Organizational R&D Concept Creating Activities Using Six-Lenses Model

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ABSTRACT

This paper show a process model for interpersonal activities concerning the reconstruction of R&D conceptual knowledge and have assessed its validity based on a case study.

We applied the six-lenses model (Hayashi, 1999: 2001: 2004) to the knowledge reconstruction process in order to focusing on interaction personal perspective through inter-personal communications. The six-lenses model consists six perspectives: subject, object, future, past, analog, and digital. Its process is based on interactions among the six perspectives and has three stages: (1) discussing the right position, by using questions such as "for what?" and "for who?," (2) positively envisioning from a future perspective (2-F) while identifying related known concepts and constructing concepts from a past perspective (2-P), and (3) reconstructing the knowledge through practice from the future perspective based on the past consciousness (3-F), while reconstructing the vision through practice from the past perspective based on future consciousness (3-P). In addition, interactions between the subject and object perspectives and between the analog and digital perspectives occur in all stages.

A case study of a particular on-going research team was tested our hypothetical model. Our observations and interview data indicate that the concepts of the research team's members had developed through their knowledge reconstruction process. Based on this finding, we determined that our hypothetical model was partially valid. We also indicate four prior conditions that have to be met for the knowledge reconstruction process to work well: (1) members need to resolve personal issues based on a wealth of field experience and mature research competency, (2) members need to be in trusting relationships, (3) members need effective support of senior managers and advisers, and (4) members need high expectations from related teams.

Keywords: Six-Lenses Model, conceptual knowledge, knowledge reconstruction

1. INTRODUCTION

There have been discussions about the essential conditions for innovation in various academic fields. In economics, Shumpeter (1934) argued that innovation was discontinuous change from previous research or technology (Shumpeter, 1934) [1]. In philosophy of science, Kuhn (1962) [2] explained the process of scientific change as a "paradigm shift." He defined a scientific revolution as an event that cut off the established tradition of "normal science" that had justified its own assumptions. In the field of technology management, Rosenberg (1982) [3] accounted for two types of innovation process: radical innovation and incremental innovation. Radical innovation indicates "discontinuous" change; on the other hand, incremental innovation indicates "continuous" and ameliorative change. Recently, this field has tended to focus on radical innovation. For example, Leonard-Barton (1992) [4] pointed out the process of changing from "core capability" to "core rigidity." This means that knowledge capitals, which are built up over the years, may have constitutive factors that are obstructive to radical innovation. From a similar perspective, Christensen (1997) [5] argued that a "destructive technology," which provides the market with some radically new value, changes the state of organizational knowledge capital from useful to detrimental.

Researchers who belong to the knowledge management field pay attention to role of R&D concept creating activities for producing innovation. For example, Nonaka and Takeuchi (1995) [6] called these activities "externalizations" based on their theory called the Organizational Knowledge Creation model. They also argued that this model is typically seen in the process of concept creation and is triggered by dialogue or collective reflection (Nonaka and Takeuchi, 1995). In addition, Nonaka and Konno (2004) [7] argued that new concepts develop from personal and individual ideas and that involves context, perspective, and framework. In addition, they defined "conceptual knowledge" as a set of concepts related to each other like a cause-effect relation. Nonaka and Takeuchi (1995) [6] defined knowledge as a dynamic process of justifying true belief; therefore, the process to create conceptual knowledge involves a justification process for a radically new concept through communications and common practices among team members. Thus, Nonaka and Konno (2004) [7] related conceptual knowledge creating process in four steps: (1) "Observation" for socialization,

(2) “Conceptualization” for externalization, (3) “Modeling” for combination, and (4) “Practice” for internalization.

Regarding the first step, members acquire personal ideas through observation. To get rid of bias, members have “pure experiences” outside of any particular analytic framework. Members must also have an observer who has an objective perspective.

Second, members create concepts by following two methodologies: abduction and metaphor based discussion. Members must do abduction subjectively, based on their own experience, and objectively, by imagining themselves in the place of their customer and using a consumer’s experience (Nonaka and Konno, 2004) [7]. Nonaka and Toyama (2005) [8] also argued that knowledge was created through the dynamic interaction between subjectivity and objectivity.

Third, members assemble the concepts they’ve created in order to create solutions for their problem and predict future actions (Nonaka and Konno, 2004) [7]. This step to acquire conceptual knowledge is similar to the “Concept Map” developed by Novak and Gowin (1984) [9].

