Does sticky information affect the locus of innovation?
Evidence from the Japanese convenience-store industry

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ABSTRACT

Scholars have long discussed the locus of innovation and its determinants. There is empirical evidence that innovations can be developed by those holding any of a number of "functional" relationships to them such as manufacturer, user, or materials supplier. Past studies have considered two factors important in predicting the functional locus of innovation. One is "expected profit of a player involved in the innovation" and the other is "stickiness of innovation-related information."

Although some studies have shown empirically the link between an innovator's expected profits and the locus of innovation, no research has yet been conducted to test the hypothesized relationship between stickiness of innovation-related information and locus of innovation. In the study reported upon here, I explore relationships between these two variables via a study of 24 innovations for the Japanese convenience-store industry. My study shows empirically that stickiness of innovation-related information does have the hypothesized relationship to the functional locus of innovation. I discuss implications of these findings, and some directions for future research.

Key Words: Sticky Information, Problem Solving, Product Innovation, Convenience-Store, Information Technology.

1. Introduction and overview of this study

What factors should we consider in order to predict the locus of innovation? Researchers studying innovation have attempted to answer these questions. Conventional wisdom holds that innovation is carried out by manufacturers who perceive a need for new products and then develop and market them. For example, many researchers have assumed that the manufacturer is the innovator and have discussed the conditions under which "incumbents" or "entrants" within the manufacturing sector innovate (Cooper and Schendel, 1976: Gilbert and Newbery, 1982: Reinganum, 1983: Tushman and Anderson, 1986). However, von Hippel (1976, 1988) challenged this assumption by demonstrating that the "functional" locus of innovation (manufacturers, users, or suppliers) varies among industries and product categories. Beginning with his work, a group of past innovation studies has particularly emphasized the role of the user in the innovation process (e.g. Leonard-Barton, 1995; Lee, 1996; Shaw, 1985, 1986). They take the view that the user generates the idea for a new product and initiates various stages of the development of the product (Lee, 1996).

To date, two variables have been considered important for predicting the functional locus of innovation. One is an "expected profit" of the players involved in innovation (von Hippel, 1988). The other is "stickiness of innovation-related information" (von Hippel, 1994). The "expected profit hypothesis" maintains that, of the players involved, the player who expects the highest profit from the innovation is most likely to innovate. On the other hand, the sticky information hypothesis contends that the player who has the stickiest innovation-related information is most likely to innovate. Before I proceed to my research question, I will briefly explain the sticky information hypothesis that is the focus of this paper.

The sticky information hypothesis begins with the observation that information is often costly to transfer from place to place. In 1994, von Hippel hypothesized that information transfer costs would have an impact on the locus of innovation, and that innovation-related problem-solving would tend to be carried out at the site of costly-to-transfer information utilized by the problem-solvers. He also proposed a variable, information "stickiness" that was focused strictly on the level of information transfer costs independent of cause. (Information can be costly to transfer for any of a number of reasons. Some have to do with the nature of information itself (e.g. tacitness of knowledge: Polanyi 1958, Nonaka and Takeuchi, 1995), some with the amount or structure of the information that must be transferred (e.g. Rosenberg 1976,78), and some with attributes of the seekers and providers of the information (e.g. absorptive capacity of the seekers or/and the providers: Pavitt 1987,186; Cohen and Levinthal, 1990).) He defined stickiness of a given unit of information as the incremental expenditure required to transfer that unit of information to a specific site in a form usable by a given information seeker. When this cost is low, information stickiness is low; when it is high, stickiness of information is high (von Hippel, 1994).

According to von Hippel (1995), product (or process or service) innovation requires us to combine two or more types of information that may be located in physically different places, and that may be sticky. For example, innovators require information on user needs, a type of information which is initially located with the user who has generated it. Innovators also need information on technological solution possibilities. This type of information is often generated by and initially located at the site of product manufacturers. It is necessary to transfer at least a certain amount of each type of information from one place to another because successful product development requires a combination of the two. In the case of product innovation, von Hippel's sticky information hypothesis would suggest that, when information on technology is sticky and information on user needs is not sticky, the manufacturer is more likely to innovate because it is easier for the manufacturer to understand the user needs than for the user to understand the technology to satisfy the needs. Similarly, the hypothesis would suggest that when information on technology is not sticky and information on user needs is sticky, the user is more likely to innovate because it is easier for the user to understand the technology to satisfy the needs than for the manufacturer to understand the user's needs.

