Application of analytic hierarchy process in performance appraisal system

Gao-yang Shi 1*, Xiao-yan Wang 2

1 School of science, Xi’an Shiyou University, Xi’an, Shaanxi, 710065, China
2 School of science, Xi’an Shiyou University, Xi’an, Shaanxi, 710065, China
* Xiao-yan Wang: shiyouwxy@126.com

Abstract: Based on the KPI and BSC assessment method commonly used in management, combined with the analytic hierarchy process in mathematics, the core algorithm of the assessment system is updated, the weight of each assessment element is scientifically measured, and the requirement of fairness and justice in the assessment function of the system is guaranteed, which provides scientific basis for the final performance appraisal results. Zero client B/S architecture is adopted, and UML modeling is used for system analysis. Modeling methods such as timing diagrams are used in the system design, and combined with JavaWeb technology to complete the construction of system pages and interaction with the server. It realizes the design and development of the performance appraisal system, and makes human resource management more scientific and convenient.

1. Introduction
Performance management is the core and hub of enterprise organization management. It is the most powerful means for organizations to improve team performance. An effective performance management system will greatly help employees improve their work and performance, encourage employees to continue to improve, and achieve organizational strategic goals [1]. According to the performance management ideas of an oil extraction plant, combined with the popular assessment methods at home and abroad, while defining the employee's task indicators, taking into account the employees' learning and growth capabilities, a set of assessment systems suitable for the long-term development of oil extraction plants was developed. Combining mathematical methods with enterprise business, considering weight calculations, and applying analytic hierarchy process to performance appraisal systems play an important role in the evaluation of targets and are consistent with the evaluation of employee performance in performance appraisal [2]. Different performance management programs can be set according to different departments, and each program generally includes management elements such as setting performance evaluation goals, appraisers, evaluation rules, performance evaluation data collection, performance evaluation results summary calculation, performance rating and other management elements, automatically generates a performance appraisal table for related system users to query, download, and analyze.

2. Algorithm
It is divided into target layer, decision-making layer and scheme layer. It can judge the importance of the conditions related to the target to the maximum extent, and calculate the ranking of the advantages
and disadvantages of the scheme layer to the target layer by the judgment matrix, so as to obtain the optimal solution of the decision [3-4].

2.1. Algorithm steps

2.1.1. Establishment of a hierarchy.
The purpose of this algorithm is to make a reasonable assessment of the performance of employees, so first select excellent employees; secondly, the factors that affect the assessment are the six criteria described in the above corporate needs; finally, the scheme for participating in the assessment should be all employees of the enterprise [5]. The established hierarchy is shown in Figure 1:

![Decision hierarchy of employee performance evaluation AHP method](image)

C1: routine, C2: Priority work, C3: Style construction, C4: Grassroots comments, C5: Learning ability, C6: Others

2.1.2. Construction of judgment matrices.
AHP judgment matrix is constructed according to 1-9 scale table, and the importance degree is scaled by the natural number between 1-9 and its reciprocal, the greater the importance of numbers is, the stronger the importance is. In general, the importance scale of each factor is determined according to the suggestions of experts and scholars, and the judgment matrix is constructed as a comparison value [6].

The judgment matrix is recorded as the internal value of the judgment matrix by judging the relative importance of the target layer between two and two criterion layers $C_i C_j a_{ij}$

$$ A = \begin{bmatrix} a_{11} & a_{21} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{bmatrix}, $$

where $a_{ij} = \frac{1}{a_{ji}} a_{ij}$Among them, the n is the number of decision-making factors, and the value should conform to the scale range of the nine-scale table.
2.1.3. Consistency testing.
After the judgment matrix is constructed, it is necessary to test the consistency index to determine whether the value will cause too much error. Introduction of consistency indicators $a_{ij}$

$$CI = \frac{\lambda_{MAX} - n}{n - 1},$$ \hspace{1cm} (2)

$\lambda_{MAX}$ where, is the maximum characteristic root and $n$ is the number of rows or columns of the matrix.

$\lambda_{MAX}$ If it's not equal to $n$, you need to calculate the consistency ratio

$$CR = \frac{CI}{RI},$$ \hspace{1cm} (3)

further judge whether the matrix passes the consistency test. A partial value of the RI is shown in Table 2.1:

| n  | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   |
|----|------|------|------|------|------|------|------|------|
| RI | 0.89 | 1.12 | 1.26 | 1.36 | 1.41 | 1.46 | 1.49 | 1.52 |

If the value of the $CR$ is less than 0.1, the judgment matrix passes the consistency test, otherwise it is corrected.

