The Design and Evaluation of Performance Indexes of Project Managers in Software Enterprises

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Abstract: It is the software enterprises’ project actuation that makes it more difficult to evaluate project managers than the research and development personnel relatively. Based on the job analysis of project managers in enterprises, this article selects the performance indicators of project managers, and then evaluates the evaluation results through the analytic hierarchy process and weighted average method to make the performance evaluation more object and effective.

Keywords: Software enterprise, Project managers, Performance evaluation

1 Introduction

With the increasing development of information industry, software industry is also gradually becoming huge. Software industry has become the fundamental, leading and strategic industry, which is playing an important role increasingly in optimizing the economic structure and promoting information construction. As a knowledge-intensive industry, it is base to establish effective developing teams for software enterprises. As the leaders and decision-makers, project managers play a crucial role in the software development process, thus the performance evaluation for them is the key to sharpen enterprises’ competitive edge. Currently, most software enterprises have standardized evaluation mechanisms, but the mechanism towards developing teams is lack of rationality and effectiveness, because it only evaluates the managers of developing teams from the aspects of work ability and work attitude. Therefore, in order to mobilize the enthusiasm and combat effectiveness of the entire project team effectively, as well as to improve the performance and management level of project managers in software enterprises, it is imperative to establish performance indicators for project managers in software enterprise.

2 Work Analysis of Project Managers in Software Enterprises

2.1 The work flow of project managers
Project manager is to guarantee the quality, quantity, and completion of the project. The difference between the project managers in software enterprises and the project managers in general enterprises is mainly on the work flow. The work flow of project managers mainly includes: after undertooking the project, they make system planning and requirement analysis to start the project; they break down the project, and then assign the task to project team members as well as prescribe the process of the project; in the process of the implementation of the project, they ensure the normal operation of the project and the soft quality, as well as coordinate and motivate the project team members to evaluate the work process and the results of the research fellows; in the whole process of the project, they should always coordinate and communicate with customers, and timely monitor the process of the project and adjust the function through two-way communication.

2.2 The job function of project managers
As the knowledge-based organizational form, software enterprise is different from the traditional enterprise. Its work content has changed and has converted from the unskilled jobs to intellectual jobs, from repetitive tasks to innovation, from the individual work to team work, from functional work to project work, from a single skill to multiplex ones, from the superior power to customer power and other important transformation[1]. Therefore, besides responsibilities in general enterprise, the focus of project
manager in software enterprise has transferred. What they pay more attention is knowledge management, project management, team members’ management and effective incentive and broader foreign-related duties for team members.

2.3 The ability that project managers should have
The capability requirements of project manager in software enterprise include: having plenty knowledge of project management to break down the tasks effectively according to the theory of software engineering; possessing the skills of stronger leadership, independent judgment and decision; taking on higher communication and coordination ability. This ability shows in two aspects: on one hand, they can main good relationships with customers, on the other hand, they can deal with the relations between project team members as well as superior and subordinates. Thus, employees can be motivated effectively and team construction can be promoted. In the software industry, the technique of project manager must have authority, that is to say, the excellent technical ability can ensure the timeliness and functional for the completion of the whole project.

3 The Selection of Performance Evaluation Indexes for Project Managers in Software Enterprise
This article selected the performance evaluation indexes of software enterprise’ project manager mainly have three steps. Firstly, construct the basic framework through analysis of literature; Secondly, gather the evaluation indexes of various kinds of the research and development personnel and collect interrelated people’s experience through the questionnaire; Finally, interview with the enterprise managers, exchange opinions with the research and development personnel and determine the indexes library through Delphi method. Based on analysis and research, the performance evaluation indexes of project managers mainly have the following aspects. This article selected the performance evaluation indexes of software enterprise’ project manager mainly have three steps. First, construct the basic framework through analysis of literature; Secondly, gather all kinds of the research and development personnel’s evaluation indexes through the questionnaire to collect interrelated groups’ experience; Finally, interview with the enterprise managers, exchange opinions with the research and development personnel and determine the indexes library through Delphi method. Based on analysis and research, the determination of the project manager’s performance evaluation indexes mainly have the following aspects.