No empirical research has been conducted to test the hypothesized relationship between the stickiness of innovation-related information and the locus of innovation. In this paper, I attempt to test this relationship. Therefore, my primary research question is: " does the stickiness of innovation-related information in fact have a measurable impact on the locus of problem solving in product innovation ?" In the next section, I describe my research setting for this study (section 2). I then explain the methods and the hypotheses in my empirical study of innovations for the Japanese convenience-store industry (section 3) and report on my study findings (section 4). Finally, I elaborate on some of the patterns found and offer suggestions for future research (section 5).

2. Research Setting

In the study I report on here, I empirically explore the relationship between sticky information and the locus of innovation via a study of 24 innovations in store inventory management systems developed by Seven-Eleven Japan (SEJ), the leading convenience-store company (CVS) in Japan, and NEC, a leading manufacturer of computer hardware and software in Japan. The goal of store inventory management is to accomplish streamlined just-in-time inventory, which improves store efficiency by (1) removing "dead" and slow-selling items; (2) replacing them with better-selling items; (3)providing forms to assist in analysis of data such as dead items, ordering efficiency, and new product sales.

The innovations related to store inventory management introduced into the CVS field by SEJ have played a critical role in facilitating employees' order data-input, order data-transfer, and data-analysis to accomplish streamlined just-in-time inventory[1]. To try to catch up with SEJ, its rivals have imitated these innovations. This fact shows the excellence of innovations for SEJ's store inventory management.

My decision to focus on this particular category of innovations was dictated by four practical considerations. First, I sought to combine my background in innovation research with my previous research experience in the Japanese retailing industry. Second, several books and journal articles on the Japanese CVS industry were available to understand the history of the product innovation in this industry. Third, almost all the innovations in my sample were developed by NEC for SEJ and both SEJ and NEC allowed me to obtain information needed to test my hypotheses. This access was very valuable because, to explore relationships between the stickiness of innovation-related information and the locus of problem solving, it is necessary to collect data from both the user and the manufacturer. Finally, the fact that the product innovations were developed relatively recently meant that most of the important contributors to the innovations are still professionally active and therefore able to provide me with rich, first-hand information on their activities.

Brief history of SEJ

A convenience-store is a retail store that supplies items to consumers, such as food and beverages and household supplies, that are typically used within one hour of purchase. SEJ is the leading firm in the Japanese CVS industry. SEJ ranks first among Japanese retailers in terms of ordinary profit ($ 93.3 million in 1994) and third in terms of net sales ($ 13,923 million in 1994). SEJ operates Japan's largest CVS chain, consisting of almost 6,000 stores in 1994 (see Table 1).

[1]With regard to the list of the manufacturers for the ten largest CVS companies, see Table 1.

Table 1. The ten largest CVS companies ranked by sales: their manufacturers in store computer systems in 1994.

Rank	CVS company (User)	Sales ($ million)	Number of Stores	Manufacturer of Store Computer
1.	Seven-Eleven Japan	13,923	5,905	NEC
2.	Lawson	8,214	5,139	NEC
3.	Family Mart	4,863	2,749	TEC
4.	Sun Shop Yamazaki	3,532	2,616	NEC
5.	Circle K Japan	2,571	1,622	NEC (from 1995)
6.	SunKus and Associates	1,859	1,093	NEC
7.	Mini-stop	940	603	TEC
8.	Kasumi Convenience Networks	897	721	Fujitsu
9.	Kokubun	880	612	IBM
10.	Seiko Mart	833	529	NEC

Source: Ryutsu Keizai no Tebiki 97 (Handbook of Distribution Economy 97, Nihon Keizai Shinbunsya, 1996) and the author's own research.

