

Industrial Paper**Knowledge Transfer of Project Management Technology Using The PBL Method**

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Abstract - Process improvement activities are important in organizations that develop software systems. Using Capability Maturity Model Integration (CMMI), we are working towards achieving maturity level 3. However, if the activity breaks down, the resources of the indirect department become unnecessary, and it often remains a project management office (PMO). However, the PMO's role has not been specifically defined, and in many cases, the original purpose has not been achieved. In this research, we use the case of a company that completed CMMI level-3 activities and have outlined the role played by the PMO. In this case, after pointing out the challenges, we propose the role of process improvement and the method of transferring technology to the project manager as an in-house consultant. When this method is applied to actual development sites, it is expected to effectively improve the reuse rate and implementation of autonomous improvement of Project Manager (PM).

Keywords: CMMI, Project Management Office, Knowledge Transfer

1 INTRODUCTION

According to the Capability Maturity Model Integration (CMMI) Maturity Profile [1] published by the CMMI Institute, CMMI [5] appraisals have been conducted continuously in many countries around the world every year. CMMI is supported worldwide as the most reliable tool in the field of process improvement.

When CMMI was introduced in Japan around the year 2000, the level of competition was that of a temporary boom and focused on not only improving process but also achieving CMMI Maturity level 3. However, it has now been recognized as a perpetual and continuous activity as part of the organizational culture.

When the organization aims to achieve CMMI Level 3, the organization needs a lot of resources to conduct process improvement activities. This resource is named the Engineering Process Group (EPG).

However, once CMMI Level 3 is achieved, the next goal is to maintain this level of surveillance for implementation once every three years. The activity itself is not profitable: From an organizational point of view, EPG is an indirect operation and a cost center. After achieving the preliminary organizational goals, personnel in the indirect department should be transferred to a profit center or assigned a new meaningful role as an indirect department. However, CMMI

activities need to be continued and the EPG cannot be abolished.

Therefore, the issue is to define the role and responsibilities of the EPG in the second stage of process improvement. In this context, the study proposes the way in which the project management office (PMO) may be established after achieving a CMMI maturity level and evaluates its validity through application to the actual organization.

As part of a previous study in this field, the authors proposed establishing a methodology for process improvement activities across the entire organization that will continue after achieving CMMI level 3. However, we have cautioned that CMMI's appraisals have rated the achievement of process improvement across the organization based on an evaluation of a few representative projects. We have proposed a methodology for disseminating CMMI activities throughout the organization [2]. However, at this stage, it has not been proposed as a PMO-based activity.

Various consulting firms have proposed that the organization of the EPG be transferred to the PMO after the introduction of CMMI activities. These proposals emphasize the cost improvement through in-house consulting by PMO rather than paying consulting fees to external consulting firms [3], [4].

However, there is no case where experienced PMOs give technology transfer to PMs and propose continuous process improvement using Project Based Learning (PBL).

2 ROLE AND ISSUES OF PMO

After achieving the organizational goals of CMMI activities, the EPG often turns to the PMO to continue to support project management and process improvement. The PMO is defined as a team that supports individual project management in an organization across the board. In general, the role of the PMO is as follows:

- ♦ Standardization of the project management system
- ♦ Human resource development including training on project management
- ♦ Project management support
- ♦ Coordination of resources and costs between projects
- ♦ Development of a project environment tailored to individual companies
- ♦ Other related project management tasks

Because the PMO is an indirect operation, sufficient rationale for the survival of the PMO is required. The long-term role may be CMMI surveillance measures, and the short-term role, support activities such as reducing overload of PMs. If the PMO absorbs the work associated with CMMI activities, it can survive by providing a value-added role.

However, the PMO often does not successfully reduce the burden of the project manager (PM). Here, we will discuss the role of the PMO through a case when a company that achieved CMMI Level 3 established a PMO.

2.1 PMO Failure Case

Company Z started activities of ISO9001 and CMMI about 10 years ago, passed ISO9001 certification registration 3 years later, and achieved CMMI maturity level 3 in 8 years. The management has a strong commitment to CMMI and about 10 EPGs were in operation. Company Z's EPGs were focused on project guidance and included some fixed-term employees who had passed the retirement age of 60.

