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Research Article

Performance Evaluation of Accounting Business Process Reengineering Based on AHP Optimization DEA Model

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It is well known that accounting business process reengineering is constantly improving, and this change is usually closely related to incentive mechanisms. The establishment of this incentive mechanism requires performance appraisal of accounting business process reengineering. Although there are many evaluation indicators for the success of business process reengineering, there is a lack of a simple and easy standard. In order to reduce the complexity of business process reengineering (BPR) performance evaluation, the paper regards BPR as a closed input and output system from a systematic point of view, and a corresponding input-output evaluation index system is established for BPR performance based on the resource input support system. By using super-efficiency data envelopment analysis (DEA) and utilizing the advantages of adversarial cross-evaluation and analytic hierarchy process (AHP), a performance evaluation DEA model for accounting business process reengineering is proposed. The model is used to evaluate the performance of QCFF company after business process reengineering. The research results can focus on the supervision and improvement of the departments with poor performance by completely ranking the performance of each process unit. The proposed method for assessing the performance of BPR thus serves a practical purpose and can be used to support the subsequent development of BPR.

1. Introduction

Since the emergence of the relevant theories of business process reengineering, researchers have never stopped studying the performance evaluation of business process reengineering. The main goal of business process reengineering is to improve production efficiency and enhance core competitiveness [1]. Based on this foundation, many researchers have proposed that the evaluation indicators of business process reengineering include four indicators of finance, customer satisfaction, internal processes, and organizational learning. Some scholars believe that the four aspects of quality, cost, time, and flexibility should be considered [2]. S. D. P. Flapper et al. (1996) divided the performance indicators into financial and non-financial, global and partial, internal and external, and organizational level and application scope. S. Yoshiaki and S. Yasua-ki (2000) thought through research that business process performance evaluation indicators include cost [3], and production includes both engineering costs and engineering gross profit. Therefore, the balance of the account and the balance of the project settlement account are offset and listed in the inventory item. First of all, it does not comply with the provisions of the inventory standards on the principles and methods of inventory measurement. Secondly, the project settlement account is only the amount settled by the construction contractor and the owner, and the balance is included in the advance payment project, which is not consistent with the actual situation [4]. Finally, China is not allowed to balance assets and liabilities after the presentation of financial statements; the proposed method does not meet the requirements of financial statement presentation standards.

Generally speaking, in the process of evaluating performance, accounting business process reengineering is of great importance as it not only provides guidance for future accounting business process reengineering, but also allows management's confidence in accounting business process reengineering to gradually increase. M. Hammer and J. Champy believe that business process maturity assessment should include process performance evaluation [5–7]. It

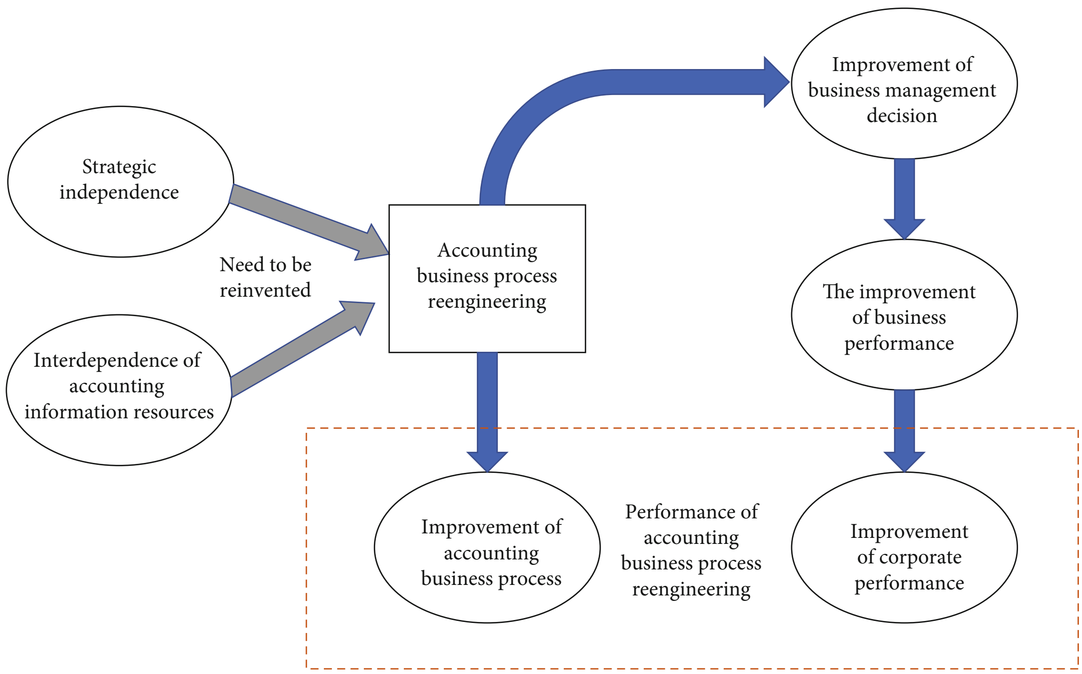

Figure 1: Accounting business process reengineering performance delivery mechanism.

