Summary of Doctoral Dissertation

A Study on Organizational Ambidexterity Based on Complex Adaptive System Theory:

Creating Radical Innovation from Incremental Innovations in a New Product Development System

Graduate School of International Social Sciences

Yokohama National University

SHANG HUAXING

September 2020

Challenging a strict exploration-exploitation dichotomy, this research seeks to explain how radical innovation (RI) can be created from incremental innovations (II). To do so the research adopted a complex adaptive system (CAS) approach to new product development (NPD). In-depth analysis of two cases of radical innovation at Toyota Motor Corporation showed that two kinds of adaptation (external and internal) and a bridge between them were needed to create RI from II in a multi-level NPD system. Manufacturing engineering was found to play a critical role in facilitating this creative process.

The first chapter begins with a general discussion of organizational ambidexterity and its application to innovation management. While existing research has shown that RI can be created from II, the way by which this can be done within an NPD system remains an open question. Pioneering work on CAS theory is introduced as a promising potential NPD framework that may be used to fill in this theoretical gap. The chapter closes by briefly introducing each chapter.

The second chapter systematically reviews previous studies of organizational ambidexterity (OA), which is the capability to reconcile exploitation (using existing knowledge) and exploration (generating new knowledge) across multiple levels in a system under certain conditions to help an organization obtain a sustainable competitive advantage. Key themes reviewed are the relationship between organizational ambidexterity and organizational performance in different context, the relationship between exploitation and exploration, the mechanisms for managing exploitation and exploration, and the factors that influence this management. Some studies have indicated that exploitation and exploration can be reconciled across different organizational levels, and exploration can be built on exploitation. This general discussion of OA branches into six research streams that consider specific applications of the concepts. This research is concerned with the innovation ambidexterity stream.

Innovation ambidexterity, which has incremental innovation and radical innovation as its primary focus, is one of the main considerations of the field of innovation management. Existing studies suggested that it might be possible for an organization to create radical innovation from one or more incremental innovations. However, the theoretical basis for doing so within the same organizational system is not clear. In addition, although some initial studies have addressed the issue of creating radical innovation from incremental innovations, rigorously gathered empirical data on the subject is quite limited. Since no research was found that directly and explicitly discussed this issue across multiple levels within an NPD system, this is identified as the theoretical gap to be addressed by this research.

The third chapter presents the theoretical framework and research method of the dissertation. It positions CAS theory within complexity sciences and reviews studies on innovation and NPD that are based on CAS theory to build a theoretical framework and three related propositions. The general research question presented in Chapter 2 was reformulated into a specific descriptive research question that asked how Toyota was able to create radical innovation from incremental innovations in a multi-level NPD system. The proposed framework contains thee-levels (external environment, organization, and organizational sub-unit) within which semi-autonomous and malleable agents interact in unpredictable ways in the development of new products. From the proposed research framework, the following three propositions about an NPD system are presented. Proposition 1 is concerned with “external adaptation” and holds that RI requires an organization to adapt to its external environment. Proposition 2 is concerned with “internal adaptation” and holds that II requires an organizational sub-unit to adapt to its organization. Proposition 3 holds that for RI to come from II, there needs to be a “bridge” between the external adaptation and the internal adaptation.

In order to answer the “how” question posed by this research and provisionally validate the proposed research framework and propositions, Yin’s method for case-study research was adopted. Specifically, a multiple-case embedded research design was developed using methods to avoid biases and to meet the four criteria of construct validity, internal validity, external validity, and reliability. Following the definition of RI in Leifer et al. (2000), two cases of new product development projects at Toyota Motor Corporation that contained numerous II and resulted in RI were selected: the first Prius (NHW 10) and the first Lexus (LS 400) cars. Each case was analyzed according to analytic units corresponding to the three levels of the framework.

To guide case study data collection and analysis and increase the reliability of the research, a case study protocol was prepared for each case, including data collection procedures, questions to be investigated, and a tentative outline of the case study report. In accordance with this protocol, data were collected from three data sources: documentation, interviews, and physical artifacts. For data analysis, data were first classified into different arrays according to different themes and sub-themes. Then, data were linked to the theoretical propositions and pattern matching was used as a data analysis technique. Criteria for verifying the propositions were set containing specific conditions for each proposition.

The fourth chapter presents the findings from the two case studies, Toyota’s Prius NHW 10 and Lexus LS 400. Case data were organized into the three levels of the research framework. The elements at each level and the adaptations that occurred across different levels were shown, while highlighting the roles and responsibilities of manufacturing engineering in building a bridge that connected the internal adaptations such that the external adaptation could be realized. The findings confirm that Prius NHW 10 and Lexus LS 400 are radical innovations that were each created from numerous incremental innovations that were created across multiple levels in their specific NPD systems.