SEJ's spectacular success in Japan can be attributed to its management information system, which allows inventory to be turned over as many as 30 times a year, versus 12 times a year in the United States (Kotabe, 1995). To improve the efficiency of store operations, SEJ has introduced and reformed its comprehensive store information system four times. (1978-1981, 1982-1984, 1985-1990, 1990-now). Each system reform has contributed to improvement of SEJ's store efficiency in terms of average stock turnover time, average daily sales, and average gross profit margin.

Not only Japanese researchers but also some American researchers have recently paid attention to the Japanese CVS, particularly SEJ in its efficiency (Kotabe, 1995; Bernstein, 1996). In his case study of The Vanguard Program by SEJ to renovate the Southland Corporation's Seven-Eleven store in USA, Kotabe (1995) pointed out that "the next generation of Japanese competition may come unexpectedly from the service sector such as retail business." In this sense, SEJ's operation might be highly efficient on an international level. In SEJ's operation, store inventory management has played a critical role, and it is no exaggeration to say that SEJ's outstanding performance so far has depended on product innovation developed for SEJ's store inventory management. Thus, the product innovations developed for SEJ deserve to be examined, as the study of the patterns of such innovation might provide us with a better understanding of "best practice" with regard to locus of problem solving in product innovation. That is another reason that I elected to focus my study on product innovation in store inventory management systems within the Japanese CVS industry.

Overview of SEJ-NEC System Development Procedures

SEJ inventory management system development is the responsibility of the Information Systems Development Group in SEJ. During the period covered by this study, this Department has consisted of a staff of approximately 6 people, and has had a single manager. No one in the Department has an engineering degree, or skills in hardware or software development. (This is perhaps not surprising: the SEJ inventory management system was an entirely paper-based one at the start of the events recorded in this study. Systems using computer software and hardware were only introduced as a consequence of the events we have documented in this study.) NEC is the traditional supplier of equipment such as hand-held terminals to SEJ, and was the company customarily selected by SEJ to develop any new systems and equipment that SEJ might need. The Department that SEJ dealt with at NEC was the System Integration Department specializing in the development of systems for retail and service industries. This Department was staffed by approximately 600 engineers specializing in computer hardware and software development. During most of the period covered by this study, the SEJ projects at NEC were managed by the same individual.

To identify needs for changes in its inventory management systems, SEJ's Information Systems Development Group periodically set up temporary task forces specifically for this purpose. Four such task forces were set up during the period covered by this study, each existing for a period of 2-3 months. The first such "task force" consisted of the Department manager only. The succeeding task forces consisted of 4-6 people drawn from both the Department and from SEJ store personnel. Each task force was entirely an internal SEJ matter: No one from NEC or other outside firms served on them. At the conclusion of each task force, proposals for needed new inventory management system hardware and software were written and passed to SEJ headquarters for approval. After approval was received, the proposals were sent out to multiple vendors (such as Fujitsu, NEC and IBM) for bid. A single vendor was then selected to build and supply the improved system, and in all the cases studied here, the successful bidder was NEC.

After NEC had been selected as the successful vendor, SEJ and NEC personnel would meet frequently as the development work progressed. At later stages of the project, NEC would often provide partial system prototypes for testing by SEJ. Experience with these would often result in progressive refinement of SEJ system specifications, in the back-and-forth pattern that is characteristic of situations where design work depends on information that is sticky at more than one site (von Hippel 1994). For example, SEJ requested that a hand-held terminal to be designed by NEC be "light in weight." When NEC provided a "light-weight" prototype, SEJ tested it and found that the prototype was in fact much too heavy for store workers to hold for long periods of time, and told NEC that it must be made much lighter.

3. Research Methods and Hypotheses

Source of Information

The information used in this paper comes from several sources. Semistructured interviews were conducted (both face to face and via telephone) with those who had actually been involved in SEJ's system reform and /or had first-hand knowledge of the development of the innovations in our sample. I also interviewed several of SEJ's competitors in the convenience-store industry and those who were or are involved in similar projects for SEJ's competitors. Most interviews lasted from one to three hours. Additional information was collected from SEJ's and NEC's published literature. Follow-up questions were discussed in additional face-to-face meetings, and by telephone, fax, and electronic mail. All information from interviews that we report has been cross-checked with two or more experts to ensure accuracy.