can also be said that the management needs to understand and grasp the difference between the current accounting business process and the expected goal in the process of accounting business process reform, so as to provide basis and confidence for the formulation of further accounting business process reengineering plans. The indirect measurement of business performance can increase the performance of business process reengineering, but it cannot be measured directly. This kind of lack will generate distrust between management and business process reengineering [8]. In order to make the accounting business process reengineering sustainable development, it needs to rely on a set of scientific and reasonable process reengineering performance evaluation system to support.

The practice of accounting business process reengineering often requires the use of millions or more of funds. The management often pays too much attention to the benefits of capital use and pays attention to whether the financial arrangements for accounting business process reengineering meet the requirements. For a series of issues such as whether the expected target of funds is reached, a set of scientific and reasonable process reengineering performance evaluation system is also needed to monitor the use efficiency of accounting business process reengineering funds. George A. Akerlof (1970) believes that information problems will cause the entire market to collapse, and the phenomenon of information asymmetry also exists in the process of accounting business process reengineering [9]. The former has the advantage of more information in comparison to the former and can prevent misuse of information. It avoids a negative impact on accounting BPR compared to users of funds by corporate management. Through the transparency of the capital use process of accounting business process reengineering, information asymmetry can be prevented This method can not only prevent the waste of funds, but also scientifically measure the benefit of accounting business process reengineering.

Accounting business process reengineering performance evaluation is very important, through continuous evaluation and dynamic correction can improve the level of performance. BPR performance appraisal is essential as it is an important indicator to measure whether a company is meeting its expectations [10]. Accounting business process performance evaluation is a complex process, which includes not only qualitative indicators, but also quantitative indicators, so as to comprehensively evaluate the effect of accounting business process reengineering. To change the internal accounting process of enterprises is to provide internal strategic management accounting information related to their decisions, so as to improve the core competitiveness. It is also essential to understand the performance evaluation of accounting business process reengineering, which can not only directly measure the effect of process reengineering, but also indirectly reflect it in the business activities of enterprises, as shown in Figure 1.

Kuwairi et al. have confirmed the important role of BPR in continuous improvement for performance evaluation [11]. The existing BPR evaluation indicators are diverse, but fundamentally speaking, the evaluation indicators of BPR performance cannot be separated from the four indicators of cost, quality, service, and speed [12]. Among them, the data development analysis method (DEA) and the analytic hierarchy process (AHP) have become the mainstream, but these two methods still have their own limitations: First, the DEA method uses the weight of change to determine the decision unit (DMU (i)). In the evaluation, only the weights that are most beneficial to the corresponding DMU are selected, there is no ability to distinguish the pros and cons

Table 1: Input index system of performance evaluation for BPR.

Capital investment	Staff input	People participation and support input	Time investment
Training fees	Number of senior leaders directly involved	Active participation and support of senior leaders	Training period
Personnel service fee	Number of employees directly involved	Active participation and support of middle-level leaders	Project implementation time
BPR consulting fee	Number of middle-level leaders directly involved	Active participation and support of employees	
Equipment cost	Number of external experts	Active participation and support of the process reengineering team	

of the decision-making unit, the evaluation results are not completely ranked, and it is easy to fall into the local optimum. AHP fully reflects the preference of decision-makers [13] and makes up for the defect that DMU cannot distinguish between primary and secondary. The combination of the two can also make primary and secondary judgments when there are too many indicators. We have combined the advantages of DEA and AHP to propose the DEA-AHP model, which further simplifies the computational complexity of BPR.

2. The Complexity of BPR Performance Evaluation and the Issues That Should Be Paid Attention to

The following issues should be paid attention to in the evaluation process of BPR performance: (1) The implementation of BPR will affect all links of enterprise operations, and the evaluation of BPR performance cannot only evaluate the performance of the business process itself. (2) The BPR proposed in the article is based on the system, which is an input-output system, so performance evaluation has multiple input and output evaluation problems. It shows that BPR performance has measurability. Only by integrating various input and output indicators and establishing a complete indicator system can the most accurate evaluation of the implementation of BPR. (3) BPR is a long cycle process. During the implementation of BPR, the evaluation indicators that enterprises pay attention to at different stages are also different.

2.1. The Establishment of BPR Performance Evaluation Indicators. Typically, internal support systems, capacity support systems, and resource input support systems are significantly affected by BPR, and the effects of the different systems are independent of each other. Here, the inputs to BPR are the resource input variables, and the resource output variables are the outputs of BPR [14]. Establish the input-output indicator system of BPR performance evaluation by comprehensively considering the enterprise's investment in the implementation of BPR and the complexity of BPR performance evaluation. In order to improve the comprehensive competitiveness of the enterprise, by redesigning the business process of the enterprise, the performance of the cost and other aspects can be improved. This improvement is mainly reflected in the economic benefits of the enterprise and the increase in organizational work efficiency. In this paper, benefit and efficiency are used to measure the economic value and organizational value of BPR.

