Internalization Method of R&D Project Management Knowledge in Stage Gate Analysis

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Abstract

Stage gate analysis is a method of reviewing previous R&D projects from the viewpoint of the stage gate method and extracting project management knowledge, which we proposed at PICMET'05. Stage gate analysis clarifies success and failure factors of the project with a cause-and-effect relation map. The extracted project management knowledge is stored in a project case database. However, it is not trivial for project managers to internalize the knowledge using the case database. This paper proposes the "internalization workshop" method to internalize the project management knowledge based on the scenario planning approach. The method selects and shows similar success and failure scenarios from the case database to the managers and prompts them to imagine and analyze future scenarios of their ongoing project. We apply the method to R&D project managers and show our method has a positive effect on internalization.

1. Introduction

R&D management knowledge transfer is effective for improving the success probability of R&D projects because success or failure of these projects largely depends on quality of management rather than quality of technology. Therefore, project managers should learn best practices from previous projects. Although many success stories of R&D projects have been reported, it is difficult for managers to understand and internalize knowledge and skills from these stories. The stage gate approach (Cooper, 2001) is popular and effective framework for managing ongoing R&D projects. Stage gate analysis is a method of reviewing finished R&D projects from the viewpoint of the stage gate method and extracting project management knowledge, which we proposed at PICMET'05 (Uchihira, 2005). Stage gate analysis clarifies success and failure factors of the project with a cause-and-effect relation map. The extracted project management knowledge is stored in a project case database. This paper analyzes a process of internalization of the project management knowledge, and then proposes the "internalization workshop" method to support internalization based on the scenario planning approach. The method selects and shows similar success and failure scenarios from the case database to the managers and prompts them to imagine and analyze success and future failure scenarios of their ongoing project. We apply the method to R&D project managers of a certain Japanese electronics manufacturer and show our method has a positive effect on internalization.

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2. Knowledge of R&D Project

Decision making with respect to an R&D project requires several types of knowledge (Fig.1):
(i) Technology and market knowledge
(ii) Management knowledge
(iii) Human network knowledge

Technology and market knowledge is embodied in a variety of sources, including technical papers, patents, prototypes, exhibitions, and products. Engineers become accustomed to making these sources. Human network knowledge is also important for team building and customer relationships. Management knowledge consists of knowledge of routine procedures and knowledge of project management. Knowledge of routine procedures is usually described in manuals by an administrative organization. We focus on project management knowledge, which is utilized to make correct decisions at every stage of an R&D project, but is relatively difficult to transfer.

In system integration projects, the project management guidelines (PMBOK: Project Management Body of Knowledge) (PMI, 2004) state that project management knowledge should be recorded as project summary reports. In R&D projects, the management knowledge is tacit for the most part. Since there is no systematic method to describe it, knowledge is usually transferred through on-the-job training. Sometimes, project management knowledge is recorded as success and failure stories/cases. However, there is no structural framework to represent these stories. We have introduced “Stage Gate Analysis” (Uchihira, 2005) to represent these stories/cases from the perspective of stage gate management.

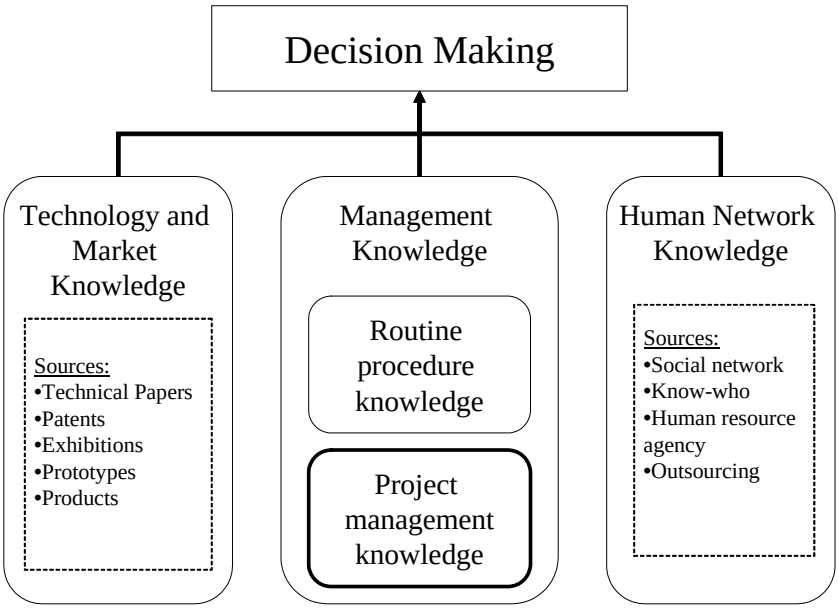

Figure 1. Knowledge of R&D Project

3. Knowledge Transfer of R&D Management

A great deal of research has been done on knowledge transfer (Szulanski, 1996) (Grant & Gregory,

