The Empirical Analysis of Meaning Observed in the Patent Documents for Effective Utilization of Patented Technology (*)

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In order to innovate under today's situation of stronger international competition and shorter product cycle due to rapid globalization, firms need to carry out research and development (R&D) by actively using not only internal but also external knowledge and technology. Due to the expansion of "open innovation," various government measures regarding the utilization of intellectual property including patents have been conducted. However, such measures have not yet worked sufficiently.

In consideration of the above-described situation, in order to acquire clues for effective patent utilization, this study aimed to investigate the actual features of open innovation. By analyzing text information which is unstructured information of patent data, the actual features of open innovation could be grasped, and it was implied that open innovation contributed to the innovation of meaning that firms weaved into product design. Therefore, the possibility that it is useful to utilize the unstructured information of patents for effective patent utilization was implied.

I. Introduction

Recently, various government measures regarding the utilization of intellectual property including patents have been conducted. However, such measures have not yet worked sufficiently.

In consideration of this situation, in order to acquire clues for effective patent utilization, this study aimed to investigate the actual features of open innovation by using patent data.

II. Background and purpose of this study

1. Background

As leaders of innovation, firms traditionally have carried out R&D by using internal resources. However, recently firms are increasingly using external resources such as knowledge and technology. Due to the expansion of "open innovation," various government measures regarding the utilization of intellectual property including patents have been conducted. However, such measures have not yet worked sufficiently.

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2. Purpose of this study

In consideration of the above-described situation, in order to acquire clues for effective patent utilization, this study aimed to investigate the actual features of open innovation by using patent data. Because it has not been made clear sufficiently what the actual features of open innovation are, to investigate it in depth could be helpful for effective patent utilization.

III. Previous studies and approach of this study

1. Previous studies

(1) Previous studies using patent data

Information found in a patent document contains structured and unstructured information. While structured information includes bibliographic information such as the filing date, inventors and citations etc., unstructured information includes free text such as titles, abstracts, descriptions of the invention, or claims (Tekic et al., 2012; Tseng et al., 2007). Patent analysis using structured information has been a major approach for years. On the other hand, attention has been paid to unstructured information recently.

(2) Previous studies regarding open innovation using patent data

In the research field of open innovation, there are some studies using patent data. For example, as a patent analysis using text information, Jeon et al. (2011) used and analyzed a technology needs database and a patent database in order to search for potential technology partners. Patent analysis using structured information has also been a major approach in this field.

2. Approach of this study

Because there are not many studies regarding open innovation using text information of patent data, new aspects about open innovation could be discovered by using it. Therefore, this study used text information of patent data.

In this study, I conducted the analysis using similarity and keywords. It is an orthodox way to use similarity as a text analysis of patent data. In the analysis using keywords, I used the concept of "design-driven innovation," and tried to read meanings which a firm weaved into product design.

IV. Data

1. Selected field

The industrial field of non-alcoholic beverages was selected to analyze.

In order to compare the case in Japan with that in the US, I used patent data from the Japan Patent Office (JPO) and the United States Patent and Trademark Office (USPTO).

2. Samples

(1) Samples of Japanese firms

I used PatentSQUARE, a patent search system of Panasonic, to collect patent data[1]. In this study, I selected three major Japanese beverage firms: Asahi, Kirin and Suntory. Patents relating to non-alcoholic beverages held by the three firms were collected from the JPO. The patent search covered the filing date period from July 1, 1995, to June 30, 2015 (for 20 years). This search included keywords such as "beverage" and "drink" in patent titles, abstracts or claims. This search also included "A23" in IPC. After the patents with missing data were eliminated, 425 patents of Asahi, 288 patents of Kirin and 434 patents of Suntory were collected.

(2) Samples of US firms

I selected two major US beverage firms: The Coca-Cola Company and Pepsico. Patents were collected from the USPTO in the same way as the case of Japan. After the patents with missing data were eliminated, 121 patents of The Coca-Cola Company and 114 patents of Pepsico were collected.

3. Proxy indicators of open innovation

As proxy indicators of open innovation, joint applications with other firms, which mean "industry-industry collaborations," joint applications with universities, which mean "university-industry collaborations," and assignment of patent were utilized.

[1] I used data of unexamined patent publications, granted patent publications, and patent process information.

