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Critical Success Factors in the Commercialization Process of  
Intellectual Property by New Technology Based Firms in Japan

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## Abstract

In this paper, I discuss critical success factors at each of the three stages of commercialization process of intellectual property by new technology based firms (NTBFs) in Japan. To examine this, the commercialization process is classified into three stages: the basic research, the product development, and the commercialization stages.

A questionnaire survey of NTBFs reveals that they recognize serious managerial difficulties at the commercialization stage. The survey found that “human resources” and “vision extraction and demand conceptualization” are perceived to be the main managerial issues/challenges in all stages. My analysis found that there are some positive correlations between success in management and “clarification and sharing of market needs” at the basic research stage; “top-down management” and “clarification and sharing of market needs” at the product development stage; and “cooperation with external specialists (such as certified public accountants, venture capitalists, and lawyers)” at the commercialization stage.

Finally, I conclude with some recommendations for overcoming the managerial difficulties at each of the three-stages of commercialization in NTBFs in Japan.

**Keywords:** New Technology Based Firms, Commercialization, Human Resources, Vision Extraction and Demand Conceptualization.

## 1. Introduction

New technology based firms (hereafter abbreviated NTBFs) are defined in this paper as innovative and progressive venture firms that base themselves on inventions generated by technological ideas and pursue advanced technology based businesses focusing on their own intellectual properties, especially legally-protected patents. In the commercialization process of advanced technologies that are based on intellectual properties, including patents, there are a variety of issues and challenges that needed to be overcome<sup>2</sup>. It is no surprise that many excellent advanced technologies frequently fail to be commercialized. This paper sets out to illustrate the reality and causes of managerial difficulties observed at each of the three-stages of commercialization process in NTBFs and examine the types of internal or external management required to overcome such difficulties. The analysis is based on the results obtained from questionnaire survey conducted with NTBFs in Japan and restricted to only those trying to commercialize their new technologies by taking advantage of their own intellectual properties.

In order to scrutinize the causes of managerial difficulties in the commercialization process of intellectual property-based advanced technologies, the commercialization process must first be classified. Although this could be done in a number of ways, this paper adopts the three-stage

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2 See, for example, Vesper, 1993: 63, Suzuki, Kim, Bae, 2002: 604-605.

commercialization process classification based on prior researches<sup>3</sup>; basic research, product development, and commercialization stages. In the basic research stage, fundamental science is turned into technologies represented by patents and other intellectual properties. In the product development stage, prospective technologies derived from fundamental research are further developed and a product prototype is produced. Finally, in the commercialization stage, the sale of newly-developed product is expanded with the aim to create a sustainable new market.

Do managerial difficulties exist at each of the three stages of commercialization by NTBFs? If so, what are the causal factors and what kinds of internal/external management are required to overcome these difficulties? In the following sections, I will examine these questions based on a questionnaire-based survey conducted with NTBFs in Japan.

## **2. Methodology**

The questionnaire-based survey was conducted with managers and employees of NTBFs who attended a distance learning program offered by Nara Institute of Science and Technology, and are seeking to establish businesses based on intellectual properties, including patents. Managers and employees from 184 business entities who applied for the distance learning program advertised through the Internet and a number of small business and economic associations all over Japan were surveyed through a questionnaire delivered via electronic or postal mail. In total, 116 business entities responded to the questionnaire distributed between mid-November and December 2004 (response rate: 63 percent). Out of these 116 responding entities, 47 unlisted companies currently applying for or have already obtained patents were identified and selected for study in this paper. To the question “How important is intellectual property to your business?”, 81 percent of the 47 companies answered “important” (51 percent answered “very important” and 30 percent answered “fairly important”). On the other hand, only 19 percent answered that intellectual property is “not important” (17 percent answered “not really important” and 2 percent answered “not at all important”). These results suggest that the majority of companies studied regard intellectual property as a core element of their business.

## **3. Results**

### **3.1. Difficulties at each stage of commercialization process**

The survey first questioned companies regarding their business performance, i.e. whether and to what extent they face difficulties at each of the three stage of the commercialization process. For each stage, I set up four levels of performance assessment, ranging from “steadily producing positive results (level 1)” to “facing a significant number of difficulties (level 4)”. The response for commercialization stage was 2.66, followed by product development stage at 2.41, and basic research stage at 2.28 on average. These results reveal that companies face more difficulties in business performance as they move on from one stage to the next.

