An approach of Software Development Support in Reference to Organization Management Paradigm

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Abstract

We have seen great variability in the outcomes of activities to improve the capabilities of software development, and that such variability has been attributed primarily to the skills and experiences of promoters of individual support activities. In this paper, we propose an approach of software development support activity that enhance the probability of achieving expected result with reference to service approach and organization management paradigms.

Keywords, software process improvement, organization capability, service approach, organizational paradigm, SEPG

1 Introduction

In general, the abilities of software development organizations means the following two items.
1) Scientific and technical knowledge and skills of development area
2) Software engineering knowledge and skills, such as project management, capability maturity model, requirements development/management, verification and validation

In this paper, software development support activities means improving abilities of (2) software engineering knowledge and skills mainly, and activities to improve these abilities are analyzing the organization’s problems from the point of view of software development processes, and incorporating solutions into development processes. These activities are generally conducted by members called SEPG (Software Engineering Process Group)\(^{(1)}\) providing support to software development organizations so that together they can achieve outcomes such as solving the organization’s problems or improving development abilities of the organization. In these activities, it is said that involving organization members and understanding the context of organizations are important\(^{(2)}\). However, the way of involving members and understanding organizational context haven’t been discussed until now. Consequently, outcome of improving activities are greatly dependent on the SEPG individual(s) involved.

On the other hand, it is reported that software development support activities become more effective and are more certain to have desired outcome by using a service science approach\(^{(3)}\) that has been investigated heavily in recent years. However, there hasn’t been enough discussion about organization characteristics and how to provide support activities according to organization characteristics.

Based on such considerations, this paper proposes a methodology of identifying and delivering support services to software development organizations to improve their abilities that is suitable to the organization persona by personifying software development organization, making use of both organization characteristics which impact support activities as well as Constantine’s organization paradigms\(^{(4)}\).

In Chapter 2, we clarify organization characteristics which impact support activities and propose four organization personas of software development organizations in reference to Constantine’s organization paradigms \(^{(4)}\). In Chapter 3, we propose the methodology to provide support service to improve abilities of software organizations that is suitable to the organization persona. In Chapter 4, the
methodology proposed in this paper is investigated by using real cases of development support in the past.

2. Software development support activities and organization persona

2.1 Significance of organization characteristics in software development support

Software development support activities are generally carried out in four steps as follows.

Step 1: Identify problems and analyze causes
Identify problems of the organization, and analyze causes. Specifically, with respect to problems such as poor quality or cost overruns, causes are identified such as lack of skills of project management and requirements management, inadequate quality assurance activities, or mismatch of development method with business model.

Step 2: Identify abilities in areas to be developed
Identify the areas in which organizations should improve to eliminate causes that are analyzed in Step 1, and set the goal of improvement.

Step 3: Develop strategies for support activities
Develop strategies to achieve the goal set for each area in Step 2. It is said to be important to consider organization culture and its strengths and weaknesses to develop strategies for carrying out activities to achieve the goal efficiently and effectively.

Step 4: Perform support activities
According to the strategy developed in Step 3, develop a concrete activity plan and execute the support activities.

In general, after having verified the result of Step 4, go back to Step 1 to improve further.

Table 1. Activities on each step of development support

| Step | 
| --- | --- |
| **Step 1** Identify problems and analyze causes | • Identify problems in the organizations  
• Analyze the root causes  
• Clarify the goal |
| **Step 2** Identify abilities in areas to be developed | Identify areas in which organizations should improve and set the goal |
| **Step 3** | |

To ensure that these four steps proceed, the SEPG provides support activities to the software development organization, and perform activities to improve their abilities together with members of the organization. As a result, the software development organization realizes outcomes like resolved problems or improved abilities. When progressing through these four steps, the outcomes are greatly dependent on SEPG because of the complexity of these activities at the present. On the other hand, it is reported that software development support activities become more effective and are more certain of getting desired outcomes by using a service science approach\(^{(3)}\). This means that software development support activities are services to software development organizations being provided by SEPG, adding to traditional steps of software development support activities new steps of personifying software organizations to understand the organizations’ environments and real needs. It makes support activities more appropriate to characteristics of a target organization, consequently improvement activities become more efficient and effective.

