Tacit Knowledge in Government-led R&D Project Selection

Eun-Hong Kim

School of Business Administration, Gyeongju University
San 42-1, Hyohyun-Dong, Gyeongju, Gyeongbuk (ehkim@gyeongju.ac.kr)

Summary

This paper explains that tacit knowledge is a critical component for the success of government-led R&D project selection, where rapid and accurate decision making need to be made under lack of information circumstances. It also explores ways to fully exploit the tacit knowledge of experts participating in the Korean government's R&D project selection process. Some of these include: (1) strategic attention from the top officials, (2) forming self-organizing teams, (3) establishing a horizontal and risk-taking culture, (4) encouraging a sense of responsibility in creating and sharing tacit knowledge, and (5) providing a seamless monitoring system and training.

Key words: government-led R&D project, project selection, tacit knowledge, Nonaka and Takeuchi's model

1. Introduction

The Korean government has recently decided to focus its R&D resources in the so-called "ten growth engines" areas. Focused investment on selected technologies, such as the digital TV and broadcasting, displays, intelligent robots, future automobiles, next generation semiconductors, and other technologies with a high probability of being a leader in the world market within ten years is expected to boost per capita income from the current, approximate $10,000 up to $20,000 within five years. The focused approach seems relevant from the perspective that the comparatively limited Korean economy cannot effectively compete against advanced countries in all of the sectors of science and technology.

The so-called "selection and focus" strategy requires, in large part, tacit and action-based knowledge. Since R&D is unique and uncertain in nature, decision makers have no sufficient explicit knowledge upon which to rely. As R&D is a "Solution-Chasing Problem" in which problems can be identified only after the projects have been completed (Cole, 1989), it is almost impossible to predict its costs and benefits in advance (Meredith and Mantel, 2000). In addition, rapid changes in technology and the market do not allow decision makers enough time to collect concrete data. In this respect, Isenberg (1984) argued that tacit knowledge is a critical element for successful strategic decision making, like R&D.

This paper aims to explain how tacit knowledge may improve the quality of government-led R&D project selection. It also explores means to improve the R&D project selection process through tacit knowledge, thus reducing waste that could result from applying government-promotion policies. It concludes with the view that significant changes need to be applied to development, both individual and organizational, for the promotion of tacit knowledge.

2. Tacit nature of R&D Project Selection

Organizational environment is generally divided into two types: analyzable and unanalyzable (Daft and Weick, 1984; Aguilar, 1967). The analyzable environment allows organizations to gather hard and objective data about the environment, thus enabling them to formulate clear solutions based on rational analysis. On the other hand, when an environment changes rapidly and new patterns are emerging, lack of concrete and measurable data keeps decision makers from analyzing it. Managers in this environment rely more on soft data such as judgement, intuition, non-routine and informal data, personal contacts, hunches, and rumors. In addition, experimentation, testing, and learning-by-doing are among the active modes of behavior utilized in this type of environment (Tung, 1979; Duncan, 1972).

R&D project selection is one of the most difficult and turbulent environments to analyze. Effective project selection requires decision makers to consider various factors that include size and growth potential of the market; diffusion to science, engineering, and industry; relatedness to previous R&D; appropriateness of the R&D period; and suitability of R&D support capabilities (Lee and Om, 1996). However, as the speed of technological advance becomes phenomenal, complete data on these factors are not available. Thus, R&D project selection needs tools and techniques that enable decision makers to select a set of appropriate projects in a timely manner.

There has been a long history of attempts to improve the R&D project selection process. Schmidt and Freeland (1992) divided the attempts into two groups: the decision event approach and the decision process (or system) approach. The decision event approach uses economic models and decision theories to provide answers to specific selection problems. Among the models in this approach are market research, benefit measurement, portfolio selection, and economic models (see Table 1). Models in this category are mainly quantitative and constitute the majority of the existing literature.

