

A Study on Evaluating Projects Strategic Coincidence Degree using Multi-level Extension Assessment

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Abstract — Choosing the right project portfolio is a prerequisite for the successful implementation of its management. The method for combining enterprise projects to reflect their strategic orientation is the first problem that we deal with in this paper. Because of the lack of research on existing project portfolio selection from a strategic point of view of its evaluation, this paper proposes the concept of ‘corresponding degree’ of project strategy and using the strategy of the corresponding portfolio selection we establish the evaluation index system of project strategic coincidence degree. Due to the fuzziness of subjective judgment, this paper proposes a multi-level extension method for the evaluation of project strategic correspondence degree. This method connects the qualitative with quantitative factors and quantifies evaluation to solve the problem of compatible, quantitative and qualitative coexistence, and then proves the validity of the method through a case study.

Keywords - *strategy; project portfolio management; multi-level extension method; project strategic correspondence degree*

I. INTRODUCTION

To do the right project, choose the right combination of projects is the key to the successful implementation of the project portfolio management based on limited resources. To investigate whether the project is in line with the corporate strategy is a key step in the project portfolio selection under the suitable evaluation index system. At present, the research of project portfolio selection is mainly focused on the mode and method of project portfolio selection. From the practice of evaluation and selection of enterprise technology projects, literature [1] established technical project evaluation index system based on the characteristics of multi-stage of enterprise technology project selection. The literature also built the evaluation model by using DEA method and gave the method of project selection after DEA evaluation. The integration method based on the comprehensive evaluation method makes up for the lack of a single comprehensive evaluation method, such as the (FAHP) [2], AHP/DEA [3] and others. Usually these methods have certain limitation which get the weight of the index just based on the established index hierarchy or depend on the experts' experience or some of them are so complex and difficult that decision maker can't understand or master them. In addition literature [4] established a fuzzy programming model for the selection of multiple investment projects with constraint conditions based on the fuzzy multi-objective evaluation. Literature [5] built a multi factor evaluation index system of IT project and constructed the risk return model of IT project portfolio selection through the analysis of the characteristics of IT

project and tested the model by a case. Literature [6] discussed the project selection and implementation of the organization structure by using the method of DSS and proposed the project analysis and selection system. Usually these documents are mainly aimed the financial, risk and technical feasibility and other aspects of the selection of the project, but few research on the angle of enterprise strategy to evaluate the project.

Enterprise strategy is implemented through the project and the first requirement of achieving it is to take an effective management for the multiple projects in the enterprise under the guidance of enterprise strategy. In other words, enterprise strategy is the key to the success of the project. Therefore, in order to investigate the enterprise strategy and alternative project consistency, this paper puts forward the concept of project strategic coincidence degree, which is defined as the coincidence degree between the project and enterprise strategy. And then establish the corresponding strategic project evaluation index system and put forward the method of multi-level extension project strategic evaluation, the evaluation results of project strategic coincidence degree are used as the basis for the enterprise to choose the project portfolio.

II. EVALUATION INDEX SYSTEM OF PROJECT STRATEGIC COINCIDENCE DEGREE

The enterprise strategy can look into the distance for the enterprise development prospects and it also the guiding light for the development of the enterprise. However, making strategy does not mean the successful

implementation and final realization of enterprise strategy, so this paper proposes the use of balanced score card to guide the implementation of specific strategic objectives.

The core idea of balanced score card is seeing the traditional financial indicators as a class can only show the results of the past actions lag indicators and it consists four aspects: finance, customers, internal business processes, learning and growth. Then increased ability to create critical "performance drivers "for future financial results and create the so-called "leading indicators" in relation to financial results. Finally divide the strategy to financial, customer, internal processes, learning and growth of four levels of indicators and form a comprehensive performance measurement index system covering the financial and non-financial indicators. Index system breaks through the limitation of traditional single financial index to evaluate the operating performance of the enterprise by introducing the non financial index to enterprise performance evaluation system, among them, financial indicators are tangible results of the implementation of the strategy, non financial indicators are the driving factors of future financial results. The causal relationship between indicators can reflect the implementation strategy of enterprise organization and the process of strategic correction. And the four aspects of the index can achieve the management which closely related the strategic objectives.

