

## Abstract

### 論文の内容の要旨

論文題目      Mathematical modeling of interaction between standards and patents and the interplay's influence on organizational function and innovation strategy in high-technology firms  
(ハイテク企業における標準と特許に係る相互作用の数学的モデル化とその組織機能やイノベーション戦略に対する影響)

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This is the abstract of the doctoral dissertation of Mr. TAMURA, Suguru. In this thesis, I will investigate and discuss how standardization activities affect organization management and the nature of intellectual property (IP). Based on this motivation, Chapter 2 will describe the historical background of problems related to the measurement of technical standards. In Chapter 3, I primarily discuss the issues of interaction between standards and patents. As a special case, this discussion includes standard-essential patents (SEPs). Chapters 4 and 5 discuss issues related to standardization organizations, both within and outside these organizations.

First, previous research mainly discussed standardization activities in relation to standard development organizations (SDOs) (Gandal, Gantman, and Genesove, 2007). One reason for this was that researchers were academically interested in SDOs, and the information exchange and coordination mechanisms within them. Another reason was that information and data on past participation in SDO membership and the SDOs themselves are relatively accessible. In other words, SDOs appear to be a topic of major research related to standards owing to the limitations of information and available data. This is the first topic I focus on in this thesis. Researchers consider that companies can maximize their performances because they have detailed information related to internal resources (i.e., within the boundaries of the company). Based on information within their organizations, companies can consider the cost of producing goods and services, and decide the optimal level of production.

Essentially, companies cannot necessarily make the most efficient choice. The reason for such irrational behavior in decision-making has been previously discussed in economics. In the

case of standardization, companies appear to possess incomplete information related to internal standardization activities. I posit that this imperfection is the cause of the exploratory state of the practice of relevant research and management related to standardization. In this case, the optimization of a company's production behavior may be biased owing to the lack of internal information, and the selected strategy may be biased. If companies become aware of not having sufficient internal information, they seek complementary information from external resources (i.e., SDOs). However, in the case of standardization activities within corporations, the behaviors of firms appear irrational from the theoretical point of view of knowledge acquisition, as they do not appear to have sufficient internal information. In some cases, even if firms possess internal information, they do not know how to use it. Nonetheless, in general, organizations with a systematic management system naturally exploit internal information, and find new information on technology and resources that complement internal resources across enterprise boundaries.

Finding and managing complementary information is the essence of a strategy that helps companies improve sustainable competitiveness. A practical example is a merger and acquisition strategy. Considering the above, I aim to understand why an organization does not have sufficient data on standardization activities. Furthermore, one research objective of this thesis is to discuss the reasons for the lack of data on standardization. This issue is elaborately discussed in Chapter 2 (Tamura, 2013).

Second, this thesis has other motivations as well. In the 2000s, standardization strategies played an important role in technological innovation, both at the enterprise and national levels. This was due to the rapid development of networking technology, which connected many digital devices through networks and standardized interfaces. Consequently, the interaction between standardization and patenting activities becomes increasingly relevant. The interactions cause changes in product designs. In this study, I will examine if there is a complementary relationship between standards and patents.

I discuss integration between standards and patents. In the past, standards and patents were regarded as different entities, but to appropriately understand and evaluate their characteristics, I discuss them uniformly, and consider the new conceptual framework. A new concept of IP (i.e., integrated IP) is presented for uniform handling of standards and patents. I propose a normative definition for the new concept of IP as follows (Tamura, 2016).

- (1) *Integrated intellectual property (integrated IP) encompasses all activities relating to intellectual resources, including patents and standardization.*
- (2) *Patent-related intellectual property (patent IP) refers to activities relating exclusively to patents or patenting, except standardization activities.*

In addition, I develop and present mathematical models dealing with standards and patents as factors. For this purpose, I describe patents and standards in vector form rather than scalar form. In an integrated approach to represent their relationship, I introduce the notion of integrated IP, as defined in the following mathematical model (Tamura, 2016).

$$\overrightarrow{\text{integrated IP}} = \overrightarrow{\text{patent IP}} + \overrightarrow{\text{standardization}} \quad (\text{Equation 1})$$

Using the vector format, I can describe the most complementary case (i.e., standards and patents have an additive effect) and the least complementary case (i.e., standards and patents cancel each other out) in a mathematical model. In the latter case, I describe the role of the standard as a “negative patent.”