Identification of Innovations

Using the sources noted above, I identified a total of 24 innovations that met the following three criteria:

(1) were embodied in software and/or hardware products provided by NEC to SEJ.

(2) were first commercialized prior to 1992 (when the last comprehensive information system reform was completed) .

(3a) offered users improvement in an existing function relative to the previous best practice

or

(3b) offered users a new function to enable them to accomplish streamlined just-in-time inventory.

My sample of major innovations was identified via a two step process. First I reviewed (1) SEJ's corporate history (written by SEJ); (2) other documents proposed by

SEJ to NEC and also by NEC to SEJ; (3) published literature about SEJ and /or other convenience-store companies. After that, I conducted exploratory interviews with 32 participants in the field, and generated a preliminary list of 24 innovations meeting my criteria. Next, I asked experts from SEJ and NEC to review the list I had assembled, and to suggest additions and deletions. The result of this procedure was the selection of 24 major innovations that met my sample selection criteria (see Table 2).

Table 2. Innovation list: Year and Description of innovations developed by NEC for SEJ store inventory management (1978-1992).

No.	Year	Description of the innovation
1.	1978	Easy input of ordering data with a bar-code and a pen-reader
2.	1978	Electronic data transfer through public line
3.	1978	Print-out of records of order entry
4.	1980	Size reduction of the hardware by 1/3
5.	1980	Easy switch from a phone mode to an electric data transfer mode
6.	1980	Fast print-out of records of entry data by 1/3
7.	1982	Electronization of the ordering book (EOB)
8.	1982	User-friendly design of the electric ordering book
9.	1982	Portability of the hardware
10.	1982	Aggregation of item-by-item data
11.	1982	Running 3 jobs simultaneously on the hardware (3 applications)
12.	1985	Making the actual sales data available on the EOB display
13.	1985	Increasing data processing capabilities of the hardware
14.	1985	Dust protection for the hardware
15.	1990	Making graphical data available on the display of the hardware for ordering
16.	1990	User-friendly design for data entry and data analysis
17.	1990	Checking punctual and precise delivery by vendors
18.	1990	Registration of the place where each item is organized on the shelf
19.	1990	Making delivery data available for demand prediction
20.	1990	User-friendly design of the hardware for delivery inspection and item-place registration
21.	1990	Running 8 jobs simultaneously in the hardware (8 applications)
22.	1990	Water protection for the hardware
23.	1990	Easy maintenance of the store computer
24.	1990	Automatic data transfer

Hypotheses

As I mentioned above, the purpose of this study is to explore the relationships between the stickiness of innovation-related information and the locus of problem solving in the product innovation. To explore the relationships, I look at two aspects of problem solving involved in development of product innovation. In general, product innovation can comprise two types of design. One is need (functional) design and the other is technology design. "Need design" is defined as design giving a new solution to the problem (user need) which the user actually or potentially has. An example is "easier data input for order entry." "Technology design" is defined as design giving a new technological solution to meet a given user need. An example here is "developing the software program language enabling the graphical data analysis on the liquid crystal display." In this sense, we can say that players involved in product innovation solve these two design problems. Nevertheless, technology management literature has paid attention to the technology design problem rather than the need design problem. I think that the need design problem should not be overlooked because we often see cases in which companies failed in finding promising user needs to be met by their existing or newly developed technologies. Particularly, in IT (information technology) -related innovations like those in this study, not only technology design but also need design is very important because new technologies are often developed as part of reform of the user's business process, which in turn leads to a new configuration of user functions (needs). In this study, I thus make distinction between two design problems (need design and technology design) involved in each innovation process, and I treat these two separately.

Now, I propose my hypotheses for this study. Concerning the "stickiness of innovation-related information," I have two hypotheses.

H1. The stickier the user information is, the more of the need design is done by the user.

