Engineering Project Review Method Based on Matter-Element and Hierarchy Model

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Abstract. Project review is always the key link of the engineering project management. Project review is a complex work, which involves many factors. The final review result is always influenced directly by the definition of various evaluation indexes and the corresponding weight. Mainly study the judgment of the experts' ability and the establishment of the project evaluation index system in the peer communication review, analyze deeply the engineering project review work, build a evaluation index system for the engineering project, and put forward a comprehensive evaluation method based on the matter-element and hierarchy model in the engineering project, at last, apply it in the actual project which proves the practicability of the paper's theory.

Introduction

The impartiality of the engineering project review is very important, which most applicants pay close attention to. Nowadays, peer communication review [1] is commonly used in the review work, which means experts of the same field review the project back to back. Peer communication review can take full advantage of scientists who are in the scientific community to realize the reasonable allocation of scientific and technological resources. It also contributes to the democratization of the scientific decision-making, and puts an end to the purely administrative decision-making.

This article attempts to establish the evaluation index system of the engineering project, give the knowledge set representation of engineering project knowledge, put forward engineering project evaluation method based on the matter-element and hierarchy model [2], and at last validates it through an actual project.

Project evaluation index system

Table 1. Project evaluation index system

Comprehensive index	Single index
Research goal (b_1)	Scientific level (c_1)
	Expected results (c_2)
	Application prospect (c_3)
Research content (b_2)	Implementation content (c_4)
	Technical route (c_5)
	Schedule (c_6)
	Budget (c_7)
Research ability (b_3)	Pre-implementation work (c_8)
	Implementation ability (c_9)
	Implementation conditions(c_{10})

The evaluation of engineering project involves many factors, such as the rationality of project contents, the ability of the executors, and the application prospect of the engineering project, which all need carrying on the comprehensive evaluation. In this paper, we define a comprehensive evaluation index system for the project to be reviewed. The system contains three comprehensive indexes and ten single indexes, as shown in table 1.

Matter-element representation of project knowledge

The project as a knowledge carrier, it contains the knowledge is called project knowledge, according to matter-element, project knowledge can be represented as

$$KS_P = (N_P, C, V) = \begin{bmatrix} N_P & c_1 & v_1 \\ & c_2 & v_2 \\ & c_3 & v_3 \\ & \cdots & \cdots \\ & c_n & v_n \end{bmatrix}, \quad (1)$$

where N_P is project, C is the project's feature set $\{c_1, c_2, \ldots, c_n\}$, V is quantum set of N about C $\{v_1, v_2, \ldots, v_n\}$.

Classical domain and section domain

Classical domain matter-element is defined as

$$R_j = (N_j, C, X_j) = \begin{bmatrix} N_j & c_1 & X_{j1} \\ & c_2 & X_{j2} \\ & \cdots & \cdots \\ & c_n & X_{jn} \end{bmatrix} = \begin{bmatrix} N_j & c_1 & < a_{j1}, b_{j1} > \\ & c_2 & < a_{j2}, b_{j2} > \\ & \cdots & \cdots \\ & c_n & < a_{jn}, b_{jn} > \end{bmatrix}, \quad (2)$$

where $N_j(j=1,2,\ldots,m)$ is the j-grade status of the review; $c_i(i=1,2,\ldots,n)$ is the corresponding characteristic for a grade status of the review; interval $X_{ji}=<a_{ji}, b_{ji}>$ is the range of the value c_i for N_j, namely, the data range of the corresponding index of the each grade of the review status—classical domain.

Section domain matter-element is defined as

$$R_p = (N_p, C, X_p) = \begin{bmatrix} N_p & c_1 & X_{p1} \\ & c_2 & X_{p2} \\ & \cdots & \cdots \\ & c_n & X_{pn} \end{bmatrix} = \begin{bmatrix} N_p & c_1 & < a_{p1}, b_{p1} > \\ & c_2 & < a_{p2}, b_{p2} > \\ & \cdots & \cdots \\ & c_n & < a_{pn}, b_{pn} > \end{bmatrix}, \quad (3)$$

where N_p is the whole evaluation grade; $c_i(i=1,2,\ldots,n)$ is a characteristic of the whole grade; interval $X_{pi}=<a_{pi}, b_{pi}>$ is the range of the value c_i for N_p, namely, the data range of the index of the whole review grade----section domain. Obviously, there is $X_j \subset X_p$.

Correlation function

Correlation function [3] describes the degree of the required level of the matter-element, giving the matter-element value x mapping to the real axis in the matter-element analysis evaluation. The distance between node x_i and limited reality interval X=<a, b> is defined as

$$r(x_i, X) = \left| x_i - \frac{a+b}{2} \right| - \frac{1}{2}(b-a) = \begin{cases} a - x_i & x_i \le \frac{a+b}{2} \\ x_i - b & x_i > \frac{a+b}{2} \end{cases}, \quad (4)$$

where the distance between node x_i and interval X can be negative value, the difference of the negative value determines correspondingly the difference of the position x_i in the interval X.