Finally, members practice their conceptual knowledge through reflection (Shon, 1983 [10]; Nonaka and Konno, 2004 [7]) and story-telling (Baker and Greene, 1977 [11]; Nonaka and Konno, 2004) [7]. Shon (1983) [10] argued for the importance of keeping practice and reflection when developing a concept that can be adapted to a particular reality. On the other hand, Baker and Greene (1977) [11] argued for the importance story-telling activities in order to transfer knowledge to other members.

There are very few satisfactory analyses of a concept creating process from the viewpoint of personal perception and inter-personal communication. For example, Yoshinaga and Toyama (2005) [12] studied several cases of R&D projects at a corporate laboratory of a Japanese manufacturing company and described a process model for R&D conceptual knowledge reconstruction after the experience of failure. They focused on the change in the image or feeling about the R&D concept that managers and researchers experienced. The conceptual knowledge reconstruction process consisted of three stages: Awareness of questions, generation of answers, and practice answers from a personal view. However, it is not clear as to what and how R&D team members share a perceived reality and knowledge in each stage. Thus, we have tried to build a hypothetical model for conceptual knowledge reconstruction process on organizational R&D creating activities in technological fields and have tried to test it based on previous research.

2. HYPOTHETICAL MODEL

Our approach to building a hypothetical model is to extend the Knowledge Reconstruction Process (KRP) model of Yoshinaga and Toyama (2005) [12]. First, we modify the naming of each stage as required to fit a general experience or not focused on failure experience of R&D members: (1’) Awareness of “issues”, (2’) Generation of “solutions” and (3’) Practice “solutions.” (Fig. 1) Based on the above modification, we regard “issue” as synonymous with “concept” and regard “solution” as synonymous with “conceptual knowledge.”

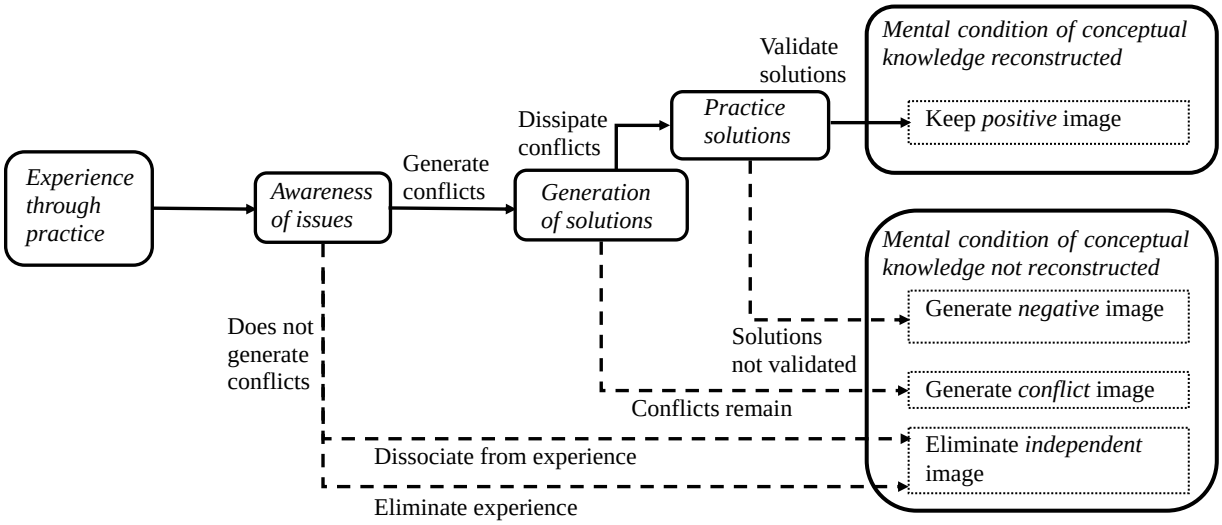

Fig. 1. Knowledge Reconstruction Process model (Adapted from Yoshinaga and Toyama, 2005)

Next, to import the view of personal perception and communication, we apply the six-lenses model (Hayashi, 1999:2001:2004) [13] [14] [15], which was developed in the inter-cultural management field, to the KRP model (Yoshinaga and Toyama, 2005) [12]. Hayashi (2001) argued that this model is useful for problem solving regarding envisioning possibilities. The advantage of this model is that it focuses on not only building a social system but also personal perceptions and inter-personal communications (Hayashi and Jolley, 2002) [16].