![Fig. 1. Definition of software development support as service](image)

This approach is not only identifying abilities to improve but also understanding organization characteristics and providing support activities according to their characteristics. This means when treating a patient, to understand patient’s characteristics and customs with the effect of a
disease makes treatments more effective.

According to this idea, it is important to understand what the organization truly demands, and to understand this fully, it is crucial to understand the organization characteristics.

2.2 Software development support and organization characteristics

In this chapter, we try to clarify organization characteristics that impact software development support activities with reference to Table 1 activities on each step of development support. In Step 1, problems are either taken up by organization management from a medium- to long-term perspective, or identified in daily development work by members. These problems identified somewhere in the organization are taken up at the level of organization and action is taken to shift problems into issues that should be dealt with by the organization. Furthermore, the ideal situation to attain once these problems are resolved is considered at the organization level. From these actions, organizational problem recognition process and consensus building process are executed in Step 1 to determine how problems will be identified by whom in which role, and then how these problems will be taken up as an organizational issue. In addition, consensus building is executed regarding the ideal situation for the organization, which is greatly influenced by what the organization sets a high value on.

In Step 2, the ideal situation described in Step 1 is used to identify what kinds of abilities are needed and to what degree the abilities are lacking. In these activities, organizational consensus building process and decision making process are executed to make organizational judgment.

In Step 3, organizational strategies are developed to improve abilities which were identified in Step 2. In this step, organizational decision making process and consensus building process are executed because of the importance of organizational agreement and decisions on strategies. In addition, regarding the content of the strategies, it is important to consider the organization’s flexibility to change and what the organization sets a high value on.

In Step 4, strategies developed in Step 3 are substantiated to an activity plan, which is then executed. During these activities also, organizational decision making process and consensus building process are executed when organizational agreement or decision are needed.

From these, it can be seen that the following five organizational items have a great impact on how to perform support activities and on their outcomes.

- Problem recognition process
- Decision making process
- Consensus building process
- What the organization sets a high value on
- Flexibility to change

In other words, these five items are main characteristics which should be considered to perform support activities to improve abilities of the software development organization.

2.3 Personification of the software development organization

It is said that software development organizations can be divided into four groups of Closed, Random, Open, Synchronous based on the group cohesion and intrinsic flexibility. In this paper, we personify software organizations by using software organization management paradigm and the organization characteristics described in 2.2.

Fig. 2. Map showing relationships among reference organizational paradigm

(1) Closed
They have strong cohesion and weak flexibility. This type of organization is structured as a pyramid, where members tend to behave based on superior’s directions. They have well-defined
roles specified for each position in the hierarchy, and information is carefully controlled. They tend to value loyalty to the organization

(2) Random
They have weak cohesion and strong flexibility. This type of organization is managed based on the independent initiative and values of individuals. They communicate with each other having respect for each other and for diversity.

(3) Open
They have strong cohesion and flexibility. This type of organization is managed by exchanging a lot of information between members, thereby building consensus.

(4) Synchronous
They have weak cohesion and flexibility. They place importance on shared and accepted common vision and discipline rather than values held by individuals. This organization is managed by members’ harmony while maintaining mutual distance.

From these ideas and based on the software organization management paradigm, organization persona can be derived from the organizational characteristics described in 2.2 which impact improvement of software development abilities as shown in Table 2.

3. A proposal of a methodology to provide development support suited to organization persona

In the following sections, for each software development organization persona are shown the way to effectively and efficiently conduct activities to improve development abilities, the characteristics of development processes which are a part of the outcome of these activities, and the way of providing the required support services.

