Research and Evaluation on Procurement Techno-Economic Benefits of NC Grinder Technology Projects Based on the AHP

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Abstract—**With regard to the NC grinder technology procurement project of a machinery， according to a large number of data this paper makes use of The AHP to establish a mechanical plant AHP model. The third layer (Tender licensors) is taken as the evaluation indicators. Based on the relationship between production technology and economic benefits, with the establishment of judgment matrix and the integrated use of Satty the largest eigenvector method, it determines the relative importance of this layer on layer (weights). Calculated through AHP the best program can be determined, which provides reliable scientific basis and decision-making method for the project procurement.**

Keyword-AHP; NC grinder; Techno-Economic; judgment matrix; weights

I. INTRODUCTION

With the scale and complexity of the equipment acquisition increasing, and objectively the procurement has the characteristics that require only succeeding. Therefore, when analyzing economic benefits of technology procurement project, a series of interrelated, complementary indicators is needed to adopt to make up different levels of economic efficiency index system in order to fully reflect the industrial economy condition. In order to systematically accurately recognize the importance and the relative position of the economic benefits of various indicators in its system, Author plan to apply the AHP to systematically analyze and calculate technical and economic benefits and indicators system in NC grinder technology procurement project of a machinery.

II. BASIC CONDITIONS OF THE PROCUREMENT ENTERPRISE

Certain machinery Factory main products are NC machine tools, with many years experience in the production of NC machine tool products, which have a higher reputation in the domestic. With 800 employees now, 98 sets of key equipment, the factory covers an area of several hectares. The highest yields in history produce products of 10,222 tons. For the procurement of High-grade NC grinders production technology, the company intends canteen located (the plant covers an area of 432 m2) to a professional workshop to purchase the production of High-grade NC grinders, and two workshop space into a three-dimensional warehouse of 468 square meters. in addition ,this project introduce software, and just two key equipment, additional 16 units of domestic equipment, and use the factory original nine intact devices (totally 27 units).

III. THE AHP OF TECHNOLOGY PROCUREMENT PROJECT

Under normal circumstances, the evaluation of the entire system is more for multi-objective evaluation of multi-judge system. So the project applies the AHP to comprehensively analyze and evaluate the technical and economic indicators. Because various indicators for a particular project have differently importance, so according to the actual situation of the construction projects, the analytic hierarchy process (AHP) can determine the weight coefficient to determine the weights ω, and then the linear weighted method can calculate the coordination function C:

$$C=W_1\times U_1+W_2\times U_2+W_3\times U_3+ W_4\times U_4$$

Where $\sum_{i=1}^{4} W_i = 1$, C $\in$ [0,1], obviously, the greater the value of C, the better system coordination. It will coordinate the best option for the most satisfactory program.

By AHP the weights of the four indicators can be sought. Following NC grinder technology procurement project's technical feasible analysis and analysis of economic rationality, it draw entirely correlation chart as follows:

A: The best program
B1：technical feasibility
B2：National economic
B3：corporate financial
B4: Uncertainty analysis
C1：Advanced process
C2: Reliable technology
C3：Enterprises tolerance
C4：Payback period
C5：Internal rate of return
C6：Profit rate
C7：IRR
C8：Breakeven point
C9：Capacity utilization

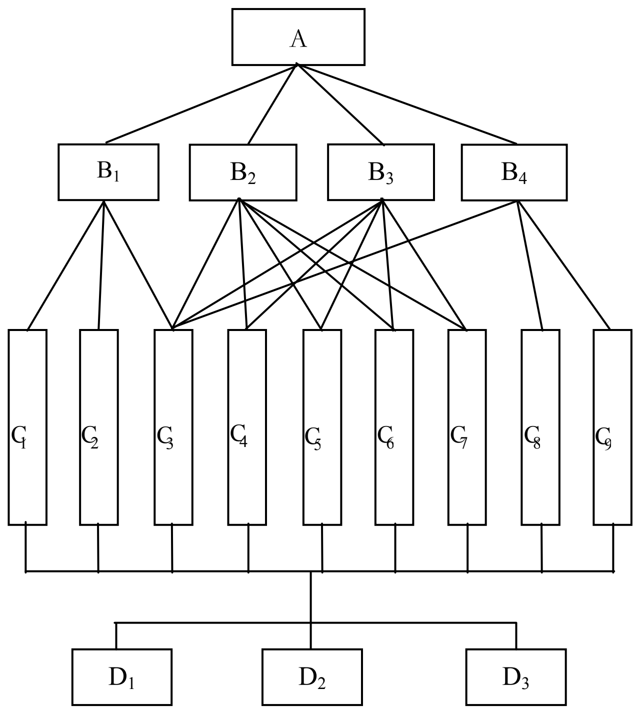

Figure 1. The completely correlation chart for the procurement of technology projects

Inspecting the work of the NC grinder technology procurement projects，the project indicators can be divided into three layers (Fig. 1). Through a lot of historical data and expert evaluation , The relative importance of the four indicators and the judgment matrix (A-B judgment matrix) are shown in Table 1. Layer 3, the relative importance of each factor and the judgment matrix (B-C) are shown in Table 1.

