

Research Article

Application of Neural Network Sample Training Algorithm in Economic Information Management System

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Received 6 May 2022; Accepted 8 July 2022; Published 30 July 2022

Academic Editor: Muhammad Muzammal

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In order to make up for the shortcomings of traditional financial evaluation, this paper proposes a method of enterprise comprehensive performance evaluation system based on the balanced scorecard method and BP artificial neural network model. This method focuses on the application methods and steps of BP artificial neural network model in enterprise comprehensive performance evaluation system. In addition, it also makes a detailed study on the initial weight and threshold assignment of the BP network, the selection of training samples, the determination of hidden layer, the convergence of network, and so on. The experimental results show that this method verifies the comprehensive performance evaluation results of 15 manufacturers, and the results are 4 excellent, 5 good, 3 average, 2 poor, and 1 very poor. This method effectively reduces the limitations of enterprise comprehensive performance evaluation by introducing nonfinancial evaluation indicators.

1. Introduction

Economic information is a description of the state of mutual connection and interaction in social and economic activities. It is an objective reflection of economic activities and their essential characteristics. Economic information management technology includes the production, transmission, identification, processing, transformation, storage, retrieval, and control of economic information. It is a tool to present human information functions as a guide to the principles and processes of information research. Its important pillar is 3C (communication, computer, and control) technology. Its wide application will promote the rapid development of social productivity and lead to profound changes in social life [1].

The characteristics of traditional economic information management are wide range of information sources, large amount of information, diverse but not complex ways and means of information processing, and often only elementary mathematical knowledge is enough. However, with the acceleration of the process of world economic integration, the randomness and uncertainty of economic information in the socio-economic system increase, and the form of the

socio-economic system becomes more complex. There are many random, nonlinear, and time-varying complex socio-economic systems in reality. In order to effectively manage the economic information in the complex socio-economic system, the traditional economic information processing technology has been incompetent. Neural network theory and technology have shown strong functions not only in information recognition, transformation, and processing but also in information transmission, storage, and control. Many research results have shown that neural network theory and technology have great potential in economic information processing in complex social systems [2, 3].

2. Literature Review

From a macro perspective, the first concern is the standardization impact of the development of world economic globalization on human resource informatization. Economists mentioned that the globalization of enterprises and industries has promoted the standardization of systems and practices, as well as central planning and coordinated action. Second, European scholars believe that the implementation of a human resource management information system is of

great significance to social responsibility and sustainable development of enterprises. At the microlevel, that is, within an enterprise, economists are also very interested in the diffusion of MNC's management information system between parent and subsidiary companies. Chen and Xu, in their cooperative works, discussed the localization of human resource management information system in the process of multinational corporation expansion, that is, the phenomenon and reason analysis of transfer from the parent company to the subsidiary company [4]. Similarly, Majumder and Mondal focused on the transfer process and root causes of the human resource management system of another multinational company from its subsidiary to its parent company [5]. This also shows how the digital human resource management platforms of different branches and parent and subsidiary companies affect each other in the same enterprise.

At the same time, economists deeply explore the relationship between enterprise strategy and human resource management (Figure 1). Numada discussed in detail the "process of human resource management information system assisting in enterprise strategic decision-making" [6] and also deeply discussed the dynamic influence relationship and influence principle of the interaction between human resource management function and strategic information management function. Zhang et al. believe that human resources strategy, principles, and system are an inseparable iron triangle and need to be considered as a whole [7]. Yang et al. applied the empirical analysis method to confirm the significance of the integration of information technology and human resource management for enterprise development, and the research results provide a basis for studying the relationship between human resource management and information technology from the economic level [8].

In the current era of information and information technology, competition in this field continues and intensifies over time. In order to survive in the long run and achieve sustainable development, businesses need to pay close attention to the development of their management systems [9]. Therefore, Lu et al. believe that a comprehensive performance evaluation procedure and goal are needed to guide the behavior of company management and employees in this field. The concept of measurement and the incentive process influence test and modify business growth performance through measurement. The results measure the implementation of the company's development strategy and then form the basis for strategic growth and business strategy reform [10].