In the project construction period, development man-hours are set in line with the estimate. About 15% of the entire project term is appropriated for management operations [6], [7]. Furthermore, introducing CMMI increases overhead man-hours by about 10%. Therefore, when CMMI is introduced, about 25% of the total project man-hours would go toward the management, and the delivery date may be delayed due to unnecessary management costs. Therefore, the reduction of management man-hours after achieving CMMI level 3 has become an issue.

The PMO replaced management-related activities with project support. If the delay in delivery date is resolved by this PMO, the PMO activities are considered as value-added activities and it would be a position with merit for both.

PMO was substituted for the following management work as a specific effort to reduce the load on the PM:

- ♦ Create weekly reports
- ♦ Create progress meeting minutes
- ♦ Create the trail necessary for the appraisal

2.1.1 PMO Reporting

The project situation is reported directly to the Executive Committee at a meeting held every Monday. If the project status is not reported in a timely manner by all executives attending the meeting, the management cannot manage the project status.

Until now, the PM has delivered project reports in Company Z. However, in small-scale organizations, the creation of weekly reports tends to be delayed because the PM is involved in both management and development. There have been many cases where reports were lacking in politeness. Since the PMO has EPG knowledge, they have learned to prepare the risk and problem management sheets. They have delivered plausible reports and there have been no delays in

reporting. They are also valued by the Executive Committee, and the PMO was recognized as a value-added group.

2.1.2 Create Progress Meeting Minutes

Since the management meeting is held on Mondays, the project progress meetings are held on Thursdays. The project progress meeting reports regular issues that occurred in the week. The PMO attends the progress meeting of the project-in-charge and provides minutes of the meeting. Although the progress meeting had been held until the creation of the PMO, creating the record was the individual responsibility of participants, and no official minutes were captured for the project.

Company Z was a small-scale organization, and was not able to prepare, review, and approve official minutes in weekly progress meetings for small-scale projects.

However, CMMI has processes that require the creation of minutes, such as project progress management, official reviews, and peer reviews, and they tend to be short. The PM therefore took charge of this meaningful activity, but he was not interested in it.

2.1.3 Creation of The Evidence for Appraisal

To pass three-year surveillance, evidence of ongoing practice must be presented. For example, to pass the configuration management process, a configuration management plan must be prepared, and the evidence for carrying out the activities according to the plan must be presented. In addition, when modifying the source code, there is a procedure to check out the source code from the repository, modify the file, hold the configuration management committee, analyze the impact, and check in.

Configuration management was performed at Company Z, but there was no custom of creating forms and recording the contents of changes each time. The PMO substitutes for the difficult task of countermeasures and highlights the added value of the PMO.

In small organizations, the PM is relatively young and the PMO was able to compensate for their lack of skills. A proper weekly report has been submitted to the Executive Committee every week. Surveillance that will be conducted once every three years will also pass with confidence. Since the PM burden has been reduced with the introduction of PMO activities, this method seems to have benefits for both parties.

However, in this method, the PMO is only a substitute for the PM. Furthermore, the PMO sometimes reported the causes of problems and measures to prevent recurrence, to the Executive Committee, without the consent of the PM. The management said, "Every time a problem occurs, we ask for measures to prevent a recurrence, but it is not improved at all." Measures to prevent recurrence were written by the PMO without confirming the problem with the PM.