The six-lenses model is an interaction model with three axes and six perspectives: (1) “Subject” and “Object”, (2) “Future” and “Past”, (3) “Analog” and “Digital” (Hayashi, 1999:2001:2004) [13] [14] [15].

The “Subject” perspective refers to self-identity, while the “Object” perspective refers to outside the self-identity (Hayashi, 2004) [15].

The “Future” perspective refers to desirable visions, goals, targets, and ideal situations for subjects, while the “Past” perspective refers to the memory of pasts experiences about subjects (Hayashi, 2004) [15].

The “Analog” perspective is based on continuous, holistic perception of reality without a distinct boundary between figure and ground, while the “Digital” perspective is based on discontinuous, analytical perception of reality with a definitional, categorical boundary between figure and ground (Hayashi and Jolley, 2002) [16].

We tried to apply the six-lenses model (Hayashi, 1999: 2001: 2004) [13] [14] [15] to the knowledge reconstruction process in order to focusing on interaction personal perspective through inter-personal communications. The process based on interactions among the six perspectives has three stages: (1) discussing the right stance, by using questions such as “for what?” and “for who?,” (2) imagining the impact positively from the future perspective (2-F), while gathering related known concepts and constructing conceptual knowledge from the past perspective (2-P), and (3) reframing the knowledge structure through practice from the future perspective based on past consciousness (3-F), while reframing the vision through practice from past perspective based on future consciousness (3-P), all toward conceptual knowledge reconstruction. Interactions between the subjective and objective perspectives and between the analog and digital perspectives occur during all stages (Fig. 2).

The first stage is nearly equivalent to the first and second stages of the conceptual knowledge creation process of Nonaka and Konno (2003) [7]. In other words, this stage is a process of creating personal ideas and moving from these ideas to a “prototypic concept.” Members of the R&D team may hold discussions so that they can be made aware of issues that reality imposes. Members may adopt a subjective perspective based on their belief or an objective perspective based on experience they gained from their environment, such as their dealings with customers and consumers. Members may also adopt a future or past perspective in order to understand their stance. They may keep an analog perspective based on holistic perception or an digital perspective based on analytical perception in order to support their “system thinking.” Through such discussions, members may arrive at the “right” stance for them and their stakeholders.

The second stage is nearly equivalent to the third stage of the conceptual knowledge creating process of Nonaka and Konno (2003) [7]. That is, this stage is a process of constructing conceptual knowledge or solutions based on various concepts or by accounting for various issues. This stage contains two sub-stages, which use using subjective and objective interactions and analog and digital interactions. The future-oriented sub-stage is a process of envisioning a future. Members may imagine it positively. Positive thinking is effective for creating a powerful vision (Cooperrider & Srivastva, 1990; Watkins and Mohr, 2001) [17]. On the other hand, the past-oriented sub-stage is a process of shaping the prototypic concept, gathering related known concepts and constructing conceptual knowledge for the vision. Thus, the processes may interact with each other.

The third stage is nearly equivalent to the fourth stage of Nonaka and Konno (2003) [7]. That is, this stage is a process of reconstructing the concept knowledge or solutions through practice. This stage contains two sub-stages, which use subjective and objective interactions and analog and digital interactions. The members may reconstruct the vision and conceptual knowledge (solution) by doing a feasibility study.

After the members have reconstructed their environment’s vision and conceptual knowledge (solution), they move on to the next conceptual knowledge or solution creating activities following the above three steps.

