Research on Performance Evaluation Index System and Empirical of Cross-Border E-Commerce Enterprises Based on BP Neural Network

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Abstract: Improving company efficiency greatly benefits from conducting performance reviews of cross-border e-commerce businesses. This study uses cross-border e-commerce firms' performance evaluation as its research subject; First, by reconstructing five dimensions based on a thorough analysis of the distinctions between the Balanced Scorecard and the performance evaluation dimensions of cross-border e-commerce enterprises, and second, by using the most recent research findings on performance evaluation of cross-border e-commerce enterprises, a new and simple performance evaluation index system; Second, the efficacy and dependability of the index system created in this research are confirmed using the index validity evaluation technique; Thirdly, in order to provide a useful performance evaluation model of cross-border e-commerce firms, this research uses the BP neural network approach as the core model in conjunction with an analytical hierarchy procedure to decide the weight of each index; Finally, the data of 16 cross-border e-commerce businesses listed on the A-share are chosen for model training and simulation testing. The accuracy and empirical findings are in line with the demands of practice.

Keywords: Performance Evaluation; Cross-Border E-Commerce; Index System; BP Neural Network; Balanced Scorecard

1. Introduction

Cross-border E-commerce has expanded quickly with the fast growth of economic globalization and information technology, and many conventional businesses have started to transition to cross-border E-commerce mode. Cross-border E-commerce performance evaluation will aid in the better development of businesses and the selection of investors. Therefore, it is important to conduct performance assessments and empirical research on international E-commerce companies.

2. Literature Review

The usual findings of domestic and international research on performance assessment indicators of cross-border e-commerce firms are combed through and analyzed in this article, as shown in Table 1.

Table 1.Domestic and overseas cross-border e-commerce enterprises performance evaluation indicator literature

Author	Time	Typical indicators and dimensions
Wang Bihong	2014	3 dimensions of external marketing, internal operation and leadership decision-making[1]
Ye Hankun	2016	4 dimensions of investment and income, customer service, system construction, learning and[2]
Wang Xia	2017	3 dimensions of financial ability, learning and innovation ability, product competitiveness[3]
Ma Shuzhong	2018	4 dimensions of profitability, debt repayment, operation and cash flow capacity[4]
SEGIuniv	2018	Constructing indicator systemfrom customer satisfaction view[5]
Chen Li	2019	4 dimensions of profitability, operational capacity, solvency and risk level[6]
Du Zhiping	2020	3 dimensions of risk management, service quality and resource management[7]
M Anshari	2021	4 dimensions of economics, politics and policies, socio-cultural, and technology[8]

The investigation reveals that there is no systematic approach to studying cross-border e-commerce firms' performance evaluation systems. The majority of the scholarly study conducted by domestic and foreign researchers on the performance assessment indicators of cross-border e-commerce firms ignores several influencing elements in favor of the financial operating level. Building a new and fair performance evaluation index system is therefore crucial.

3. System of Evaluation Indicators Based on BSC and Index Validity Test

BSC is a tool for assessing and managing business performance. To analyze and manage performance, it adds a customer dimension, internal process dimension, and learning and growth dimension. Customers, staff, and company procedures are considered when determining how well cross-border e-commerce businesses are run. No element may be disregarded. The legislative environment and economic environment are other factors that limit and influence the growth of cross-border e-commerce businesses. Therefore, this paper reconstructs five dimensions based on BSC. By referring to the relevant literature at home and abroad and the questionnaire survey results of experts, the final index system includes 7 secondary indicators and 16 tertiary indicators (As shown in Table 3).

Additionally, the RST approach employed in this research tests the correctness of the index system. The results in Table 2 show that the performance assessment index system developed in this research satisfies the criteria that the redundancy is less than 0.5 and the sensitivity is less than 5, proving that it is both effective and based on science.

