Fuzzy Evaluation Model of Software Project Performance based on Grey Clustering Analysis

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***Abstract*— This paper introduces the general principles that should be followed in project performance evaluation through the analysis. The main factors affecting software project performance evaluation, it provides a guiding principle for the construction of project performance. Its evaluation index system includes software project characteristics and project characteristics. The empirical study shows that the model can effectively evaluate software project performance and knowledge. It also provides decision support information for software organizations to formulate risk aversion strategies, improve project performance level and other risk factors.**

***Index Terms*— Grey Clustering Analysis, Software Project, Performance Evaluation, Fuzzy Evaluation, Fuzzy Neural Network.**

I. INTRODUCTION

The project performance evaluation is based on the principles of mathematical statistics, statistical operations research and specific index system. according to the designated project performance evaluation criteria, in accordance with certain procedures, through quantitative and qualitative analysis and comparison, to make an objective, fair and accurate comprehensive evaluation of the benefits and performance of the project in a certain period of operation. With the continuous development of information, the government and enterprises pay more and more attention to the return of information development [1]. Promoting the performance evaluation of project performance and the performance evaluation of enterprise information transformation has become an urgent task for information to drive industrialization in China. Project performance evaluation is usually carried out by organizations or groups outside the project team [2]. Usually it is the evaluation before and after the project is completed. Pre-evaluation mainly refers to the feasibility of the project evaluation; post-completion evaluation refers to the project after the end of the project, according to the relevant laws and regulations, project plans, contracts or agreements. With the help of perfect measures or means to evaluate the level, effect and impact, development rate of return, target relevance and economic rationality of information projects. Project performance evaluation is an objective analysis and summary of the project establishment, operation process, benefit, effect and impact, so as to achieve the purpose of improving development efficiency [3]. At the same time, it can also provide reference for the feasibility analysis and decision making of similar projects in the future.

II. EVALUATION MODEL ALGORITHM OF PROJECT PERFORMANCE INDEX BASED ON GREY CLUSTERING ANALYSIS

This paper presents an algorithm of project performance index evaluation model based on grey clustering analysis. The formula is:

$$Ji = min\ \delta^2 + (Rp) + Ri \qquad (1)$$

Where:
Ji = Gray-scale performance index parameter
ft = The market development portfolio performance in the t period
Ri = The project performance in the t period
Rf = The risk-free performance in the t period
βi = The systemic risk of software development portfolio

The gray index is an absolute performance index, indicating the difference between the project portfolio performance rate and the market portfolio performance rate under the same level of system risk. When the value is greater than zero, the project performance is better than the market portfolio performance [4]. When comparing items the bigger the grayscale index is, the better. Grayscale model lays the theoretical foundation of project performance evaluation. However, when using gray-scale index to evaluate the overall performance of a project, there is an implicit assumption that the non-systematic risk of the project has been thoroughly dispersed through the development portfolio. Therefore, the model only reflects the relationship between the performance rate and the system risk factors. If the project does not completely eliminate the non-system risk, the grayscale index may give wrong information. Therefore, the quadratic regression term is introduced into the model, and the dual β-value market model is proposed. The quadratic regression term and the random variable term are used to further study the stock selection ability of project managers and the time selection ability in the market application. The formula is as follows:

$$Ti = Ji\ \frac{(Ri - Rf)^2}{\beta i} \qquad (2)$$

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Where:
T_i = The performance index, which is the average performance rate of Item I in the sample period, and
F = The average risk-free performance rate in the sample period
R_i-R_f = The average risk premium for the project during the sample period
The project evaluation index represents the size of the risk performance obtained by the project under the risk of each unit factor. Its evaluation method is to calculate the risk index of various projects and markets in the sample period, and then compare them [5].
The larger numerical index means better performance. In order to better protect the operation of fuzzy evaluation, combined with three-dimensional clustering extraction algorithm to evaluate the performance of software project development, if L is the system operation effect, W is the software system development flow, K is the feedback parameter. The system evaluation parameter D and the evaluation vector p are u, and the software running evaluation parameters are:

$$Q = pl_{1w} - T_i\,(\frac{1}{L_1}u_w + \frac{1}{L_2}u_k) = T_i\frac{da_{1w}u_k}{L_t} \tag{3}$$