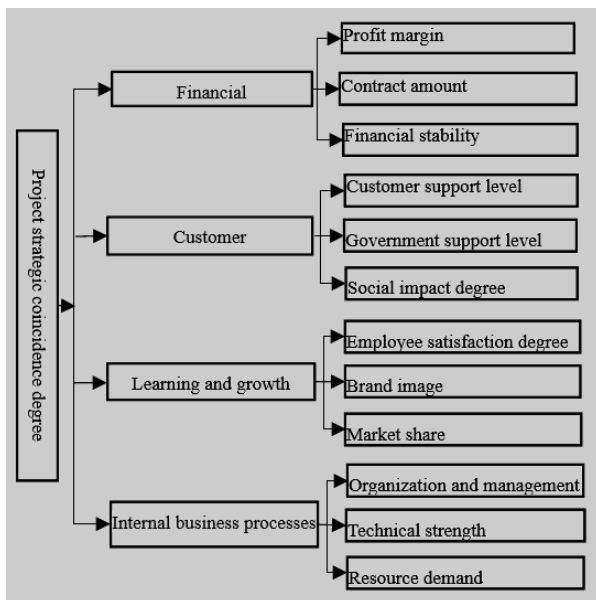


Fig.1 Evaluation index system of project strategic coincidence degree.

The core part of BSC is the enterprise strategy and its biggest advantage is that it can establish the evaluation index system of project strategic coincidence degree, showed in figure1. The objectives and evaluation indicators of the BSC are derived from enterprise strategy

and it can convert the mission vision of the enterprise and strategy decomposition into tangible goals and measures.

III. EVALUTION MATHOD

A. Multi-level extension evaluation method

From the above evaluation index system we can see that the selection of evaluation indicators include quantitative indicators and in-qualitative indicators which need to be determined by the organization of experts or managers. This paper uses the theory of multi-level extension to evaluate the degree of the project strategy in view of the fuzziness of subjective judgment .As a kind of comprehensive analysis theory and method, the extenics is introduced into the matter element theory, which can be used to link the qualitative and quantitative factors. And quantify the problem of evaluation to solve solve the question of contradiction compatibility, quantitative and qualitative coexistence [7].Extension evaluation is one of the important applications of extenics. It is mainly through the analysis of the quantitative and qualitative analysis of the evaluation object by the correlation function, and then divide the level of the evaluated target, so compared with other evaluation methods, the method of extension evaluation is more comprehensive in analyses the degree of object belongs to collection. Traditional extension evaluation is limited to single factor evaluation, but it is necessary to expand the theory of single factor extension evaluation when the evaluation object contains more categories and quantity. Because of the shortage of traditional extension evaluation, multi-level extension evaluation introduced the concept of index weight to extension evaluation of factors. And then obtained the correlation degree of the upper factors through the single factor correlation and the weight of the composite calculation. At the end, obtained multi-level extension evaluation results of the target which to be evaluated according to the principle of maximum membership degree.

B. Multi-Level Extension Evaluation Model

1) Determination of matter element

Matter element is the basic element to describe things and can be described through ordered three tuple $R=(N, c, v)$. N , c and v are known as the three elements of the matter element, among them N means things, c means names of feature, v represents the amount of value taken by N on c . In the concept of matter element, $v=c(N)$ reflects the relationship between the quality and quantity of things and the characteristics consists of c and v , but one thing usually has many characteristics[7]. In this paper,

assuming that the target to be evaluated includes P indicators C_1, C_2, \dots, C_p , according to the above mentioned matter element definition, the matter element model of the object to be evaluated is shown in the formula (1).

$$M = (U, C_k, V_k) = \begin{bmatrix} U & C_1 & V_1 \\ & C_2 & V_2 \\ & \vdots & \vdots \\ & C_p & V_p \end{bmatrix} \quad (1)$$

In the formula (1), U represents the evaluation level of the project strategy; V_k represents the potential value of the index K of the project strategy.

2) *Determine classical field*

Divide the project strategy coincidence degree into d ($d=1,2,3,4$) levels and the evaluation results correspond to the degree is D =(poor, general, good, very good), and then described it as a comprehensive evaluation of the matter element model, as shown in the formula (2).

$$M_j = (U_j, C_k, V_{jk}) = \begin{bmatrix} U_j & C_1 & \langle \alpha_{j1}, \beta_{j1} \rangle \\ & C_2 & \langle \alpha_{j2}, \beta_{j2} \rangle \\ & \vdots & \vdots \\ & C_p & \langle \alpha_{jp}, \beta_{jp} \rangle \end{bmatrix} \quad (2)$$

M_j represents the matter element model of the evaluation level of j , U_j represents the grade of evaluation results of project strategic coincidence degree under the evaluation level of j ; and $V_{jk} = \langle \alpha_{jk}, \beta_{jk} \rangle, (j=1,2,\dots,n; k=1,2,\dots,p)$ represents the U_j , volume range after the specification which connected C_k , that is U_j represents the evaluation level of j , it also means the value range of C_k .