3.1 Project performance indexes
Project performance is evaluated by contributions made by the project to software enterprise and the influence of the project performance to enterprise in the long run.
Input-output ratio: The project income which reflects the net can make people understand the project performance more objectively and accurately, and then compare with the similar projects and analyze.
Project profit: on one hand, people can know the project performance from the net of software in short time; on the other hand, people can learn the long term performance of project manager from the potential value and market conditions of software.
Reconfiguration: whether the software development have generalizability, that is to say, the software can be applied with small changes in similar projects.
Personnel growth: from the strategic thought, project performance is not only reflected in software achievement, but also the growth of the research and development personnel which is the core resource of software enterprise.
Knowledge accumulation: It mainly includes software development technology and management experience accumulated.
3.2 Project management indexes
Project management is the management that project manager in charge of the whole project’s completion.
Functional control: whether the function which is antecedent for software can meet customers’ requirements as well as can be measured through the related technology.
Time control: whether they can finish the project on time.
Budget control: whether the funds of research and development is under control of the budget requirements.
Risk control: in the process of project, whether they can predict the risk associated with the project and then take measures to reduce the adverse effect which the risk produces to the minimum.

3.3 Team management indexes
Team management refers to the project manager’s ability of team management and handling with things and so on.
Role in place: the degree whether the team members can clear their duties, meet the role request and comply with the role.
Team cohesion: the ability whether it can make the team members involve in the group well and improve the efficiency of the whole team.
Aspiration of team work: whether team members can collaborate with each others and their loyalty and turnover intension for the team is also involved.
Incentive intensity: whether project manager can effectively use the personality charm and incentives to fully mobilize the enthusiasm of team members and make them do their best.

3.4 Technical ability indexes
Software project development requires that the software managers must have the relevant knowledge of software engineering and muster relevant technology to ensure the quality of software.
Ability of software analysis: include feasibility analysis, project development plan and the ability of demand analysis. The feasibility research and project development plan are mainly answer the question what problems should be solved and demand analysis is to determine what the software system must do. The assessment of analysis ability is the base for the software developed successfully.
Capability of software design: design ability is the ability that they design the logical model to specific computer software program. The logical model is attained in the period of analysis to. It mainly includes ability of outline and detailed design. Outline design is to design the software structure. The problem that the structure is made of what modules and how these modules’ hierarchical structure and invocation relation are must be considered. The detailed design is to describe specifically the functions completed by every module.
Testing and coding ability: project manager should also get familiar with the testing and coding ability which the grassroots developers possess. Thus they can grasp the software’s quality on the whole to guarantee the project developed successfully.
Software maintenance ability: software may be modified due to the implicit error after use in the process of operation. Software may be made appropriate alterations to accommodate changes and software function may be expanded and strengthened for the customer business changes either. This needs the
ability that project manager leads the team for efficient maintenance.

3.5 Communication and coordination ability indexes
Communication and coordination ability is the ability that the project managers have to handle with interpersonal relationship and solve with conflicts, etc. in work.
Coordination in project team: the degree that the information communicated smoothly between team members and the members cooperate with others in the development process of the whole team.
Coordination between the customers: it mainly refers to the condition that they keep good relationship with customers in the process of requirement analysis, project schedule, system maintenance and trial process.
The relationship between colleagues: the degree that the project manager deals with the relation between other department employees for finishing the task.
Superior-subordinate relationship: the relationship between the upper and lower level and the degree of employee participation.