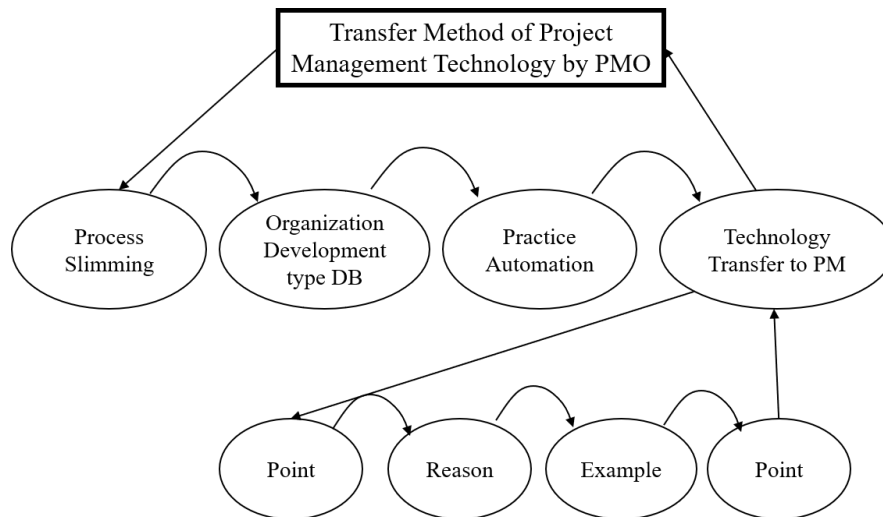


Figure 1 : Framework for the PMO work in this study

The lesson learned from this case is that although the involving the PMO is a value-added activity, the method should be aligned to the process of reducing the burden of the PM. The role of the PMO is to support process improvement and not of a PM substitute.

2.2 Issues to Be Solved

These issues we observed in 2.1 are not specific to Company Z, but are commonly seen in many companies.

The importance of process improvement and project management is recognized widely. Even if one hires an external consulting company and develops an EPG in-house, no methodology has been proposed for how to use the resources after the activity has ended. Defining the PMO's value-added activities remains an issue to be resolved.

3 TRANSFER METHOD OF PROJECT MANAGEMENT TECHNOLOGY BY PMO

In this research, after defining the role and responsibility of the PMO, we propose a method of continuous improvement of the process by PMO.

3.1 Basic policy

In this research, the PMO not only reduces the burden of the PM but also inherits the EPG and is responsible for post-approval in-company process improvement. Unlike the EPG, which is a permanent organization, the PMO has the role of transferring the completed process to the next-generation PM.

3.2 Framework

In this study, we propose a framework for the PMO work that consists of process slimming, organization development-type database creation, practice automation, and technology transfer to PM. The first three are organizational-level activities, and the fourth, a project-level activity. Technology

transfer to the PM follows the PREP method. The PREP method first conveys the conclusion, then explains the reason, reinforces the reason with the case, and finally presents the conclusion again. This is then classified based on importance of activities (Point), reasons (Reason), specific examples (Example), and situations where activities are important (Point). This framework is shown in Fig. 1.

3.2.1 Process Slimming

Achieving CMMI's maturity level cannot be avoided through CMMI's "embedding." However, CMMI has been developed as a procurement model for the US Department of Defense, so a large-scale project is assumed. After achieving the CMMI level, the company selects only what is needed and slims the process by removing the excess. However, there are many practices that are not as familiar as domestic practices.

3.2.2 Organization Development Type Database Creation

In a system development organization, projects with the same degree of development and difficulty are repeatedly implemented for similar customers. By classifying the development type of the organization and converting it into a database, standardization for each customer is possible.

Next, the individual information of the classified forms is sanitized, the past information is accumulated in a database for each customer, and the reuse environment is constructed.

3.2.3 Practice Automation

When creating a form for each process area, the form is retrieved from the organization's database and the organization management profile is automatically embedded.

The basis of project management is PDCA (Plan, Do, Check, Act). At the project start stage, make a project plan document and execute the project according to the plan. However, in the upstream process, the load on the PM is large, and there is no time to create a detailed project plan. As a result, project management cannot be planned. Database forms classified by organization type can be used without much change in repeatable projects.

Therefore, we automatically generate forms as much as possible using historical project information accumulated in the organization.

3.2.4 Technology Transfer to PM following The PREP Method

Technology transfer is to transfer management skills to inexperienced PMs through development projects. Generally, the practice is to fill in the form given, even if it was to create a plan for an unknown project. This practice does not outline the intention clearly.

In this study, we use the concept of the PREP method to make the PM learn the management by the PDCA cycle. The PREP method first conveys the conclusion, then explains the reason, reinforces the reason with the case, and finally presents the conclusion again.

First, the purpose of the practice is clarified, and then its necessity is explained through concrete examples. By explaining the purpose of implementing the practice once again, and being convinced by the PM, management skills are passed on.

