Evaluation Model for ERP Implementation Capacity For SMB In China

Li Jianfeng¹, Lin Yang²
(¹. College of Management, China Jiliang University, P.R.China, 310018;
². Engineering College, Northeast Agricultural University, P.R.China, 150030)

Abstract: Through the analysis of application status of ERP system in Chinese small and medium business, we think that in the initial implementation stages, most of them are lack of the sufficient feasibility argumentation, and the feasibility analysis method and indicator evaluation system suitable for them, which results in the blindness in project performance. The following thesis applies fuzzy mathematics method to set up an evaluation model for ERP system implementation capacity for SMB in China, providing an evaluation method and diagnostic tool for the project entities (including performing enterprises, software manufacturers and consulting firms) that are to implement ERP system.

Keywords: SMB, ERP, fuzzy mathematics

1 Foreword

Enterprise Resource Planning (ERP) represents perfect amalgamation of information technology and advanced management, becoming an important role in modern enterprise management. In China, most ERP users are large-scale and foreign-funded enterprises. But with constant improvement of information management demand of small and medium business(SMB), and rapid development of ERP software, ERP system enters SMB gradually. CCID Consulting Company made a survey over purchasing affairs of SMB with annual sale (or assets) between 5 million yuan to 500 million yuan, which shows that among these enterprises, those that have purchased or are selecting ERP account for 31.4%. There are 16.7% that will purchase ERP within one year, 37.5% within three years, while only 14.4% figure to develop ERP system independently or to purchase 3 years later.

Application of ERP system is actually a process of project management. According to theory of project management, affection brought by right or wrong conclusion of feasibility demonstration exceeds 60% and ERP project takes on this characteristic approximately. Present success rate of ERP application is not high in China, esp. SMB. One of the most important causes is that the demonstration in feasibility analysis phase is not sufficient, lacking of feasibility analysis method and index evaluation system in accordance of China[1]. To this status, I have consulted relevant research achievements at home and abroad, established an evaluating model of ERP system application capacity in SMB with fuzzy overall evaluation method, providing a method of evaluation and tool of diagnosis for the project applicants of ERP system (including enterprises, software manufacturers and consultant companies).

2 Evaluation model for ERP implementation capacity for SMB

2.1 Designing principle

A series of practical ERP application capacity evaluation method should follow some fundamental principles in the designing process of evaluation index:

a. Principle of comprehensiveness: The evaluation index system should reflect as comprehensive as possible the ERP application capacity and conditions of each aspect affecting ERP application.

b. Principle of instructiveness: The evaluation index system should be able to give instructions on ERP application, point out insufficiency and impel constant amelioration of the enterprise, ultimately improving the management level.

c. Principle of feasibility: The evaluation index should be of operation feasibility. The concrete results or numerical values should be reflected through a series of methods of spot check or statistics.

2.2 Design of overall evaluation index system
Evaluation index collection refers to the concrete names involved in evaluation and evaluation factor index collection refers to a series of classification and grouping names of evaluation index collection \[3\]. The evaluation factor index collection is of various grades. The first-grade evaluation factor collection might include a lot of second-grade evaluation factor index collection. Those only includes evaluation indexes but no sub-grade evaluation factor index collection are called bottom evaluation factor index collection.

The evaluation system demonstrated in the articles includes six first-grade evaluation factor index collection, i.e., fundamental index of enterprise information construction \(X_1\), capital affording capacity index \(X_2\), technology force index \(X_3\), basic management level index of enterprise \(X_4\), factor index of corporate leaders \(X_5\), preparation condition index of ERP project \(X_6\). Among them, each first-grade index includes four second-grade indexes. The tree-type model of the evaluation system is showed in Fig.1.

When there are a lot of evaluation projects, it’s very hard to make sure the weighting coefficient. Meanwhile, for meeting unification requirements, the weighing coefficient will certainly decrease with increasing of evaluating items, which makes it hard to differentiate the primary and secondary evaluation indexes, even unable to obtain the evaluation results. The tree-type model can well settle the problem \[4\]. At the same time, for evaluation is carried out from each aspect of an enterprise, it helps in discovering concrete insufficiency of the enterprise in order to make improvement.

In Fig. 1, the main principle tier B is first-grade index and the sub-principle C is second-grade index. Relations between them can be expressed as \(X = (X_1, X_2, X_3, X_4, X_5, X_6)\), among which \(X_1 = (x_{11}, x_{12}, x_{13}, x_{14})\), \(X_2 = (x_{21}, x_{22}, x_{23}, x_{24})\), \(X_3 = (x_{31}, x_{32}, x_{33}, x_{34})\), \(X_4 = (x_{41}, x_{42}, x_{43}, x_{44})\), \(X_5 = (x_{51}, x_{52}, x_{53}, x_{54})\), \(X_6 = (x_{61}, x_{62}, x_{63}, x_{64})\).