1997) (Cohen & Levinthal, 1990) and knowledge retention (DeLong, 2004). We assume a logical model of knowledge transfer (Koruna, 2002) shown in Fig. 2. In this model, knowledge transfer consists of 2 steps: externalization and internalization. Both steps require some supporting methods and tools for smooth and effective transfer. We focus on intra-organization knowledge transfer in an R&D laboratory, in which stage gate project management (Cooper, 2001) is performed. This paper proposes a knowledge transfer system utilizing "Stage Gate Analysis" (Uchihira, 2005) for the externalization step and "Internalization Workshop" for the internalization step (Fig. 3).

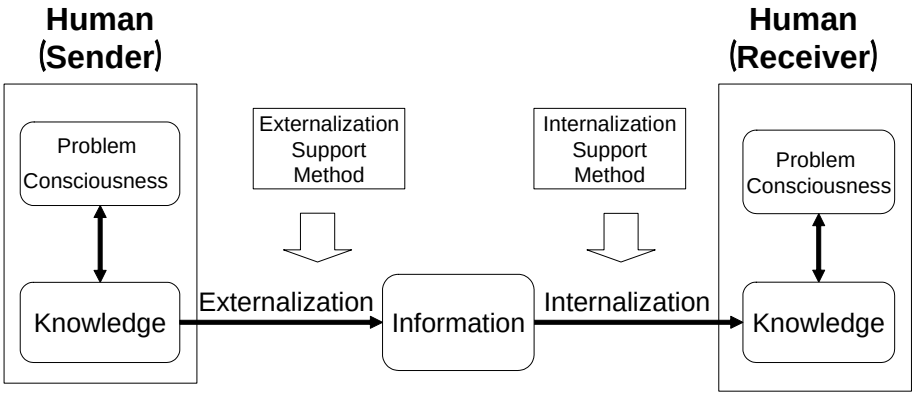

Figure 2. Logical Model of Knowledge Transfer

In the externalization step, stage gate analysis summarizes the history of previous projects and clarifies success and failure factors with a cause-and-effect relation map, and then stores it in a project case database (Fig. 4). In the internalization step, a project manager of an ongoing project learns project management knowledge from similar project cases extracted from the database. The internalization workshop is a method of systematically supporting internalization. The following chapters explain these steps in detail.