3) *Determine segment field*

Define the range of possible values of each evaluation index as the joint evaluation of the project strategy comprehensive evaluation model based on the concept of segment field:

$$M_m = (U_m, C_k, V_{mk}) = \begin{bmatrix} U_m & C_1 & V_{m1} \\ & C_2 & V_{m2} \\ & \vdots & \vdots \\ & C_p & V_{mp} \end{bmatrix} \quad (3)$$

In the formula (3), M_m represents the segment field of project strategic correspondence degree comprehensive evaluation matter element model; U_m represents the degree of project strategic correspondence; $V_{mk} = \langle \alpha_{mk}, \beta_{mk} \rangle$ represents permitted range of C_k , V_{mk} includes $V_{jk} = \langle \alpha_{jk}, \beta_{jk} \rangle, (j=1,2,\dots,n; k=1,2,\dots,p)$.

4) *The establishment of correlation function and calculation*

The correlation between the two kinds of things can be used to form the correlation function, it is needed to define the distance between the point and the interval for establishing correlation function. The correlation function can describe the extension set. And by using the correlation function, we can avoid the traditional subjective judgment or statistical method to calculate the correlation degree of the project strategy and the correlation degree of the matter element model and the classical domain of the matter element model, and then improve the accuracy and the scientific nature of the calculation results.

The calculation method of the project strategic correspondence degree model and the correlation degree of classical field and segment field is shown in the formula (4).

$$\begin{cases} \xi(V_k, V_{jk}) = \left| V_k - \frac{\alpha_{jk} + \beta_{jk}}{2} \right| - \frac{\beta_{jk} - \alpha_{jk}}{2} \\ \xi(V_k, V_{mk}) = \left| V_k - \frac{\alpha_{mk} + \beta_{mk}}{2} \right| - \frac{\beta_{mk} - \alpha_{mk}}{2} \end{cases} \quad (4)$$

$(k = 1, 2, \dots, p; j = 1, 2, \dots, n)$

Correlation degree represents the similarity among V_k and V_{jk}, V_{mk} . If $\xi(V_k, V_{mk}) \geq 0$, then means V_k is not included in the interval of V_{mk} ; If $\xi(V_k, V_{mk}) \leq 0$, then means V_k belongs to the section of V_{mk} and the different values represents the different position. V_k belongs to the

range of V_{jk} , the different position of V_{mk} can be shown as:

$$E(V_k, V_{mk}, V_{jk}) = \xi(V_k, V_{mk}) - \xi(V_k, V_{jk}) \quad (5)$$

On the basis of the formula (5), we can solve the problem of correlation degree of evaluation grade of C_k based on the formula (6).

$$K_j(V_k) = \frac{\xi(V_k, V_{jk})}{[\xi(V_k, V_{mk}) - \xi(V_k, V_{jk})]}, (k=1, 2, \dots, p; j=1, 2, \dots, n) \quad (6)$$

The correlation degree set between the sample and the evaluation index can be expressed as:

$$Y_{1 \leq k \leq p} K_j(V_k) = \{K_j(V_1), K_j(V_2), \dots, K_j(V_p)\} \quad (7)$$

C. Determination of index weight based on FAHP

In this paper, the FAHP method is used to calculate the single sort and total sort respectively, and the single sort is the impact degree of each index of a hierarchy with respect to the level of a certain index, total sort is the overall weight of each indicator relative to the total objective. Specific calculation methods are as follows:

1) *Constructing fuzzy complementary judgment matrix by experts opinion.* We designed a questionnaire about the weight of each index according to the evaluation index system of the project strategy corresponding to the previous paper and collected data through the form of expert questionnaire, the volume content is the relative importance of each index in the evaluation index system. In order to avoid the shortage of information, we used more in line with the thinking habits of 0.1~0.9 fuzzy complementary compare scale and we formed the e fuzzy complementary judgment matrix finally based on the relatively comparison among evaluating indicators. The elements on the diagonal of the judgment matrix are 0.5, and the symmetric elements of the symmetric axis are 1.