Table 2. Results of the index system's validity tests

	RD	SD
Index evaluation system of cross-border e-commerce enterprise	0.353	1.667

4. Evaluation Model and Empirical Analysis

4.1 Evaluation Model Selection

Because there are many evaluation indexes, BP neural network can improve the evaluation accuracy when evaluating complex index system. Therefore, this paper proposes a BP neural network model based on analytic hierarchy process.

4.2 Sample Selection and Data Collection

As the study object for this work, 16 A-share enterprises that have engaged in international e-commerce are chosen (see table 4 for stock code). In addition, the enterprise operation level index data in the financial dimension of this paper are from the financial index analysis database in the research series of CSMAR company; For the data of other dimensions, this paper obtains it through questionnaire survey and expert interview on cross-border e-commerce enterprises. Concurrently, use formula 1 to normalize the retrieved financial data such that it falls between [0,1]. The weighted technique is used to the questionnaire data to get each index's score.

$$X = (x - x_{min})/(x_{max} - x_{min}) \qquad (1)$$

4.3 Construction Model Framework

This research chooses the three-layer BP neural network model to assess the performance of international e-commerce businesses to increase evaluation accuracy. There are 15 nodes in the input layer and 1 node in the output layer, representing the functionality of international e-commerce companies. Formula 2 also specifies that there will be six hidden layer nodes overall. (v is a constant between 1 and 5, m and n are the number of input and output layer nodes, and z is the number of hidden layer nodes)

$$v = \sqrt{m+n} + z \qquad (2)$$

Therefore, Figure 1 depicts the framework for the cross-border e-commerce firms' performance evaluation model built in this article.
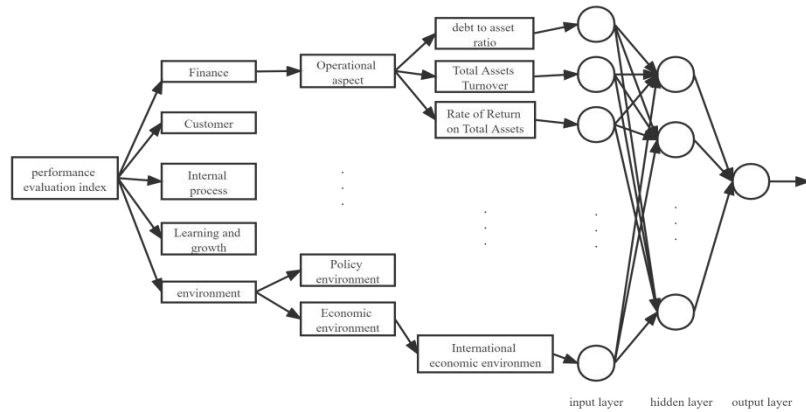
Figure 1. Performance evaluation model framework of cross-border e-commerce enterprises

4.4 AHP to Determine Weight and Expected Output

To establish the weight of each index, this study chooses an analytical hierarchy technique. Table 3 displays the particular outcomes. The expected outcome of the performance assessment of cross-border e-commerce enterprises is the sum of the normalized data of each three-level index multiplied by the comprehensive weight corresponding to the three-level index (the comprehensive weight corresponding to the third-level index is the result of multiplying the first level index weight, the second level index weight, and the third level index weight). Table 4 displays the particular outcomes.

Table 3. Performance evaluation index system and weight of cross-border e-commerce enterprises

First indicators	Weights	Second indicators	Weights	Third indicators	Weights
Finance	0.0980	Operational aspect	1	debt to asset ratio	0.20
				Total Assets Turnover	0.40
				Rate of Return on Total Assets	0.40
Customer	0.1843	Consumer aspect	1	Customer	1
Internal process	0.3491	Competitive power	0.50	International reputation of enterprises	0.33
				Market share	0.67
		Operation quality	0.50	International logistics service capability	0.50
				Business resource management level	0.50
Learning and growth	0.1843	Technical aspect	0.67	New product R&D level	0.33
				Information technology level	0.67
		Employee aspect	0.33	Enterprise staff training	0.25
				Proportion of cross-border	0.75
environment	0.1843	Policy environment	0.50	Perfection of cross-border e-commerce laws and regulations	0.50
				Perfection of cross-border e-commerce tax policy	0.50
		Economic environment	0.50	International economic environment	1