The software operation evaluation parameters are used to calculate the operation control effect of software development performance L1w and L2w respectively. Let V be the output parameter of the software performance, and CK is the contrast number of the software fuzzy evaluation standard. The software project control effectiveness evaluation algorithm is as follows:

$$R = \begin{cases} L1w = Q(v - u_c k) \\ L2w = Q\left[\frac{da_{1w}u_k}{L_t}\,(P1 - P2)^w\right] \end{cases} \tag{4}$$

III. FUZZY EVALUATION MODEL OF PROJECT PERFORMANCE BASED ON CLUSTERING ANALYSIS

Successful software projects can improve the competitiveness of organizations (including project implementation organizations and application organizations themselves), so it is urgent to establish a scientific and reasonable software project performance evaluation index system [6]. At present, there is no unified standard for the performance evaluation index system of software projects, and experts and scholars in various countries have their own views and tendencies. The evaluation index system is the basis and standard, for evaluating the performance of any project. The evaluation index system selected by each author is different and interrelated [7]. The performance level of a software project is investigated from four aspects: financial index, user orientation, project process management, innovation and learning ability. Among them,
The financial indicators are divided into four secondary indicators:

- The total cost of the project
- The performance of the project investment
- The net present value of the project and
- The payback period of the project

The user-oriented indicators are divided into four secondary indicators:

- The matching degree of the project and the user strategy
- The degree of meeting the user's functional needs
- The degree of user satisfaction and
- The help to the user [8]

The project process management index is divided into four secondary indexes:

- The development time of the project
- The elimination time of the project
- The maintainability of the project and
- The usability of the IT project

In the process of software project performance evaluation, different stakeholders consider different interests, i.e., different concerns. Throughout the software development process, software project organizations often focus on the time and cost of software project development, as well as the ability of software organizations to acquire knowledge, team coordination and control of project resources. The main content of fuzzy evaluation of project performance in cluster analysis as shown in the following table i.e., Table 1.

Table I: Main Contents of Fuzzy Evaluation of Project Performance in Cluster Analysis

Stage	Project
Plan	File User's Manual
Design	Data Description
Realization	Software Requirement Analysis Software Development Data
Test	Module Specification
Maintain	Performance Evaluation Test
Assessment	Maintenance Record Accident Report Assessment Report

The end users of software use often focus on the time and cost of software project development, as well as the final quality, performance, applicability and adaptability of software products. Before the project is developed, it is necessary to identify the risks and risks that the project will face. The objective of risk identification process is to transform the uncertainty in project implementation into a clear risk statement. From the perspective of project management, risk identification is based on: scope benchmark, risk management plan, activity cost estimation, activity duration estimation, stakeholder register, schedule, cost plan, quality management plan, business environment factors and organizational process assets. From the life cycle of software development, the output documents of each stage are the basis for risk identification in the next stage and many technical risks can be analyzed accordingly. The following figure i.e., Fig. 1, gives the principle of software project risk identification and evaluation [9].
Software risk identification is the first link of risk management and the basis of risk assessment. Therefore, we must identify all risks systematically and comprehensively to ensure the smooth implementation of software development projects. At the same time, identifying the risk is not only to determine the source of risk, but also to determine the time when the risk occurs, the conditions under which the risk occurs, to describe

its risk characteristics, and to determine which risk events are likely to affect the project.