3.1 Organization persona 1: Closed type
Because Closed type persona organizations tend to place greatest value on organizational approval, for conducting support activities, it is important to obtain organization management approval at milestones and to make this approval public. It is also important to establish the approved structure to conduct support activities with well-defined roles, responsibilities and authority.

In the development processes and rules of the organization defined as a result of improvement activities, it is necessary to emphasize the timing of decisions, what should be decided, and the appropriate position of the members who make each decision, to ensure that decisions are made by individuals in accordance with their role in the organization. It is effective and efficient to make public the new development processes and rules by top management’s top-down announcement.

From these points, what are expected from support services are understanding management’s intention and providing sufficient and objective information to management for adequate decision making in the phase of identifying problems and developing strategies. After developing strategies, it is important in conducting activities to guide the organization to ensure appropriate execution of the approval process at the right level in accordance with organizational hierarchy, by taking care to collect and provide information to decision makers in each level. This means support service providers (SEPG) are expected to behave as staff to support decision making by organization top management.

Table 2. Defining characteristics of four organizational reference paradigms

<table>
<thead>
<tr>
<th>Organization persona</th>
<th>1: Closed</th>
<th>2: Random</th>
<th>3: Open</th>
<th>4: Synchronous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem recognition</td>
<td>Hierarchy</td>
<td>Initiative</td>
<td>Process</td>
<td>Alignment</td>
</tr>
<tr>
<td>Decision making</td>
<td>Formal, top-down</td>
<td>Informal, bottom-up</td>
<td>negotiated consensual</td>
<td>Unnegotiated, predefined,</td>
</tr>
<tr>
<td>Consensus building</td>
<td>Hierarchy</td>
<td>Initiative</td>
<td>Process</td>
<td>Alignment</td>
</tr>
<tr>
<td>Priorities</td>
<td>Stability, group</td>
<td>Variety, individual</td>
<td>Stability and change</td>
<td>Harmony, mutual identification</td>
</tr>
<tr>
<td>Intrinsic flexibility</td>
<td>Rigidity</td>
<td>Flexible</td>
<td>Flexible</td>
<td>Rigidity</td>
</tr>
</tbody>
</table>
3.2 Organization persona 2: Random type

Random type persona organizations tend to place greatest value on shared knowledge of essential significance rather than formal approval activities because they tend to attach a great deal of importance to individuals and diversity. Therefore the suitable approach for this type of persona is to develop and deploy solutions using a working group approach with a key member as leader who is reputed to have a great deal of knowledge about that problem area and members whose work are related to that problem area. To make public the development processes and rules, it is effective that working group members, instead of management, explain these processes to organization members including context and significance to obtain full understanding of them. In development process definitions, this type of organization tends to buy into processes that place a greater emphasis on individuals or groups such as design reviews. On the other hand, formal approval activities and reviews should be minimized, such as only at phase reviews.

Consequently, what are expected from support services are primarily identifying key members in the organization and facilitating working groups while maintaining emphasis on the key member’s intension. In addition, SEPG must take care to encourage attention and communication in order to ensure that formal and informal communication paths are in place to transfer necessary information certainly from working group members to related members in the organization.

3.3 Organization persona 3: Open type

Open type persona organizations tend to have strong loyalty to the organization, are flexible, and place greatest value on consensus. Consequently, for conducting support activities, gathering opinions from every related member, discussing these, and coming to agreement are important. They prefer a working group approach in considering solutions because of a relative lack of awareness of organization hierarchy. Members of the working groups are more effective when composed of volunteers rather than by management’s designation. It is important to share information about working group status within the organization, and receive organization members’ opinions to be considered by the working group. When an organization decision is needed, it is effective to establish a forum such as an explanatory meeting to collect organization members’ opinions regardless to organization hierarchy before making a final decision.

As for development processes and rules, it is often preferred to manage with milestone reviews done primarily by experts, rather than executing formal approval processes.