(1) The case of Japanese patents

I regarded a patent as a patent by industry-industry collaboration if it was applied for jointly with other firms.

I regarded a patent as a patent by university-industry collaboration if it was applied for jointly with universities. I also regarded a patent as a patent by university-industry collaboration if an individual applicant gave personal residential addresses, because academic inventors sometimes use personal information instead of university information when they apply for patents (Tamada & Inoue, 2007; Motohashi & Muramatsu, 2012).

I regarded a patent as an assigned patent if the applicants/holders of the unexamined patent publication did not include Asahi, Kirin or Suntory and the latest applicants/holders included them.

(2) The case of US patents

Because the inventors had to be named as applicants before 2012 in the US, if applicants/holders of a patent included only personal names, I referred to assignee data. I identified industry-industry collaborations, university-industry collaborations, and assignment of patent in the same way as the case of Japan.

V. Analysis using similarity

In this section, I used only patents by open innovation, and investigated the similarity of patent contents including technological contents.

1. Method

(1) Word Extraction

I exacted nouns and adjectives from patent abstracts. Then, I brought different notation words together, and eliminated unneeded words and stopwords.

(2) Similarity

The similarity between two patents was measured by using cosine similarity between TFIDF-weighted word vectors. Then, I calculated dissimilarity from cosine similarity, and used

non-metric multidimensional scaling for visualization.

2. Result

(1) Result of the case of Japanese firms

The patents by industry-industry and university-industry collaborations were scattered on the graph, which meant that they contained a wide range of contents. In addition, the contents of the assigned patents were not similar between firms.

(2) Result of the case of US firms

The patents by the two firms' industry-industry and university-industry collaborations were placed in separate positions on the graph between firms. In addition, the contents of each firm's assigned patents were not similar to the patent by industry-industry and university-industry collaborations applied for by each firm.

3. Brief summary of this analysis

The patents by the two U.S. firms' industry-industry and university-industry collaborations were placed in separate positions on the graph, which meant that the contents were not similar between the two firms. On the other hand, the patents of the three Japanese firms were scattered on the graph, which meant that there was no significant difference in patent contents between the three firms. In addition, in both cases, the tendency of the assigned patents was not similar to that of industry-industry and university-industry collaborations.

VI. Analysis using keywords

In this section, I used the concept "design-driven innovation" and tried to read meanings which firms weaved into product design.

Verganti (2009) proposed "design-driven innovation" as an innovation strategy focusing on "meaning," and it is the R&D process for meanings, based on the idea that each product holds a particular meaning (Verganti, 2009; Maekawa, 2015). As Maekawa (2015) suggests that recently meaning has become more important in product development, "meaning" is an important indicator of innovation.

In this analysis, I focused on the functions of non-alcoholic beverages. It is said that food and beverages have three functions: “nutritional function” which is nutritional work for life support, “sensory function” which is work in sensory aspects such as taste, and “biological regulation function” which is work such as adjusting the condition of a body (Consumer Affairs Agency, Government of Japan, 2014). Maekawa (2015) presented a green tea beverage “Healthya” by Kao as an example of design-driven innovation, and argued that it innovated the meaning of non-alcoholic beverages by emphasizing the biological regulation function. Thus, in the industrial field of non-alcoholic beverages, the function of a product is deeply related to the innovation of meaning.

1. Method

In this analysis, because I focused on not technological contents but the functions of products, I used not patent claims but patent descriptions as texts to exact keywords.

I extracted keywords related to the three functions mentioned above and health which relates to all three functions, and counted the number of times that keywords occurred in each patent. Because it depends on the length of the texts to extract keywords from, the number of occurrences of keywords was divided by the number of letters in the texts to extract keywords from.

2. Result of corresponding analysis by year

In order to figure out how the meaning which firms weaved into product design has changed by year, cross tabulation was performed by dividing the patents into periods every two years according to the filing date, and corresponding analysis was conducted.

(1) Result of the case of Japanese firms

Regarding Asahi, while the patents applied for from 1995 to 1999 were relatively associated with the sensory function, the patents applied for from 1999 to 2003 were relatively associated with health and the nutritional function. Then, the patents applied for from 2003 to 2005 were associated with the biological regulation function, and the patents applied for recently were associated with the sensory function again.