Table 1 .The A-B judgment matrix

A	**technical feasibility B_1**	**National economic B_2**	**corporate financial B_3**	**Uncertainty analysis B_4**
B_1	1	2	1/3	3
B_2	1/2	1	1/5	1/2
B_3	3	5	1	7
B_4	1/3	2	1/7	1

The above table show:
For the overall objectives, The A-B the judgment matrix:

$$B = \begin{bmatrix} 1 & 2 & 1/3 & 3 \\ 1/2 & 1 & 1/5 & 1/2 \\ 3 & 5 & 1 & 7 \\ 1/3 & 2 & 1/7 & 1 \end{bmatrix}$$

By the product of square root law, the calculated result can be obtained as follows:

(1) calculation of the matrix by row:

$$\varsigma_1 = \sqrt[4]{1 \times 2 \times (1/3) \times 3} = 1.1892$$

$$\varsigma_2 = \sqrt[4]{1/2 \times 1 \times (1/5) \times (1/2)} = 0.4729$$

$$\varsigma_3 = \sqrt[4]{3 \times 5 \times 1 \times 7} = 3.2011$$

$$\varsigma_4 = \sqrt[4]{(1/3) \times 5 \times (1/7) \times 1} = 0.5555$$

$$\text{So , } V = \begin{pmatrix} 1.1892 \\ 0.4729 \\ 3.2011 \\ 0.5555 \end{pmatrix}$$

(2) normalization

$$W_1 = \frac{1.1892}{1.1892 + 0.4729 + 3.2011 + 0.5555} = 0.2105$$

$$W_2 = \frac{0.4729}{1.1892 + 0.4729 + 3.2011 + 0.5555} = 0.0873$$

$$W_3 = \frac{3.2011}{1.1892 + 0.4729 + 3.2011 + 0.5555} = 0.5908$$

$$W_4 = \frac{0.5555}{1.1892 + 0.4729 + 3.2011 + 0.5555} = 0.1025$$

$$\text{So, } W = \begin{pmatrix} 0.2195 \\ 0.0873 \\ 0.5908 \\ 0.1025 \end{pmatrix}$$

(3)Consistency test

$$AW = \begin{bmatrix} 1 & 2 & 1/3 & 3 \\ 1/2 & 1 & 1/5 & 1/2 \\ 3 & 5 & 1 & 7 \\ 1/3 & 2 & 1/7 & 1 \end{bmatrix} \begin{pmatrix} 0.2195 \\ 0.0873 \\ 0.5908 \\ 0.1025 \end{pmatrix} = \begin{pmatrix} 0.8985 \\ 0.3665 \\ 2.4033 \\ 0.4347 \end{pmatrix}$$

$$\lambda_{\max} = \frac{1}{4}\left[\frac{0.8985}{0.2195} + \frac{0.3665}{0.0873} + \frac{2.4033}{0.5908} + \frac{0.4347}{0.1025}\right] = 4.150$$

$$X.I. = \frac{4.150 - 4}{4 - 1} = 0.05$$

$$X.P. = \frac{C.I.}{R.I.} = \frac{0.05}{0.89} = 0.0562 < 0.1$$

therefore, consistency of judgment matrix is acceptable. Similarly, A-B matrix calculation method can test the consistency of the C-D matrix and the B-C matrix, and calculate their elements of weight.Such as shown in Table 2,3.

Table 2 . The B-C judgment matrix and its processing

1							
B_1	C_1	C_2	C_3	W_i	W_i^o	λ_{m_i}	λ_{max}=3.0037
C_1	1	1/5	1/3	0.4055	0.1095	3.00274	C.I.=0.0018
C_2	5	1	2	2.1544	0.5816	3.00395	R.I.=0.52
C_3	3	1/2	1	1.1447	0.3090	3.00421	C.R.=0.0036

2									
B_2	C_3	C_4	C_5	C_6	C_7	W_i	W_i^o	λ_{m_i}	
C_3	1	1/5	1/2	1/3	5	0.6987	0.0388	5.3738	λ_{max}=5.2730
C_4	5	1	5	3	7	3.4997	0.1006	5.2892	C.I.=0.0682
C_5	2	1/5	1	1	4	1.0956	0.5038	5.1448	R.I.=1.12
C_6	3	1/3	1	1	5	1.3797	0.1581	5.1380	C.R.=0.0609
C_7	1/5	1/7	1/4	1/5	1	0.2698	0.1986	5.4160	