3. Research Methods

3.1. Construction of Enterprise Comprehensive Performance Evaluation System

3.1.1. Limitations of Traditional Financial Performance Evaluation. Under generally accepted accounting standards, the calculation of accounting income does not consider the cost of all capital but only the cost of debt capital, ignoring the compensation for the cost of equity capital. Under the accrual basis accounting system, due to the

selectivity of accounting methods and the considerable flexibility of the preparation of financial statements, there is a certain degree of distortion in accounting income, which often cannot truly and comprehensively reflect the operating performance of enterprises [11]. At the same time, in the reflection of the intangible impact on the future development of the enterprise, the financial evaluation index is even more inadequate. One-sided emphasis on profits is likely to lead to the short-term behavior of operators sacrificing the long-term interests of the enterprise in pursuit of short-term benefits, which may encourage the thought of eagerness for quick success and instant benefits and short-term speculation of enterprise management authorities, and make enterprise operators unwilling to make the capital investment in pursuit of long-term strategic objectives and interests, which may reduce the current profit objectives [12]. Performance measurements consistently based on financial indicators indicate that there are a number of limitations and weaknesses in the performance measurement of the industry. Therefore, it is necessary to introduce nonfinancial evaluation indicators on the basis of financial evaluation indicators to make up for the shortcomings of traditional financial evaluation.

3.1.2. Build an Enterprise Comprehensive Performance Evaluation Index System Based on the Balanced Scorecard. The balanced scorecard performance evaluation method integrates financial and nonfinancial indicators [13], uses nonfinancial indicators from three dimensions of customers, internal business processes, learning, and innovation to make up for the shortcomings and defects of traditional financial evaluation indicators, and provides strong support for the strategic management of enterprises. Its index system has the characteristics of orientation, long-term, timeliness, and motivation and is gradually widely used. However, the balanced scorecard performance evaluation method only focuses on customers and ignores other important stakeholders, such as the government, the public, suppliers, and operators, which is extremely unfavorable to the development of enterprises. Therefore, on this basis, other stakeholder dimensions are added, and appropriate evaluation indicators are designed for each dimension. The performance evaluation system is trained and optimized in the BP neural network model introduced below, and relevant indicators should be adjusted and modified in time according to the actual application effect and environmental changes, so as to meet the requirements of practical application [14]. Tables 1–3 show the manufacturer's specific application performance measures. For specific applications, the necessary increase, decrease, and adjustment measurements should be made according to the actual situation and business needs.

3.2. Methods and Steps for Applying the BP Neural Network Model in the Field of Performance Measurement

3.2.1. Basic Idea of BP Neural Network Application in Enterprise Comprehensive Performance Evaluation. The structure of the BP neural network consists of three layers:

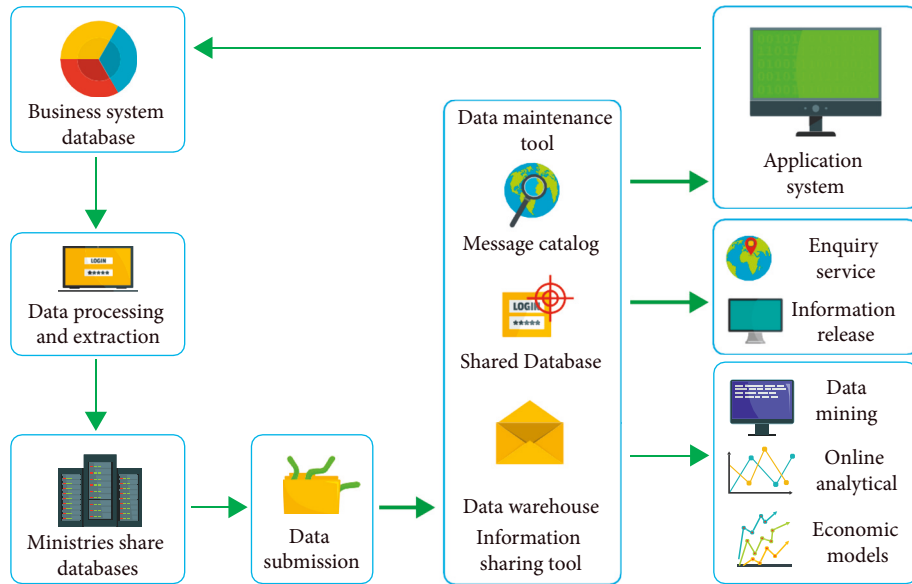


FIGURE 1: Economic information management system.

TABLE 1: Comprehensive performance evaluation index system of manufacturing enterprises for reference-financial dimension.