Table 2: Output index system of performance evaluation for BPR.

Benefit	Organizational efficiency index
Cost ratio of business process value-added activities	Market share
Operating cost	Quality of work life of employees
Equity interest rate	Customer satisfaction
Process activity cycle efficiency	Human resource utilization
Organizational communication efficiency	Corporate cohesion
Equipment utilization	Information efficiency

Funds, time, number of personnel, and investment in personnel participation and support are not negligible for the implementation of BPR. In fact, this kind of effort will be reflected in the changes in organizational efficiency, but also in the benefits of the enterprise (including economic and social benefits). Due to the complexity of the management system, not all the expenditures for BPR implementation show a proportional relationship in organizational efficiency, and it is not necessarily proportional to the improvement of economic benefits. Therefore, it is necessary to analyze the two types of indicators separately. The previous analysis of the resource input support system can conclude that the main output indicators of BPR performance are benefit indicators and organizational efficiency indicators. The efficiency coefficient method [15, 16] can calculate the specific values of the two types of outputs, respectively. The input and output indicators are shown in Tables 1 and 2, respectively.

2.2. The Establishment of Super-Efficiency DEA Model. Assuming that the optimal solution in model (1) in DEA is u_i^* and v_i^*, which ω_i^* is the optimal weight of DMU(i), then, there is $\omega_i^* = \begin{bmatrix} v_i^* \\ u_i^* \end{bmatrix}$. It is calculated based E_{ii} on the most favorable weight of DMU(i), which is called the self-evaluation value of DMU(i) [6]. If the E_{ii} maximum value

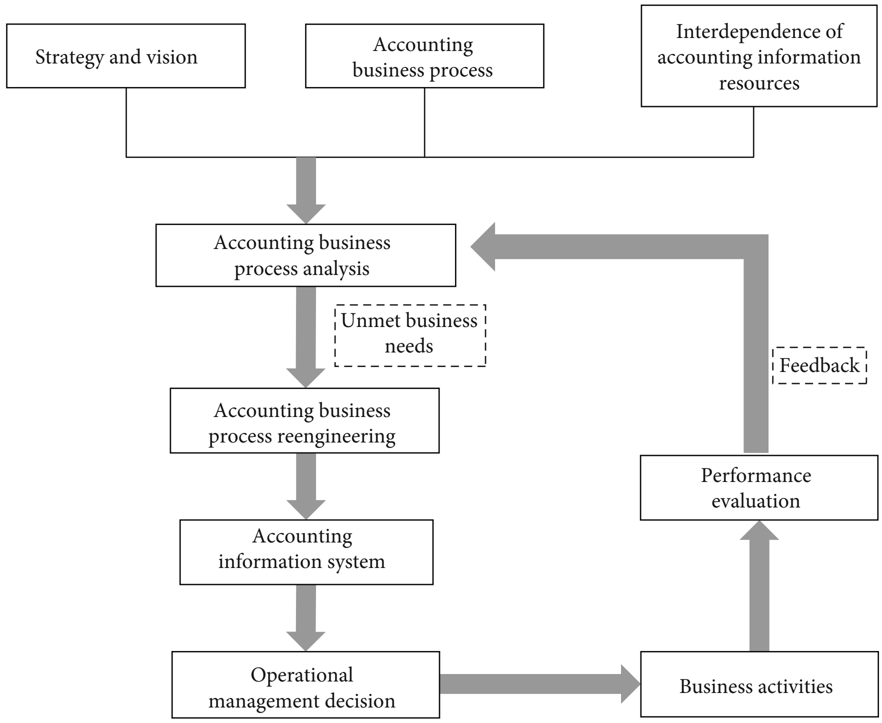

FIGURE 2: The performance evaluation process of accounting business process reengineering.

in super-efficiency DEA is 1, it is said that DMU(i) is effective. If $E_{ii} < 1$, DMU(i) is said to be invalid [17].

$$\begin{cases} \max y_i^T u = E_{ii} \\ y_i^T u \leq x_j^T v, (1 \leq j \leq n), \\ x_j^T v = 1.u \geq 0, v \geq 0 \end{cases} \quad (1)$$

where $x_i = [x_{1i}, \cdots, x_{2i}, \cdots, x_{mi}]^T$ is the input of DMU and $y_i = [y_{1i}, \cdots, y_{2i}, \cdots, y_{si}]^T$ is the output, where m is the number of input indicators and s is the number of output indicators.