H2. The stickier the technology information is, the less of the technology design is done by the user.

Earlier, we noted that past innovation researchers have also considered another factor to predict the locus of innovation: expected profit. However, SEJ and NEC have an agreement that NEC cannot sell any innovations developed for SEJ's store inventory management to competitors for a period of 2 years after first put into use by SEJ. This agreement was tacit prior to 1985 and explicitly encoded in a contract after that date. This contract is independent of the amount of problem-solving efforts invested by SEJ in a given innovation. Accordingly, I do not expect to find a link between the amount of user problem-solving and the user's ability to appropriate innovation-related benefit in the sample studied here. In fact, the user might have an incentive to invest less in an innovation, because he gets the same level of innovation protection regardless. In this sense, I do not expect to find a link between the expected profit of the user and the amount of problem solving done by the user. Similarly, I do not expect to find a link between the expected profit of the manufacturer and the amount of the problem solving done by the manufacturer because the agreement does not allow the manufacturer to get the profit comparable to the amount of problem solving done by the manufacturer (the manufacturer cannot sell the innovation to other users for 2 years).

Thus, I propose the following hypotheses with regard to the relationships between "expected profit" and locus of problem solving involved in product innovation development. Due to the special contractual relationship between the user and the manufacturer in this case:

H3. The amount of the user's expected benefit from using the innovation is not correlated with the amount of the need design done by the user.

H4. The amount of the user's expected benefit from using the innovation is not correlated with the amount of the technology design done by the user.

H5. The amount of the manufacturer's expected profit from selling the innovation is not correlated with the amount of the need design done by user. [2]

H6. The amount of the manufacturer's expected profit from selling the innovation is not correlated with the amount of the technology design done by user.

Operationalization of variables used to test hypotheses

Here, I describe how I measure stickiness of innovation-related information, the locus of innovation, and expectations of innovation-related profit.

Measurement of information stickiness

As was noted earlier, information stickiness can have many causes: the amount of information that must be transferred; the way that information is encoded; and attributes of the seekers and providers of the information. It is very difficult to measure any of these variables directly, especially retrospectively. Therefore I have measured the stickiness of need-related information via a proxy variable: the number of user "activities" affected by an innovation that were not already previously known to the manufacturer. (See examples given below for illustrations of what is meant by an activity. By "previously known," I mean "the same activity was already delivered to SEJ by an equipment produced by NEC.") Similarly, I measure stickiness of technology-related information in terms of the number of component technologies to be incorporated in an innovation that were not already previously known to the user. By "component technologies," I mean "technology

[2] In H5 and H6, I use the amount of problem solving done by the user instead of the amount of problem solving done by the manufacturer because the amount of the problem solving done by the user is inversely related to the amount of the same problem solving done by the manufacturer and, as I mention later, I only collected information on the amount of problem solving done by the user in this study.

(e.g. LCD display) that can be relatively independently developed as one part of the whole product," (see additional examples given below.) and by " previously known," I mean "previously used by SEJ in a store inventory management system."

These proxy measures are in essence measures of the novelty of key innovation-related information to user and/or manufacturer. I argue that they are useful proxies for information stickiness in the particular circumstances of this study for the following reasons. First, the amount of novel information to be transferred in each innovation is (crudely) measured in the proxies in terms of the number of user activities that were novel to the manufacturer, and the number of manufacturer component technologies that were novel to the user. Second, I assume that the encoding-related stickiness of information in each activity is similar. Third, I also assume that information transmitters and receivers are the same for all innovations in the sample, and therefore attributes of information transmitter and receiver did not vary from case to case. All of these assumptions are admittedly very crude ñ but I think that the proxy is nonetheless acceptable because the assumptions are conservative with respect to the hypothesis I am testing. That is, to the extent that they are incorrect, they will tend to lessen any correlation that might exist between the proxy for information stickiness and the locus of innovation.

Measuring Need Information Stickiness - Examples

Recall that I measure stickiness of need information that would be required by a manufacturer-based problem solver to develop the innovation in question in terms of the number of user "activities" affected by an innovation that were not already previously known to the manufacturer.

