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An Empirical Study of Standardisation, Open Architecture, and Profitability in an Internet of Things Business

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Abstract: The objective of this research is to clarify the actual condition of a technological strategy in which a company opens its technology and contributes to the construction of an industry standard for the Internet of Things (IoT) industry, which at present is in the dawn or growth phase. In particular, it verifies the influence of the growth potential and the profitability of a company on the industry aggregate. In preceding research in other industries, although opening its own technology is not necessarily linked directly to a profit, it has been shown that it can contribute to long-term profitability by a strategic effort. As an examination method, a questionnaire was conducted among companies that have entered the IoT industry. As a result of this research, it also became clear that, in the IoT industry, prior investment in standardization can contribute indirectly to long-term revenue. In addition, the necessity for a strategic shift in the business model was observed.

Key Words: Standardisation, Open architecture, Platform leadership, Internet of things

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INTRODUCTION

The objective of this research is to verify empirically the influence of disclosing an IoT businesss technology and attaining standardization of its own product on its profitability.

The selection of an open or closed technological strategy is a difficult decision for a company. The excellent technology that is peculiar to a company is a source of its competitive advantage. A company's revenue can be raised by incorporating inimitable technology. For example, a manufacturer with the technology of very high-performance components or a raw material can acquire a larger revenue by selling the finished product, the service, and the solution incorporating the components or raw material.

On the other side, a technological strategy that builds partnerships with companies using inimitable technology is considered rather than incorporating inimitable technology. For example, in the auto industry, an affiliated group is formed and the revenue of the whole group is expanded by sharing a product technology among the companies in the group.

Furthermore, a technological strategy whereby a company opens its technology and product interface widely and encourages various external companies to use them is also possible. For example, the strategy of Google in the Internet industry or smartphone products is among them. Since Google opened its Application Programming Interface (API) for Android OS, an external company that is not connected to Google can directly use Google's technology, fundamentally without costs. Google is thought to be aiming to standardize its own technology by spreading it widely. A technical development requires many resource inputs. By standardizing, a counter value cannot necessarily be obtained with the technology itself. However, for example, a scheme that is called an ecosystem or suchlike is created, and it is thought that the larger revenue is acquired in another way. It may be an interesting technological strategy like the proverbial "You must lose a fly to catch a trout " and "He who gives to another bestows on himself".

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Aside from such a technological strategy, there is also an effort that standardizes and opens technology as a public standard from the start, in which the International Organization for Standardization (IOS) is involved. For example, although the Internet was originally the communication technology of the United States army, now it is open and developing as a public domain. Many companies are strategically concerned with the institution and the growth of such an international standard.

This research concerns a technological strategy regarding the latter in the various technical levels of openness mentioned above. That is, the significance of a private business firm adopting a technological strategy that does not necessarily acquire revenue directly with the technology itself is an object for analysis. Furthermore, the hereafter IoT is observed as an object for research. The IoT is currently in the dawn or growth phase, and it has a great expectation as an industry. It is thought that standards are being decided, while various technologies are currently being born and competing in the IoT industry. In this research the actual condition and the effect of the technological strategy regarding the disclosure or non-disclosure of their own technology are surveyed in IoT-related companies. As an examination method, a questionnaire was conducted among companies that have entered the IoT industry.

PRIOR RESEARCH

Types of standards

David (1987) proposed a taxonomy of standards that is fairly comprehensive, separating standards into reference, minimum attribute, and compatibility standards that can be applied to technical design as well as behaviour. Since network-type products represented by mobile telephones and PCs spread explosively, the maintenance of interchangeability has a very important meaning for product development (Cargill, 1989).

Common forms of standardization are de facto, forum/consensus, and de jure (Swann, 2000). Traditionally, de facto standards have been based on existing products. A de facto standard is the actual standard obtained by those with the dominant design through the marketing process. The information technology industry initially followed this model (Weiss, 1989). An example of a de facto standard is the IBM personal computer.

The de jure standard is determined by the proposal of the specification that is most commonly used in the market or the specification of quality. Examples of de jure standards are the electromagnetic radiation standards that are mandated by the Federal Communications Commission.

Consensus standards have attracted attention in recent years (Weiss & Cargill, 1992). These standards are based on the agreements of groups, such as international forums and industry organizations. The standards actually precede the products, instead of lagging products by several years. Manufacturers no longer compete to have their product adopted as a standard but to develop the standard before they build the product. Weiss (1989) concluded that they are in effect performing a significant portion of their product development in the public domain.