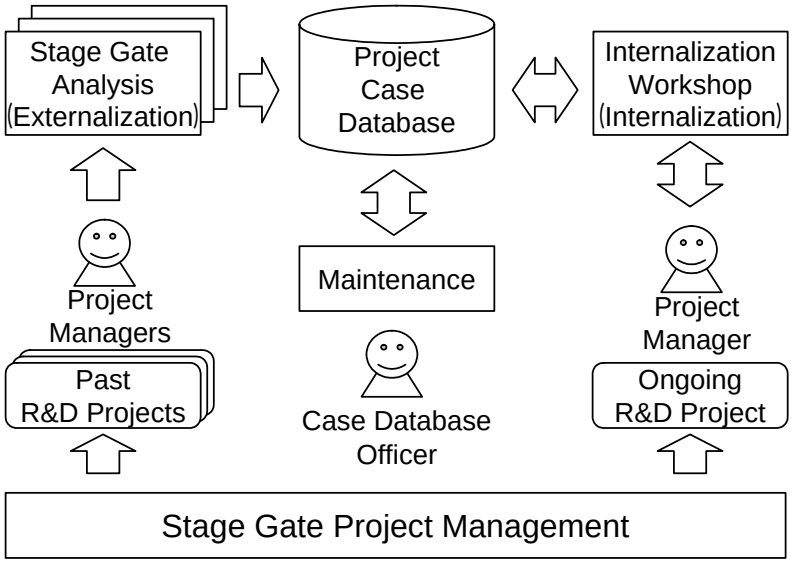

Figure 3. Proposed Inter-Organization Knowledge Transfer System

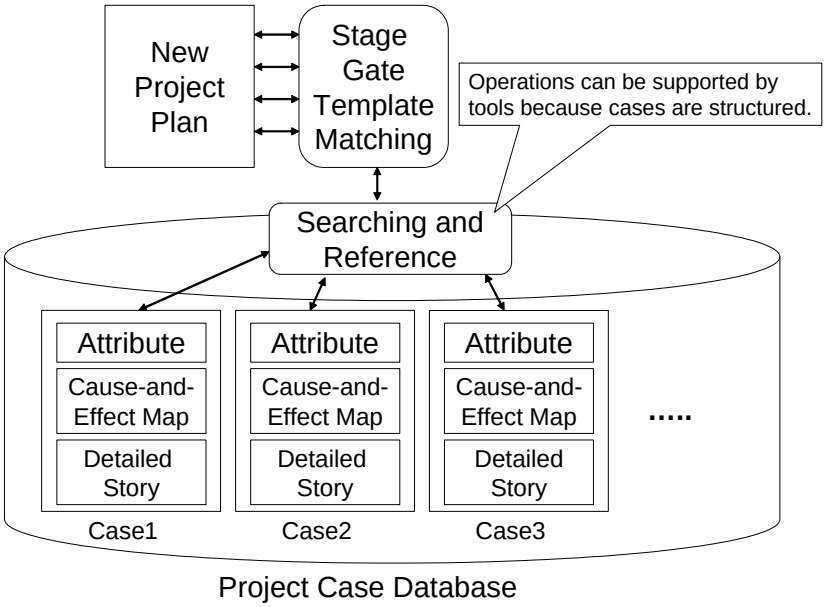

Figure 4. Project Case Database

4. Stage Gate Analysis

The stage gate method (Cooper, 2001) is used to manage, direct, and accelerate R&D processes in many companies (e.g., 3M, Kodak, General Electric, Motorola, DuPont, Toray, Asahi Kasei). The main purpose in applying the stage gate method is to provide guidelines for project managers. The method suggests what the manager should do at each stage and what the important checkpoints of the stage are. Although these guidelines of the stage gate method are of help, we still recognize the need for backward review after finishing projects ("Stage Gate Analysis") and aim to store practical tips of R&D project management in a reusable form for subsequent projects. The following stage gate analysis method is proposed to satisfy the above requirements.

We adopt a customized stage gate method for R&D projects concerning software and services. Our method consists of 7 stages and 6 gates (Table 1). The proposed stage gate analysis consists of the following 4 steps. As we only explain its outline, please refer to our previous paper (Uchihira, 2005) for a detailed explanation.

- Step1: Story-telling
  Make a full story of the project according to historical records and decompose it into 7 stages.
- Step2: Template matching
  Associate activities and conditions with norms of stages and gates specified in Table 1.
- Step3: Analyzing
  Analyze success and failure factors using a cause-and-effect relation map (Fig. 5). In the cause-and-effect relation map, the positive relation (solid line) means that there is actual positive causality between activities and conditions in the target project. The negative relation (dotted line) means that causality exists between weak/poor activities and unsatisfied conditions. For example, a gate G33 is unsatisfied because an activity S33 is poor in Fig.5.
- Step4: Summarizing
  Summarize analysis and store findings in the project case database (Fig. 4).

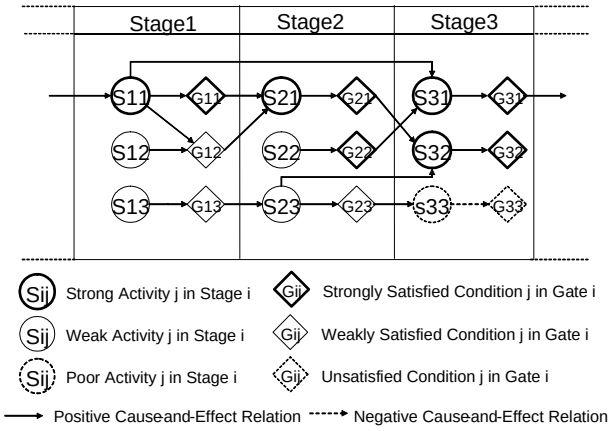

Figure 5. Cause-and-effect relation map

5. Internalization Workshop

A typical method of supporting internalization is OJT (on-the-job training) and coaching. For example, reviewers involved in the stage gate review, who are experienced managers, can give advice to the manager of the ongoing project by referring to similar project cases. The internalization workshop is another method of supporting internalization based on the scenario planning approach.