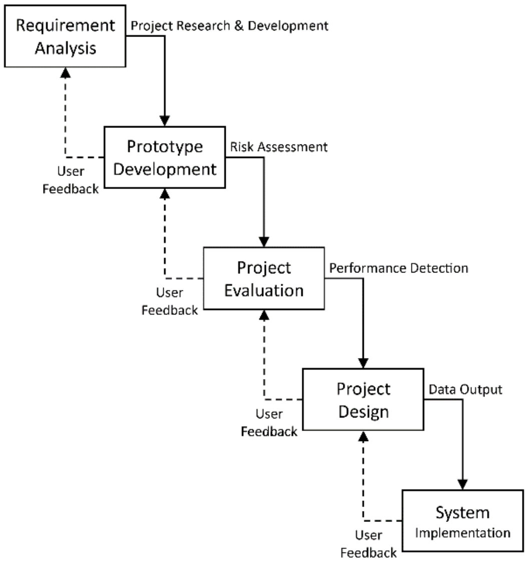

Fig. 1: Software Project Performance Risk Identification Principle

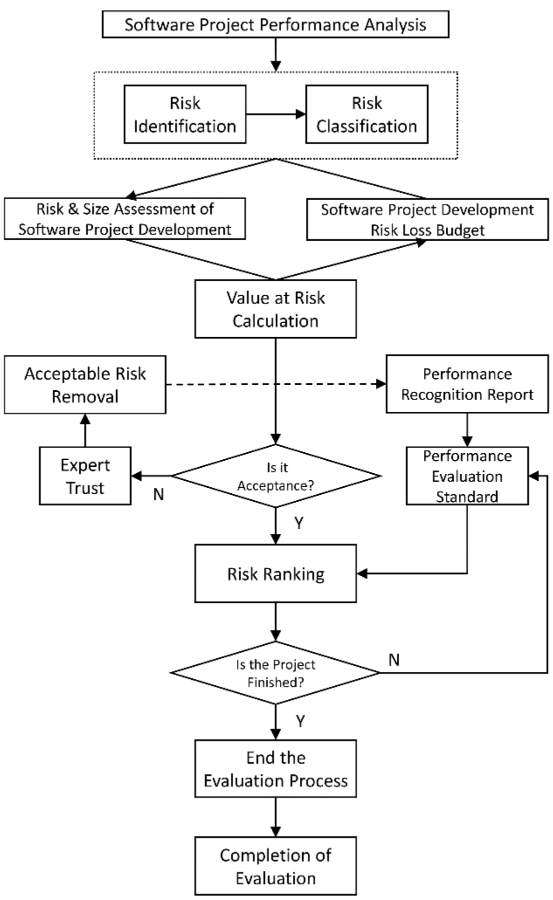

Fig. 2: Fuzzy Evaluation Process of Software Project Performance Based on Grey Clustering Analysis

Risk identification is not an activity because new risks may arise during the software project lifecycle as the project progresses, so they should be carried out periodically throughout the project execution process. Software projects are highly uncertain projects, so risk identification is very important. Due to the gradual nature of the project and the limitations of people's understanding, it is quite difficult to identify all risks accurately and comprehensively. This is a complex task, and it must follow a standard process to operate the software project performance. The evaluation is divided into process performance evaluation and product performance evaluation. Process performance evaluation is subjective evaluation from the perspective of software project organization. Product performance evaluation includes not only subjective evaluation from the perspective of software end-users, but also objective evaluation of common concern of software project organization and software end-users. The characteristics of software project performance are shown in the following table i.e., Table II.

Table II: Performance Indicators of Software Projects

Performance Classification		Evaluation Content	Concerned Parties
Project Performance	Objective	* Software Project Development Time * Software Project Development Cost	* End User * Project Organization
	Subjective	* Software Project R & D Quality * Software Performance * Software Practicability * Software Adaptability	* Software End User
Performance Evaluation Process		* Knowledge Gained By Software Organization * Teamwork Ability * Project Resource Control Capability	* Software Project Organization

Any project is unique i.e., the software project has both the characteristics of the general project and its particularity. This paper divides the characteristic indexes of software projects into six secondary indexes:

- The degree of perfection of software project requirements
- The degree of complexity of functions
- The degree of technical difficulty
- The time
- Cost and
- Team size of project development

The way the same project is deployed in different organizations varies so does the final outcome of the project. The feature index of software project organization is divided into five items:

- The structure and division of responsibility of the project organization
- The comprehensive ability of the project organization
- The familiarity of the project execution team with the business.
- Strength level and Team cohesion

The research focus of software project performance level which is mainly based on the following aspects:

- The project development time
- Cost
- Project Risk

- Project organization growth and so on.

The performance indicators selected in this paper are:

- Software reliability
- Ease of operation
- Ease of maintenance
- User satisfaction with the acceptance and application of the software
- Overall software quality

Some important points to be considered like; whether the project is completed under the expected time and cost, whether the ability of project organization to acquire knowledge, team coordination and how project resource control is raised.

According to the content of risk assessment, the risk assessment process can be divided into two activities: risk assessment and risk analysis. Usually, project managers and team members, customers, experts outside the team, do risk assessment together. This process is a repeated process; throughout the life cycle and must be planned as it is a regular risk assessment. The whole concept is shown in the figure i.e., Fig. 3.

IV. ANALYSIS OF EXPERIMENTAL RESULTS

In order to test, the fuzzy evaluation model of software project performance based on grey clustering analysis which can detect the emergency effect and stability in the process of software project operation, a comparative simulation experiment is designed. In the process of emergency software project operation evaluation, the traditional performance evaluation methods and effects are compared under the same link, and the operation effects of software project performance evaluation based on grey clustering are compared. In order to verify the validity of the test, evaluation and testing are carried out simultaneously.