2.1.4. Calculation of weight vectors.
After determining the judgment matrix, we need to normalize the matrix, that is, calculate and line average weight\[^{12}\] The weight is obtained by arithmetic mean method.

$$\omega_i = \frac{1}{n} \sum_{j=1}^{n} \frac{a_{ij}}{\sum_{k=1}^{n}} a_{kj},$$ \hspace{1cm} (4)

where, $i = 1, 2, 3, n$, weight vector is

$$\omega_1, \omega_2, \cdots, \omega_n \text{T}.$$ \hspace{1cm} (5)

2.2. Algorithm Implementation
The performance evaluation index modification function is set in the administrator system. The administrator can quantify the strategic goals according to the development strategy of the oil production plant, enter according to the system prompts, and complete the importance of the evaluation factors. After filling in, the check function can be used to ensure that the judgment matrix is valid, and the weight of each factor can be applied to the assessment through verification.

2.2.1. Verification of judgment matrix and calculation of weight.
Through the system check index weight calculation page prompt, the completion index relative importance degree fill in, call the page after filling in the value, use array type to store the value to complete the judgment matrix write. Using the length properties of the array to get the n values mentioned above, and the initial column vector, vector normalization, maximum eigenvalue can be done by for loop statements with different method bodies, part of the code is as follows:

```javascript
for (var k=0; k<n; kk=){
    w2[k]=w1[k]/sum;
    w0[k]=w2[k];
}
for (var k=0; k<n; kk=){
    lamta +=w1[k]/(n*w0[k]);
}
```
The calculation of the maximum eigenvalue \( \lambda \) is very simple, and then the if statement is used to determine whether the value meets the consistency requirement. After all the value calculation is completed, call the program method of page information printing, display the required value on the page, check whether pass or not can use the window component of the page, pop up the display box to remind the administrator to do the next step. If the above process prompts to pass the consistency test, the corresponding weight can be printed in the examination index table.

2.2.2. Weight application.
According to the organizational structure of the company, through the leadership to fill out the performance form, ordinary staff have the right to view feedback. After the administrator completes the index weight update, not only will use in the performance form to complete the comprehensive operation with the staff special achievement, but also needs to display the final achievement in the employee system.

3. System implementation
Based on the above design principles and the requirements of the enterprise, we need to achieve multi-login, display different system pages, according to their different permissions to the system operability is different. For the events to be handled by all levels, the functions are presented in a hierarchical structure, so that users do not have technical problems in the use of the system. The whole system is divided into 10 functional modules: daily work, key work, style construction, grass-roots review, other work, personnel assessment, report statistics, performance analysis, assessment management, system authority management. In the design of system functions, use the use cases in UML modeling to complete the design of system logic. Leadership use case: through the login port verification, for the leader authority user, the authority low leader, will be able to use the performance management function, thus to the employee and its corresponding department performance appraisal table to add, delete, change, check and submit the function, can not use the approval function. The leader with high authority can complete the approval function to the submitted form and send the approval status back to the department leader. At the same time, it has the function of modifying its personal information and login password, as well as the login permission of employee forum. Employee use case: the user who is verified as ordinary permission by login will enter the employee system, which can complete the review index of the department and the ranking of the department assessment. Enter the personnel assessment module, complete the review of their own assessment results detailed information function, and the results of the challenge to submit complaints, to the leadership for review.

4. Conclusions
The performance evaluation system based on the analytic hierarchy process has been completed. In the overall system functional design, the effect of the evaluation process status display and evaluation results are adopted to enable users to find problems in time during use and solve the problem of untimely feedback in the traditional model. The model of updating the evaluation index and recalculating the weight is adopted to realize the calculation of employee performance results. Each employee's maximum contribution to the company is compared to ensure the fairness and impartiality of the assessment. The employee system module's ranking of department performance evaluation results makes the evaluation more transparent, and employees can clarify the specific differences with other employees based on the evaluation results. It avoids the question of employees' dissatisfaction after the company makes employee promotion decisions. The learning module can improve the professional ability of employees, make up for the lack of assessment results, and better complete daily work, thereby improving personal performance.
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