Companies in which responded they have faced “some”, “a fair number of”, or “a significant

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3 See, for example, Hanks and Chandler, 1995: 529, Pfirrmann, Wupperfeld and Lerner, 1997: 11-21.

number of” difficulties were further questioned about the causal factors of these difficulties. In the basic research stage, ‘human resource (HR)’ issues are perceived to be the most crucial challenge, followed by ‘funding (FU)’, and issues of ‘vision extraction and demand conceptualization (VD)’. In the product development stage, issues with ‘vision extraction and demand conceptualization (VD)’ rises to the top, followed by ‘human resource (HR)’, ‘funding (FU)’, and ‘linkage among internal departments and organizations (LI)’ issues. Finally, in the commercialization stage, ‘human resource (HR)’ issues are also perceived to be the most crucial challenge, followed by issues with ‘vision extraction and demand conceptualization (VD)’, ‘funding (FU)’, and ‘linkage among internal departments and organizations (LI)’.

Human resource issues are recognized as the most significant challenge in the basic research and commercialization stages and second most significant in the product development stage. Issues with vision extraction and demand conceptualization are thought to pose the greatest challenge in the product development stage, and third and second greatest challenge in the basic research and commercialization stages, respectively. This suggests that these two issues represent the major causal factors of managerial difficulties in all stages of commercialization process.

Table 1: Causes of managerial difficulties at each stage of commercialization process

|    | B.R.S. | P.D.S. | C.S. |
|----|--------|--------|------|
| FU | 38     | 30     | 30   |
| HR | 45     | 40     | 53   |
| LI | 31     | 30     | 30   |
| IR | 3      | 10     | 15   |
| VD | 34     | 47     | 50   |
| CC | 24     | 20     | 23   |
| MO | 31     | 13     | 18   |

Note:

- Unit = Percentage of NTBFs participating in the causal factors of managerial difficulties survey
- Basic research stage (B.R.S.): N=29, Product development stage (P.D.S.): N=30, Commercialization stage (C.S.): N=40
- FU = funding issues, HR = human resources, LI = linkage among internal departments and organizations, IR = interactive relationships with external parties and specialists, VD = vision extraction and demand conceptualization, CC = corporate culture, MO = motivation.
- Multiple answers allowed

### 3.2. Internal management in NTBFs

To understand the fact regarding internal management of NTBFs, the survey further addressed questions regarding the following three subjects in which are taken as major internal management; ‘clarification and internal sharing of market needs (CM)’, ‘speedy management (SM)’, and ‘top-down management (TM)’. In order to study how each of these factors is valued and to what

degree is put into practice at NTBFs, I set up a four-level measurement for these internal management commitment from “very engaged/necessary (Level 4)” to “not at all engaged/necessary (Level 1)”. The analysis shows that a large number of companies seem to recognize the necessity of clarification and sharing of market needs, speedy management and top-down management toward commercialization. However, much less companies actually practice this management. The degree of actual practice of clarification and sharing of market needs, speedy management and top-down management, in fact, occurs in reverse sequence from the recognition of its necessity.

Table 2: Recognition of necessity and actual practice of major internal management

|    | Necessity |       | Practice |       |
|----|-----------|-------|----------|-------|
|    | Ave.      | S.D.  | Ave.     | S.D.  |
| CM | 2.77      | 0.476 | 1.34     | 0.962 |
| SM | 2.62      | 0.534 | 1.51     | 0.748 |
| TM | 2.60      | 0.496 | 1.81     | 0.992 |

*Note: CM = clarification and internal sharing of market needs, SM = speedy management, and TM = top-down management*

### 3.3. External management in NTBFs

The companies were asked questions regarding the following two subjects: the recognition of necessity and actual practice of “establishing interactive relationships with external parties and specialists”. Regarding this issue, external parties include “customers (CU)”, “business partners (BP)”, “companies in other industries (CI)”, “government agencies (GA)”, “competitors (CO)”. Also, external specialists include “patent attorneys (PA)”, “banks (BA)”, “lawyers (LA)”, “certified public accountants (CP)”, “management consultants (MC)”, “temporary staffing agencies (TS)”, and “Venture capitalists (VC)”. The respondents were to choose between “very engaged/necessary”, “fairly engaged/necessary”, “not very engaged /necessary”, or “not at all engaged/necessary” for their answers to the necessity recognition and actual practice of establishing interactive relationship with each of the above parties. The results show that an average number of companies establishing interactive relationships with external parties and specialists is lower across the board than the average number of companies recognizing the necessity of such practice.