Standards and open architecture

Heller and Eisenberg (1998) described the situation in which an individual patent is asserted too strongly and technology is not used broadly as the "tragedy of the anticommons". On the other side, according to Weiss and Cargill (1992), the creation of standards is very difficult. Standards spread easily, so there are many participants in their creation, but the cost of forming an agreement becomes large. In addition, once a technical standard exists, a free-rider problem will occur. According to Schelling (1978), a solution is for a small number of users with a very similar interest to form a standardization society. Introducing restrictive membership makes coordination easy. In detail, a dominant user or a sectoral association is important. However, restrictive membership tends to induce fission and competitors in a standardization activity.

Some firms literally place technologies in which they have invested significant sums of money into the public domain so that they may be adopted into a voluntary consensus standard, at the risk of firms benefiting from the technology without making R&D investments (Weiss & Toyokuku, 1996). An open architecture is a type of computer architecture or software architecture that is designed to make adding,

upgrading, and swapping components easy (Ericson, 2011). For example, the IBM PC has an open architecture supporting plug-in cards. Open architecture systems may use a standardized system bus that allows multiple hardware manufacturers to produce add-ons and users to install them freely. An open architecture enables potential users to see inside all or parts of the architecture without any proprietary constraints. As a result of many vendors entering into the PC/AT compatible machine that is the IBM PC and its derivations, immense software and hardware assets were produced and it succeeded in market formation, but International Business Machines itself declined and withdrew.

Standards and innovation

In the early stages, consensus standardization was studied regardless of the competitive strategy theory. As mentioned above, to maintain interchangeability, a volunteer had to perform the standardization by applying costs, but they were not for differentiation (Weiss & Cargill, 1992).

However, the consortium activity that a business firm leads increased rapidly with the transformation of the innovation politics of Europe and the U.S. that started in the middle of the 1980s. Then, consensus standardization strengthened the implications as a strategic tool. Especially the platform leader company uses consensus standardization strategically (Due Au, 2016; Gawer & Cusumano, 2002; Iansiti & Levine, 2004). The latter standardization is characterized by a large-scale innovation being introduced into a market. In the case of a large-scale innovation, various instances of component engineering are necessary and the profit made by a partnership of multiple companies is inevitably large. In addition, a huge market is formed by introducing the result of an innovation into a market for a short period of time.

In the standardization process, partnership and competition between companies take place frequently. For a company to expand a market, the open strategy in which it cooperates with other companies is followed, and to monopolize a profit, the closed strategy in which it competes with other companies is adopted (Nalebuff, Brandenburger, & Maulana, 1996). Standardization affects greatly the number of entry companies and the degree of vertical integration (David & Greenstein, 1990). A product can be developed and produced without the centralized tuning up by a vertical integration company if a compatible standard is observed. Under a compatible standard, since many companies are able to generate an innovation dispersively, an autonomous division-of-work network is easy to form (Baldwin & Clark, 2000; Bernik, Azis, Kartini, & Harsanto, 2015; Langlois & Robertson, 1992). In recent years such an autonomous and dispersive division-of-work structure has been called an industrial ecosystem.

In addition, while such autonomy is supported, there is a case in which the strategy of a specific company may greatly influence the direction of industrial development. For example, the company acting as a platform leader utilizes the standardization process strategically (Gawer & Cusumano, 2002; Iansiti & Levine, 2004). The platform leader company makes the industry evolve in the direction that it desires, promoting free innovation by a complementary company.

Platform leadership

According to Gawer and Cusumano (2002), platforms are the product and service that act as a base on which multiple complementary companies make a product or provide a service. The company that manages such a platform is called the platform leader. The characteristic strategies for a platform leader to lead its own platform to success are classified into four. They are the clarification of the business scope, the open/closed design, the relationship with an external complementary company, and the design of the inner structure (Gawer & Cusumano, 2002).

To gather complementary companies, it is important for a platform leader that the network externality (Katz & Shapiro, 1985) works well. The network externality stimulates the participation of complementary companies, and the increase in the number of participating complementary companies raises the network externality. For that purpose it is important for a platform to solve the substantial problem of the system and to support the strong relation of interdependence between the platform and the complementary goods (Gawer & Cusmano, 2008). Furthermore, this viewpoint develops into the view of a two-sided market (Rochet & Tirole, 2003). In the case of a platform for two kinds of markets,

such as a dealer and consumers, the indirect network externality between each market is caused by a suitable price strategy, and the competitiveness of the platform is strengthened.

In addition, according to Gawer and Cusumano (2008), so that the users of a platform cannot easily move to a competing platform, it is important to raise an incentive and switching cost. It is necessary for a platform leader not to require a profit hastily but to make prior investments in an industry standard, to open the technical specifications appropriately, and to build a fiduciary relation with complementary companies (Gawer & Cusumano, 2002).