Moreover, I show the following equation:

$$\text{Revenue} = R \cdot |\overrightarrow{\text{integrated IP}}| = R \cdot (\sqrt{2 + 2 \cos(\theta)}), \quad (\text{Equation 2})$$

where  $|\overrightarrow{\text{integrated IP}}|$  is the magnitude of integrated IP,  $R$  is the royalty rate of the patent, and  $\theta$  is the angle between  $\overrightarrow{\text{patent IP}}$  and  $\overrightarrow{\text{standardization}}$ . This equation demonstrates the existence of the “SEP paradox” or “FRAND paradox.” It indicates that SEPs generally seem to garner more revenue, but this is not always true. This issue is elaborately discussed in Chapter 3 (Tamura, 2016).

Third, I am interested in the organizational management of standardization activities. In order to understand standardization activities within organizations, it is important to comprehend the characteristics of organizations. In previous research on patent management, scholars examined the function and structure of the IP division (Granstrand, 2000). However, knowledge of the function and structure of standardization departments is limited. I deduce that the functions of organizations related to standardization activities are not being studied because the standardization activities themselves are not necessarily measured within organizations. I also discuss the issues that arise when information on standardization activities is not shared within an organization, along with the information management mechanism that an organization should implement. A new concept of IP management “Patent and Standard Information Management” (PSIM), which increases the exchange of information amongst divisions, is presented. In addition, a new comprehensive evolutionary model of IP organizations is proposed.

I discuss the necessity to integrate information management both inside and outside organizations. In addition, I normatively discuss the information management functions and the evolutionary model of IP organizations, including standardization activities. This issue is elaborately discussed in Chapter 4 (Tamura, 2012).

Finally, I discuss why an organization chooses to participate in standardization activities. Evidently, one reason is their interest in standards formulation. However, some companies may not be interested, as they do not participate in standardization activities despite their

involvement in R&D activities. This issue is discussed considering the costs and benefits of participation in the Japanese Industrial Standards (JIS) setting from the viewpoint of information management within an organization. This issue is aimed at practically discussing trade secret protection when participating in SDO activities. This topic is elaborately discussed in Chapter 5 (Tamura, 2015).

In summary, this thesis normatively discusses the basic issues related to standardization. Therefore, some of the results continue to be in progress, and require further development. Nevertheless, I believe that the results are valuable, and I am convinced that they contribute to the practical and academic development of the field.

### **References:**

- Gandal, N., Gantman, N., and Genesove, D. (2007). Intellectual property and standardization committee participation in the US modem industry. In S. Greenstein and V. Stango (Eds.), *Standards and Public Policy* (pp.208-230). New York, NY: Cambridge University Press.
- Granstrand, O. (2000). Corporate management of intellectual property in Japan. *International journal of Technology Management*, 19(1/2):121-148.

### **Author's Related Publications:**

- Tamura, S. (2012). Effects of integrating patents and standards on intellectual property management and corporate innovativeness in Japanese electric machine corporations. *International Journal of Technology Management* (Inderscience), 59(3/4):180-202. doi:10.1504/IJTM.2012.047242
- Tamura, S. (2013). Generic definition of standardization and the correlation between innovation and standardization in corporate intellectual property activities. *Science and Public Policy* (Oxford University Press), 40 (2) : 143-156. doi:10.1093/scipol/scs075
- Tamura, S. (2015). Who participates in de jure standard setting in Japan? The analysis of participation costs and benefits. *Innovation: Management, Policy & Practice* (Taylor & Francis), 17(3): 400-415. doi:10.1080/14479338.2015.1054604
- Tamura, S.(2016). A new intellectual property metric for standardization activities. *Technovation* (Elsevier), 48-49: 87-98. doi: 10.1016/j.technovation.2016.01.007