Table 3: Necessity recognition and actual practice of establishing interactive relationships with external parties and specialists

|                      |    | Necessity |       | Practice |       |
|----------------------|----|-----------|-------|----------|-------|
|                      |    | Ave.      | S.D.  | Ave.     | S.D.  |
| External parties     | CU | 2.63      | 0.618 | 1.68     | 0.909 |
|                      | BP | 2.42      | 0.583 | 1.66     | 0.987 |
|                      | CI | 2.10      | 0.878 | 1.00     | 0.873 |
|                      | GA | 2.02      | 0.869 | 1.07     | 0.884 |
|                      | CO | 1.60      | 0.912 | 0.67     | 0.808 |
| External specialists | PA | 2.52      | 0.552 | 1.70     | 0.930 |
|                      | BA | 1.93      | 0.894 | 1.40     | 1.050 |
|                      | LA | 1.98      | 0.841 | 1.21     | 0.951 |
|                      | CP | 1.90      | 0.821 | 1.35     | 1.021 |
|                      | MC | 1.72      | 0.797 | 0.91     | 0.868 |
|                      | TS | 1.55      | 0.942 | 1.02     | 0.988 |
|                      | VC | 1.63      | 0.900 | 0.74     | 1.026 |

Note: CU = customer, BP = business partners, CI = companies in other industries, GA = government agencies, CO = competitors, PA = patent attorneys, BA = banks, LA = lawyers, CP = certified public accountants, MC = management consultants, TS = temporary staffing agencies, and VC = venture capitalists

### 3.4. Success factors at each stage of commercialization process

What types of internal/external management are required for NTBFs to overcome managerial difficulties during the basic research, product development, and commercialization stages of commercialization process? To answer this question, I conducted a correlation analysis between companies' business performances and commitment levels to major internal or external management for each of the commercialization stages.

At the basic research stage, a positive correlation was observed between the progress in overcoming managerial difficulties and commitment to "clarification and sharing of market needs" (5 percent level). In the product development stage, positive correlations were observed between the progress in overcoming managerial difficulties and commitment to top-down management (5 percent level) and clarification and sharing of market needs (10 percent level). Furthermore, at the commercialization stage, positive correlations were identified between the progress in overcoming managerial difficulties and commitment to interactive relationships with external specialists, especially with certified public accountants (1 percent level), venture capitalists (1 percent level), and lawyers (10 percent level).

Table 4: Correlation between business performance and internal/external management

|                      |    | B.R.S.  | P.D.S.  | C.S.     |
|----------------------|----|---------|---------|----------|
| Internal management  | CM | 0.364** | 0.291*  | 0.237    |
|                      | SM | 0.256   | 0.156   | -0.006   |
|                      | TM | 0.249   | 0.379** | 0.027    |
| External parties     | CU | -0.096  | -0.154  | 0.1      |
|                      | BP | 0.004   | -0.054  | 0.215    |
|                      | CI | 0.064   | -0.057  | 0.123    |
|                      | GA | 0.213   | 0.275   | 0.182    |
|                      | CO | -0.149  | -0.181  | -0.052   |
| External Specialists | PA | 0.198   | 0.276   | 0.277    |
|                      | BA | 0.096   | -0.057  | 0.193    |
|                      | LA | -0.038  | 0.021   | 0.163*   |
|                      | CP | -0.006  | 0.165   | 0.455*** |
|                      | MC | 0.014   | -0.074  | 0.063    |
|                      | TS | -0.021  | -0.265  | 0.119    |
|                      | VC | 0.096   | 0.219   | 0.478*** |

Note: \*: Positive at 10 percent level (two-sided test),

\*\*: Positive at 5 percent level (two-sided test)

\*\*\*: Positive at 1 percent level (two-sided test)

## 4. Discussion and implications

### 4.1 Summary of results

The questionnaire survey with NTBFs reveals the following three points: 1) NTBFs recognize that serious managerial difficulties exist at the commercialization stage of commercialization process, 2) the issues concerning human resources and vision extraction and demand conceptualization are perceived to be the main causes of managerial difficulties in all stages, and 3) there are some positive correlations between success in overcoming managerial difficulties and clarification and sharing of market needs at the basic research stage; top-down management and clarification and sharing of market needs at the product development stage; and interactive relationships with external specialists, such as certified public accountants, venture capitalists, and lawyers, at the commercialization stage.

