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著者(和文)	ラリットノラセット パウイナー
Author(English)	Paveena Lalitnorasate
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**DYNAMICS OF EXPLORATION AND  
EXPLOITATION OF TECHNOLOGICAL  
CONVERGENCE AND COMPETENCE  
BUILDING IN THE FOOD AND LIFE-  
SCIENCE SECTOR: FUNCTIONAL FOOD  
IN JAPAN**

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Dissertation to be submitted for the degree of Doctor of Management of  
Technology

**Paveena Lalitnorasate**

Graduate School of Innovation Management

Supervisor: Prof. Kumiko Miyazaki

Co-supervisor: Prof. Yoshitoshi Tanaka

## Summary

Changing human lifestyle and health consciousness have created a new market demand for “Functional Food” (FF) or food that provide health benefits for the promotion of good health and prevention or management of chronic diseases. An opportunity created by the FF market has attracted firms from both food and life-science sectors, blurring the sectoral boundary and driving them into “convergence” at the level of technological knowledge. While food manufacturers, pharmaceutical firms and personal care firms attempt to gain benefit from FF market, they have faced various strategic challenges from the market constraints, legislative requirements, and technical issues which affect each sector in different ways. The main question here is how firms are able to efficiently explore and exploit the opportunities that arise from the convergence of technological knowledge and the emergence of FF market.

Previous studies on convergence indicated a scarcity in the study of convergence in the industries other than ICT, and even though the process of convergence has been generalized, there has been no explanation on how the dynamics of changes in technological knowledge convergence affect an organizational learning (Curran & Leker, 2011; Hacklin, 2008; Stieglitz, 2003). In line with the evolutionary theory (R. R. Nelson & Winter, 2002) that investigated the roles of knowledge, routines and selection processes on the firms’ innovative activities, this study considers the diffusion of technological knowledge, existing resources and core competences to be important factors that influence a learning approach on tackling with FF convergence in different types of firms.

To understand how opportunities from a convergence in technological knowledge affect the pattern of learning towards FF in firms of different characteristics, this research studies the flow of technological knowledge, a firm’s strategies on FF innovative activities and draws a

framework for learning and technological competence building in the organizations. Firstly, it investigates the characteristics of technological knowledge that diffuses across sectors and plays a key role as an external driver of FF convergence. Secondly, it explores the roles of intra-organizational factors, specifically core competences and learning approach (Miyazaki, 1999; C. K. Prahalad, 1993a) on the firms' strategies to explore and exploit new opportunities that have been created from the FF technological knowledge convergence.

This research has focused its scope on Japanese FF industry for two reasons. Firstly, unlike many countries that FF regulation has not yet clearly established, FF product labeling system in Japan is strictly regulated by the government under FOSHU (food for specified health use) and secondly, market value of FF in Japan is considered the world top. Based on FOSHU data and FF related patent applications, the main analytical methods consist of bibliometric study and social network analysis on the FF related patent applications from Japanese Patent Office (JPO). In addition, case studies are conducted on the selected firms from food and beverage (F&B) industry and life-science sector i.e. pharmaceutical and chemical firms, on their patenting activities and FOSHU development.

An analysis on the FF patenting activities reveals the dynamics of changes in the FF technology and knowledge bases to be characterized by unequally diffusing across sector, and shifting from emphasizing on the primary functions of food to the more advanced functions. The bibliometric information from patent citations reveals that technological knowledge that contributes to both F&B and life-science sector was relatively more novel and more pervasive, but showing to have smaller lifespan than the sectoral specific technological knowledge.

While firms from different industries generally differ in their core competences, some similarities were found in the pattern firms built technological competences. An evidence from the network of FF co-patenting activities reveals an importance of inter-sectoral collaboration in

technological capability building at the early stage of convergence and this role is later replaced by the public research institute and university. Furthermore, firms were in general shown to be the least persistent and most technologically diversified at the early period of FF convergence and they become more focused on a narrower range of research activities when the growth of market become stagnated.

From an empirical study on technological competence profiles in twelve firms, four kinds of technological competences were identified in FF development: essential FF competence, peripheral competence, core competence and cross-sectoral competence. Each type of competence implies different extent of technological capabilities firms need to explore and exploit in building competence to compete in the FF market. Furthermore, from the case studies, learning patterns in firms can be categorized based on their degree of orientation towards its own sector and towards another sector. While sectoral differences are reflected in the way firms exploit technological capabilities, the strategic direction can be largely influenced by market opportunities in both sectors.

This research gives a theoretical contribution by filling the gap in the study of organizational learning and competence building in a unique case of technological knowledge convergence in FF. In addition, it gives a managerial implication in dealing with convergence opportunities by elaborating the framework for competence building via exploration and exploitation in firms that possess different resources.