Low stickiness (score is 0) if the innovation does not affect any user's activity that was not already previously known to the manufacturer.

Sample innovation with low stickiness: Faster print-out speed of order entry record. In the case of this innovation, need information has low stickiness because the print out of order-entry record activity by the user was already known to the manufacturer.

Medium stickiness (score is 1) if the innovation affects a single user activity that was not already previously known to the manufacturer.
Sample innovation with medium stickiness: Easy input of ordering data with a bar- code and a pen-reader. In the case of this innovation, need information has medium stickiness because the data input activity (single activity) of item names and their quantity was not done by the user before using NEC equipment. (Before the innovation, the employee at the SEJ shop had to hand-write the quantity of the item to be ordered.)

High stickiness (score is 2) if the innovation affects multiple user activities that were not already previously known to the manufacturer.
Sample innovation with high stickiness: Graphical data display on the electronic ordering book. In the case of this innovation, need information has high stickiness because this innovation links three activities, that is, order entry, graphical data analysis, and visual check of the inventory of the store shelf by SEJ's shop stuff. The equipment previously used did not enable SEJ to do these activities simultaneously. Before the innovation, the employees at the SEJ shop had analyzed data such as slow-selling items, ordering efficiency, and new product sales in the back office of the shop and then they had ordered the item in the different place, that is, on the sales floor. The innovation made it possible for them to analyze, on the sales floor, such graphical data as had been analyzed in the back office, count

the items on the shelf visually, and reorder if necessary and make decision to cut an item if it is not selling well.

Measuring Technology Information Stickiness - Examples

Recall that I measure stickiness of technology information that must be transferred to the user in order for the user to specify the technical means to implement the innovation in terms of the number of "component technologies" affected by the innovation that were not already previously known to the user.

Low stickiness (score is 0) if the innovation does not involve any technology that was not already previously known to the user.

Sample innovation with low stickiness: Developing a better printer for the existing order-terminal. In the case of this innovation, technology information has low stickiness because SEJ previously used a printer for the print-out of the entry data.

Medium stickiness (score is 1) if the innovation involves an improvement to single component technology that was not already previously known to the user.

Sample innovation with medium stickiness: Developing a novel software programming language to control graphical chart on a liquid crystal display. In the case of this innovation, technology information has medium stickiness because SEJ did not previously use this software language, nor did it previously do graphical data analysis on portable equipment.

High stickiness (score is 2) if the innovation involves improvements to multiple component technologies that were not already previously known to the user.

Sample innovation with high stickiness: Employing a battery and a liquid crystal display in order to make an order entry equipment that was portable and could be held in one hand. In the case of this innovation, technology information has the high stickiness because SEJ had never used component technologies such as a battery and a liquid crystal display for portable order entry equipment.

Measurement of "locus of problem solving" and "expected profit"

Here I show how I measure "locus of problem solving involved in product innovation development" and "expected profit of a player involved in product innovation".

In the case of Japanese product development, it is often difficult to identify the locus of problem solving by simply asking them "who was the designer ?", because both the user and the manufacturer are generally involved in both user need design and technology design process. Thus, I do not measure the locus of problem solving directly. Instead, I measure the amount of problem solving done by the user with regard to "user need design" and "technology design".

In my study, I collected information on (1) the amount of problem solving done by the user with regard to need design to define the innovation (user's need specificity); (2) the amount of problem solving done by the user with regard to technology design to define the innovation (user's technology specificity) ; (3) the expected benefits by SEJ from using the innovation (user expected benefit); (4) the expected benefits by NEC from selling the innovation (manufacturer expected profit)[3]. Table 3 shows how I measure these.

Table 3. Description of how to measure "locus of problem solving" and "expected profit."