The internalization workshop is designed to improve capability to imagine future scenarios. Consideration of possible future scenarios promotes correct decision making by R&D project managers. Figure 6 shows the knowledge internalization model from the scenario planning viewpoint.

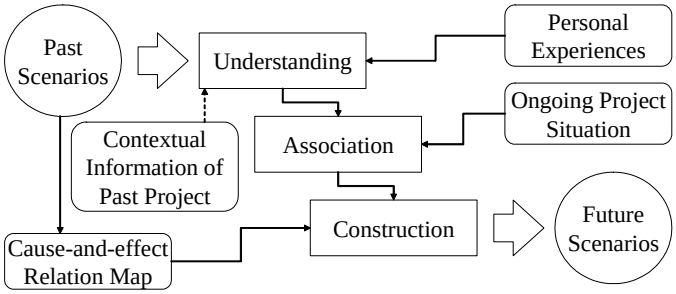

Figure 6. Knowledge Internalization Model

Knowledge internalization consists of three phases.

(i) Understanding
Understand success and failure scenarios of past projects. In this phase, contextual information of the past project and personal experiences of the manager facilitates understanding.

(ii) Association
Associate these past scenarios with the situation of the ongoing project. In this phase, correct

understanding of the ongoing project situation facilitates rich association.

(iii) Construction

Construct future scenarios of the ongoing project. In this phase, imagination capability is required.

The internalization workshop facilitates these phases from the stage gate analysis viewpoint. Participants in the workshop include a project manager, members of the project team, and a workshop facilitator. The internalization workshop proceeds according to the following steps (Fig.7).

- Step 1: The facilitator selects a past project *PP* similar to the ongoing project *CP* from the project case database.
- Step 2: The project manager and members generate future possible scenarios of the ongoing project *CP* by the scenario planning approach (Schwartz, 1996).
- Step 3: The project manager and members understand and discuss a story of the past project *PP* (Fig.8 (a)). The facilitator complements contextual tacit information.
- Step 4: The project manager and members associate scenario fragments (activities and conditions of the cause-and-effect relation map) of *PP* with ones of *CP* (Fig.8 (b)).
- Step 5: The project manager and members construct additional future scenarios of *CP* induced by the above association of the cause-and-effect relation map (Fig.8 (c)).
- Step 6: The project manager lists up action items in the current situation based on constructed future scenarios.