3									
B_3	C_3	C_4	C_5	C_6	C_7	W_i	W_i^o	λ_{m_i}	
C_3	1	1/4	1/3	1/2	3	0.6598	0.0561	5.2166	λ_{max}=5.1658
C_4	4	1	3	3	5	2.6052	0.1046	5.1813	C.I.=0.0415
C_5	3	1/3	1	1	4	1.3195	0.4479	5.1568	R.I.=1.12
C_6	2	1/3	1	1	3	1.1487	0.2092	5.0417	C.R.=0.0370
C_7	1/3	1/5	1/4	1/3	1	0.3540	0.1821	5.2323	

4							
B_4	C_3	C_8	C_9	W_i	W_i^o	λ_{m_i}	λ_{max}=3.0536
C_3	1	1/3	1/3	0.4807	0.5278	3.05444	C.I.=0.0268
C_8	3	1	1/2	1.5183	0.3325	3.05323	R.I.=0.52
C_9	3	2	1	1.8171	0.1396	3.05343	C.R.=0.0516

Table 3. The C-D judgment matrix and its processing

1 λ_{max}= 3.0026 C.R.=0.0025

C_1	D_1	D_2	D_3	W_i^o
D_1	1	1/2	1/7	0.1025
D_2	2	1	1/3	0.2158
D_3	7	3	1	0.6817

2 λ_{max}= 3.0037 C.R.=0.0036

C_3	D_1	D_2	D_3	W_i^o
D_1	1	3	5	0.6483
D_2	1/5	1	2	0.2297
D_3	1/5	1/2	1	0.1220

3 λ_{max}=3.0858 C.R.=0.0825

C5	D1	D2	D3	W_i^o
D_1	1	1/5	1/4	0.0936
D_2	4	1	3	0.6267
D_3	4	1/3	1	0.2729

4 λ_{max}= 3.0037 C.R.=0.0036

C_7	D_1	D_2	D_3	W_i^o
D_1	1	1/5	1/2	0.1220
D_2	5	1	3	0.6483
D_3	2	1/3	1	0.2297

5 λ_{max}=3.0092 C.R.=0.0088

C_9	D_1	D_2	D_3	W_i^o
D_1	1	1	1/3	0.1919
D_2	1	1	1/4	0.1744
D_3	3	4	1	0.6337

6 λ_{max}=3.0037 C.R.=0.0036

C_2	D_1	D_2	D_3	W_i^o
D_1	1	1/3	1/5	0.1095
D_2	3	1	1/2	0.3090
D_3	5	2	1	0.5816

7 λ_{max}=3.0324 C.R.=0.0311

C_2	D_4	D_2	D_3	W_i^o
D_1	1	1/7	1/3	0.0841
D_2	7	1	4	0.7049
D_3	3	1/4	1	0.2109

8 λ_{max}=3.0324 C.R.=0.0311				
C6	D1	D2	D3	W_i^o
D_1	1	1/7	1/4	0.0786
D_2	7	1	3	0.6586
D_3	4	1/3	1	0.2628
9 λ_{max}= 3.0291 C.R.=0.0279				
C_8	D_1	D_2	D_3	W_i^o
D_1	1	3	9	0.6717
D_2	1/3	1	5	0.2854
D_3	1/9	1/5	1	0.0629

The above table 2,3shows that the judgment matrix are in line with the consistency requirements，The C-layer and D-layer sort results as shown in Table 4,5.

Table 4 The C-layer sort results

B / C	**B_1 (0.2195)**	**B_2 (0.0873)**	**B_3 (0.5908)**	**B_4 (0.1025)**	W_i'
C_1	0.1095	0	0	0	0.024
C_2	0.5816	0	0	0	0.128
C_3	0.3090	0.0388	0.0561	0.5278	0.158
C_4	0	0.1006	0.1046	0	0.071
C_5	0	0.5038	0.4479	0	0.309
C_6	0	0.1581	0.2092	0	0.137
C_7	0	0.1986	0.1821	0	0.125
C_8	0	0	0	0.3325	0.034
C_9	0	0	0	0.1396	0.014

Table 5 D-layer sort results

D / C	**(ProgramⅠ) D_1**	**(ProgramⅡ) D_2**	**(ProgramⅢ) D_3**
C_1(0.024)	0.1025	0.2158	0.6817
C_2(0.128)	0.1095	0.3090	0.5816
C_3(0.158)	0.6483	0.2297	0.1220
C_4(0.071)	0.0841	0.7049	0.2109
C_5(0.309)	0.0936	0.6267	0.2797
C_6(0.137)	0.0786	0.6586	0.2628
C_7(0.125)	0.1220	0.6483	0.2297
C_8(0.034)	0.6716	0.2654	0.0629
C_9(0.014)	0.1919	0.1744	0.6337
W_i'	0.2057	0.5072	0.2871

IV. CONCLUSION

With regard to the typical practical example of procurement project, through a large number of detailed data, establishment of the corresponding mathematical model, this paper applies AHP to draw the weights of each program so that we can select the best program. Its calculation results are in good agreement with the theoretical analysis. Thus, a reliable scientific basis and decision-making method can be provided for this project.

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