Research hypotheses

The objective of this research is to clarify the actual condition of a technological strategy in which a company opens its technology and contributes to the construction of an industry standard for the IoT industry, which at present is in the dawn or growth phase. In particular, it verifies the influence of the growth potential and the profitability of a company on the industry aggregate.

In the preceding research, opening technology is not necessarily directly connected with operating revenue. However, although there is no direct relationship, there may be a causeeffect relationship whereby a certain factor improves and can contribute to the prospective profitability by opening technology strategically and contributing to the standardization.

Regarding the factors, they can roughly be divided into the factors inside a company and the factors of the industry aggregate. As an internal factor, by opening technology, the number of external companies using the technology increases, and it is possible for the technology to spread among the public. When various products and services using the technology are developed and sold by the external company, the suite-of-products group of technology is formed, and it expands like an ecosystem. In the ecosystem various data are shared and experience is accumulated. As a trait of an IoT business, in particular sharing, the accumulation and utilization of data are important. The IoT involves advanced features and smart-ization of various devices. The significance is advanced utilization of big data. Various devices collect data autonomously, a database group is shared through a network, the collected big data are analysed by artificial intelligence and so on, and various devices are controlled. In an IoT business, the utilization of such data is thought to become a source of revenue. If data are collected and the know-how of data analysis is accumulated as the whole inside of an ecosystem, each participating company's product value will improve. For the user, the product and service based on the diffused technology have a high degree of interchangeability and become easy to adopt. In such an ecosystem, it is believed that imitation becomes difficult for competitors. Even if a counter value is not obtained with the technology itself, it is thought to be connected with the revenue as a result of the increase in competitiveness of the product and service using the technology.

H1: In an IoT business, by advancing the standardization of its own technology, the collection of data, analysis know-how, and so on are accumulated and the revenue improves.

H2: In an IoT business, by advancing the standardization of its own technology, the competitiveness of the product and service toward competitors increases and the revenue improves.

Next, the factor of an industry aggregate is considered. In relation to the above-mentioned internal factor, it is believed that the standardization of the technology in an industry aggregate promotes the evolution of the industry aggregate. A company can enter the industry easily, because there is standard technology. Even if it is a venture business with scarce managerial resources, they can be concentrated on an appropriate area for the company by utilizing standard technology. Innovations are promoted because various companies participate in the industry. If various innovations happen in the industry, the value of a product and service as an industry aggregate will improve. Of course, if there are many entry companies, the competition will also intensify, but regeneration is promoted considerably and the cost performance as an industry aggregate will improve. In addition, when a company appears that does not leave the standardization of the industry only to a spontaneous market mechanism but demonstrates leadership strategically, it is thought that the evolution of the industry is fostered. When a platform leader exists, it points in the direction of the innovation as an industry aggregate, the stake of the in-

dustry aggregate is adjusted well, and it is possible that the cooperative relation between companies becomes easy to build.

H3: In an IoT business, the technical standardization of an industry aggregate raises the profitability of each company.

H4: In an IoT business, when a platform leader exists, the profitability of the companies in each industry increases.

RESEARCH METHOD AND RESULT OF THE ANALYSIS

Research method

To verify each above-mentioned research hypothesis, a questionnaire was conducted among companies that have entered into the IoT business. The items in the questionnaire were designed based on each hypothesis, and all the responses were made following the Likert-style five-point form.

In addition, questions were asked about the domain identity, business model, and so on in an IoT industry. The research collaborated with adult graduate students who attend a business school in Japan. A total of 100 persons who have entered the IoT business were extracted. The types of industry to which the respondents belong are manufacturing industries, such as electrical machinery and motorcars, an information and telecommunications company, and a distribution and service business. The period during which the questionnaire was implemented was from July to August 2016.

Result of the analysis

Based on each above-mentioned hypothesis, a correlation analysis was conducted regarding the results of the questionnaire. The results of the correlation analysis are shown in Figure 1.