Regarding Kirin, while the patents applied for from 1995 to 2001 were associated with the nutritional function, the patents applied for from 2001 to 2005 were associated with the biological regulation function. The patents applied for recently were associated with health and the sensory function.

Regarding Suntory, although the patents applied for from 1999 to 2007 were associated with the nutritional function, the patents applied for from 1999 to 2005 were associated with the biological regulation function more than those applied for from 2005 to 2015. The patents applied for recently were associated with the sensory function.

(2) Result of the case of US firms

Regarding The Coca-Cola Company, the patents applied for through the whole time period were associated with the nutritional and sensory function more than health and the biological regulation function. While the patents applied for from 2007 to 2011 were associated with the nutritional function, the patents applied for from 2011 to 2015 were associated with the sensory function.

Regarding Pepsico, the patents applied for through the whole time period were also associated with the nutritional and sensory function more than health and the biological regulation function. While the patents applied for from 2007 to 2011 were associated with the sensory function, the patents applied for from 2011 to 2015 were associated with the nutritional function.

(3) Brief summary of this analysis

Differences in functions that each firm focused on by year were found, and a change of the meaning which firms weaved into non-alcoholic beverage products by year was shown.

3. Result of corresponding analysis by type of open innovation

In order to discuss each feature of open innovation, cross tabulation was performed by the type of open innovation and corresponding analysis was conducted.

(1) Result of the case of Japanese firms

Regarding Asahi, the in-house patents were associated with the nutritional and sensory function. While the patents by industry-industry and university-industry collaborations were associated with the biological regulation and nutritional function, the assigned patents were associated with the sensory function.

Regarding Kirin, the in-house patents were associated with the sensory function. While the patents by industry-industry collaborations were also associated with the sensory function, the patents by university-industry collaborations were associated with the biological regulation function.

Regarding Suntory, the in-house and the assigned patents were associated with the sensory function. While the patents by industry-industry collaborations were also associated with health, the patents by university-industry collaborations were relatively associated with health and the biological regulation function.

(2) Result of the case of US firms

Regarding The Coca-Cola Company, the in-house patents were relatively associated with the sensory function. The patents by industry-industry collaborations and the assigned patents were associated with the nutritional function.

Regarding Pepsico, the in-house patents were associated with health and the sensory function. While the patents by industry-industry and university-industry collaborations were associated with the nutritional function, the assigned patents were associated with health.

(3) Brief summary of this analysis

In the cases of both Japanese and US firms, the in-house patents were associated with the sensory function.

In Japanese firms, there were differences in the patents by industry-industry collaborations among firms. The patents by university-industry collaborations of all three firms tended to be associated with the biological regulation function. The assigned patents were associated with the sensory function. Thus, a common tendency was seen among the three Japanese firms.

4. Result of principal component analysis

In this section, principal component analysis was carried out for the purpose of grasping the features of individual patents. Then, each patent was plotted on the principal component axes by using the first and the second principal component for visualization.

(1) Result of the case of Japanese firms

In the three Japanese firms, the patents by industry-industry collaborations were scattered on the graph, which meant that they were related to various functions. Most of the patents by university-industry collaborations were related to the biological regulation function, whereas most of the assigned patents were related to the sensory function.

(2) Result of the case of US firms

In both US firms, compared to the patents by industry-industry collaborations, the patents by university-industry collaborations and the assigned patents showed variations in terms of functions.

(3) Brief summary of this analysis

In Japanese firms, a common trend was roughly observed among the three firms.
In US firms, compared to the patents by industry-industry collaborations, more characteristic features were seen in the patents by university-industry collaborations and the assigned patents.

VII. Analysis using the number of forward citations

In this section, I evaluated patents by open innovation by using the number of forward citations as structured information.

1. Method

In this analysis, only Japanese patents were used. The patents to be used here are the same as the Japanese patents used for the analysis using text information.
I utilized the number of forward citations by examiner as a dependent variable. As independent variables, I utilized industry-industry collaboration (it was coded as “1” if a patent fitted industry-industry collaboration), university-industry collaboration (it was coded as “1” if a patent fitted university-industry collaboration), and assignment of patent (it was coded as “1” if a patent fitted assigned patent). I also used firm dummies, the filing date, the number of inventors, the IPC number, and the number of claims as control variables.
I conducted regression analysis by using a negative binomial generalized linear model. Because the number of forward citations by examiner depends greatly on the filing year, I also analyzed 17 years of patents excluding the last three years.