4 Comprehensive Performance Evaluation of Project Managers in Software Enterprises

4.1 The weight of evaluation indexes
This article determines the weight of various hierarchical indexes through analytic hierarchy process. Firstly, the evaluation indexes of project managers are divided into target layer(performance evaluation for project managers), criterion layer(project management, team management, communication skills and time management), sub-criterion layer(various indexes under criterion layer).
Then, construct judgment matrix. The judgment matrix of project management, team management, communication skills and time management for criterion layer is as follows:

\[
M = \begin{bmatrix}
1 & 2 & 3 & 4 & 6 \\
\frac{1}{2} & 1 & 2 & 2 & 4 \\
\frac{1}{3} & \frac{1}{2} & 1 & 1 & 3 \\
\frac{1}{4} & \frac{1}{2} & 1 & 1 & 2 \\
\frac{1}{6} & \frac{1}{4} & \frac{1}{3} & 2 & 1
\end{bmatrix}
\]

And use formula \( A \omega = \lambda_{max} \omega \), find the largest eigenvalue \( \lambda_{max} = 5.0332 \), the eigenvector \( \omega_M = (0.435,0.243,0.141,0.122,0.060) \)\(^T\), that is the sorting weight value of criterion layer to target layer. Based on the research process, this article carries on group decisions through ten experts to determine weight more accurately. Thus, it is necessary to calculate the largest eigenvalue and eigenvector for nearly 100 judgment matrix, the computational complexity of which is very large. So, this article uses calculation software for analytic hierarchy process, namely Expert Choice. It is a decision tool based on analytic hierarchy process (AHP) and it can compute the eigenvector of various judgment matrices to get the relative weight of various layers quickly.

Finally, carry on consistency check. Compute consistency index C.I.

\[
CI = \frac{\lambda_{max} - n}{n - 1} = \frac{5.0332 - 5}{5 - 1} = 0.0083, \quad RI = 1.12
\]

Compute random consistency rate C.R.

\[
CR = \frac{CI}{RI} = \frac{0.0083}{1.12} = 0.0074
\]
After computation, \( n \) is 5 and \( CR \) is 0.0074. It can be seen that the matrix \( M \) has acceptable consistency. With the same method, various index weights under the sub-criterion layer can be obtained. The index weights of performance evaluation for project managers are shown in Tab.1.

<table>
<thead>
<tr>
<th>criterion layer</th>
<th>sub-criterion layer</th>
<th>weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project performance</td>
<td>input-output ratio</td>
<td>0.437</td>
</tr>
<tr>
<td></td>
<td>project profit</td>
<td>0.285</td>
</tr>
<tr>
<td></td>
<td>reconfiguration</td>
<td>0.145</td>
</tr>
<tr>
<td></td>
<td>personnel growth</td>
<td>0.066</td>
</tr>
<tr>
<td></td>
<td>knowledge accumulation</td>
<td>0.066</td>
</tr>
<tr>
<td>Project management</td>
<td>functional control</td>
<td>0.438</td>
</tr>
<tr>
<td></td>
<td>time control</td>
<td>0.333</td>
</tr>
<tr>
<td></td>
<td>budget control</td>
<td>0.181</td>
</tr>
<tr>
<td></td>
<td>risk control</td>
<td>0.049</td>
</tr>
<tr>
<td>Team management</td>
<td>role in place</td>
<td>0.462</td>
</tr>
<tr>
<td></td>
<td>team cohesion</td>
<td>0.274</td>
</tr>
<tr>
<td></td>
<td>aspiration of team work:</td>
<td>0.178</td>
</tr>
<tr>
<td></td>
<td>incentive intensity</td>
<td>0.086</td>
</tr>
<tr>
<td>Technical competence</td>
<td>ability of software analysis</td>
<td>0.583</td>
</tr>
<tr>
<td></td>
<td>ability of software design</td>
<td>0.290</td>
</tr>
<tr>
<td></td>
<td>testing ability and coding ability</td>
<td>0.085</td>
</tr>
<tr>
<td></td>
<td>software maintenance capability</td>
<td>0.042</td>
</tr>
<tr>
<td>Communication skills</td>
<td>coordination in project team</td>
<td>0.557</td>
</tr>
<tr>
<td></td>
<td>coordination between the customers</td>
<td>0.164</td>
</tr>
<tr>
<td></td>
<td>relation between colleagues</td>
<td>0.190</td>
</tr>
<tr>
<td></td>
<td>superior-subordinate relationship</td>
<td>0.089</td>
</tr>
</tbody>
</table>