A. Setting of Experimental Parameters

In order to ensure that the software project evaluation system designed for emergency performance evaluation can effectively encrypt the current situation, the software project evaluation matrix is arranged by flipping and mixing in which is within the range [100-350], The diffusion parameter of the information software running evaluation is 10. Ensure that testing data are applicable within the scope of the experiment which is carried out according to the parameters set in the simulation and environment settings. The results are shown accordingly in figures i.e., Fig. 3 and Fig. 4 respectively.

B. Experimental Results

The results show that the traditional encryption method software project detection system fluctuates greatly in the detection process, which shows that the detection effect of this method is not stable enough. It can be seen from the image that the software project is prone to errors in the evaluation accuracy during the operation process and it is difficult to ensure its accuracy.

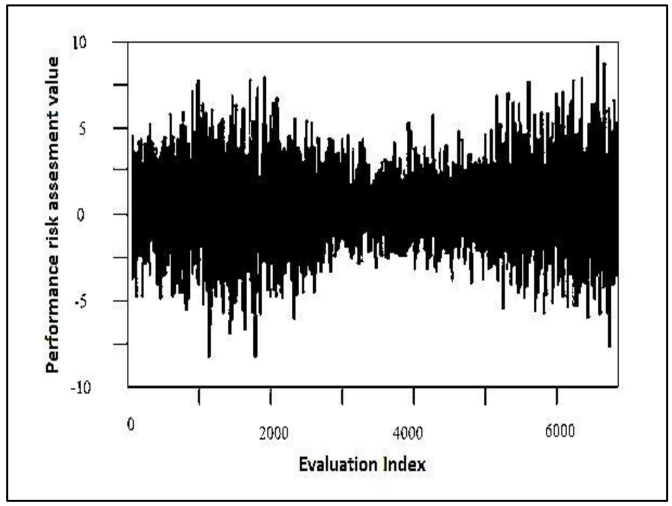

Fig. 3: Software Project Performance Test Results of Traditional Methods

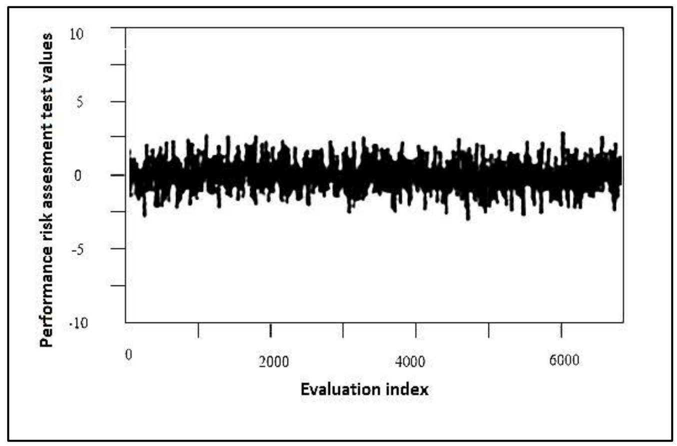

Fig. 4: Fuzzy Evaluation Test Results of Software Project Performance Based on Grey Clustering Analysis

The results show that the software project evaluation system designed for the emergency performance evaluation does not exceed the range of 5, even if there is a certain degree of fluctuation, but the floating index is relatively low, so the stability of the formal method is relatively higher, and because its floating rate is always in the [-5,5] norm. Therefore, the method does not have large calculation errors and is more accurate.

To sum up, this paper designs a fuzzy evaluation model of software project performance based on grey clustering analysis, which can effectively evaluate the performance of software projects as seen in Fig. 4.

V. CONCLUDING REMARKS

The organizational state and the characteristics of the software project are the main factors that affect the performance level of the software project. Good organizational state and complete project requirements are the key to the success of the software project. Fuzzy neural network model for comprehensive evaluation of software project performance integrates the advantages of neural network and fuzzy theory; makes up for each other's shortcomings; makes full use of the past knowledge and experience of software project development; makes the evaluation system; have the ability to learn and overcomes the uncertainty problem in the fuzzy system and the effect is better than that of the individual. The artificial neural network system is more accurate. However, the selection of network training samples and the determination of network topology constraints its further promotion and application, needs to continue to explore and improve.

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