2.3 Evaluation index

Evaluation index can be divided into qualitative and quantitative indexes. For the convenience of evaluation calculation, the qualitative indexes must be quantified. The detailed method is as follows: the experts score for each index through field survey (the hundred mark system) and then convert the score into relevant grades, conversion details are showed in Form 3-2. There are four grades of final evaluation results: A (excellent), B (good), C (ok) and D (poor). Each expert should score for relevant evaluating indexes and convert into the above-mentioned grades. Through statistic disposal, distributing of evaluation among four grades can be concluded. If evaluation of corporate capital affording capacity is carried out, there is an evaluation index of corporate capital affording capacity. If evaluation of corporate capital affording capacity is carried out, there is an evaluation index of corporate capital affording capacity. If evaluation of corporate capital affording capacity is carried out, there is an evaluation index of corporate capital affording capacity. If evaluation of corporate capital affording capacity is carried out, there is an evaluation index of corporate capital affording capacity. If evaluation of corporate capital affording capacity is carried out, there is an evaluation index of corporate capital affording capacity.

In Form 1, if evaluation on technology force of corporate information construction is carried out, there is an evaluation index of ratio of IT personnel. Generally, it’s figured that if ratio between quantity of technical personnel engaged in IT development and management and that of the total management personnel exceeds 10%, it can be scored from 80 to 100 marks (Grade A); if between 10% and 5%, 79 to 70 marks (Grade B), if between 5% and 3%, 69 to 60 marks (Grade C) and if less than 3%, below 60 marks (Grade D). If ratio of IT technical personnel in a factory is 7%, its evaluation result is \((0, 1, 0, 0)\), Grade B. Details of mark grade contrast are as Form 1.

In establishment of the detailed evaluation indexes, I mainly referred to the ABCD evaluation form.
of Oliver Weight and relevant research achievements by domestic scholars Qi Er-shi etc., on the basis of which detailed processing and expansion were made.

### Form 1 Contrast form of mark grades

<table>
<thead>
<tr>
<th>Index grade</th>
<th>A (excellent)</th>
<th>B (good)</th>
<th>C (OK)</th>
<th>D (poor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index marks</td>
<td>100-80</td>
<td>79-70</td>
<td>69-60</td>
<td>Below 60</td>
</tr>
</tbody>
</table>

### 2.4 Weight of evaluation index

Weighing of evaluation should first meet the requirement of unification, i.e., the weighing factor should meet the following conditions:

\[
W = (w_1, w_2, w_3, \ldots, w_n), \quad 0 < w_j < 1, \quad \sum_{i=1}^{n} w_i = 1.
\]

In actual application, ascertainment of weighing factors should be disposed flexibly according to industry variety the enterprise belongs to, operation characteristics and the application emphasis of ERP. Calculation methods of concrete weight can be fuzzy judgment method, expert scoring method and tier analysis method etc. Evaluation indexes and weight for reference are as form 2. Weight for reference of each index in Form 2 comes from survey on ERP consultant experts of Xinzhongda Software (Beijing) Stock C., Ltd., Scientific Software Stock Co., Ltd. of Harbin Industry University and Harbin Gold Mind Sci-tech Co., Ltd.

### 2.5 Evaluation calculation

#### 2.5.1 Fuzzy evaluation matrix of sub-principle tier

In this article, ERP application capacity of SMB is reflected by \( X = (X_1, X_2, X_3, X_4, X_5, X_6) \). An evaluation can be concluded of ERP application capacity from each factor. If the remark collection obtained is \( Y = \{y_1, y_2, y_3, y_4, y_5, y_6\} \), then \( y_i \) is comprehensive evaluation on ERP application capacity from point of \( x_i \). Classified factor indexes of tier B are evaluated through indexes of tier C. If \( X_i (i = 1,2,3,4,5,6) \) is singly considered, a \( 4 \times 4 \) fuzzy evaluation matrix \( R_i \) can be established:

\[
R_i = \begin{bmatrix}
    r_{i11} & r_{i12} & r_{i13} & r_{i14} \\
    r_{i21} & r_{i22} & r_{i23} & r_{i24} \\
    r_{i31} & r_{i32} & r_{i33} & r_{i34} \\
    r_{i41} & r_{i42} & r_{i43} & r_{i44}
\end{bmatrix}, \quad \text{marked as } R = (R_1, R_2, R_3, R_4, R_5, R_6). \quad [5]
\]