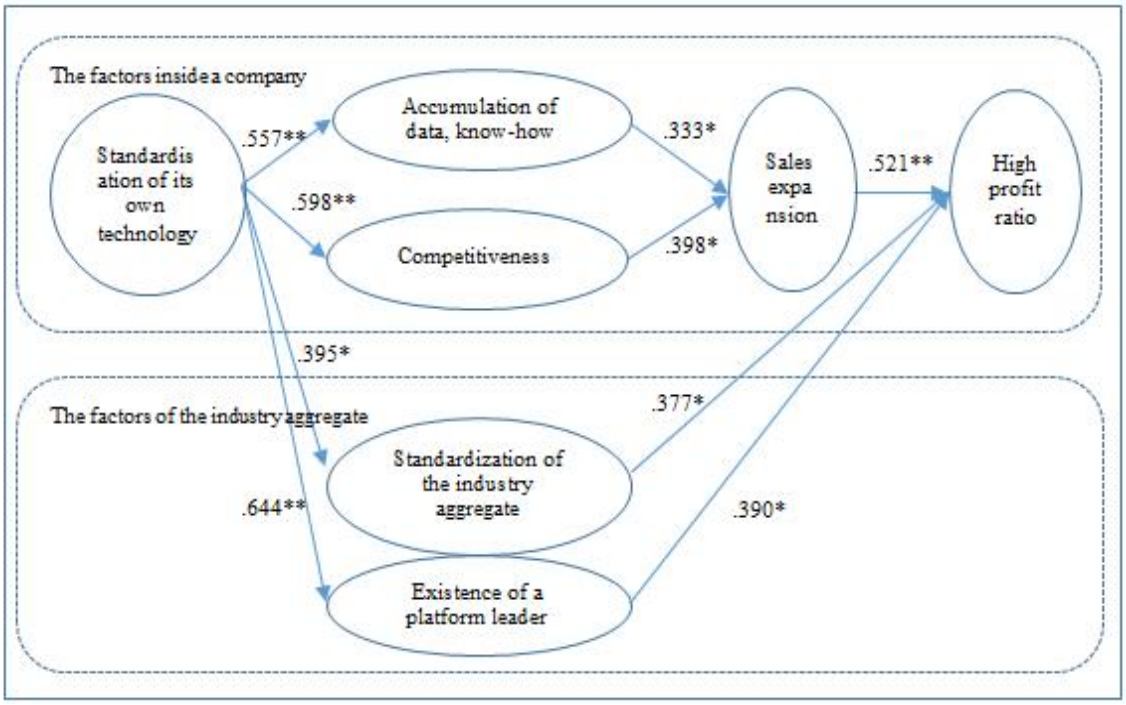

Figure 1. The results of the correlation analysis

DISCUSSION

Each hypothesis was verified based on the results of the analysis. First, hypothesis 1 and hypothesis 2 regarding the internal factors were mostly verified. They were connected with the accumulation of data or know-how that a company contributes to the standardization. In addition, they were linked to the competitiveness of in-house products and services that the company contributes to the standardization and to the improvement of the amount of sales of in-house products and services, although they were not directly connected with the profitability ratio. Furthermore, the expansion of the sales amount was

connected with an improvement in the profitability ratio. A company opening its own technology and tackling standardization were not directly connected with the profitability ratio. However, the capability of the company was heightened, the competitiveness increased, the business expanded, and the profitability ratio increased as a result. So to speak, the chain of the causeeffect relationship was verified.

Hypothesis 3 and hypothesis 4 regarding the external factors were also verified. In cases in which the company contributed to the standardization and the standardization of the industry was progressing, the profitability ratio of the company increased. In addition, in cases in which the company contributed to the standardization and a platform leader existed, the profitability ratio of the company increased. Such a causeeffect relationship chain may originate in particular in the item for which an IoT business is in the dawn or growth phase. It is thought that the IoT industry is still following the path towards standardization. Thus, it is easy for a company that contributes to standardization to gain a profit promptly. The above-mentioned internal factors are a necessary condition to earn a profit, and the factors of the industry aggregate may be a sufficient condition.

In addition, as a supplement, the response regarding the business model of an IoT business was analysed. The degree of difference between the existing business model and the business model of the IoT had a significant correlation with the profitability ratio (the correlation coefficient was 0.386*). It is considered that business models such as an open architecture and platform leadership are suitable for the IoT business. Generally, many Japanese firms until now have tended to adopt the business model of a closed architecture and a vertical integration style. For such a Japanese firm, a shift in the business model may be the condition for success in the IoT business.

CONCLUSION

The objective of this research was to prove quantitatively the influence that standardization and an open architecture as a technological strategy have on the profitability of a company in the IoT business. In preceding research in other industries, although opening its own technology is not necessarily linked directly to a profit, it has been shown that it can contribute to long-term profitability by a strategic effort. As a result of this research, it also became clear that, in the IoT industry, prior investment in standardization can contribute indirectly to long-term revenue. In addition, the necessity for a strategic shift in the business model was observed. As the limitations of this research, since the object of research was only Japanese firms, there is the possibility that the business environment that is peculiar to Japan influenced the research findings. An international comparative study is expected to be conducted in the future.

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