Indicator category	Reference index
Profitability	Return on net assets, sales profit margin, cost profit margin
Operational capacity	Turnover ratio of total assets, turnover rate of working capital, turnover rate of inventories, turnover rate of receivables
Solvency	Current ratio, interest earned multiple, cash current liability ratio
Development capacity	Sales growth rate, profit growth rate

TABLE 2: Comprehensive industrial enterprise index rating system dimension.

Indicator category	Reference index
Customer satisfaction	Service satisfaction, price satisfaction, new customer acquisition rate
Market share	Market share
Customer loyalty	Repeat purchase rate, product recommendation rate, contract performance rate

TABLE 3: Comprehensive performance evaluation index system of manufacturing enterprises for reference-internal business process dimension.

Indicator category	Reference index
Plan control	Purchase plan realization rate, production plan realization rate, sales plan realization rate, inventory control completion rate
Manufacturing	Completion on-time rate, product qualification rate, and production capacity utilization rate
After-sale service	Delivery accuracy, timely troubleshooting rate of after-sales products, customer complaint rate
Internal management	Business process standardization, cost accounting accuracy, cost control completion rate

the input layer, the latent layer, and the output layer. The error was corrected by republishing the error. It is a computer with the properties of self-knowledge, self-organization, self-transformation, and self-learning. His experience is coded as a whole heavy network, storage, and error tolerance [15].

Simple data sets of industry performance metrics are input to the login process and are sent to the output process

after the encryption process is completed and evaluated for efficiency. In the anterior distribution phase, the state of the neurons in each layer affects only the state of the neurons in the next layer [16]. If the error value obtained from the release process and the desired result exceeds the permission error, the error recovery phase is entered. The error problem goes back to the old connection method, recalculates the error, takes the general error of the hidden process, adjusts the weight of each

layer, and starts the hidden and unloading layer until the system error is received, and the weight and startup do not change this time. The network was adequately structured using the standardized BP training algorithm. The group of weights of the training network is the weight of the industry's performance measurement in determining [17]. Finally, in accordance with the principles of the BP training model, the specific costs of measuring the performance of the target sector can be taken to achieve the target market performance. It can be divided into measurement models, appropriate levels, and used to measure performance and compare similar plants [18].

3.2.2. Establish a Performance Measurement System Based on the BP Neural Network. The topology of the BP model for production performance measurement is shown in Figure 2. The model consists of three nerve cells: the input layer, the latent layer, and the output layer. Layer nerve cells are fully interconnected, and there is no interaction of neurons in one layer [19], refer to the measurement data given in Tables 1–3. Twenty measurement data were selected as network input neurons, along with a representative for each type of measurement. The input data of the neurons in the input process are the simple data of the performance measurement system after completion. At present, there is no general structure for the concealment process. If necessary, the latent layer containing 8 neurons is adjusted. The urinary tract contains only one nerve cell, and the effects of urinary tract nerve cells are commercial [20]. It is a nonquantitative index of comprehensive enterprise valuation that ranges from 0 to 1. The higher the value, the higher the performance of the enterprise, and vice versa.

Suppose that the input layer of the BP neural network has n neurons, the output layer has q neurons, and the hidden layer has p neurons. The number of input mode groups for training (the number of training samples) is $k = 1, 2, \dots, m$; the input mode vector is $X_k = [x_1^k, x_2^k, \dots, x_n^k]$; the expected output (teacher value) vector is $Y_k = [y_1^k, y_2^k, \dots, y_q^k]$; the input activation value vector of neurons in the hidden layer is $S_k = [s_1^k, s_2^k, \dots, s_p^k]$; the output vector of each neuron in the hidden layer is $Z_k = [z_1^k, z_2^k, \dots, z_p^k]$; the input activation value vector of each neuron in the output layer is $L_k = [l_1^k, l_2^k, \dots, l_q^k]$; the actual output vector of each neuron in the output layer is $C_k = [c_1^k, c_2^k, \dots, c_q^k]$.

The connection weight from input layer neurons to hidden layer neurons is W_{ij} . The connection weight from hidden layer neurons to output layer neurons is V_{ij} . The threshold of neurons in the hidden layer is θ_j . The threshold of neurons in the output layer is γ_t where $i = 1, 2, \dots, n$; $j = 1, 2, \dots, p$; $t = 1, 2, \dots, q$.