2) *Judgment matrix consistency test.*

3) *The calculation of single sort.* Establish optimization model when the judgment matrix has satisfactory consistency.

$$\min z = \sum_{i=1}^n \sum_{j=1}^n [0.5 + a(w_i - w_j) - r_{ij}]^2 \quad (8)$$

$$s.t. \sum_{i=1}^n w_i = 1, w_i \geq 0, 1 \leq i \leq n$$

Obtain the sort weight by the method of Lagrange multiplier:

$$w_i = \frac{1}{n} - \frac{1}{2a} + \frac{1}{na} \sum_{j=1}^n r_{ij}, i \in I \quad (9)$$

In order to make $w_i \geq 0$, there should be $a \geq \frac{(n-1)}{2}$, in

the practical application often take $a = \frac{(n-1)}{2}$, it shows that decision makers pay attention to the differences in the importance of factors.

4) Comprehensive Weight Calculation.

D. Multi-Level Extension Evaluation

1) Three Level Fuzzy Comprehensive Evaluation

According to the method of calculating the index weight and the correlation degree, calculate the correlation degree between the standard layer evaluation index and the project strategy and the evaluation level j according to the formula (10).

$$K_l(U) = \sum_{i=1}^p W_{li} K_j(V_{li}), (j=1, 2, \dots, n; l=1, 2, \dots, p) \quad (10)$$

In formula (10), $K_l(U)$ represents the index l that in evaluation index system standard layer, W_{li} represents weight distribution coefficient of the index layer evaluation index C_i , and $\sum_{i=1}^n W_{li} = 1$.

2) Two level fuzzy comprehensive evaluation

$$J = \sum W_l \cdot K_l(U), \sum_{l=1}^4 W_l = 1 \quad (11)$$

3) Project strategic correspondence level decision

According to the above steps, we can get the degree of association of the comprehensive correlation degree of the sample data set. According to the principle of maximum membership degree, the greater the comprehensive correlation degree, the greater the probability that the corresponding sample is subordinate to the rating. So, if $K_{j_0}(U) = \max K_j(U), (j=1, 2, \dots, n)$, the comprehensive evaluation level of the two level evaluation indexes and the general goal can be determined as the level of j_0 . Using the formula (12) (13) can be used to calculate the characteristic value of the class variable to define the level of the project strategy to be more accurate.

$$\overline{K}_j(U) = \frac{K_j(U) - \min K_j(U)}{\max K_j(U) - \min K_j(U)} \quad (12)$$

$$\tilde{j} = \frac{\sum_{j=1}^p j \times \overline{K}_j(U)}{\sum_{j=1}^p \overline{K}_j(U)} \quad (13)$$

\tilde{j} is the rank variable characteristic value of project strategic correspondence degree and it can indicate the degree of the evaluation results are inclined to a certain level.

IV. CASE APPLICATION

A. Case background and model application

A construction enterprise has 10 new projects and the enterprises need to be combined with the project before the implementation of the project for provide different people, financial, material and other resources to the project portfolio belonging to different levels. By using the framework of the model, we analysis the cases of each project and get the corresponding results of based on the data, this also can provide basis and reference for decision making of enterprise managers.

From the existing literature we can see that there are many ways to determine the classical field^[8,9]. Therefore, according the expertise and the actual situation of enterprises and the convenience of model operation, we divide the multi-project management level which based on the corresponding degree of project strategy into 4 levels that correspond to $U = (U_1, U_2, U_3, U_4)$. The scores of each level are as follows:

- 1) Evaluation results of project strategic correspondence degree is “poor” if $0 < U_1 = U \leq 65$.
- 2) Evaluation results of project strategic correspondence degree is “general” if $65 < U_1 = U \leq 80$.
- 3) Evaluation results of project strategic correspondence degree is “good” if $80 < U_1 = U \leq 90$.
- 4) Evaluation results of project strategic correspondence degree is “very good” if $90 < U_1 = U \leq 100$.

We can get the classical field and segment field based on the classification of the above grades, as shown in Table I, $j = 1, 2, 3, 4$ represents the 4 evaluation grades respectively.

We can get the correlation degree of the three level through the index weight that calculate by the method of FAHP and classical field and segment field of evaluation index, as shown in Table III. We can calculate the correlation degree and the evaluation grade of the two level indexes based on the the weight and correlation degree of the three level evaluation indexes and the formula (10), take the project I as an example, solution results are shown in Table IV.

TABLE I. CLASSICAL FIELD AND SECTION FIELD OF PROJECT STRATEGIC COINCIDENCE DEGREE EVALUATION

Index	Classical field				Segment field	
	j=1	j=2	j=3	j=4		
C ₁	c ₁₁	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
	c ₁₂	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
	c ₁₃	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
C ₂	c ₂₁	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
	c ₂₂	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
	c ₂₃	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
C ₃	c ₃₁	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
	c ₃₂	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
	c ₃₃	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
C ₄	c ₄₁	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
	c ₄₂	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>
	c ₄₃	<0,65>	<65,80>	<80,90>	<90,100>	<0,100>

B. Data calculation and result analysis

We can get the specific score of each evaluation index from actual base data for each item, shown in the table II.