Table 1: Selection Models (based on Farrukh et al., 2000)

Groups	Models
Market research models	Consumer panels/Focus groups, *Perceptual/Preference mapping*
Benefit measurement models	Profile, Benefit contribution, Checklist, Scoring
Portfolio selection models	Boston consulting group matrix
Economic models	Payback periods, Capital budgeting, Sensitivity analysis

The decision event approach, however, has been criticized due to its focus on the quantitative attributes of projects. First of all, the approach is rarely used in practice due to difficulty in quantifying selection criteria (Schmidt and Freeland, 1992; Steele, 1988). Agarwal, et. al. (1992) also argued that too much emphasis on quantitative data may result in assigning a higher priority to financially attractive projects than to strategically important ones. In addition, neglecting the organizational and interpersonal aspects of project selection decision making is also reported to be a limitation of this approach (Rubenstein, 1994).

The decision process approach emphasizes the process neglected by the decision event approach. As the number of participants involved in R&D projects increases, process management for coordinating their increasingly divergent needs is considered to be more important than the development of more sophisticated quantitative models (Steele, 1988). The process approach starts with identifying the activities of successful firms and their sequences. Then, the identified activities and their sequences are aggregated into a process model to be used for dealing with specific organizational context (Daniel et al., 2003). An example of the process-oriented approach includes the traditional Japanese method of R&D project evaluation, the so-called consensus-seeking process (Tanaka, 1989).

The process approach is not without shortcomings. First of all, this approach is criticized as being suitable for selecting incremental R&D projects rather than radical R&D areas that require rapid and accurate decision making under time and budget constraints (Tanaka, 1989). Assumptions that all decision makers are homogeneous and each step should be traversed in some order are criticized as being no longer relevant to radical R&D that involves diverse new systems and sophisticated users (Srinivasan and Davis, 1987). Also, Ginzberg (1975) claimed that vagueness and generality of the approach make adoption of the method difficult.

Tacit knowledge is crucial for the success of R&D project selection. Defined in various terms such as work-related practical knowledge, intuition, perspectives, beliefs, value, and even culture (Saint-Onge, 1996; Wagner and Steinberg, 1986), tacit knowledge is claimed as the only viable option when rapid decision making is required or quantification of the situation is hardly available (Schoemaker and Russo, 1993). Many authors also suggest the idea of using tacit knowledge to complement the decision process where unanalyzable environment prevents the making of an acceptable solution (Holloman, 1992; Williamson, 1975; Simon, 1957).

There are several ways in which tacit knowledge can be applied in the unanalyzable R&D environment. First, tacit knowledge can be applied to scanning the environment for selecting candidate research areas. A unique store of tacit knowledge built up through continuous monitoring of technological and market trends helps decision makers intuitively sort out promising areas for targeting. In addition, the decision makers can combine or expand their tacit knowledge to create opportunities that others cannot easily imagine (Leonard and Sensiper, 1998).