Consequently, what are expected from support services are discovering volunteers who have problem awareness, facilitating working groups, and promoting information sharing and opinion gathering/analysis within the organization about working group activities. Thus, it is important to focus on supporting the timely achievement of organizational consensus.

3.4 Organization persona 4: Synchronous type

Synchronous type persona organizations tend to place greatest value on intrinsic and fundamental matters rather than adhoc approaches because they have a shared organizational vision and perform activities with discipline based on a unified set of values. When conducting improvement activities, upon achieving a shared understanding of context, significance, and purpose, it is important to proceed while ensuring consistency with organization vision, existing discipline, and existing organizational processes. Consequently, at the start of improvement activities, attaining member’s understanding of context, significance, and purpose for starting the activities is essential. In developing solutions, a working group approach is appropriate with a leader who is well trusted by management and members selected from within the organization. The status of working group activities should be openly available for reference by related members, for instance on an internal web site. Process definitions and rules would be made more effective by including process context, significance, and purpose in addition to process descriptions.

Consequently, what are expected from support services are discovering volunteers who have problem awareness, facilitating working groups, and promoting information sharing and opinion gathering/analysis within the organization about working group activities. Thus, it is important to focus on supporting the timely achievement of organizational consensus.
services are to support to arrange briefing session at the start-up period to make members understand the needs of improvement activities through explanation and sharing of context, significance, purpose, and goal state of the activities. When developing processes and rules, attaining organization members’ understanding on the influence of the change on individuals and the context and reason for changing the processes is important. Consequently, it is essential to openly publicize the status of working group activities during process development, and to ensure that a briefing session is held at the completion of a draft version of the process documentation.

4. Analyzing proposed methodology with cases

4.1 Case 1: Closed type organization

(1) Overview
• Scheme for target organization
  About 50 members are involved to develop a business system.
• Goal and objectives
  To achieve CMMI level indicated by quality assurance group of head quarter.
• Background
  Shorten development period and quality increase are described in mid-range plan, however they didn’t break down to detailed activities. According to head quarter’s directions, they started improvement activities.

  • The structure of activities
    Support promoting group with a few full-time members are organized just under the organization managements. They have a weekly meeting with development projects to share status of activities, and report to managements regularly.
  • The strategy and a plan
    Support promoting group defined development processes and rules refer to CMMI. The contents of definitions were discussed with development projects at weekly meeting. Mini-appraisal were held regularly to understand gap with CMMI. These activities status were reported to managements regularly, and they promoted activities according to managements’ indications.

(2) Analyze with a view of organization paradigm

This organization seems to be closed type because members tend to value on achieve goals at hand along managements’ directions. The approach that the support group develop processes and rules according to CMMI and Table 3. Organization paradigms and development support activities

<table>
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<th>3: Open</th>
<th>4: Synchronous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach of improvement activities</td>
<td>Formal structure approach with top management approval</td>
<td>Working group based approach with leadership of initiatives.</td>
<td>Voluntary working group based approach.</td>
<td>Working group based approach with leadership of management.</td>
</tr>
<tr>
<td>Development processes and rules</td>
<td>Defining decision points and approval process explicitly</td>
<td>Emphasis on discretion of individuals or leaders</td>
<td>Defining milestone reviews with influential individual</td>
<td>Add background and objectives sufficiently</td>
</tr>
<tr>
<td>Key points of support activities</td>
<td>• Emphasize the management’s intention • Steady implementation of approval process • Behave as top-management staff</td>
<td>• Identify initiatives • Facilitate working group activities • Take care of communication paths</td>
<td>• Facilitate Working group activities • Share about status of activities • Organize meetings to collect opinions from organization members</td>
<td>Pursue steady implementation of activities to sharing backgrounds, objectives and status of activities’</td>
</tr>
</tbody>
</table>
deployed to development projects with managements' approval is the approach for closed type of proposed methodology in section 2. Therefore this case is providing services for closed type organizations to the closed type of organization. Form this case, it is said that the closed type methodology we proposed is demonstrated.