TABLE II. EVALUATION SCORE TABLE OF PROJECT STRATEGIC COINCIDENCE DEGREE

Index	Project									
	I	II	III	IV	V	VI	VII	VIII	IX	X
c ₁₁	86	79	88	73	68	87	90	82	76	91
c ₁₂	82	77	89	68	71	93	88	93	78	83
c ₁₃	76	86	92	70	78	87	79	87	83	78
c ₂₁	83	73	90	76	59	86	87	76	80	81
c ₂₂	78	83	86	62	70	95	92	73	91	77
c ₂₃	86	67	93	66	87	89	83	80	73	88
c ₃₁	89	75	94	71	68	85	86	72	66	83
c ₃₂	72	80	87	81	76	96	91	67	81	82
c ₃₃	93	75	89	56	79	87	80	76	75	75
c ₄₁	77	76	93	69	83	98	86	70	81	86
c ₄₂	82	80	97	77	72	91	85	68	77	80
c ₄₃	85	73	89	72	80	92	82	81	69	77

TABLE III. SINGLE FACTOR EXTENSION ASSESSMENT RESULTS AND RELATED BASIC DATA OF EVALUATION OF PROJECT STRATEGIC COINCIDENCE DEGREE (TAKE THE PROJECT I AS AN EXAMPLE)

	Weight	Index	Index weight	Correlation degree			
				j=1	j=2	j=3	j=4
C ₁	0.358	c ₁₁	0.186	-0.600	-0.300	0.400	-0.222
		c ₁₂	0.084	-0.486	-0.100	0.250	-0.308
		c ₁₃	0.087	-0.314	-0.200	-0.143	-0.368
C ₂	0.235	c ₂₁	0.112	-0.514	-0.150	0.214	-0.292
		c ₂₂	0.055	-0.371	0.100	0.083	-0.353
		c ₂₃	0.068	-0.600	-0.300	0.400	-0.222
C ₃	0.152	c ₃₁	0.036	-0.686	-0.450	0.100	-0.083
		c ₃₂	0.064	-0.200	0.333	-0.222	-0.391
		c ₃₃	0.051	-0.800	-0.650	-0.300	0.750
C ₄	0.253	c ₄₁	0.080	-0.343	0.150	-0.115	-0.361
		c ₄₂	0.110	-0.486	-0.100	0.125	-0.308
		c ₄₃	0.063	-0.571	-0.250	0.500	-0.250

TABLE IV. MULTI-LEVEL EXTENSION ASSESSMENT RESULTS OF PROJECT STRATEGIC COINCIDENCE DEGREE (TAKE THE PROJECT I AS AN EXAMPLE)

Index	Correlation degree				Weight	Evaluate grade
	j=1	j=2	j=3	j=4		
C	-0.134	-0.045	0.048	-0.070		3
C_1	-0.180	-0.082	0.083	-0.099	0.358	3
C_2	-0.119	-0.032	0.056	-0.067	0.235	3
C_3	-0.078	-0.028	-0.026	0.010	0.152	4
C_4	-0.117	-0.015	0.036	-0.079	0.253	3

The above calculation showed the project I belongs to level 3. And we also can determine the membership grade of the 10 items based on the evaluation of project strategic coincidence degree, the results are shown in the table V.

TABLE V. THE GRADE OF EACH PROJECT

Project	I	II	III	IV	V	VI	VII	VIII	IX	X
Grade	3	2	4	2	2	4	3	2	2	3

V. CONCLUSION

Project portfolio management is a kind of new management mode that can organize and manage a lot of projects under the condition that enterprises have numerous projects but limited resources. Project portfolio management is not only how to manage the project, but also the key is how to choose the project portfolio. We pointed out the importance of the project strategic correspondence degree evaluation in the project portfolio selection and established the relevant evaluation index system for the deficiency of current research on project portfolio selection. And enriched the theory of project portfolio management and reduced the subjective randomness by the evaluation of project strategic correspondence degree with the multi-level extension method. At the same time, the project portfolio

management can consider the importance of each evaluation index and realize the objective evaluation for the alternative projects. Additionally, the advantage of easy operation and easy to understand make the method of multi-level extension has important theoretical and practical significance.

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