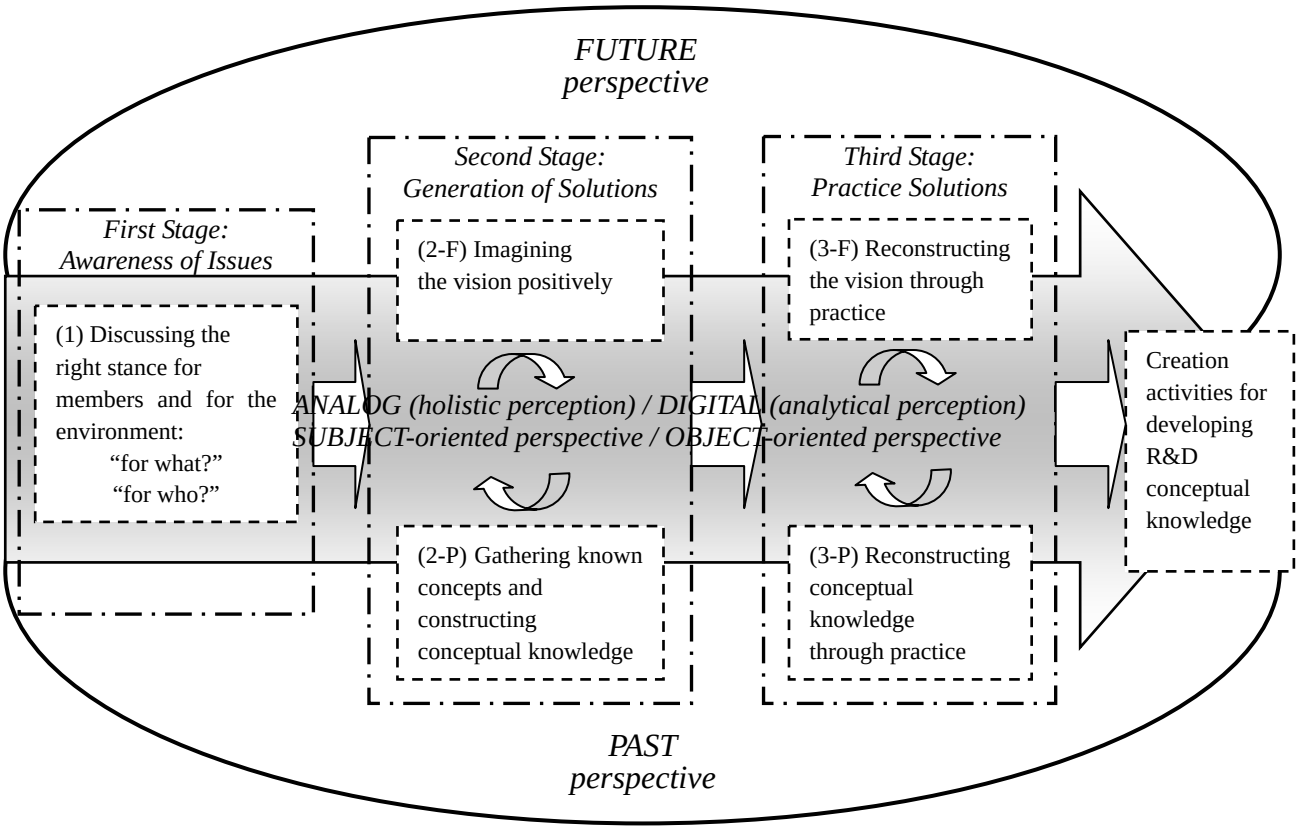

Fig. 2. Conceptual knowledge reconstruction process using the six-lenses model

3. METHODS

3.1. Sampling

We tested our hypothetical model by using the case of a research team (team-CoD) at a corporate laboratory of a Japanese manufacturing company (M-Co).

The team-CoD was studying advanced production technology in a particular domain (domain-A). The team tried to apply a technology (tech-X) that had been developed for another domain (domain-B).

We observed this team for 14 months, from August 2004 to September 2005, and interviewed five members of M-Co who were related to team-CoD: (1) RM-W, team-CoD's senior manager, (2) RA-V, team-CoD's adviser, (3) RL-G, leader of team-CoD, (4) R-J, a senior member of team-CoD, and (5) R-J, a senior member of team-CoD. Table 1 lists their major research domains and years of experience.