2. Result

In the analysis using 20 years of patents, there were no significant independent variables. However, in the analysis using 17 years of patents, the number of forward citations of patents by university-industry collaborations was significantly small.

Because the patents by university-industry collaborations were significantly negative for the number of forward citations which are often used as an indicator of the importance of patents, it was implied that the importance of patents by university-industry collaborations was low.

VIII. Summary and discussion

1. Summary and discussion of the results

Here, I discuss the features of open innovation in Japanese firms in comparison with US firms.

The patents by industry-industry collaborations had diverse patent contents and functions. The industry-industry collaborations targeted in this study included collaborations with various firms such as food companies, fragrance companies and pharmaceutical companies. Based on diverse technologies created as a result of collaborations with such various companies, industry-industry collaboration might be widely involved in the innovation of meaning.

Regarding the patents by university-industry collaborations, though the importance as patents was not high, many of them were concerned with the biological regulation function, and from the viewpoint of function, differences from the in-house patents were large. Even though the importance of the patents by university-industry collaborations was low, it was possible that university-industry collaboration might have played a significant role in the innovation of meaning given to non-alcoholic beverage products using the biological regulation function.

Regarding the assigned patents, although differences in patent contents were found between firms, in terms of function, most of the assigned patents were related to the sensory function as well as the in-house patents. From the viewpoint of function, there was little difference from the in-house patents. Therefore, there was a possibility that patents that supplemented the sensory function developed by a firm alone were assigned.

As described above, by using text information which is unstructured information and analyzing patent data, I could grasp the actual features of open innovation. In addition, by analyzing keywords related to functions as an intermediary, it was implied that open innovation contributed to the innovation of meaning that firms weaved into product design.

2. Discussion for effective patent utilization

Due to the expansion of open innovation, measures for effective patent utilization have been carried out. However, it is pointed out that measures to support commercialization of intellectual property are necessary in the future (Hamagishi, 2011).

Under such circumstances, it seems to be useful to utilize the unstructured information of patents. In this study, by using text information which is unstructured information of patent data, I could grasp the change of meaning that firms weaved into product design by year and the actual features of open innovation. Thus, by using unstructured information of patent data, not only the technological contents of a patent but also the trend of product design and product development closer to commercialization could be grasped. Therefore, it seems to be able to lead to effective patent utilization for commercialization to utilize the unstructured information such as text information.

References

Consumer Affairs Agency, Government of Japan. (2014). White paper on consumer affairs 2014. （平成26年版消費者白書.）(http://www.caa.go.jp/adjustments/pdf/26hakusho_honbun.pdf, referred on March 20, 2017). [In Japanese].

Hamagishi, H. (2011). 中小企業における知財活用のための支援施策（特許情報施策および事業）. Japio year book, 2011, 138-141. [In Japanese].

Jeon, J., Lee, C., & Park, Y. (2011). How to use patent information to search potential technology partners in open innovation. Journal of Intellectual Property Rights, 16, 386-393.

Maekawa, T. (2015). Demonstration of design-driven innovation -Analysis of intellectual property information-.（デザイン・ドリブン・イノベーションの実証：知的財産情報の分析.）Doctoral thesis, Ritsumeikan University. [In Japanese].

Motohashi, K., & Muramatsu, S. (2012). Examining the university industry collaboration policy in Japan: Patent analysis. Technology in Society, 34(2), 149-162.

Tamada, S., & Inoue, H. (2007). 大学もしくは公的研究機関と民間企業との共同出願特許の分析. RIETI Discussion Paper Series. [In Japanese].

Tekic, Z., Kukolj, D., Nikolic, L. J., Drazic, M., Pokric, M., Vitas, M., Panjkov, Z., & Nemet, D. (2012, May). PSALM-Tool for business intelligence. MIPRO, 2012 Proceedings of the 35th International Convention, 1629-1634. IEEE.

Tseng, Y. H., Lin, C. J., & Lin, Y. I. (2007). Text mining techniques for patent analysis. Information Processing & Management, 43(5), 1216-1247.

Verganti, R. (2009). Design-driven innovation: Changing the rules of competition by radically innovating what things mean. Harvard University Press.