In the actual problem processing process, the actual data enables many decision-making units to obtain an efficiency value of 1. Therefore, it is impossible to distinguish the pros and cons of these decision-making units E_{ii}. According to the model (1), the most favorable weight ω_i^* of each DMU(i) can be calculated, and it can be calculated E_{ii} that this approach is flawed; that is, only a few most favorable input and output indicators are considered, and other indicators are not considered. In this way, the self-evaluation value E_{ii} calculated by the model (1) cannot reflect the sequence of DMU(i) [18]. The introduction of a cross-evaluation mechanism can avoid this problem. Its working principle is to use the best weight ω_i^* corresponding to each DMU(i) to calculate the efficiency value of other DMU(k), and the cross-evaluation value is

$$E_{ik} = \frac{y_k^T u_{ik}^*}{x_k^T v_{ik}^*} y_k^T u_{ik}^*, \quad (2)$$

where the larger the value of E_{ik}, the more favorable it is for DMU(k), and vice versa, the more unfavorable it is for DMU(k) [19, 20].

2.2.1. DEA Constructs the Judgment Matrix. For the decision cells in the judgment matrix, it is assumed here that each cell has m inputs and k output indicators [21, 22]. Decision-making units with a relative effective value of 1 are in fact the best, and perhaps under an inappropriate weight structure, the relative effective value can reach 1. The following introduces a cross-evaluation mechanism to calculate the relative efficiency between several decision-making units. Because the optimal solution u_i^* and v_i^* of Eq. (1) is not unique, the cross-evaluation value of E_{ik} obtained by Eq. (2) is uncertain. For this reason, adversarial cross-evaluation can be used to obtain the cross-evaluation value.

The formed cross-evaluation matrix is

$$E = \begin{bmatrix} E_{11} & E_{12} & \cdots & E_{1n} \\ E_{21} & E_{22} & \cdots & E_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ E_{n1} & E_{n2} & \cdots & E_{nn} \end{bmatrix}. \quad (3)$$

Generally, the comparison value of the pairwise efficiency of n decision-making units is $a_{ij} = (E_{ii} + E_{ij})/(E_{jj} + E_{ji})$, and $a_{ij} = 1/a_{ji}, a_{ii} = 1$. Therefore, the judgment matrix constructed by the DEA method above does not contain subjectivity and does not need to be tested for consistency [23–25].

2.2.2. AHP Method Ranking Optimization DEA Model. Based on the two judgment matrices obtained by the DEA

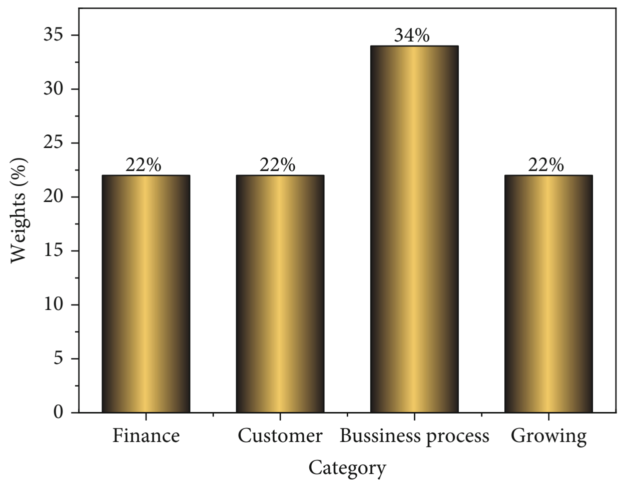

Figure 3: Weights of balanced scorecard indicators.

method above, the maximum eigenvalues of these two matrices and their corresponding eigenvectors can be obtained using the analytic hierarchy process. Here, the feature vector ranked in the *i*th position is taken as the priority of the *i*th decision unit, because the analytic hierarchy process here only takes one layer.

2.2.3. Performance Evaluation Process of Accounting Business Process Reengineering. The reengineering of accounting business processes is different from the previous approach. The design can lead to direct economic benefits, whereas the previous approach usually led to economic benefits in an indirect way [26]. Its economic benefits are mainly reflected in the improvement of the quality of accounting information for the accuracy of production and operation decisions and strategic decisions. Its value can be compared to the process.

The accuracy of business management decisions before and after process reengineering and the increase in value brought by decision accuracy are measured. Based on the above recognition, here is a performance evaluation process for accounting business process reengineering, as shown in Figure 2.

2.2.4. Accounting Business Performance Improvement. Enterprises can determine the weight of the two indicators in the performance evaluation index system of accounting business process reengineering through expert review or brainstorming. As for the weight design of corporate performance improvement, in addition to the expert scoring method and brainstorming method, the company can also adopt the viewpoint of Professor R. S. Kaplan to determine the weight composition of the four dimensions of corporate performance improvement as shown in Figure 3.

Table 3: Aggregate of DMU system.