3.3. Algorithm and Steps of BP Model for Enterprise Comprehensive Performance Evaluation. According to the BP neural network model and its optimization algorithm, combined with the enterprise comprehensive performance evaluation index system, the training steps can be summarized as the following nine steps [21]:

- (1) Parameter initialization. The connection weights W_{ij} and V_{ij} of BP model neurons and their threshold vectors θ_j and γ_t are given initial values. The random number between $[-1, +1]$ can be used to initialize the weight and threshold [22].
- (2) Standardized processing of sample data. For quantitative indicators, the linear proportional transformation method is used to standardize the original data. For positive index (benefit type) data, $S = (S - S_{\min}) / (S_{\max} - S_{\min})$. For the reverse cost indicator, $S = (S_{\max} - S) / (S_{\max} - S_{\min})$. The qualitative index should be transformed into a score between 0 and 1 by the fuzzy evaluation method and then used as the input value.
- (3) Randomly select an input-output mode to input BP network, where the input vector is $X_k = [x_1^k, x_2^k, \dots, x_n^k]$, and the expected output vector is $Y_k = [y_1^k, y_2^k, \dots, y_q^k]$. Each training mode (sample) includes standardized input index data and corresponding expected output.
- (4) The input activation value s_j^k and the response output value z_j^k of each neuron in the hidden layer were calculated. Input activation value of neurons in hidden layer [23] is as follows:

$$s_j^k = \sum_{i=1}^n W_{ij} \cdot x_i^k - \theta_j, \quad (1)$$

where $j = 1, 2, \dots, p$. The response output value of each neuron in the hidden layer is $z_j^k = f(s_j^k)$. The activation function is a nonlinear, differentiable, and nondecreasing sigmoid function, $f(u) = 1 / (1 + e^{-u})$.

- (5) Calculate the input activation value l_t^k and response output value c_t^k of each neuron in the output layer. The input activation value of each neuron in the output layer is

$$l_t^k = \sum_{j=1}^p V_{ij} \cdot z_j^k - \gamma_j, \quad (2)$$

where $t = 1, 2, \dots, q$. The response output value of each neuron in the output layer is $c_t^k = f(l_t^k)$.

- (6) Calculate the correction error of each neuron in the output layer and hidden layer. For the neurons in the output layer, the expected output (teacher value) vector is $Y_k = [y_1^k, y_2^k, \dots, y_q^k]$, the actual output vector of the BP network is $C_k = [c_1^k, c_2^k, \dots, c_q^k]$, and the correction error of each neuron in the output layer is [24]

$$d_t^k = (y_t^k - c_t^k) \times c_t^k \times (1 - c_t^k), \quad (3)$$

where $t = 1, 2, \dots, q$. According to the calculated correction errors d_t^k , V_{jt} , and z_t^k of neurons in the output layer, the correction errors of neurons in the hidden layer can be calculated.

$$e_j^k = \left[\sum_{t=1}^q d_t^k \cdot V_{jt} \right] \times z_t^k \times (1 - z_t^k), \quad (4)$$

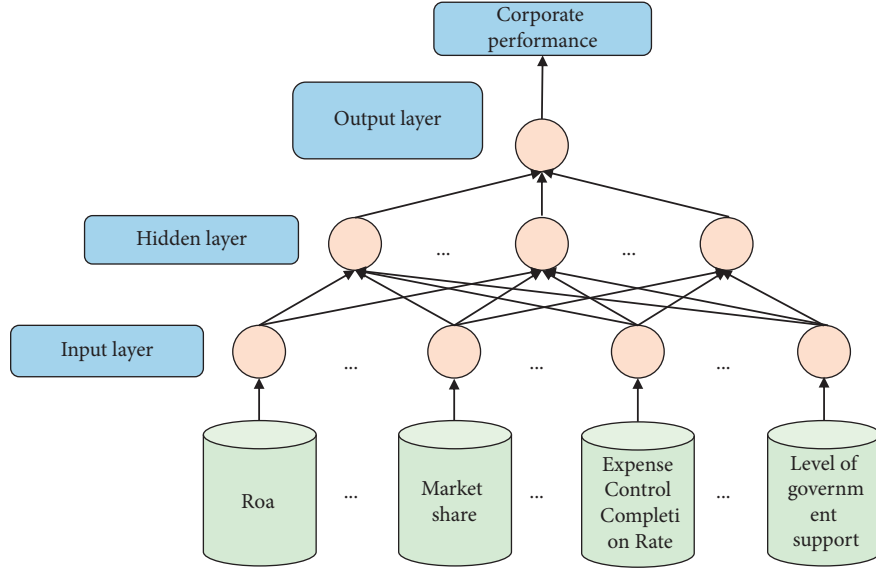


FIGURE 2: Topology of BP model for enterprise comprehensive performance evaluation.

where $j = 1, 2, \dots, p$.

