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Research on Post-Evaluation of Oilfield Ground Engineering Project

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Abstract
Based on the research results of the scholars from domestic and overseas, we construct a evaluation index system for post-evaluation of oilfield ground engineering project focusing on the characteristics of the ground engineer project and combining the characteristics of the development of oilfield. The system includes 3 primary indicators, such as pre-project, 8 secondary indicators and 35 tertiary indicators. Multistage fuzzy evaluation with the combination of quantitative analysis qualitative analysis and degree of success method are used for Post-evaluation of oilfield ground engineering project which may lead to the reference of the decision-making of investment and management for oilfield ground engineering project.

Key words: Oilfield ground engineering; Post-evaluation; Evaluation index; Multistage fuzzy evaluation

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INTRODUCTION
Post-evaluation of oilfield ground engineering project is an indispensable part in the management of oilfield construction and development projects, and also the experience summary of the ground engineer project that has been accomplished already. We can assess if the expected goal is reached; the project process is scientific, effective and reasonable; the economic benefits, impact and continued indicators are achieved by the objective and systematic evaluation of project preparatory, project implementation process and result. The purpose is to improve the management and decision-making level by analyzing the evaluation results and summarizing and learning the lessons from the reasons that lead to success or failure. Most of the scholars in this area mainly focus on the study of economic benefits and qualitative issues of oil and gas exploration and development post-evaluation. Although some oil companies develop the post-evaluation mechanism according to their own characteristics, the mechanism is for the overall oilfield development. This paper is to post-evaluate the oilfield ground engineer project by constructing the reasonable evaluation index system and selecting the practical evaluation methods and to feedback the evaluation information into oilfield ground engineer which may lead to the reference of the investment plan, investment policy, decision-making and control of the project for the project investment decision makers and project managers.

1. CONSTRUCTION OF THE EVALUATION INDEX SYSTEM OF OILFIELD GROUND ENGINEER POST-EVALUATION
A scientific evaluation index system is a meter reflecting the project results and also an important factor of the quality of the post-evaluation. The setting of evaluation index system need to be designed to explain the main situation of the evaluation object as well as to meet the requirements of industry and sector management and to obtain universality and versatility for the horizontal comparison to other projects. On this basis,

the preliminary index system including 3 primary, 8 secondary and 41 tertiary indicators within pre-project, implementation process and project implementation results period should be constructed following the principle of goal-consistency, direct measurable, completeness, independence and simplification. Then we revised and improved the system into 35 tertiary indicators by the taking the expert questionnaire. In addition, the evaluation results are seriously impact by the weight of each index during the project evaluation which makes the determination of index weight becomes rather important. This paper uses the Analytical Hierarchy Process (AHP) to determine the index weight. The post-evaluation index system and index weight of the oilfield ground engineering project are shown in Table 1.

Table 1
Post-Evaluation Index System of Oilfield Ground Engineering Project

Primary indicator	Secondary indicator	Tertiary indicator
Pre-project f_1(0.25)	Pre-decision f_{11}(0.59)	Feasibility study f_{111}(0.34) Decision quality f_{112}(0.32) Evaluation report f_{113}(0.34)
	Project preparation f_{12}(0.41)	Construction organization preparation f_{121}(0.23) Construction technique preparation f_{122}(0.37) Construction site preparation f_{123}(0.20) Construction material preparation f_{124}(0.20)
Project implementation process f_2(0.27)	Construction f_{21}(0.48)	Bidding and purchasing f_{211}(0.20) Civil engineering and construction f_{212}(0.20) Installation and construction f_{213}(0.12) Electric facilities construction f_{214}(0.10) Road construction f_{215}(0.10) Production system constructing f_{216}(0.25) completion acceptance f_{217}(0.23)
	Production and operation status f_{22}(0.30)	Oil recovery f_{221}(0.35) Facilities operation management f_{222}(0.23) Staff quality and ability f_{223}(0.21) HSE Implementation f_{224}(0.21)
	Process management f_{23}(0.22)	Perfection of management system f_{231}(0.31) Normalization of procedure management f_{232}(0.24) Project planning f_{233}(0.15) Schedule control f_{234}(0.30)
Project implementation results f_3(0.48)	The degree of realization f_{31}(0.10)	Production rate f_{311}(0.65) Project cost control f_{312}(0.35)
	Cost and benefit f_{32}(0.62)	Overall income f_{321}(0.10) Net benefits f_{322}(0.16) payback period f_{323}(0.18) Profit rate of cost f_{324}(0.15) internal rate of return f_{325}(0.21) Rate of investment f_{326}(0.20)
	Influence and persistent f_{33}(0.28)	Effectiveness of risk forecast and control f_{331}(0.26) Capacity to drive the local economy f_{332}(0.30) "Three wastes" treatment and control f_{333}(0.10) Adaptability of the level of process technology f_{334}(0.16) Effective resource utilization degree f_{335}(0.18)

2. OILFIELD GROUND ENGINEERING POST-EVALUATION METHOD BASED ON THE MULTI-LEVEL FUZZY COMPREHENSIVE EVALUATION AND SUCCESSFUL EVALUATION

Qualitative and quantitative indicators are included in Oilfield surface engineering evaluation index system. The qualitative indicators cannot be described by a single value due to the ambiguity evaluation of their effectiveness but can be suitable for fuzzy evaluation method. Meanwhile, in order to take multi-indicators comprehensively, this paper uses successful method to give the evaluation criteria of qualitative and quantitative indicators in the process to determine fuzzy evaluation matrix. Steps for post-evaluation of oilfield ground engineering are as follows.