DMU(*i*)	MU system
DMU(1)	Procurement business management
DMU(2)	Sales business management
DMU(3)	Material inventory management
DMU(4)	Financial accounting management
DMU(5)	New product technology research and development
DMU(6)	Production transaction process management
DMU(7)	Human resource management
DMU(8)	Quality management and control
DMU(9)	Company management business process

Table 4: Index system of input-output.

Serial number	Index content
Input 1	Capital investment
Input 2	Input of the number of personnel
Input 3	Personnel participation and support input
Enter 4	Time investment
Output 1	Benefit
Output 2	Organizational efficiency

Table 5: Input statistic data.

Benefit	Organizational efficiency
Cost ratio of business process value-added activities	Process activity cycle efficiency
Operating cost	Human resource utilization
Quality of work life of employees	Organizational communication efficiency
Customer satisfaction	Equipment utilization

Table 6: Selected input index.

DMU(i)	Input1/10 thousand	Input2/person	Input3	Input4/d
DMU(1)	8.36	8	0.64	212
DMU(2)	10.64	11	0.80	217
DMU(3)	8.15	5	0.77	231
DMU(4)	6.68	4	0.66	209
DMU(5)	18.26	9	0.71	249
DMU(6)	15.70	12	0.74	255
DMU(7)	3.76	3	0.84	206
DMU(8)	6.8	8	0.82	225
DMU(9)	6.92	7	0.76	247

3. Case Analysis

Data from QCFF is used in this paper to validate the performance of the DEA-AHP model. In reality, QCFF company suffers from low equipment utilization, high overtime, and other malpractices that make the market response slow. The company therefore needs to conduct a BPR performance assessment to improve the efficiency and effectiveness of the company and thus increase its competitiveness in the market.

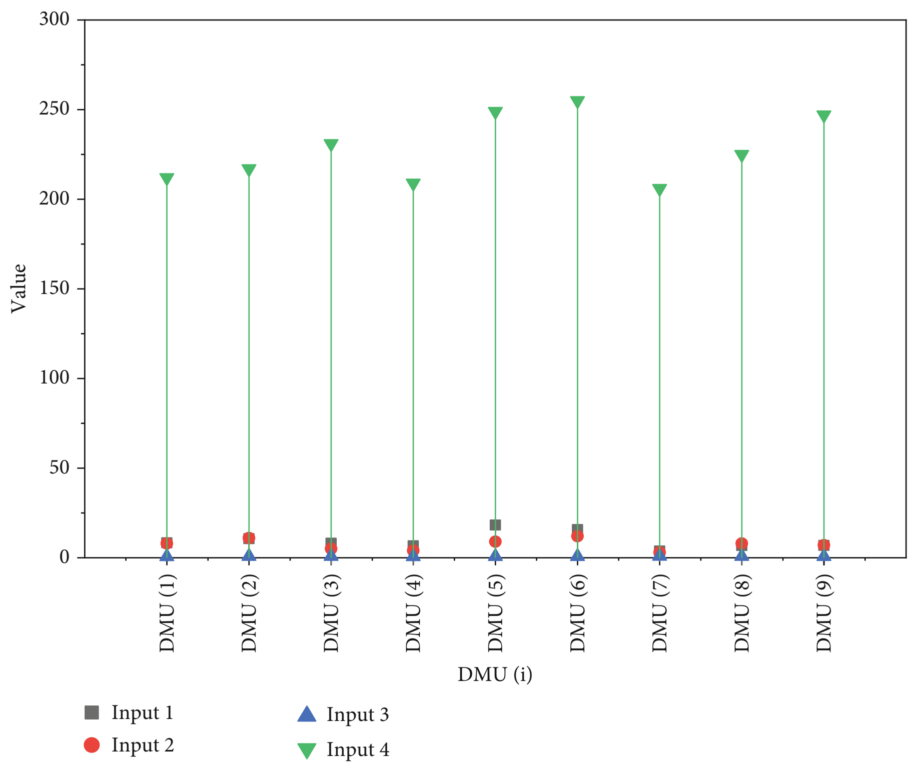

FIGURE 4: Relationship between input components.

TABLE 7: Output statistic data.

DMU(i)	Business value-added ratio	Operating cost	Quality of work life of employees	Customer satisfaction	Process activity cycle efficiency	Human resource utilization	Organizational communication efficiency	Equipment utilization	Information efficiency
DMU(1)	78.00	0.51	0.68	0.78	17.14	0.75	0.82	0.73	0.86
DMU(2)	68.82	0.42	0.75	0.85	20.80	0.83	0.86	0.70	0.83
DMU(3)	76.67	0.64	0.70	0.75	17.70	0.78	0.79	0.78	0.87
DMU(4)	72.50	0.77	0.73	0.71	14.30	0.85	0.90	0.86	0.93
DMU(5)	86.25	0.81	0.82	0.84	12.50	0.89	0.85	0.83	0.92
DMU(6)	84.00	0.47	0.66	0.70	15.98	0.73	0.72	0.72	0.79
DMU(7)	66.67	0.81	0.86	0.85	18.12	0.91	0.88	0.91	0.93
DMU(8)	86.73	0.78	0.83	0.78	16.23	0.96	0.85	0.82	0.85
DMU(9)	71.24	0.65	0.74	0.80	13.46	0.86	0.80	0.79	0.91

3.1. Establish the Input and Output Index System. The existing main transactional business processes of the company's internal operations are formed into a DMU system, as shown in Table 3.