Let’s presume weights of \( X_1, X_2, X_3, X_4, X_5 \) and \( X_6 \) to object tier A are respectively \( B_1, B_2, B_3, B_4, B_5 \) and \( B_6 \), the weight collection is \( B = (B_1, B_2, B_3, B_4, B_5, B_6) \). In turn, weight collection of each index in the sub-principle tier C to its corresponding main principle tier B is \( W_1 = (W_{11}, W_{12}, W_{13}, W_{14}) \), \( W_2 = (W_{21}, W_{22}, W_{23}, W_{24}) \), \( W_3 = (W_{31}, W_{32}, W_{33}, W_{34}) \), \( W_4 = (W_{41}, W_{42}, W_{43}, W_{44}) \), \( W_5 = (W_{51}, W_{52}, W_{53}, W_{54}) \), \( W_6 = (W_{61}, W_{62}, W_{63}, W_{64}) \).

Fuzzy comprehensive evaluation collection of each index in the main principle tier \( A_i = (a_{i1}, a_{i2}, a_{i3}, a_{i4}) \) can be obtained from \( A_i = W_{ij} \cdot R_i \). There are several methods getting \( a_0 \). According to definition of fuzzy calculation, usually four operators can be adopted, i.e., \( M(\vee, \wedge), M(\vee, \oplus), M(\wedge, \oplus), M(\vee, \odot) \). For the convenience of calculation, operator \( M(\vee, \wedge) \) is adopted in this article, i.e., \( a_0 = \frac{1}{4} \sum_{i=1}^{4} \left( W_{ij} \cdot \frac{4}{i=1} \sum_{j=1}^{4} r_{ij} \right) \).

#### 2.5.2 Fuzzy evaluation matrix of main principle tier

To calculate the fuzzy evaluation matrix \( A \) of the evaluation object:
\[
\bar{A} = (a_1, a_2, a_3, a_4) = B \circ \begin{bmatrix}
A_1 \\
A_2 \\
A_3 \\
A_4 \\
A_5 \\
A_6
\end{bmatrix}, \text{ thereinto } a_j = \frac{4}{i-1} \frac{4}{j} (B_i / a_j).
\]

### Form 2 Evaluation indexes and weight

<table>
<thead>
<tr>
<th>Overall evaluation on ERP application capacity</th>
<th>First-grade evaluation index collection</th>
<th>Second-grade evaluation index collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corporate information construction level (0.1)</td>
<td>Supporting grade of ERP from all circles of the enterprise(0.4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Computer level of the staff(0.3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Application conditions of the corporate information construction software(0.2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hardware construction conditions of the enterprise(0.1)</td>
<td></td>
</tr>
<tr>
<td>Corporate capital affording capacity (0.1)</td>
<td>Assets management capacity of the enterprise(0.3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Assets planning and budget conditions of ERP project(0.2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average profit in recent three years(0.4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ratio between initial investment and circulating fund (0.1)</td>
<td></td>
</tr>
<tr>
<td>Technical force of corporate information construction (0.15)</td>
<td>Proportion of IT technical staff(0.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Composing of technical personnel engaged in ERP project (0.4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Training degree of IT technical personnel(0.2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Information construction experience of IT technical staff(0.3)</td>
<td></td>
</tr>
<tr>
<td>Corporate fundamental management level (0.15)</td>
<td>Development period of new product development(0.3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficiency of the organization(0.4)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Market promotion capacity(0.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>H.R. performance management level(0.2)</td>
<td></td>
</tr>
<tr>
<td>Factors of corporate leaders (0.3)</td>
<td>Stability of corporate leaders(0.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Support from high-level leaders(0.5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Level of project principal (Programming Manager) (0.2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Comprehension degree of ERP and the application risks of leaders(0.2)</td>
<td></td>
</tr>
<tr>
<td>Preparation conditions of ERP project (0.2)</td>
<td>Organization guarantee conditions(0.2)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ERP project demand analysis conditions(0.5)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Conditions of retaining information construction supervisor (management consulting company) (0.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acknowledging degree of the enterprise for the preferable ERP and its manufacturer(0.2)</td>
<td></td>
</tr>
</tbody>
</table>

Making unification disposal to \(\bar{A}\), fuzzy distributing method can be applied in evaluating ERP application capacity of the enterprise.

### 3. Conclusion

An evaluation model for ERP application capacity is established in this article, which offers an
evaluation method and a diagnosis tool and to a certain extent settling the problems in ERP application process of lacking essential prophase demonstration and feasibility research tache. After the ERP application capacity grade is distinguished, AHP can be applied to make sure weights of each index in order to further quantify evaluation of the application capacity, finding bottle neck in ERP application and the breakthrough in improvement.

References