- (7) According to the back propagation of the correction error, the connection weights and thresholds are corrected layer by layer. Now, the improved BP algorithm is widely used; that is, the momentum parameter is added to its weight coefficient to prevent it from repeated oscillation and nonconvergence.

The new connection weight adjustment formula between the hidden layer and the output layer is as follows (5):

$$\Delta V_{jt}(N+1) = \eta d_t^k \cdot z_t^k + \alpha \Delta V_{jt}(N), \quad (5)$$

where $\Delta V_{jt}(N+1)$ is the adjustment value of the $N+1$ st weight, $V_{jt}(N+1) = V_{jt}(N) + \Delta V_{jt}(N+1)$. α is the inertia factor, $\alpha \in (0, 1)$. $\Delta V_{jt}(N)$ is the weight adjustment value of the last learning cycle, and $\alpha \Delta V_{jt}(N)$ is a momentum term, reflecting the past learning process of the network; η is the constant of the learning rate, and N is the number of learning times. The threshold adjustment formula of the output layer is the following formula (6):

$$\gamma_t(N+1) = \gamma_t(N) + \eta d_t^k. \quad (6)$$

The adjustment formula of the connection weight between the input layer and the hidden layer is the following formula (7):

$$\Delta W_{ij}(N+1) = \eta e_j^k \cdot x_i^k + \alpha \Delta W_{ij}(N), \quad (7)$$

where $\Delta W_{ij}(N+1)$ is the adjustment value of the $N+1$ st weight, $W_{ij}(N+1) = W_{ij}(N) + \Delta W_{ij}(N+1)$. The meaning and function of parameters α and η are the same as above. The threshold

adjustment formula of the hidden layer is the following formula (8):

$$\theta_j(N+1) = \theta_j(N) + \eta e_j^k. \quad (8)$$

- (8) Reselect a mode randomly from m groups of training modes and return to step 3 for training until the global sum of squares error $E = \sum_{k=1}^m E_k = \sum_{k=1}^m \sum_{t=1}^q (y_t^k - c_t^k)^2 / 2$ of BP network is less than the preset limit value ε (when the network converges) or the number of training N is greater than the preset value M (when the network cannot converge) where $E_k = (y_t^k - c_t^k)^2 / 2$ is the sum of squares error of the output of the k ($k = 1, 2, \dots, m$)-th training mode. ε can generally take a value of or less, and the maximum training times m should generally be selected according to the actual situation.
- (9) BP neural network learning training is completed, and a BP neural network has been trained. According to the connection weights and thresholds held by the trained BP network, the evaluation effect can be tested and the actual evaluation application can be carried out.

The value proposition of a business objective performance measure is that the concept of the BP model studied has not been fully implemented. After the calculation, you can get the execution of the business plan. The target business classification and performance level can be determined by comparing the evaluation results with the best performance measurement standards. When using the BP neural network model to complete the measurement of market performance, the weight of each measure that affects market performance is also taken. Based on the scales, the impact of each scale rating and measure on business performance can be determined; it can also

TABLE 4: Comprehensive performance evaluation results of subordinate enterprises of an enterprise group.

Index	Manufacturer 1	Manufacturer 2	Manufacturer 3	Manufacturer 4	...	Manufacturer 14	Manufacturer 15
C_1	0.732	0.849	0.685	0.957	...	0.889	0.925
C_2	0.935	0.698	0.897	0.947	...	0.698	0.958
C_3	0.796	0.874	0.698	0.942	...	0.951	0.912
C_4	0.548	0.697	0.785	0.917	...	0.847	0.901
...
Evaluation results	0.748	0.801	0.764	0.938	...	0.901	0.922
Evaluation grade	Commonly	Good	Good	Excellent	...	Excellent	Excellent