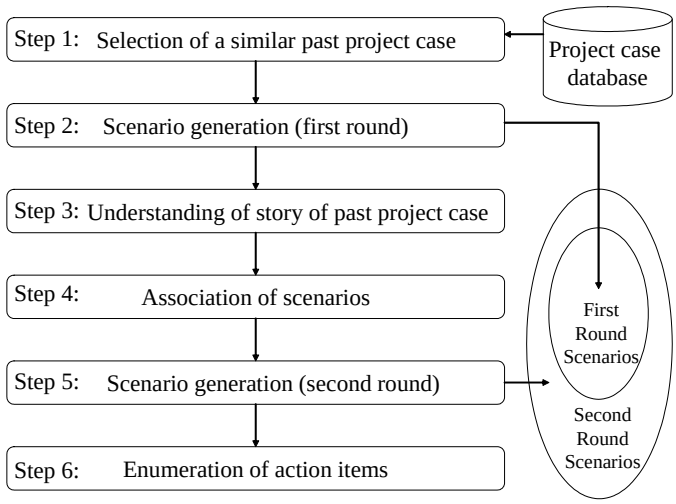

Figure 7: Procedure of Internalization Workshop

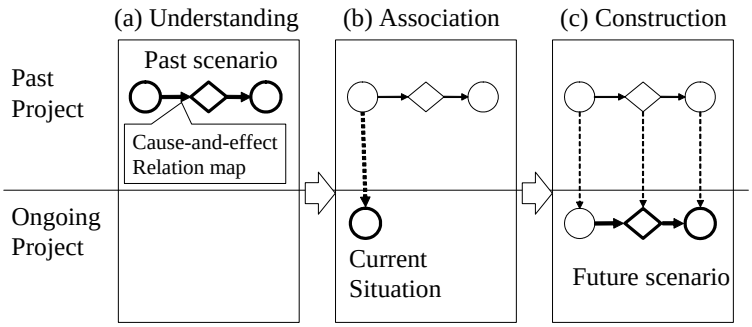

Figure 8: Typical Image of Internalization Workshop Procedure

6. Discussion

Since the proposed method is intended to improve success probability of R&D projects, an evaluation of the method should be performed by observing how projects proceed successfully. However, it requires several years. Therefore, we evaluate the method by counting the number of generated future scenarios during the internalization workshop.

We apply this method to a certain project manager and members of a project team in an R&D division of a certain Japanese electronics manufacturer. The target of the project is construction of system engineering methods and tools. After the internalization workshop, the project manager and members can generate more than 1.5 times as many as original scenarios.

Internalization requires three types of capabilities: understanding, association, and construction. For example, a new manager transferred from another department may lack the capability of understanding because he doesn't know contextual tacit information of the project. An inexperienced manager may lack the capability of association because he has few receptors to associate past scenarios with the ongoing project situation. A veteran manager may lack the capability of flexible scenario construction because he tends to sticks to the traditional scenarios.

The internalization workshop should be customized according to these managers' capabilities. For example, the more detailed explanation of the project including contextual information is needed for the new managers to understand the past project, the more attentive support by the facilitator is needed for the inexperienced managers to associate, and the cause-and effect relation maps of up-to-date projects can help rich scenario construction for the veteran managers.

6. Conclusion

This paper presented the knowledge transfer system of R&D projects which consists of stage gate analysis and internalization workshop. The project managers who experienced the workshop stated that this system seems to work well in practice. In future work, we intend to apply this system to a variety of R&D projects and refine the logical model and the procedure of the internalization workshop.

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Table1: Stage Gate Process for Stage Gate Analysis

Stage/ Gate	**Activities and Conditions**
Stage0	**Idea Discovery:** Pre-work designed to discover and uncover opportunities and generate ideas.
Gate1	Idea screen from 3 viewpoints: (G11) Strategic fit, (G12) Market attractiveness, and (G13) Technological competitive edge. In this gate, it is not necessary to satisfy all viewpoints, but one of them should be outstanding.
Stage1	**Concept Development:** Activities to make an R&D project plan including initial marketing and technology survey.
Gate2	Decision to start the R&D project from 3 viewpoints: (G21) Strategic fit, (G22) Market attractiveness, and (G23) Technological competitive edge. In this gate, it is not necessary to satisfy all viewpoints, but one of them should be outstanding.
Stage2	**Feasibility Study:** Development of key technologies forming competitive edge and establishment of intellectual property. Activities to secure the commitment of the business sectors that will start the business based on this project in future.
Gate3	Decision to develop detailed plan, investigate, and develop from 3 viewpoints: (G31) Are key technologies forming competitive edge established? (G32) Is there a business sector that makes a commitment? (G33) Are a target and goal, tasks and roadmap to the goal clear and concrete?
Stage3	**Development:** Detailed planning, investigation, and development with the business sectors, especially strengthening of competitive edge and reinforcement of weak points. Activities to acquire an early customer.
Gate4	Decision to progress to testing and validation in the marketplace from 2 viewpoints: (G41) Do an early customer and a business sector exist? (G42) Can the total quality of the system satisfy the customer's requirements?
Stage4	**Testing & Validation:** Tests or trials in the marketplace, especially for early customers. Settlement of problems that appear in the trials.
Gate5	Final approval for production and launch from 2 viewpoints: (G51) Is the business profitable? (G52) Are problems settled?
Stage5	**Product production and launch:** The business sector launches the business, and the R&D sector develops additional attractive technologies to deal with competitors.
Gate6	Decision to continue production and expand the business from 3 viewpoints: (G61) High profit performance, (G62) Increasing marketability, and (G63) Product competitive power.
Stage6	**Product Support and Program Review:** The business sector elevates it to be one of the backbone businesses (shining stars) of the sector.