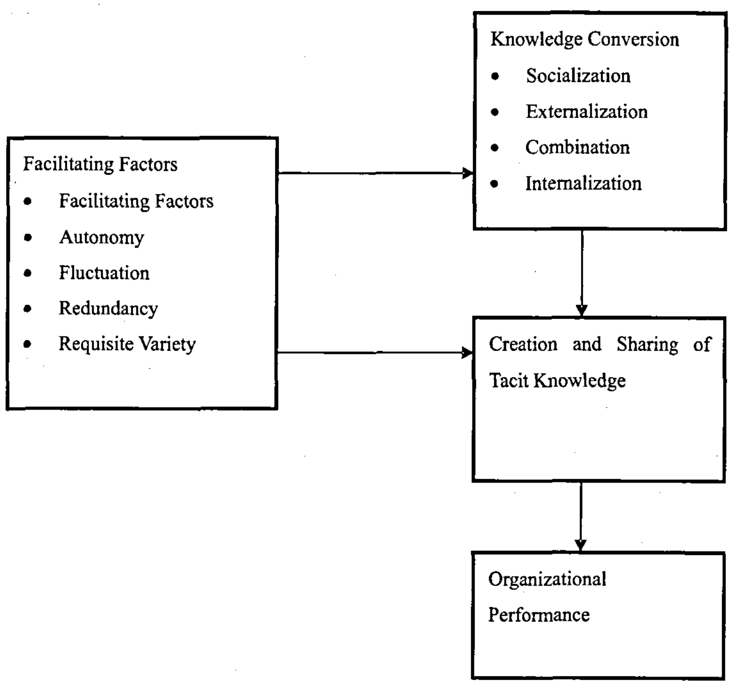

Figure 1 : Nonaka and Takeuchi's Model for Tacit Knowledge

The most common application of tacit knowledge is in the by-pass of in-depth analysis for the selection of various R&D options. R&D project selection needs to consider complex interdependencies among projects, such as resources, benefits, and technical interdependencies (Santhanam and Kyparisis, 1996). A mental network of the interdependencies is tacit knowledge that allows decision makers to select R&D projects more flexibly, accurately, and rapidly. Enhanced capability of tolerating ambiguity is another form of tacit knowledge that transforms the highly uncertain R&D project selection process into a more easily understandable one. Isenberg (1984) claimed that senior managers with intuition "tend to have ways of thinking that make issues seem less inconsistent."

Nonaka and Takeuchi (1995) insist that tacit knowledge can be created effectively through the spiral repetition of the four modes of the knowledge conversion process: socialization, externalization, combination, and internalization. Socialization provides a mean for individuals to share experience to create tacit knowledge such as shared mental models and project selection skills. Externalization is a process of converting tacit knowledge into explicit knowledge with the use of various tools, such as metaphors, analogies, concepts, and hypothesis. Combination, the third stage, comes next. This is where a variety of explicit knowledge is combined in an effort to create new knowledge. Internalization, the final stage, is a "learning-by-doing" process in which experiences from previous stages are internalized in the form of tacit knowledge. Documents, manuals, or oral stories play a significant role in facilitating the process.

Nonaka and Takeuchi (1995) also suggested organizational conditions that promote the creating and sharing of tacit knowledge. Among the factors are intention, autonomy, fluctuation and creative chaos, redundancy, and requisite variety. First, intention refers to the need for clear goals and strategies to foster participants' commitment to knowledge-creation. Autonomy means an organizational form that relies on autonomous individuals and groups in knowledge creation. Fluctuation and creative chaos emphasize close interaction between the organization and environment, while redundancy signifies the importance of fast and sufficient access to information. Finally, requisite variety requires decision makers to have an equal amount of complex information to provide solutions to complex problems.

3. R&D Project Selection System in the Korean Government

The Korean government uses a five-step process to select R&D projects for funding (Table 2). The first step is the search for candidate research areas. Government officials search every available information source, and identify hundreds of candidate research areas. Then, the research areas are screened by an advisory group until they are reduced to about fifty areas. The advisory group is composed of a dozen experts recruited from government, academia, national laboratories, and companies. Government officials in the advisory group usually work as a secretary for the group. The second step is the identification of about ten research areas on which to focus. This process is performed through a survey of hundreds of experts, consensus-building among the advisory group, and consultations with related government agencies. Selection criteria include global market size, strategic importance, market and technology trends, potential competitive advantage, and synergy effects on both economy and industries.

Once the research areas for funding are selected, the next step is planning for the research. This step is mainly performed by qualified independent institutions through a series of workshops and public hearings with various experts and interest groups. The selection of research projects and performing groups then comes next. Outside experts and government officials are appointed as a review panel that produces a ranked list from the submitted proposals. Decision making is mainly based on such capabilities as facilities and expertise of researchers who perform the projects. The final step is the execution and the post-audit research. The post-audit is conducted in various forms, including regular monitoring of progress, mid-point, and final audits.

Table 2: R&D Project Selection Process

Stage	Activities	Performers
Search for Candidate Research Areas	• Search • Screening	Government officials Advisory group
Identification of Research Areas	• Survey • Consensus building • Consultation	Government officials Advisory group Government agencies
Research Planning	• Workshop • Public hearing	Independent institutions
Selection of Research Projects	• Submitting of Proposal • Selection	Research groups Review panels
Research and Post-Audits	• Research • Post-audit	Research groups Government officials

The Korean government's R&D project selection system, however, does not seem to produce satisfactory performance. The so-called "G7 project" to which the Korean government had invested a great deal is evaluated as not having achieved its originally planned for outcomes. In addition, research on more than 1, 000 R&D projects performed in 1999 shows that 31.5 percent of the projects were rated as a complete failure and only 10.7 percent as a complete success (Lee, 2004). Lee (2004) argued that this unsatisfactory result is due in part to inadequate R&D project selection, which neglected careful consideration of the marketability of the technology.