**4.2 Selection and weight of evaluation subject**

Selecting and collocating evaluation subject appropriately is a basic problem affecting the effectiveness of performance evaluation. In the issue of determining "Who evaluates whom", the enterprise should regard the specific objects and the situation and then make decisions. Generally speaking, the general principle is that the evaluators must have enough ability and time to judge and evaluate the performance of the person being evaluated objectively. The idea of 360-degree performance evaluation system is used in this article to determine a combination of evaluation subject. The evaluation subject mainly includes superiors, colleagues, subordinates, on behalf of themselves and their customers. In determining the weight. This article uses "consistent" Delphi method to predict[3]. According to the expert evaluation, we can get weights of evaluation subject of various research and development personnel in software enterprise. The specific distribution weight is as shown in table 2.
### Table 2: The weight distribution of evaluation subject

<table>
<thead>
<tr>
<th>The person being evaluated</th>
<th>superiors</th>
<th>subordinates</th>
<th>colleagues</th>
<th>self-assessment</th>
<th>customer representative</th>
</tr>
</thead>
<tbody>
<tr>
<td>project managers</td>
<td>0.6</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

### 4.3 Calculation and application of evaluation result

After determining the weight of indicators and evaluation standards of performance indicators, this article uses Richter's 5 thoughts, who is the U.S. social psychologist, to mark the performance evaluation.

M (Excellent) = 5; M (good) = 4; M (general) = 3; M (poor) = 2; M (inferior) = 1

Rate the results of performance appraisal according various scores. $ω_i$ represents the weight of first grade index $M_i$, $ω_{ij}$ represents the weight of secondary index $M_{ij}$, $ω_{ijk}$ represents the weight of various evaluation subjects. $d_{ijk}$ represents specific appraisal scores of various evaluation subjects. The specific calculation steps are as follows:

1. Calculate the scores of the secondary index $M_{ij}$:

   $$d_{ij} = \sum_{k=1}^{m} ω_{ijk} \cdot d_{ijk}$$

   where $m$ is the number of evaluation subjects;

2. Calculate the scores of first grade index $M_i$:

   $$d_i = \sum_{j=1}^{n} ω_{ij} \cdot d_{ij} = \sum_{j=1}^{n} ω_{ij} \left( \sum_{k=1}^{m} ω_{ijk} \cdot d_{ijk} \right)$$

   where $n$ is the number of secondary index in the first grade index;

3. The final performance appraisal score of project managers,

   $$M = \sum_{i=1}^{l} ω_i \cdot d_i = \sum_{i=1}^{l} ω_i \left( \sum_{j=1}^{n} ω_{ij} \cdot \left( \sum_{k=1}^{m} ω_{ijk} \cdot d_{ijk} \right) \right)$$

   (where, $l$ is the number of the first grade index).

Finally, the article draws on the golden section \(^4\) of most optimal method to determine the assessment level of project managers. Seen from the table 3, we could get the assessment level according to the appraisal scores of project managers for software enterprises. When the performance evaluation score is $M \geq M_k (k = 1, 2, 3, 4, 5)$, it shows that the level of comprehensive performance is in the $k$ level.

### Table 3: The performance evaluation level of project management

<table>
<thead>
<tr>
<th>assessment level</th>
<th>worse</th>
<th>bad</th>
<th>Normal</th>
<th>good</th>
<th>excellent</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_k$</td>
<td>[0,1]</td>
<td>[1,2]</td>
<td>[2,3]</td>
<td>[3,4]</td>
<td>[4,5]</td>
</tr>
</tbody>
</table>

### 5 Conclusion

This article proposed the performance evaluation indexes system of project manager in software enterprise based on the working process, job functions and essential ability. The indexes system combine basic requirements of the project manager in current software enterprise and dynamic and continuity of project manager appraisal are also considered. The indexes can effectively avoid the shortage that the indexes system is from reality. With the performance evaluation of project manager this article determined the assessment indexes weight based on group decision and analytic hierarchy process and using weighted evaluated method of the fuzzy mathematical theory to calculate the final examination scores. It has dodged the subjectivity in performance evaluation to a certain extent and made the project
manager performance assessment results more consistency and reliability.

References