Table 1. Sample attributes

Sample code name	Position	Special research domain	Years of experience
(1) RM-W	Senior Manager	domain-B domain-A	Over 20
(2) RA-V	Adviser	domain-B	18
(3) RL-G	Leader (senior member)	domain-A	15
(4) R-J	Researcher (senior member)	domain-A	9
(5) R-D	Researcher (senior member)	domain-B	7

3.2. Interviews

We conducted three interviews over the course of the study in order to ascertain the changes in personal knowledge. Yoshinaga and Toyama (2005) [12] defined knowledge as a personal construct of justified beliefs that consist of information clusters. We referred to this definition and planned interviews accordingly in three

steps: (1) we interviewed the three senior members at the beginning of the research in order to ascertain their knowledge, (2) interview the senior manager and adviser in order to find out what outside knowledge had been added to their knowledge and (3) interview the three senior members again in order to find out changes in their knowledge have occurred to their structural basis through their research activities. Table 2 shows the interview framework

Table 2. Interview framework

	First interview	Second interview	Third interview
Interview period	From August 2004 to November 2004	From November 2004 to December 2004	September 2005
Interview timing	Preparative stage (8 ~ 11 months after start of research project)	Preparative stage (11 ~ 12 months)	Practice stage (21 months)
Interviewee	RL-G R-J R-D (team-CoD senior members)	RM-W and RA-V (providers who bring outside knowledge into team-CoD)	RL-G R-J R-D (team-CoD senior members)
Expected results	Find core members' concept knowledge at starting point	Find added foreign concept-knowledge to core members as senior manager and adviser	Find process of change in conceptual knowledge of senior members through their organizational research activities.
Object of analysis	Meanings of senior members' events and inter-event relationship	Meanings of members' events for senior manager and adviser	Reconstruction of personal issues of senior members

4. RESULTS

4.1. Results of first interview

Based on the interviewee's research experience, we got eighty four impressive events for interviewees in total: (1) PL-G provided us with thirty five events, (2) R-J provided fourteen events, and (3) R-D provided thirty five events. We interviewed them about the meanings of these events and the causal connections between each event. As a result, we assessed each member's knowledge based on their experience and thinking style, and most important concern.

RL-G's has worked in domain-A ever since he joined M-Co. He did field work three times in four years after joining M-Co. He always referred to these experiences when he made decisions. Therefore, he had a "practice" oriented thinking style. He also had a "bottom-up" operational approach to domain-A in order to change development specification dynamically. In the eleventh year of his research life, he became aware of being an expert of domain-A. In the fifteenth year, he started to building up team-CoD with RM-W. His most personal issue was how he should ensure an organic linkage among other teams of M-Co in order to research the domain-A effectively.

Despite that R-J had four experiences of domain-A fieldwork in five years after joining M-Co, he had not perceived the distinction between domain A and B until recently. He also had a practice oriented thinking style and bottom-up operational approach as RL-G did. In the ninth year of his research life, he became aware of being an expert of domain-A, when top executives of M-Co started to focus on domain-A. His most personal issue was how he should manage team-CoD's research for domain-A.

R-D's research domain was domain-B ever since he entered college. He researched the predecessor technology of tech-X. After joining M-Co, his mentor described his vision of production technology, after which his research competency improved spectacularly. He also had several experiences of fieldwork, and had a practice oriented thinking style. On the other hand, he had a "top-down" operational approach to domain-B in order to work development specification well. In the seventh year of his career a large-scale research project had finished, and he became aware of being an expert in domain-B. He became part of team-CoD and was confident in the growth potential of domain-A; therefore, he actively engaged in solution creating. His most personal issue was to understand the domain-A in its

entireing from R&D to marketing in order to develop a better research technology for domain-A.

4.2. Results of second interview

The second interview focused on the perspectives that RM-W and RA-V gave to team-CoD's senior members. RM-W provided holistic and political perspectives. He always careful to consider the product's efficiency beyond domain-A or domain-B; therefore, his stance was to regard a technology as fashionable rather than long lasting. In addition, he indicated the importance of the whole M-Co group participating in gathering important information. On the other hand, RA-V provided a perspective on the quest for the essence of tech-X. He behaved as an interpreter between management and researchers. As a result, He supported conceptualization of the research.

4.3. Results of third interview

We used the results of the third interview to verify team-CoD activities based on our hypothetical model and noted the changes in personal issues that occurred during the case study's period.

As has been previously described, each senior member had a clear personal issue based on his knowledge: (1) RL-G was concerned about the organic linkage with other teams, (2) R-J was concerned about the management of team-CoD, and (3) R-D concerned about understanding the whole of domain-A.

Team-CoD began the first stage of research, becoming aware of the issues to be dealt with. Top executives of the M-Co group outlined the issue regarding tech-X. Therefore, the first mission of team-CoD was to understand the essence of tech-X. Team members including the three senior members and RA-V, the team adviser, held nine meetings on the issue in three months. They discussed the essential differences between domain-B's and domain-A's application of tech-X. As a result, they found that they should change their assumptions about the priority of the stakeholder and efficiency range of tech-X. As a result, they no longer advocated tech-X.