4.5 BP Neural Network Model Training

Samples 1-10 are utilized in this study as training samples to establish the weight and threshold, while samples 11-16 are used as test samples. Through the use of MATLAB 7.0, the BP neural network model is trained. In the actual training process, the epochs in the training parameters are set to 1000, the target is set to 0.001, the training function is set to TRAINGDX, the adaptation learning function is set to LEARNGDM, the performance function is set to MSE, and the performance function is set to PERFORM. Figure 2 displays the end outcome. The training results demonstrate that after 81 pieces of training, the accuracy of the BP neural network satisfies the criteria.

The actual output value predicted output value, and error value of training samples for the BP neural network are displayed in Table 4 throughout training. The error's typical value is 1.97%. It demonstrates how the BP neural network model, which can be used to assess the performance of cross-border e-commerce businesses, has a high assessment impact and a relatively small error.
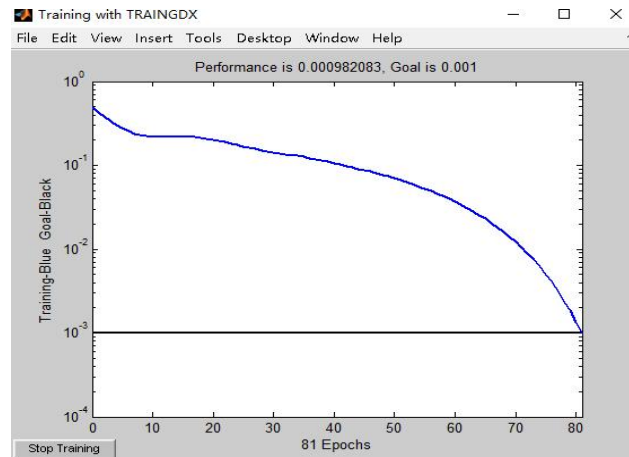
Figure 2. Convergence diagram of a neural network for assessing the performance of international e-commerce companies

4.6 Simulation Evaluation

The simulation test is carried out on the sample 11-16 data. Table 4 presents the output findings. The model's assessment results are in fact consistent with the scenario as it is since the Mean error is quite little (1.23%). It is widely applicable to the performance assessment of international e-commerce businesses.

Table 4.Sample expected output value and error

Sample	Sample	Stock code	Expected output	Actual output	Relati ··· or	Mean error
Training sample	1	002803	0.6986	0.6852	1.92%	1.97%
	2	300209	0.6106	0.6197	1.49%	
	3	002444	0.6637	0.6736	1.49%	
	4	601113	0.6708	0.6643	0.97%	
	5	002098	0.6752	0.6496	3.79%	
	6	300729	0.7158	0.6978	2.51%	
	7	002640	0.7415	0.7284	1.77%	
	8	300868	0.7108	0.6977	1.84%	
	9	300464	0.6612	0.677	2.39%	
	10	300866	0.6826	0.693	1.52%	
Test sample	11	600053	0.6791	0.6702	1.31%	1.23%
	12	603128	0.7037	0.6918	1.69%	
	13	002401	0.7093	0.7011	1.16%	
	14	002024	0.7087	0.699	1.37%	
	15	600368	0.6755	0.6687	1.01%	
	16	002095	0.6714	0.6771	0.85%	

6. Conclusion

For the long-term growth of international e-commerce businesses, the performance review is a crucial stage. The performance evaluation index method currently used by international e-commerce companies is examined in this article. Based on the Balanced Scorecard and the traits of international e-commerce businesses, it develops an assessment index system with distinct dimensions and a clear hierarchy. This paper develops a performance evaluation model based on BP neural network. It makes an empirical evaluation based on the data of 16 representative enterprises, combined with the analytic hierarchy process to determine the index weight. This provides a theoretical foundation and useful method for the future study of cross-border e-commerce enterprises.

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