Prediction results of evaluation grade of test samples

No.	Order of evaluation	SWA-LSTM	LSTM	RNN	BPNN
S21	*N3*	*N3*	*N3*	*N2*	*N1*
S22	*N3*	*N3*	*N2*	*N3*	*N3*
S23	*N2*	*N2*	*N2*	*N1*	*N3*
S24	*N1*	*N1*	*N1*	*N1*	*N1*
S25	*N1*	*N2*	*N1*	*N2*	*N1*
S26	*N1*	*N1*	*N1*	*N1*	*N1*
S27	*N1*	*N1*	*N3*	*N1*	*N1*
S28	*N4*	*N4*	*N4*	*N5*	*N5*
S29	*N3*	*N3*	*N3*	*N3*	*N3*
S30	*N2*	*N2*	*N2*	*N2*	*N2*
S31	*N5*	*N5*	*N4*	*N5*	*N4*
S32	*N3*	*N3*	*N3*	*N3*	*N3*
S33	*N3*	*N3*	*N3*	*N4*	*N2*
S34	*N4*	*N4*	*N3*	*N4*	*N4*
S35	*N4*	*N4*	*N4*	*N3*	*N4*
prediction error/%	0	6.67	26.67	40.00	33.33
computing time/h	3	0.95	0.8	0.9	0.85

It can be seen from Table 6 that the prediction result of the implementation effect of the PSP calculated by the SWA-LSTM model and the comprehensive evaluation grade based on the improved TOPSIS method have the smallest relative error, which is only 6.67%. Only one of the 15 PSPs has a different prediction result from the comprehensive evaluation level, and the prediction relative errors of the LSTM model, RNN model, and BPNN model are 26.67%, 40.00%, and 33.33%, respectively. Compared with the other three methods, the SWA-LSTM model reduces by 20.00%, 33.33% and 26.66%, respectively, which shows that the prediction results of the proposed model have the smallest error and the highest overall accuracy. Compared with the LSTM model, the SWA algorithm overcomes to a certain extent the negative impact of the blind selection of key parameters on LSTM training. Compared with the RNN model, LSTM overcomes the problems that RNN is difficult to train and the gradient disappears. It can learn the long-term dependence and continuously improve this long-term dependence. Therefore, the prediction performance of LSTM is better than that of RNN. Compared with BPNN model, LSTM model can effectively reduce the data dimension required by prediction model, thus greatly improving the accuracy of prediction. Overall, SWA-LSTM model has the best prediction performance, followed by LSTM model and BPNN model, and RNN model has the worst prediction performance.

At the same time, it can be seen from Table 6 that the LSTM model takes the shortest time, the improved TOPSIS method takes the longest time, and the SWA-LSTM model takes slightly longer time than the other three types of intelligent prediction models. The high computational efficiency of the other three intelligent prediction models is at the cost of low prediction accuracy. The proposed SWA-LSTM has the same computational efficiency as other intelligent models when the SWA optimization link is added to improve the accuracy.

6 Conclusions

In order to better improve the implementation effect of PSP, this paper designed a set of evaluation system for the implementation effect of PSP, and proposed an evaluation and prediction model based on improved TOPSIS and SWA-LSTM. Taking the data of 35PSP in China as an actual calculation example, the conclusions are as follows:

(1) The evaluation index system of the implementation effect of the Qing PSP is constructed from three aspects: the technical level of the PSP, the economic efficiency of the PSP and the social benefits of the PSP, which solves the problem of which factors affect the implementation effect of the PSP.

(2) Compared with other types of neural networks (RNN, BPNN), LSTM overcomes the difficulties of RNN training and the disappearance of gradients, and can learn long-term dependencies and continuously improve this long-term dependency. At the same time, the LSTM model can also effectively reduce the dimension of data required by the prediction model, fully tap the internal relationship between data, and make the fitting and prediction performance of the model better as a whole.

(3) The prediction accuracy of the SWA-LSTM model is better than other comparative intelligent models, and the prediction errors are reduced by 20.00%, 33.33% and 26.66% respectively compared with the LSTM model, BPNN model and SVM model. It shows that SWA algorithm can solve the problem of blind selection of key parameters in LSTM model, and its computational efficiency is basically equivalent to other intelligent models, which greatly improves the computational efficiency compared with the improved TOPSIS evaluation method.

It is worth noting that this paper uses intelligent algorithm to predict the effect of PSP implementation. In the future, other intelligent algorithms can be considered to divide and analyze the model input and model architecture in more detail, so as to further improve the prediction accuracy of PSP implementation effect.

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Conflicts of Interest: The authors declare that they have no conflicts of interest to report regarding the present study.

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