2.1 Influencing Factors of the Evaluation Object Set Determination (Index Set)

It can be seen from Table 1, primary index of oilfield ground engineering post-evaluation can be expressed as:

$F = \{f_1, f_2, ..., f_m\}, f_i = (f_{i1}, f_{i2}, ...f_{in})$

So, the index of oilfield surface engineering projects set presents the features of multi-level and multi-factor.

2.2 Reviews Set V Determination

To measure the effect of the indicators, according to the

principle of psychological tests we stipulate the level set of the index evaluation is: V = {v_1, v_2, ..., v_n} with n = 4 ± 2 for the general case. Four evaluation grade set V = {v_1, v_2, v_3, v_4} = {successful, partially successful, unsuccessful, fail} can be selected for post-evaluation of oilfield ground engineering project.

2.3 Fuzzy Evaluation Matrix Determination

Vector consisting of the indicators formed from the results of the evaluation of the reviews set is called the membership degree vector, that is, $r_i = (r_{i1}, r_{i2}, r_{i3}, r_{i4})$ where r_{ij} is called the degree of membership, indicating that factors f_i as the level of possibility of v_j. The membership vector matrix forms the fuzzy evaluation matrix (membership matrix) which shows as R as followed:

$$R_i = \begin{bmatrix} r_{11} & r_{12} & r_{13} & r_{14} \\ r_{21} & r_{22} & r_{23} & r_{24} \\ \vdots & \vdots & \vdots & \vdots \\ r_{n1} & r_{n2} & r_{n3} & r_{n4} \end{bmatrix}$$

In post-evaluation of oilfield ground engineering, membership constitutes the basis of single factor fuzzy evaluation and comprehensive analysis from the tertiary indicators (the underlying index) Fuzzy statistical method usually used for the determination of the membership of the underlying indicators, that is, $r_{ij} = \frac{m_{ij}}{S}$, within m_{ij} represents the valid questionnaires of single factor f_i was rated as v_j and s represents the number of valid questionnaires.

To determine the membership of qualitative and quantitative indicators of the oilfield ground engineering post-evaluation effectively, this paper has taken the law of success method, 35 underlying indicators' (evaluation factors) evaluation criteria were given the based on the research, four of the production and operational status of the underlying indicators of evaluation criteria are shown in Table 2, where present of pass of "oil production" = construction results/program design specifications×100%.

Table 2
Four Production and Operational Status Determination Using Law of Success Method

Underlying indicators	v_1 (Successful)	v_2 (Partially successful)	v_3 (Unsuccessful)	v_4 (Fail)
Oil recovery f_{221}	present of pass ≥ 95%	85% ≤ present of pass < 95%	75% ≤ present of pass < 85%	present of pass <75%
Facilities operation management f_{222}	The system operation runs very well	The system operation runs well	The system operation runs fair	The system operation runs bad
Staff quality and ability f_{223}	Comprehensive quality is very high	Comprehensive quality is high	Comprehensive quality is ordinary	Comprehensive quality is low
HSE Implementation f_{224}	No HSE accident	The presence of HSE hidden trouble	The occurrence of minor HSE accident	Major HSE accident

2.4 Weight of Each Evaluation Determination

Impact of the index on the evaluation results should be considered in comprehensive evaluation, that is to say, to determine the weight of some index onto the index in next level of indicators, they constitute the weight vector of A, denoted as: $A_i = (a_1, a_2, a_3, ..., a_n)$, within $\sum_{i-1}^{n} a_i = 1$. The weight of each index is given by the AHP method in Table 1.

2.5 Integrated Post-Evaluation

Assume the fuzzy evaluation matrix as R_1 and the weight vector set as A_1 in the ground floor (tertiary level) indicators, we can post-evaluate each level by fuzzy transformation: $S^{(1)} = A_1 \times R_1$ Similarly, the membership vector of the other second-level indicators can be calculated, the membership vector will form a new evaluation matrix R_2, we can comprehensively evaluate the second-level indicators with the weight parameters $A_2 = (a_1, a_2, a_3, ..., a_n)$: $S^{(2)} = A_2 \times R_2$.

Then we can easily get the membership vector of primary indicators as well as the entire complete evaluation results of the oilfield ground engineering project.

$S^{(3)} = A_3 \times R_3$

In which assume $S^{(3)} = (S_1, S_2, S_3, S_4)$, S_j represents the possibilities of evaluating results show v_j.

2.6 Evaluation Level of Post-Evaluation Project Determination

This paper uses the maximum proximity principle to determine the rating: Assume $S_k = maxS_i$, calculated $\sum_{i=1}^{k-1} s_i$ and $\sum_{i=k+1}^{m} s_i$ If $\sum_{i=1}^{k-1} s_i > \frac{1}{2}\sum_{i=1}^{m} s_i$ or $\sum_{i=k+1}^{m} s_i > \frac{1}{2}\sum_{i=1}^{m} s_i$ Evaluate using the levels of S_{k-1} or S_{k+1}; otherwise, evaluate using the level of S_k.

CONCLUSION

(1) Post-evaluation is the continuation of the project pre-evaluation and an important part of the entire project life cycle. Based on the information from the oilfield ground engineering project evaluation, post-evaluation can be an

important and valuable guiding to improve the level of project management and enhance economic efficiency.

(2) Oilfield ground engineering evaluation index system including 3 primary indicators pre-project, project implementation process and project results, 8 secondary indicators such as pre-decision and 41 tertiary indicators is the foundation and key to carry out the evaluation.

(3) Comprehensive post-evaluation is adopted the combination of law of success and multistage fuzzy evaluation method which fit the requirement of the oilfield ground project post-evaluation and characteristics of post-evaluation indicators. Meanwhile, it can provide a valuable reference to the similar post-evaluation projects.

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