We can get the distance between the node x_i and the interval X_{ji} of classical domain, as well as the distance between the node xi and the interval X_{pi} of section domain as

$$r(x_i, X_{ji}) = \left| x_i - \frac{a_{ji}+b_{ji}}{2} \right| - \frac{1}{2}(b_{ji}-a_{ji}) = \begin{cases} a_{ji}-x_i & x_i \le \frac{a_{ji}+b_{ji}}{2} \\ x_i - b_{ji} & x_i > \frac{a_{ji}+b_{ji}}{2} \end{cases}, \tag{5}$$

$$r(x_i, X_{pi}) = \left| x_i - \frac{a_{pi}+b_{pi}}{2} \right| - \frac{1}{2}(b_{pi}-a_{pi}) = \begin{cases} a_{pi}-x_i & x_i \le \frac{a_{pi}+b_{pi}}{2} \\ x_i - b_{pi} & x_i > \frac{a_{pi}+b_{pi}}{2} \end{cases}. \tag{6}$$

Then the computation formula of the correlation function K(x) is defined as

$$K_j(x_i) = \begin{cases} \dfrac{r(x_i, X_{ji})}{r(x_i, X_{pi}) - r(x_i, X_{ji})} & x_i \notin X_{ji} \\ -\dfrac{r(x_i, X_{ji})}{|X_{ji}|} & x_i \in X_{ji} \end{cases}. \tag{7}$$

Correlation function describes the degree of the required level of the matter-element, giving matter-element the value x_0 mapping to the real axis in the matter-element analysis evaluation. Actually, it describes the degree of ownership of the each index of the project to be reviewed about each review grade j, which makes mathematics "belong" and "not belong" qualitative description the extended to quantitative description.

Project matter-element to be evaluated

If there are n single indexes in the comprehensive index b_k, namely, c_i(i=1,2,…,n), and the corresponding single index matter-element to be reviewed is R_c, we can define the single index matter-element as

$$R_c = (N_o, C, V_c) = \begin{bmatrix} N_o & c_1 & V_{c1} \\ & c_2 & V_{c2} \\ & \cdots & \cdots \\ & c_n & V_{cn} \end{bmatrix}, \tag{8}$$

where N_o is the project to be reviewed; C is the whole characteristics of the comprehensive index b_k(k=1,2,…,m) of N_o, namely, all the single indexes c_i(i=1,2,…,n) of the comprehensive index b_k of N_o; v_{ci} is the value of the single index c_i.

If there are m experts to review the project N_o, v_{ci} being the comprehensive value of the single index c_i scored by the expert group, v_{ci} is defined as

$$v_{ci} = \sum_{k=1}^{m} (v_{ik} \times z_k), \tag{9}$$

where v_{ik} is the value of single index c_i scored by the expert k, z_k is the weight of expert k in the expert group.

If there are m comprehensive indexes in the project, namely, b_i(i=1, 2, ..., m), the comprehensive index matter-element R_b to be evaluated is defined as

$$R_b = (N_o, B, V_b) = \begin{bmatrix} N_o & b_1 & v_{b1} \\ & b_2 & v_{b2} \\ & \cdots & \cdots \\ & b_m & v_{bm} \end{bmatrix}, \quad (10)$$

where N_o is the project to be reviewed, B is the characteristics of N_o, namely, the comprehensive indexes of N_o; v_{bk} is the value of the comprehensive index $b_k(k=1,2,\ldots,m)$. If the comprehensive index b_k is composed of single index $c_i(i=1,2,\ldots,l)$, v_{bk} is defined as

$$v_{bk} = \sqrt[l]{\prod_{i=1}^{l} v_{ci}}, \quad (11)$$

Define the classical domain and section domain of the comprehensive index matter-element, according to the formula (2), (3). Then calculate the correlation of each comprehensive index for each grade of the review status.

After introducing the weight of comprehensive index, define the correlation of N_o for j grade of the review status as

$$K_j(N_o) = \sum_{i=1}^{n} w_i K_j(b_i), \quad (12)$$

where n is the number of the comprehensive indexes, $b_i(i=1, 2, ..., n)$ is the ith comprehensive index, w_i is the weight of the comprehensive index b_i.

If $\max(K_j(N_o))=K_{jo}$, we can conclude that the matter-element to be reviewed belongs to j_o grade.

If $K_{jo}(N_o)>1$, it means that the matter-element to be evaluated exceeds the upper limit of the standard grade. The bigger its value is, the greater the potential for development is.

Conclusion

The review work is a complex work which involves many aspects of factors in the engineering project. The final evaluation result is influenced directly according to the definition of various evaluation indexes and the corresponding weight. This paper is based on the matter-element analysis, considering fully the factors of the project itself and the review expert, establishing a comprehensive evaluation index system and comprehensive evaluation algorithm with fairness, operability.

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