The current system requires a fundamental change to get a deeper understanding of the future market and technology. Some may argue that merely allowing more time and labor in planning and feasibility studies will suffice to gather enough information for proper R&D project selection. Unfortunately, the dynamic environment of the 21st century does not allow such luxury. The rapid technological revolution and a freer market require us to learn how to draw more from our right brain, from our tacit side. The remainder of this paper will discuss ways to promote tacit knowledge in the Korean government's R&D project selection system. Nonaka and Takeuchi's model for tacit knowledge (Figure 1) will serve as the framework for identifying the suggestions.

4. Ways for Creating and Sharing Tacit Knowledge

4.1. Socialization

Facilitating socialization, the sharing of experience, requires relatively close relationships and personal contacts (Hansen, 1999). Building direct communication channels, such as face-to-face meetings are more desirable than relying on indirect ones such as documents and email. Thus, frequent meetings, both formal and informal, should be conducted, although they may be time-consuming. Drinking sessions after working hours and brainstorming camps are good examples of efficient informal meetings.

The importance of socialization is generally agreed upon by many authors. Daft and Weick (1984) insisted that the greater uncertainty the project has, the closer contact among experts is needed. Edmonson et al., (2003) also claimed that as technology development becomes increasingly complex and interdisciplinary, learning tacit knowledge as a team is relevant. McInerney (2002) argued that since the group of experts may have different disciplinary backgrounds, a work environment that promotes collaboration, and harmonious working is necessary for communication with common grammar and interpretation.

Close relationships and personal contacts can be encouraged under specific conditions. First, the R&D project selection process needs to encourage diverse groups of experts to participate and share their tacit knowledge. Second, the process needs to establish a system in which mentoring and assisting others are highly regarded and sufficiently rewarded. Third, equality in status among participants is critical for sharing tacit knowledge (Leonard and Sensiper, 1998).

None of those conditions are satisfied sufficiently in the Korean R&D project selection process. First of all, the process provides few opportunities for a majority of experts to participate in the process unless they have an invitation from government officials to do so. In addition, little incentives for sharing their knowledge are found in the process, leading to a reluctance to knowledge sharing. This reluctance is further reinforced by the cultural tradition of the hierarchical society, in which knowledge is considered to be an important method to gain higher social status.

4.2. Externalization

Externalization, articulation of tacit knowledge into explicit concepts, refers to finding a way to express the inexpressible (Koshinen et. al., 2003). One of the methods for doing so is the usage of a case study. A case study of a project selection process makes it possible to analyze the specific causes of any outcomes of projects. Figurative language and metaphors are also useful methods of externalization. These are efficient ways for individuals with different experiences and situations to understand something intuitively without the need for formal analysis.

Certain conditions need to be satisfied in order for externalization to be facilitated. In order to capture tacit knowledge by use of a case study and metaphor, dropping the fear of expressing it is required (Leonard and Sensiper, 1998). If experts regard the expression of tacit knowledge as making their appearance foolish or over-emotional in front of their co-workers, they would hesitate to externalize their knowledge. In addition, too much emphasis on communication based on logical analysis and hard data may become an inhibiting factor to externalization.

Externalization cannot be ensured without developing and nurturing work environments of trust. First, each expert needs to learn to trust their intuition. Jaggar (1989) argued that embodied emotion of trusting intuition as being more accurate than explicit knowledge is a necessary factor for effective tacit knowledge acquisition. Without the feeling of trust on intuition, no one can dare to offer an idea without sufficient hard facts to support it.