4 EVALUATION OF APPLICATION

In this chapter, we verify the effectiveness of our proposal through a case of actual application of this framework.

4.1 Case

Company A has approximately 400 employees and is developing control systems for the automotive industry. About half of the employees are in charge of development. The project period is about three months, and many are small projects with less than five project members. One engineer can participate in projects up to four times a year. Usually, about 10 projects of the organization are in operation.

Company A hired a foreign consulting firm to introduce CMMI. In order to implement unified practices in the organization, CMMI is required to create organizational standards, and each project should carry out project management according to the standards.

Company A obliges to execute the project by using CMMI's development work standard and Excel-based format, brought in by the consulting company.

Development work standard corresponds to the process area of CMMI, and refers to "requirement definition standard," "project plan standard," "progress control standard," etc. An Excel-based format refers to work products such as "project

plan document" and "Work Breaking Structure (WBS)" created when implementing project management using development standards.

However, this consulting company created consulting materials based on the project management standard originally used by the US headquarters. It is a development standard for large-scale projects. It is hard to say that it is suitable for small-scale companies like Company A.

Company A compared with other companies' proposals at the selection stage of the consulting company. Only this company provided a set of development standards and formats for use in CMMI. Company A adopted this consulting company because there was no effort to create such development standards and formats from scratch.

Company A achieved CMMI Level 3 and is preparing for surveillance after 3 years. Ten employees who worked as EPGs until CMMI Level 3 were considered. Four were transferred to the department, and the remaining six became PMOs who were positioned in the project support team.

4.2 Application of This Framework

4.2.1 Process Slimming

Company A used development standards and formats provided by a consulting company, until CMMI Level 3 was achieved. The CMMI Achievement Appeal is conducted by interviews and document review. The questionnaire is published in advance. If all the forms given by the consulting company were prepared and the questions were answered, CMMI Level 3 could nearly be achieved.

In the first round of CMMI activities, Company A prepared the form of the consulting company on a persuasive basis in preparation for the appraisal. However, after the official appraisal, it was found that several forms were created just for the preparation of the appraisal, and nearly 20 were eliminated.

Therefore, the process was streamlined by eliminating forms that were considered unnecessary. Table 1 presents an example.

4.2.2 Organization Development Type Database Creation

Many customers of Company A are major Japanese automobile manufacturers. Customers are divided into company T, company H, and company N. For customers, projects of the same size and the same degree of difficulty are implemented in a repeating manner. Therefore, the development type was classified for each customer to be delivered and put into a database.

After a certain period of time, the most commonly used format among the three customers was taken out, and customer names and personal information were sanitized, standardized, and stored in the database.

4.2.3 Practice Automation

Company A is doing SAP's ERP (Enterprise Resource Planning), the year after CMMI's level 3 activity has ended. Profile information of the project of the organization is entered into ERP when the contract is established. The ERP information is then downloaded to an MS-Excel file.

When a development project creates a project plan, ERP information is acquired by MS-Excel, and the information is automatically reflected in the standardized project plan.

Next, similar databases were searched based on customer, project schedule, difficulty level, etc. which were classified by T, H, N companies, and those that could be reused at the project planning stage, were also extracted; for example, WBS, risk management ledger, configuration management ledger, etc. If these are similar projects, the same task occurs in almost the same process. As a result, the resulting risk management ledger could be reused.

4.2.4 Technology Transfer to PM following The PREP Method

At Company A, when a project was launched, one PMO was assigned to the project and played the role of a tutor for PM, transferring the technology to the PM by the PREP method.

(1) Project Report (Point)

The role of the PM is project management. However, if young people become PMs without management experience, they would not know what must be done in every phase of the project life cycle. Therefore, the PM was made to participate in the actual project, and the importance of the project management method was highlighted through the PBL method.

Project management is performed in the PDCA cycle. Table 1 shows the relationship between PM and project members throughout the project life cycle.

The project planning and progress management phases are important management skills of the PM. Therefore, Company A taught the progress meeting in the first project to the PM, and in the second cycle, the PM learned to make a project plan. In the third cycle, the PMO became an observer and decided to implement project management through the PM.