In the second stage of generating solutions, they tried to find an attractive product that has potential but did not have an established production technology. They also tried to construct a solution based on a case study of existing production processes.

In the third stage of devising practice solutions, which is still ongoing as of this paper's writing, they tried to apply their solutions to field of the previous stage. There was tacit role-sharing recognition among the senior members. They used the perspectives that they hadn't used before; i.e., they changed from the top-down to the bottom-up approach, or vice versa. Therefore, they no longer shared knowledge only through "official" discussions. For example, RM-W transmitted R-J's particular personal idea as to the team's concept to another related team with no need for a discussion. It means their personal issues were resolved dynamically.

Despite the third stage being still ongoing, each senior member had resolved their personal issues through process of reconstruction of a solution: (1) RL-G was concerned about organic linkage among other teams in order to right product for stakeholders in right way, (2) R-J was concerned about management of the team keeping a top-down approach while at the same time acknowledging the bottom-up approach, and (3) R-D was concerned more with product planning than with design planning for domain-A.

5. DISCUSSION

The study revealed reconstructions or developmental changes of personal issues or concepts through research activities. Regarding the interaction among the six perspectives, we found interaction between subjective and objective stages. They all tended to keep their perspective based on personal ideas while perspective based on the reality of field engineers and consumers. It means the interaction between the subjective perspective and the object perspective has occurred. We also found a concrete interaction process between future and past in the second stage. Furthermore, we found interaction between analog and digital through our observation. For example, RL-G and R-J had analog-oriented perception, while RA-V and R-D had digital-oriented perception. They understood each other's orientations tacitly and utilized differences during discussion.
Based on the above findings, we believe that our hypothetical model partially worked.

We also indicated prior conditions for a knowledge reconstruction process well: (1) members need personal issues based on a wealth of field experience and a mature research competency, (2) members need to be in a trust relationship, (3) members need effective support from their senior manager and adviser, and (4) members need high expectations from related teams.

Regarding the first condition, Leonard and Walter (2005) [19] characterized mature knowledge as "deep smart." It takes a long time to acquire mature knowledge. In this study, the senior members acquired it over nine years.

For example, RL-G always referred to rich application experiences when he made decisions. Furthermore, the case of R-D indicates that the existence of mentor who provided a vision, which is useful for acquiring mature knowledge efficiently.

Regarding the second condition, we noted the importance of trust in order to utilize differences with the other perspective such as changing process from the top-down to the bottom-up approach, or vice versa based on tacit role-sharing recognition. von Krogh, Ichijo and Nonaka (2000) and Kikoski and Kikoski (2004) also cited the importance of trust for organizational knowledge creating activities, whereas our study supports their assertion from viewpoint of utilizing difference in personal perspective.

Regarding the third condition, we noted the essential role of the senior manager and adviser. The senior manager might need a wide scope to imagine the overall picture, while adviser might need a meta-thinking style among hierarchies or domains in order to become an interpreter between executives and researchers and among researchers.

Finally, we noted the importance of political techniques in order to develop conceptual knowledge. We noted that RM-W has this skill. He said it is important for team-CoD to show its symbolic value to whole M-Co participating in gathering fresh and important information.

6. CONCLUSION

We described a hypothetical model about the conceptual knowledge reconstruction process on organizational R&D concept creating activities and a case study that was a test of this model. The case study involved making observations and conducting interviews to ascertain the revolution or changes in personal issues of team members throughout the period in which they did their research. Based on the findings of the case study, we can say that our hypothetical model roughly worked well. We also found four prior conditions for our model to work well.

To overcome the model's limitations revealed in this study, we will continue the above case study in order to verify this model overall. We need to focus on the process of reconstructing conceptual knowledge through practice. In addition, we need to verify that personal issues or concepts become platforms for the next solution or conceptual knowledge creating process. Furthermore, we need to focus on the interaction process among the six perspectives in order to clarify the processes within each stage in more detail.

Toward further research, we will conduct another case study about academic conceptual knowledge reconstruction process in order to analyze the differences between a corporate laboratory and academic laboratory in order to improve our model.

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