Developing trust requires both time and a situation-related process. Trust can only be formed incrementally in a face-to-face work environment or team structure, in which experts must complete the tasks together. Group practice not only provides richer meanings from the shared contextual base, but also enables fast decision-making on whose intuitions to trust when obstacles occur. As a result, the stability of an evaluating group needs to be maintained. Moreland (1999) argued that group stability encourages interpersonally intensive forms of communication, facilitating the efficient transfer of tacit knowledge. Von Krogh et al. (2000) also emphasized situated learning, so-called "communities of practice", where groups of people build trust by working together.

The Korean R&D project selection process does not provide careful attention to externalization. First, cultural attitudes, such as perceiving failure as humiliation and reluctance to explicitly criticize others, may be obstacles to adopting a case study on a failed project. In addition, remaining bureaucratic property in the process still tends to require research groups to persuade government officials based on hard facts and formal analysis. Trust also can hardly be expected to grow between government officials and research groups because there is no mechanism or motivation to continue the relationship once the research project is selected and funded. Finally, since knowledge on how to communicate, build trust, and coordinate efficiently cannot easily be transferred, decisions on hiring government officials and selecting research groups need to be based not only on their explicitly expressed knowledge but also on their track record of successful R&D project selection (Leonard and Sensiper, 1998).

4.3. Combination

Combination means a systemization of concepts into a knowledge system. Combination also suggests that knowledge in the system must be kept current, accessible, and coded in a way that allows easy and comprehensive access to all experts in the process. Especially, since knowledge is constantly changing, knowledge management systems must be frequently updated by all participants in the organization. A variety of rewards should be designed to facilitate the updating process. Making reports on successful practices or lesson-learned documents as a routine of doing business can ease the burdens of locating expertise and knowledge elicitation (McInerney, 2002).

Interim and Post-investment audits, in particular, are helpful when building a knowledge management system. Audits can be effective if they are performed by independent auditors who examine all of the aspects of an R&D project, such as management of a project, its methodology and procedures, records, properties, budget, and expenditures (Meredith and Mantel, 2000). In this case, trust is also indispensable for auditors to collect confidential knowledge from the participants.

Combination does not function well in the Korean system. First, the decentralized system where each of the R&D projects is practically controlled by the corresponding government agency makes seamless monitoring of the selected projects almost impossible. In addition, the system needs to create the clear expectation that everyone is responsible for collecting and updating knowledge.

4.4. Internalization

Internalization is the process of converting explicit knowledge into a tacit knowledge. In the case of project selection, internalization refers that decision makers working on R&D project selection can benefit from reading or experiencing similar previous cases accumulated in a knowledge management system. Among the tools that internalization can use include experience, reflection, evaluating, reading, listening, and observing.

The Korean R&D system is also not efficient in internalizing knowledge. Lack of close cooperation and networking among government agencies or between the government and research groups prevent experience and information from being transferred to other similar areas. In addition, both government officials and research groups need to be trained to easily store and retrieve knowledge from a database.

4.5. Facilitating Factors

Intention means an organization-wide strategy to foster knowledge creation and sharing. Since success in creating and sharing knowledge can not be achieved without investing a large amount of time and expense, strong commitment from the top is essential in both mobilizing the necessary support and establishing a culture of learning in an organization. The Korean R&D system also needs more attention from the executive officials to be transformed into a tacit knowledge-based R&D project selection system.

Autonomy suggests allowing all players in the selection process to act autonomously as far as circumstances permit. Autonomy requires the so-called "self-organizing project team." Each autonomous member in the team shares the same information, and the team assumes the entire freedom of choice for the destiny of its project (Nonaka and Takeuchi, 1995). Group practice also helps team members to better understand the behavior, state of mind, and motives of the other members. This understanding establishes a feeling of trust, which is a crucial element in accessing and transferring tacit knowledge. Ethical principles, such as morality, fairness, and justice are keys for engendering autonomy. More specifically, they keep politics or personal preferences of influential individuals from intruding into the selection process. Establishing a code of ethics can be a starting point that may help autonomy and trust flourish within an organization (Koshinen et al., 2003).

Fluctuation is a sense of crisis that each member in the organization possesses about the existing selection system. The more urgently tacit knowledge is felt to be needed by the members, the faster improvement of the system can be achieved. Although there exists a growing concern among key players over the current government-led R&D selection system (Lee, 2004), more effort is needed to more extensively diffuse the fluctuation so that not only government officials but research groups too can actively participate in the knowledge creation process.