(2) Gathering Information for Reporting (Reason)

PM is an intermediate manager. The middle manager refers to the position that reports to the upper management of the organization. In order to report to upper management, the

Table 1 : PDCA Cycle of Project Management

	P	D	C	A
PM	Create a Project Plan		Progress Meeting	
Member		Development		Correction

PM correctly understands the current situation of the project and reports the problems in a timely manner.

At Company A, when the project was successful, weekly reports were made by briefly explaining the issues described in the issue management sheet. However, if there is a delay in progress or a technical bottleneck, the upper management will request a detailed report. For this purpose, PMs need to hold weekly progress meetings and collect the information requested by upper management.

In the first cycle, the PMO chaired the progress meeting and held the progress meeting using the CMMI's agenda. Company A is supposed to update WBS before coming to the weekly progress meeting. At the progress meeting, we reviewed the Earned Value Management (EVM) value of the project and interviewed each project member's progress, problems, issues, and risks. This information was collected and reported to the reporting manager.

In the second cycle, I participated in the PMO from the preparation of the project planning documents. Project management is performed by the PDCA, so project plans are prepared first and then managed for progress. However, even if you do not know the purpose, this cannot be understood through merely creating the form. Therefore, the PM had experience in managing the progress meetings and understanding the type of management to be followed with different projects. The project plan was prepared after the meeting.

Company A defines the life cycle process at the project planning stage. Tasks performed in every process are described in the WBS. The output for each process is described in the configuration management register. The first activity is to confirm the output of the process at the actual progress meeting and the second activity is to plan the output of the process at the project planning stage.

(3) Form to be created (Example)

The practices to be implemented as project management are clear. The PM needs to learn all the practices, but as a concrete example of technology transfer, he followed the practice that reversed the PDCA cycle as mentioned above.

- ◆ Report content requested by upper management
- ◆ Gathering information for accurate and timely reporting
- ◆ To manage progress meetings and to collect information weekly
- ◆ Enter Gantt chart, WBS, issue management ledger, risk management ledger interviewed at a progress meeting
- ◆ List of work products to be created in each process
- ◆ Process plan such as configuration management ledger that defined the output for each process
- ◆ A project plan document summarizing each process plan

By making a project plan document at the end of the technology transfer, we have made it possible to understand different process for the entire project life cycle.

(4) Report for Clarity (Point)

For organizations achieving CMMI Level 3, the Project Progress Meeting agenda is in the organizational standard. At the progress meeting, interviews with project members will be conducted according to the agenda, and the minutes of the progress meeting will be recorded. A project management trail is kept and used as evidence when conducting an appraisal.

However, the practices required by CMMI are minimal. Even if the information is collected by holding a progress meeting in line with the agenda, it may not be consistent with the reports that the upper management wants to hear. There are times when you call the site many times during closed hours.

The project report is finally reviewed at the management meeting. Even if the project was managed according to CMMI, number of issues were pointed out at the management meeting, and new issues were generated. As a result, management also found that CMMI was not useful.

However, the management complained that extra work would be required in the following process: project plan document → progress meeting → reporting to upper management and implementation. We set the appropriate agenda at the progress meeting and learned how to collect the necessary information.

It was understood that the project plan document would not be prepared by management if it was inaccurate, in order to manage the reality at the progress meeting. The project was planned on more accurate grounds.

4.3 Application Results

4.3.1 PM Recognized Autonomous Management

The PMO is a role set up for a fixed period, and not permanently. The number of indirect personnel should be reduced if the PM manages the project autonomously. This activity was started, and technology transfer activities were conducted for the PM. After three rounds of short-term projects were evaluated using the PREP method, the PM, who could perform autonomous project management by himself, finished with the PMO's support. This situation is shown in Fig. 2.

4.3.2 Format Reuse Rate

At first, the project plan was prepared from the beginning using the format which closely followed the given blank sheet. In the third year of introducing this activity, about 60% of the preparation of the project plan had been automated. It became better for the PM to manually input the remaining 40%. This is because project planning documents and other forms used for each client is collected, converted to DB, sanitized, and reused.

Necessary information for clients is almost the same, so it can be reused. Information required for each project automatically inputs from the Excel file output from ERP. Nearly 48% of these improvements have been automated. This situation is shown in Fig. 3.