On the basis of the index system, the input and output index system of the DMU system is established as shown in Table 4 and Table 5. Since BPR performance is evaluated within the company, the selected output indicators are shown in Table 3.

3.2. Calculation of Input Indicators

(1) The sum of BPR consultancy costs and personnel labor costs is usually used as an indicator of capital investment. Here, BPR consultancy costs are borne equally by the nine DMUs(i), while labor costs are calculated by averaging the number of people involved in the process and the labor costs, and equipment costs depend on the number of purchases and the unit price of purchases in each sector [27].

(2) The input index of the number of personnel is determined by the sum of the number of employees and leaders of the department directly participating in the BPR

(3) The input of personnel participation and support is calculated by the sum of fuzzy mathematics

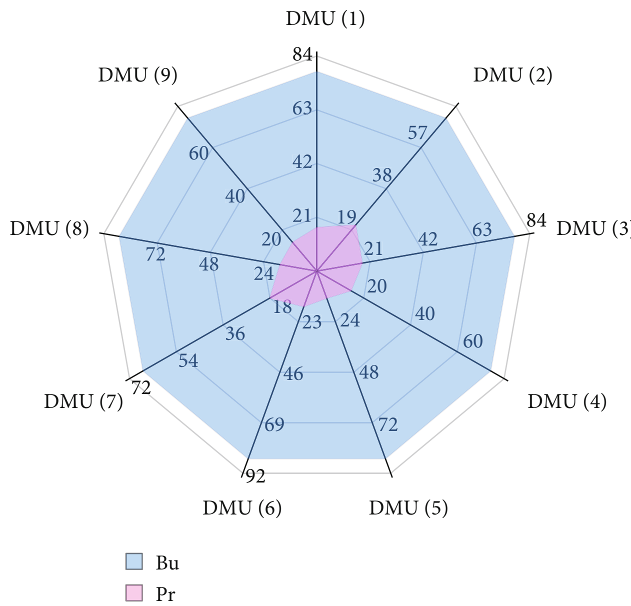

Figure 5: Comparison of each component data of output data.

(4) The time investment index is based on the time invested by each department in training

Calculated by the sum of the implementation time of the BPR project (unit: d, calculated as 8 h per day), the input index data in Table 6 and the relationship between input components are shown in Figure 4.

3.3. Calculation of Output Indicators. The evaluation indexes of efficiency and organizational efficiency are multiindex comprehensive evaluation problems, and the nature of each subindex is quite different, so this paper adopts the efficacy coefficient method to deal with these two output indexes. The output index data are shown in Table 7, and the comparison of each component data of output data is shown in Figure 5.

In order to facilitate comparisons between departments, relative data between departments are given in Table 7. A fuzzy integrated evaluation method is used to judge the indicators, where utilization rate indicates the ratio of the number of personnel to the total number of employees. The activity-based costing approach here allows for an improved cost rate for business process value-added activities [28]. In order to simplify the calculation, the choice of weights assigns the more important index to 3, the general important index to 2, and the other 1 is enough to distinguish the relative magnitude of each evaluation index. The efficiency coefficients are shown in Table 8.

The comparison of the two output point and line diagrams is shown in Figure 6.

3.4. Calculation of Weights. The software Matlab2021a was used to calculate the cross-evaluation matrix E, and the judgment matrix A constructed by DEA method was obtained by pial comparison. AHP method is used for complete sorting. The geometric average method is used to calculate the weight of DMU(i) of each decision-making unit [29, 30], as shown in Table 9.

$$A = \begin{bmatrix} 1.0000 & 0.9430 & 0.9987 & 1.0235 & 0.1230 & 0.9999 & 1.3459 & 0.9637 & 1.0320 \\ 1.0614 & 1.0000 & 1.0127 & 1.2862 & 0.9903 & 1.0285 & 1.5416 & 0.9918 & 1.0968 \\ 1.0013 & 0.9831 & 1.0000 & 1.0397 & 0.9976 & 0.9890 & 1.3171 & 1.0000 & 1.0018 \\ 0.8569 & 0.7775 & 0.9619 & 1.0000 & 0.8051 & 0.7930 & 1.1810 & 0.8370 & 0.8915 \\ 0.9997 & 1.0098 & 1.0029 & 1.2356 & 1.0000 & 0.9985 & 1.5545 & 0.9862 & 1.1981 \\ 1.0001 & 0.9726 & 1.0111 & 1.2612 & 1.0004 & 1.0000 & 1.3806 & 0.9722 & 1.7359 \\ 0.7430 & 0.6487 & 0.8456 & 0.8649 & 0.6568 & 0.7243 & 1.0000 & 0.6954 & 0.7589 \\ 1.0377 & 1.0083 & 0.8695 & 1.1948 & 1.0319 & 1.0290 & 1.4420 & 1.0000 & 1.0017 \\ 0.9690 & 0.9142 & 0.8795 & 1.1218 & 0.8347 & 0.5764 & 1.3545 & 0.9983 & 1.0000 \end{bmatrix}. \quad (4)$$