Redundancy refers to the conscious overlapping of information, activities, and responsibilities (Nonaka, 1994). Overlapping is reported to encourage the sharing of ideas and dialogue that are key elements for the effective knowledge conversion process (Senge, 1990). This suggests that regular meetings between government officials and research groups are not at all wasteful, but directly associated with the successful performance of the government-led R&D project selection.

Requisite variety suggests an aggressive and long-term view for improving R&D project selection. First, too much of a risk-avoiding attitude may cause a critical problem in the government-led R&D project selection process. A tendency to favor technological areas with higher probability of success may inhibit both government officials and research groups from considering high-risk areas that may produce the so- called "disruptive technologies" (Bower and Christensen, 1995). However, technical and commercial success can hardly be expected without the aggressive investment in the projects with technical difficulty and longer lead time (Matheson and Menke, 1994).

Table 3 : Summary of Ways for Improvement

Knowledge Processes and Facilitating Factors	Ways for Improvement	Classification
Socialization	• Broader participation in the process • Incentives to knowledge sharing • Cultural change to horizontal society	Process Organization Culture
Externalization	• Cultural change to risk-taking society • Team approach	Culture Organization
Combination	• Close networking of the agencies • Sense of responsibility	Organization Behavior
Internalization	• Training • Team approach	Process Organization
Intention	• Support from the top	Strategy
Autonomy	• Self-organizing project team	Organization
Fluctuation	• Diffusion of sense of crisis	Behavior
Redundancy	• Regular meeting between government and research groups	Process
Requisite variety	• Aggressive attitude and long-term view	Culture

Patel and Pavitt (1997), who studied many of the world's largest companies, found that their continuing competitive capabilities are based on two characteristics. First, they have highly stable and differentiated technology profiles around the firms' principal products. Second, at the same time, they also have technology profiles extending beyond their distinctive core. This finding implies that adopting a broader R&D agenda is crucial for dealing with uncertainty involved in R&D project selection, such as unexpected technological developments. Ettlie and Bridge (1987) argued that firms with long-term investments in aggressive technology produce a higher probability of success.

5. Conclusions and Policy Implications

This paper explains that tacit knowledge is a critical component for the success of government-led R&D project selection where rapid and accurate decision making needs to be made under insufficient information circumstances. Using Nonaka and Takeuchi's model for tacit knowledge, it also explores ways to fully exploit the tacit knowledge of experts participating in the Korean government's R&D project selection process. One of the main policy implications is that a broader approach that considers strategy, organizational structure, culture, behavior, and management process together needs to be adopted.

First, more strategic attention from the top is required to gather enough support for creating and sharing of tacit knowledge. Second, the requirements for change in organizational structure are as follows: (1) government officials and research groups should form self-organizing project teams so that they can autonomously control and be responsible for their R&D projects from start to end, (2) sufficient incentives are recommended for encouraging knowledge creation and the knowledge sharing process, and (3) government agencies need to be more closely networked to seamlessly monitor various projects.

Third, cultural changes are also required in the following manner: (1) the horizontal culture needs to be adopted, wherein bureaucratic attitudes of government officials do not hinder the facilitation of tacit knowledge, and (2) a risk-taking culture is needed in which no one feels humiliated for righteous failures. Fourth, participants in the Korean R&D project selection system need to have a sense of crisis that the existing system is no longer effective and requires fundamental changes. In addition, participants have to possess the sense of responsibility for creating and sharing tacit knowledge. Finally, the selection process also needs these changes: (1) the participation of more experts in the selection process, (2) more training to enable participants to easily input and output data from the database, and (3) regular meetings between government and research groups.

This paper offers only a simple outline of a path toward tacit knowledge-based R&D project selection, but it may serve to instigate more discussion. Clearly, much more experimentation and observation need to be done to build broader R&D project selection models that utilize human competencies, such as emotion, feeling, and social interaction. R&D project selection with these broader-scaled models will become invaluable for the long-term prosperity of the Korean economy.

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