An important difference between the two cases is that the first Prius is a revolutionary product that was created using a mix of new and existing product technologies, whereas the first Lexus is a revolutionary product that was created using existing product technologies. In accordance with these technological differences, the main focus of manufacturing engineers in the Prius case was building new production processes. In contrast, the main focus of manufacturing engineers in the Lexus case was improving existing production processes.

The first level of the new product development systems that produced the first Prius and the first Lexus contains the external environment, agents (e.g., Toyota Motor Corporation, competitors, suppliers, and, in the Prius case, a key joint venture supplier), and various other elements (e.g., ecological and social issues, regulations, technical limitations, market trends). The second level contains Toyota Motor Corporation and its organizational sub-units (e.g., the NPD project team, technical departments, manufacturing departments, working groups, other departments). The third level contains the organizational sub-units of Toyota and the unknown-, emerging-, and existing-knowledge sub-sub-units that exist within each organizational sub-unit.

The fifth chapter begins by summarizing the new product development systems of the first Prius and the first Lexus and presents the specific CAS configuration found in each case. Next, analysis of the each case's findings were performed with the results validating the theoretical framework and verifying the three propositions proposed in Chapter 3 for describing these two Toyota cases. In both cases, energetic interactions among different organizational sub-units was found to have contributed to both the external adaptation and the internal adaptation. Thus, this characteristic can be understood to form the bridge connecting the two types of adaptation. By comparing the case findings with past research on manufacturing engineering, the chapter highlights how the roles and responsibilities of manufacturing engineering in Toyota facilitated the bridge building that allowed radical innovation to be created from incremental innovations.

The new product development systems for the first Prius and the first Lexus had important differences in the environmental triggers, development objectives, radical innovation types, ways of cooperation with suppliers, interaction and communication methods utilized in realizing the external adaptation and creating the internal adaptations, and the main focuses of manufacturing engineering. Nevertheless, the overall process by which RI was created from II and the general facilitating role played by manufacturing engineering was found to be similar in both cases. A revised theoretical framework was made based on the findings of the two cases and was presented as the last section of this chapter to set a foundation for future study.

The sixth and concluding chapter presents ten conditions that were verified by the two cases for realizing organizational ambidexterity through the achievement of innovation ambidexterity in Toyota. As the basic conclusion to the research, in the new product development system found in Toyota in the 1980s and 1990s, radical innovation (RI) required the company to adapt to its external environment (external adaptation), incremental innovations (II) required organizational sub-units to adapt to the organization (internal adaptations), and for RI to be created from II, there needed to be a bridge between the external adaptation and the internal adaptations. Energetic interactions among different organizational sub-units were shown to be effective in linking internal adaptations to form a bridge to the external adaptation. Manufacturing engineering was found to have played a critical role in building this bridge.

The main theoretical contribution of this research is presenting and provisionally verifying a theoretical framework, related propositions, and conditions that allow an organization to create RI from II across multiple levels in a new product development system, which fills in a research gap, suggests a solution to an important managerial problem, and presents a method for achieving organizational ambidexterity. Furthermore, this research also highlights the critical role manufacturing engineering can play in building the bridge between external adaptation and internal adaptations to facilitate creating RI from II.

While acknowledging that specific boundary conditions to this research, the primary managerial implication of this research is directed at an organization that wants to imitate Toyota and create RI (a revolutionary new product that is at least partly focuses on leveraging existing technologies) from II. Such an organization should endeavor to meet the ten conditions presented at the beginning of this chapter and make complexity thinking an important element of its organizational culture. Embracing a complex adaptive system approach enables managers to arrange available resources effectively and efficiently to allow their organization to create and then leverage II into the realization of RI. However, clearly careful investigation of whether or not any other organizations have actually been able to achieve what Toyota has done is an important line of future inquiry.

The dissertation ends by listing ten additional issues for future study based on the limitations of this research. These issues are: (1) further study the relationship between the conditions presented and verified in this study; (2) explore other possible conditions; (3) study employee allocation issues; (4) study the roles of boundary spanners; (5) study the roles, responsibilities, and interactions between upstream ME personnel and downstream ME personnel at Toyota in creating RI from II; (6) explore the number of II that are needed to create RI; (7) compare with unsuccessful NPD projects; (8) perform case studies of other NPD projects that resulted in RI that contain II, in the global automobile industry and other industries, including service industries, that have products/services that are highly complex and require high levels of coordination to develop; (9) test the validity of the conditions by quantitative research; and finally (10) look for other possible answers to the general research question.