4.3.3 The Contradiction Between Measures Against Appraisal and Slimming

Company A's form was brought in by an external consulting firm for appraisal. At Company A, the form was streamlined and made easy to read.

CMMI passes if a practice called REQUIRED is implemented. There is no problem in slimming the "nice to have" part. This caused the metamorphosis. It is inevitable that this activity "fits in the mold." It was decided that the unnecessary aspects of the organization would not be included in the form.

We repeated the procedure of slimming down a part that was not actually used even though it was introduced as a full set. Moreover, only the passing of the appraisal was maintained. As a result, a lean development standard was completed, conforming to the spirit of CMMI.

4.3.4 Inconsistency of Form Creation Automation and PDCA

Project management is to create a project plan document and manage it according to the plan. If more than 60% of the project plan document is generated automatically by automating the form, the perspective of planning the project is missing. There is a meaning in labor saving. However, if you do not plan the project carefully in the upstream process of the project, it will be overturned.

About 60% of the format automatically generated in this study was client information or the project profile output from ERP. The individual information on the project is about 40% of the rest. This part was created manually by the PM.

There is an idea called Pareto's law. If 40% of the project plan is hand-crafted by the PM, it will be sufficient as a project plan. Specifically, information on project schedule and process, allocation of resources and assignment of personnel have completed.

The project plan of Company A is created with an MS-Excel of about 12 sheets in one book. In terms of the number of sheets, eight sheets were automated. The remaining 4 sheets were created by the PM. This part implements the project plan firmly and is in line with the spirit of PDCA.

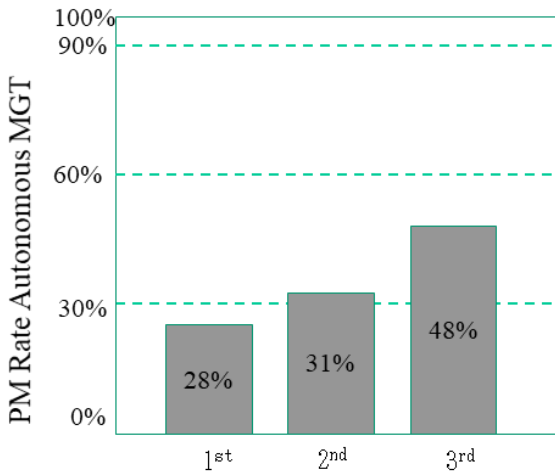


Figure 2 : PM Rate recognized autonomous MGT

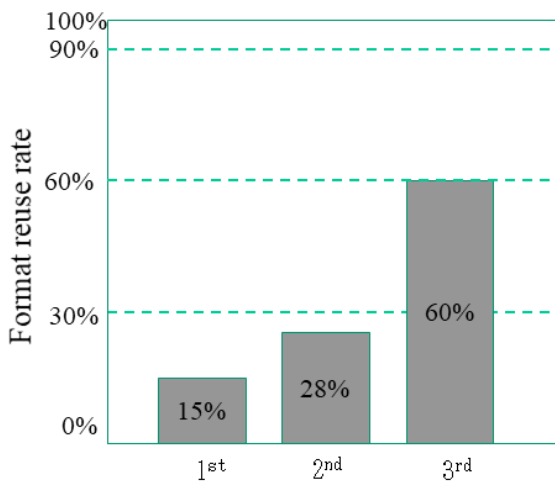


Figure 3 : Format Reuse Rate

5 DISCUSSION

5.1 Background of Process Improvement

Process improvement focuses on the idea that it is necessary to improve the underlying process to improve product quality, as suggested by the saying that "good quality comes from good processes." Even if it is difficult to improve the quality directly, it would become possible if the manufacturing process is improved. Therefore, process improvement methodologies are widely discussed globally.

However, the challenge is to improve the "current situation" to "the way it should be," which would vary greatly across organizations. The model approach is commonly used to improve processes. Under this method, a methodology generally called a best practice model, such as the CMMI, is introduced, and the level is improved according to the rank of the maturity model.