4.2 Case 2: Random type organization
(1) Overview
• Scheme for target organization
A business group consisting of 3 divisions to develop embedded software. 300 people are involved. Their business climate isn’t bad. The managements have successful experiences in the past and tend to have little appreciation for change. On the other hand, some leaders and members have problem consciousness strongly and took action to improve independently.
• Goal and objectives
To achieve CMMI level
• Background
Top management’s intension that development ability must be improved to deal with software complexity and size are getting bigger.
• The structure of activities
The support group was organized just under the top management with some members from outside of organization and a few members form this business group.
• The strategy and a plan
The Support group promoted activities according to IDEAL model. They promoted activities according to top management’s intension and reported regular basis to share the status of improvement activities among managements.
The support group defined development processes according to CMMI, got approval of managements and deployed to development projects.
• The result
Activities were continued for two years and process documents and templates that defined the outline of the development process were produced. However, as they were not referred to completely, these activities could not lead to any great successes. On the other hand, some leaders and members who have strong problem consciousness starts group working activities to define development processes for their projects. They get some kind of improvement.
Activities were stopped due to changes in top management.
(2) Analyze with a view of organization paradigm
The upper managements seemed to be closed type, but at development projects revel, they were random type with independent leaders centered. Support activities were closed type approach that organized support group under top management and emphasis reports and approval with managements. However this organization seems to be a Random type organization because of some leaders and members were independent strongly and took action to improve.
Consequently this case is that support group provide closed type service to random type organization.
The reason why these activities could not lead to any great successes in spite of process documents and templates were produced, is support activities were not suitable to organization persona. On the other hand, they got success with working group activities. From this, effectiveness of Random type approach of methodology in Chapter 2 were demonstrated.

4.3 Case 3: Open type organization
(1) Overview
• Scheme for target organization
About 150 members embedded software development organization.
• Goal and objectives
To create a environment that engineers develop software in a proactive manner.
• Background
Competition was intense, although the target organization’s technical level was top-class. It was very difficult to continue handling tough requirements and demanding schedules. Therefore, a perception gap between management and members was generated.
• The structure of activities
The support team consisted of head office members independent from development organization to analyze their problems. With
the result of analyze activities, working groups with leaders in the organization started to consider solutions and deploy them to the organization.

- The strategy and a plan
  The support activities were designed to create a good atmosphere where managers endorsed member’s activities to solve problems that members thought could be solved. This is because the support team assumed that the root causes of problems were due to the gap in organizational perception. Therefore, support members started by interviewing members. From the interviews, support members made a judgmental decision that the volunteers working group approach would be effective, because members were very conscious of their work and also exchange constructive opinions frequently. The support group provided facilitation of the working group and arranged regular basis meeting to report the status of working group activities from the members directly to reduce perception gap.

- The result
  There were more results from each working group than were expected. Furthermore, continuing to the following step was also proposed by working group members, and they continued activities to improve. The development process was also improved, and this led to improving the capabilities of the target organization

(2) Analyze with a view of organization paradigm
  This organization is evaluated as open type organization form their attitude of exchanging constructive opinions frequently. The support approach of this case was open type approach of the methodology proposed in section 2. These approach were suitable to this type of organization because of the result of this case was more than expected. From this, it is confirmed that open type approach in the proposed methodology in section 2 is suitable to open type organization.

5. Conclusion
  In this paper, we proposed and evaluated the effectiveness of a methodology of performing and providing development support activities in reference to a service approach and the Constantine organization management paradigm. From these, it can be said that this methodology can externalize a portion of an expert SEPG’s skills and experiences, and increase the potential for development support activities to achieve their expected result in order to deal with the problem that the outcomes of support activities for improving the abilities of software development organizations are heavily dependent on the skills and experiences of SEPG individuals.

  We intend to continue verification of the methodology we proposed and conduct more intensive study to refine it.

References
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