Table 8: Synthetic efficacy coefficients of benefit and organizational efficiency.

Serial number	Comprehensive efficacy coefficient								
	DMU(1)	DMU(2)	DMU(3)	DMU(4)	DMU(5)	DMU(6)	DMU(7)	DMU(8)	DMU(9)
Output1	80.00	78.56	81.59	83.56	89.25	79.89	86.52	88.36	82.33
Output2	82.06	85.63	83.45	85.98	83.42	77.84	89.65	86.32	82.16

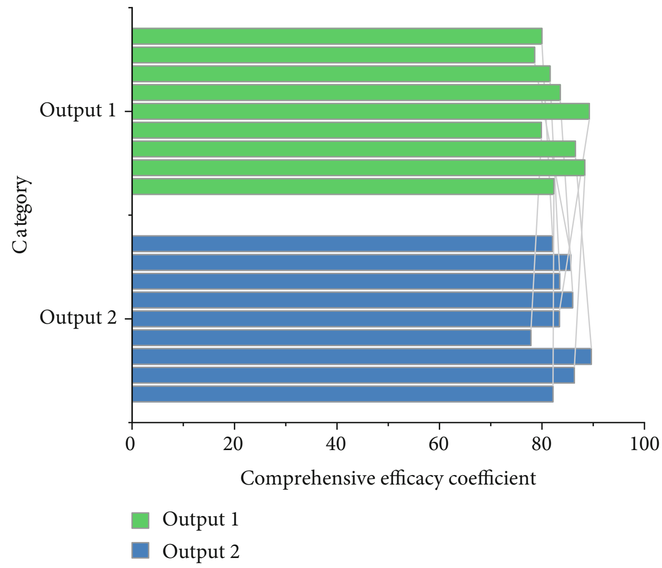

Figure 6: Comparison of two output power coefficient dot-line diagrams.

Table 9: DEA and AHP weight value and rank.

DMU(i)	DEA/AHP calculated value (weight)	Rank
DMU(1)	0.0981	5
DMU(2)	0.0886	8
DMU(3)	0.1012	4
DMU(4)	0.1353	2
DMU(5)	0.0889	7
DMU(6)	0.0846	9
DMU(7)	0.1911	1
DMU(8)	0.0933	6
DMU(9)	0.1188	3

The data comparison of the weighted processing of the four inputs is shown in Figure 7.

After the action of the comprehensive efficacy coefficient and the judgment matrix A, the image comparison of the two outputs is shown in Figure 8.

It can be seen from the data in Table 9 that DEA and AHP are combined to realize the complete ranking of the performance of each process unit by using the complementary advantage method and further distinguish the process decision-making unit whose effective value is 1 in DEA. The AHP method used in this paper is objective judgment matrix, which reduces the difficulty of making judgment on process performance. It can be seen from Figure 9 that after BPR, the company's performance in production affairs management is the worst, followed by sales management

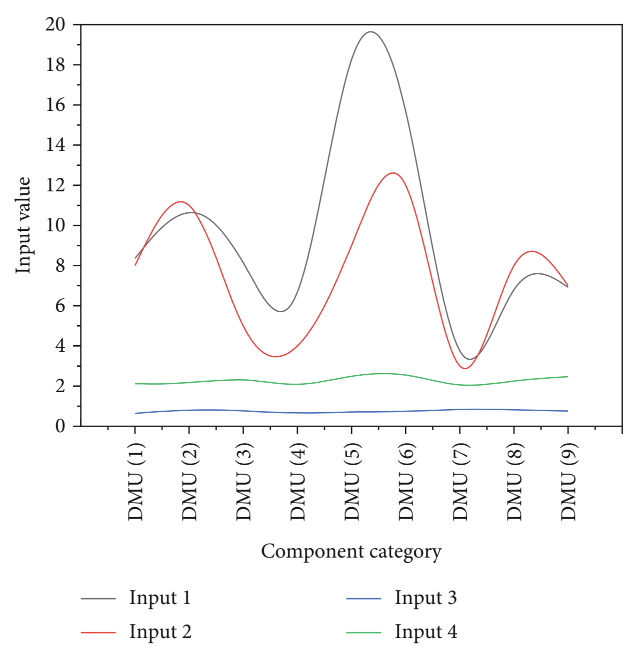

Figure 7: Comparison of four input weights.

and new product technical design process. The best performance of BPR is the human resource management process, followed by the financial accounting process and company management process. Therefore, according to the evaluation results, in the subsequent implementation of BPR, the company will focus on the departments with poor performance and focus on improving these departments.