### 4.2 Implications

Concerning the question of “what types of internal/external management are required for NTBFs in order to smoothly progress into commercialization?”, the commercialization process will be examined further in an attempt to find appropriate management applicable for each of the three stages in this section.

Looking into the survey results for the basic research stage, the majority of companies facing

managerial challenges identified human resource as their causal factor. At the same time, the positive correlation was founded between the progress in overcoming such managerial difficulties and commitment to clarification and sharing of market needs. An additional interview-based survey also shows that many of the companies expressed the importance of managerial focus on market needs. Some claimed that “It is important to initiate market need oriented R&D activities”, while some also mentioned that “We conduct market research before developing products and we only develop products that are expected to sell well”. This combined results suggest that, at the basic research stage, securing high quality researchers and conducting market need oriented R&D are considered very crucial.

In the product development stage, on the other hand, the majority of the companies found challenges with vision extraction and demand conceptualization. The results of my study also coincide with such statement, showing that there are positive correlations between commitment to top-down management and clarification and sharing of market needs with the progress in overcoming these managerial difficulties during this stage of commercialization. In other words, it can possible be stated that, in addition to the importance of market need oriented fundamental research with high qualified researchers in the basic research stage, the visions and initiatives of upper management to turn fundamental research into actual products are perceived to be significant in management of NTBFs at this second stage of commercialization.

Lastly, in the commercialization stage, serious managerial difficulties involving human resource issues were also found, especially in the shortage of human resources in the areas of marketing and sales. This statement is consistent with the results obtained from additional interview-based survey. In the survey, many of the companies pointed out the necessity of securing employees with high expertise in commercialization. For example, one explicitly stated that, “We hired sales specialists three years after the establishment of business to focus on marketing and sales and that did push up our sales”. The correlation study also show a positive correlation between the progress in overcoming managerial difficulties during commercialization and commitment to interactive relationships with external specialists such as certified public accountants, venture capitalists, and lawyers.

However, it is questioned that such interactive relationships may not contribute directly to overcoming human resource difficulties at this final stage of commercialization. Small-size companies and venture businesses, unlike larger enterprises or listed entities, have limited resource in investment and management. It is believed that, in normal circumstances, they would devote their human resource on hand in dealing with major issues and challenges in management and outsource less important tasks to external specialists. It is, therefore, difficult to imagine that the success in conquering managerial issues during commercialization stage depends largely on the established external relationships.

According to Kenney and von Burg (2000), existing organizations can be categorized into two groups. Companies, universities, research institutions, and other organizations of similar types, can be categorized as “Economy One”, while various organizations and systems supporting the

development of venture companies such as venture capitalists, certified public accountants, lawyers, investment banks, and entities of similar kinds, are known as “Economy Two”<sup>4</sup>. Based on this concept, Kenney and von Burg stress the importance of a highly functioning “Economy Two” and pinpoint it as being the strength of and also a key behind the creation of NTBFs in Silicon Valley. Comparing such circumstance to the current situation in Japan, it can possibly be stated that “Economy Two” is not yet fully playing its role in creating and developing NTBFs in the country.<sup>5</sup>

NTBFs, as ones of venture businesses, need to invest a fair amount of resources in creating intellectual properties. For that reason, they are likely to encounter significant level of difficulty in managing their limited resources, especially human resources in which are revealed to be the most frequently cited managerial challenges for intellectual property commercialization. It is believed that the support by public sector in creating technology ventures and strengthening the function of “Economy Two”, especially in terms of aiding external specialists as resource persons to NTBFs, can be one of the most effective methods in further developing NTBFs in Japan.

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4 Others also point out that “Economy Two” is an important factor in fostering the creation of new ventures. See, for example, Lee, Miller, Hancock and Rowen, eds., 2000, and Imai ed., 1997.

5 For example, one of the important external specialists as venture capitalists contributed to high-growth venture companies in the US. However, investment from Japanese venture capitalists in venture companies in Japan did not favorably influence their performance (See Brav and Gompers, 1997; Kutsuna, Okamura and Cowling, 2002; and Hamao Yasushi, Frank Packer, and Jay R. Ritter, 2000).

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