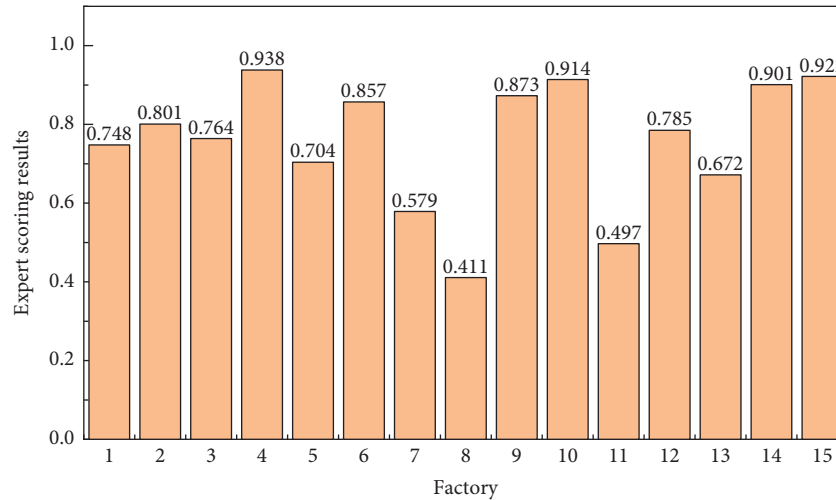


FIGURE 3: Expert scoring results.

identify factors that have a positive impact on business success, and the industry should prioritize performance improvement [25].

4. Result Analysis

4.1. Programming Calculation and Empirical Research.

The model BP neural network can be integrated into the neural network toolbox model in the Matlab environment. The main steps are (1) initiation of the BP model. When creating a BP network, the BP network can be started using the `initff()` function if differences of opinion, number of neurons in each layer, and function are known. (2) BP network training: the `trainbp`, `trainbpm`, and `trainlm` functions can train the BP network. Their use is similar, but the rules are different. The `trainbp` function recognizes the standard BP algorithm, and the `trainbpm` function recognizes the heuristic function. They are not very creative in practice. Work `trainlm` uses Levenberg Marquardt's improved method, which makes training hours shorter and more accurate but requires more memory for work and training. (3) BP network output: it is used to measure or calculate the results of the `simuff` function based on the optimal weight and initial growth obtained as a result of the training [26].

The business performance measurement model and algorithm along the BP neural network proposed in this article can be used in combination with the MATLAB function to measure the performance of trading companies' partner

TABLE 5: Comparison Table of enterprise comprehensive performance evaluation results.

Grade	Excellent	Good	Commonly	Poor	Range
Merit range	0.90~1.00	0.75~0.90	0.60~0.75	0.45~0.60	0.00~0.45

organizations. See the measurement data given in Tables 1–3, select 20 data instruments for each type of measurement according to the network neural device, and select the external test data (access fee) and performance measurement (option cost) from 15. Manufacturers who belong to a group of companies according to the data model for 2016–2020 will be trained in networking to participate in BP network training. Finally, in 2021, measurement data from each plant were included in the BP training network for functional measurement and evaluation. The results calculated in Table 4 and Figure 3 were derived from the Matlab 6.0 function, and the results of the BP neural network assessment were compared with the results obtained by the experts [27].

The evaluation grade is to convert the data evaluation results into corresponding grade evaluation results in combination with the rating methods in Table 5. Different enterprises can formulate their own grade classification standards according to their own situation and actual needs. Among the manufacturers surveyed in this survey, 4 are excellent, 5 are good, 3 are average, 2 are poor, and 1 is very poor.

5. Conclusion

A comprehensive enterprise performance assessment method based on a BP neural network model can make full use of relevant information on sample parameters. With the help of nonlinear mapping, this work reveals the internal mechanism between the overall performance of the enterprise and the factors that affect it in order to fundamentally overcome the difficulties encountered in modeling and solving the complex performance assessment of the enterprise. This method is highly efficient and applicable because it is self-learning, adaptable, tolerant of errors, and very easy to program and analyzes all assessment processes and steps on a computer. This method is sufficient only to enter the processed data into the network and perform the calculations. It is not necessary to artificially determine the weight. It is possible to effectively reduce the human factor in the evaluation process, increase the reliability of the evaluation, and make the evaluation results more effective and realistic. However, much attention needs to be paid to the initial weight distribution of the BP network, the selection of training samples, the design of the underlying layer, and the network integration. A comprehensive enterprise performance assessment method based on a BP neural network model is preferable if effective measures and algorithms can be developed to address these issues.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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