However, it is not easy to implement the CMMI, as the first steps for its introduction into an organization are often unclear. In many cases, a consulting company must be hired for guidance. Contrastingly, from the standpoint of a

consulting company, improving the process means achieving the CMMI level, and for example, a contract of "achieving CMMI level 3 in 3 years" might be signed with a client. To this end, development standards and forms are prepared in advance and provided by consulting companies and are used by development projects to achieve the CMMI level.

5.2 Process Improvement and Project Management

The basis of project management is PDCA. In this procedure, a project plan is created in the upstream process of the project, according to which the project operates, and the project is managed through proactive management. When creating a project plan, the project scope is defined in a meeting with the customer, the target requirements during the project period are agreed upon, the scale and man-hours are estimated, the budget is determined, and the planning procedure is undertaken.

However, as noted in Section 5.1, when project management is included in the large flow of process improvement activities, in reality it becomes a project plan in name only rather than an actual project plan. The focus is reduced to merely filling in the blanks in the form.

Even if a relatively young PM, who has not yet gained sufficient experience, creates a project plan for this purpose, this can only be seen as a countermeasure against the CMMI appraisal.

5.3 Purpose Consciousness by PREP Method

In the research, a PREP method was proposed. First, it explains the practice (Point) to be implemented in the project management and the reason (Reason) for its implementation. Next, it shows a specific example (Example), and helps the PM understand the significance of the practice (Point) to be implemented.

In this study, I explained to the PM that project management is incorporated in the workflow of a company. The company must report the progress of the project at the management meeting. Therefore, a project report must be prepared every week.

To make the weekly report, a progress meeting must be held weekly to understand the plan's goal. A project plan is required for the management. To create a project plan, it is necessary to estimate the scale and man-hours that will serve as its basis.

To provide an accurate estimate, the project scope and requirements must be defined. We decided to carry out project management in this way, after understanding the each of the company's practices and the reason for its implementation.

However, when adopting a process improvement such as CMMI, achieving CMMI level 3 becomes a goal, and even if the PM does not recognize its necessity, it leaves a trail in the form of appraisal measures. Often, it is necessary to achieve this goal. If such a thing is continued for many years, it will

become perfunctory with the result that the essential project management is not carried out. This seems to be the reason that CMMI, which was very popular between 2000 and 2010, is now almost unheard of.

5.4 Role of PMO after CMMI Activities

In this study, we proposed a method in which the resources that had been active in the EPG were left in the organization as PMO after the CMMI activities were completed. The EPG has most extensive knowledge about process improvement in the organization and is suitable for to mentor young PMs. The PMO joined the project and demonstrated a real example of the practice to be implemented by the PREP method, and the need for it, through a model.

In this study, the PBL method was chosen for PMOs joining the project and to train young PMs in project management. The PMO is an indirect department and a cost center and the company would like to reduce the number of staff to the extent possible. In such a case, even after the completion of CMMI activities, we can show that maintaining the CMMI level achieved by the PMO is important. The PM can also learn project management based on CMMI under the guidance of a PMO. This will allow for a mutually beneficial relationship.

6 CONCLUSION

This study proposes that, after the CMMI's activity is completed, the resources that were active in an EPG continue to function in the PMO.

As it is difficult to achieve CMMI Level 3 alone, we hire an outside consulting company. However, it is not desirable to keep paying high external consulting fees. It is therefore desirable for knowledge-rich EPGs to be in charge of process improvement as in-house consultants and to transfer technology to young PMs.

Many organizations set up PMOs after CMMI activities. However, they prepare weekly reports and minutes and collect CMMI appraisal trails, which does not fulfill the roles and responsibilities of effective in-house consulting.

In this study, we focused on the role of process improvement in PMO. The activities required for the organization were identified and narrowed down. Next, by classifying the forms for each customer, we added it to the database and made it reusable. The knowledge was transferred to young PMs using the PREP method in which the PMO played a significant role.

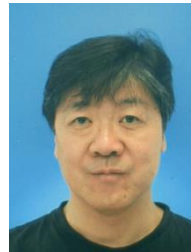
In a company that adopted the proposed method, the process reuse rate increased, and the PM began to carry out project management after acquiring knowledge of process improvement, which was considered to be an effective method.

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