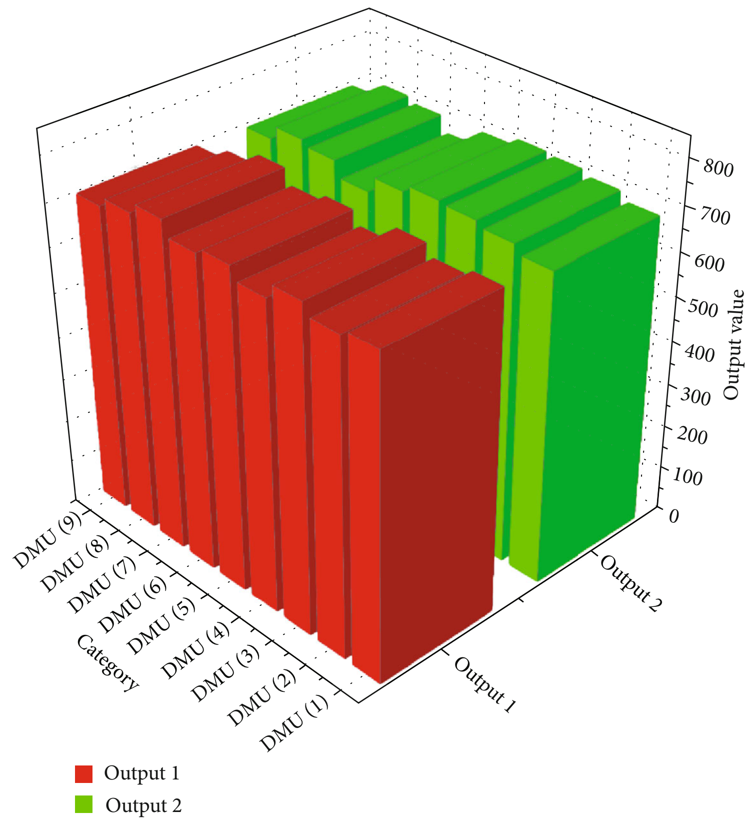

Figure 8: Comparison of the output of the comprehensive efficiency coefficient and the weighting effect.

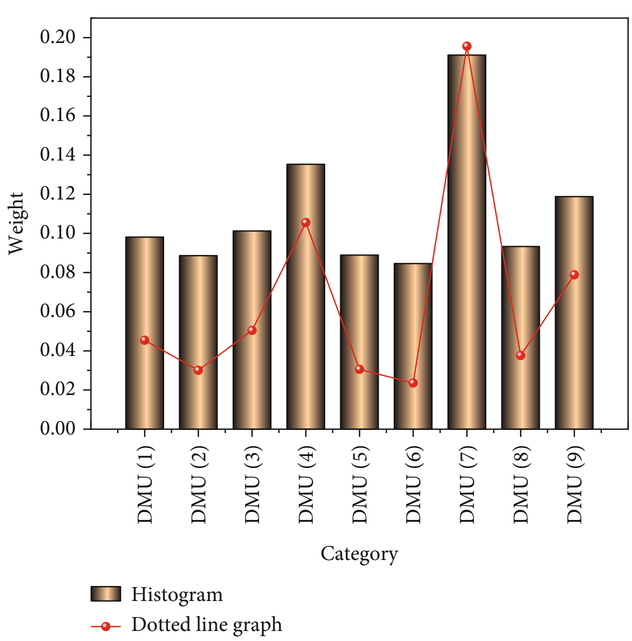

Figure 9: Intuitive comparison of DMU(i) weight values.

The company uses the proposed super-efficient DEA model to evaluate BPR performance and improve BPR according to the performance evaluation results of each stage. After improvement, the company chooses the BPR performance evaluation index in line with the target of the next stage and evaluates the performance of BPR with the above method to find out the weak links and opportunities for improvement, forming a cycle of continuous improvement and realizing the corporate strategy through BPR.

4. Conclusions

Put forward the problems that should be paid attention to in BPR performance evaluation, aiming at these problems, on the basis of BPR support system is established. The input-output performance evaluation index system of BPR can not only reflect the contribution of key factors in the input support system of BPR to BPR performance, but also objectively evaluate BPR performance systematically. (2) By combining DEA and AHP methods and using the ranking function of AHP to rank the indicators in the DEA model, the constructed hybrid DEA-AHP model makes BPR performance evaluation more effective and faster.

Data Availability

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

Conflicts of Interest

The author declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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