Variable Names	Score	Description of Questions
UNEEDSPC (amount of problem solving done by the user with regard to need design)		To what extent did SEJ initiate need design to define the innovation ?
	1	Need - SEJ expressed a general need for the innovation, but does not have any idea of how to accomplish the goal. Example: improving productivity of each shop
	2	Solution type - SEJ had enough information to be able to select specific type of solution from a variety of possibilities. Knowledge of the solution type would be derived from some understanding of the specific attributes of all the types and which of those attributes bear on the problem. Example: reforming the inventory system to reduce the order entry cost
	3	Functional specification - SEJ had a good idea of what the innovations had to do, but was not be able to specify the performance in quantitative design terms. Example: making order entry data easier
	4	Design - SEJ was able to supply quantitative requirements for most of the user-need-related features of the innovation. SEJ was also be able to provide more detailed need function-related suggestions as a result of prototyping the innovation or previous experience. Example: eight digit bar-code and a one lb bar-code reader.

[3]To obtain the score of "manufacturer expected profit", I collected information on the expected profits by NEC from selling the innovation for (i) SEJ, (ii) other convenience-store companies, and (iii) companies of other retail type respectively and calculated the total score of (i), (ii), and (iii) (see Table 4). Although I also used the highest score of the above three variables as "manufacturer expected profit," the results of my analysis did not change.

		(continued)
UTECSPC (amount of problem solving done by the user with regard to technology design)		To what the extent did SEJ initiate technology design to define the innovation.
	1	Not SEJ but NEC initiated all levels of technology design.
	2	SEJ told NEC to use a few specific technologies, but did not have enough information to be able to select specific type of technological solution from a variety of possibilities with regard to such technologies. Example: SEJ told NEC to use a liquid crystal display and a battery to reduce the hardware weight.
	3	SEJ told NEC to use a few specific technologies, and actually selected specific type of technological solution from a variety of possibilities with regard to such technologies. Example: SEJ told NEC to use an STN liquid crystal display and a lithium battery to reduce the hardware weight.
	4	SEJ told NEC to use almost all specific technologies, and also selected specific type of technological solution from a variety of possibilities with regard to a few of the technologies. Example: SEJ told NEC not only to use an STN liquid crystal display and a lithium battery but also to use RAM, mount technology, and so on to satisfy its needs.
	5	SEJ told NEC to use almost all specific technologies, and actually selected specific type of technological solution from a variety of possibilities with regard to such technologies. Example: SEJ told NEC to employ an STN liquid crystal display, a lithium battery, static RAM, surface mount, and so on to reduce the hardware weight.
	6	SEJ supplied all required technology-related information including quality control information.

		(continued)
USEPROF (user's expected benefits)		To what extent did SEJ expect a benefit from (developing) purchasing and using the innovation?
	1	SEJ had thought that it would make a loss immediately from purchasing and using the innovations.
	2	SEJ had thought that it would neither make a loss nor benefit from purchasing and using the innovation.
	3	SEJ had thought that it would benefit somewhat from purchasing and using the innovation.
	4	SEJ had thought that it could greatly benefit from the purchasing and using the innovation.
SEVEN (manufacturer's expected profits 1)		To what extent did NEC expect to pr to SEJ?
	1	The company might make a loss from developing and selling the innovation.
	2	The project would be profitable, but the profit level might not be acceptable.
	3	Everyone expected the project to be acceptably profitable, but nobody expected it to be very profitable .
	4	Everyone expected the project to be very profitable.
CVS (manufacturer's expected profits 2)		To what extent did NEC expect to profit from selling the same innovation to other CVSs, considering that NEC would additionally invest in selling it to them ?
	1	The company might make a loss from selling the innovation.
	2	The project would be profitable, but the profit level might not be acceptable.
	3	Everyone expected the project to be acceptably profitable, but nobody expected it to be very profitable .
	4	Everyone expected the project to be very profitable.

		(continued)
OTHERS (manufacturer's expected profits 3)		To what extent did NEC expect to profit from selling the same innovations to users other than CVSs, for example super-stores and specialty stores, considering that NEC would additionally invest in selling it to them ?
	1	The company might make a loss from selling the innovation.
	2	The project would be profitable, but the profit level might not be acceptable.
	3	Everyone expected the project to be acceptably profitable, but nobody expected it to be very profitable .
	4	Everyone expected the project to be very profitable.

In terms of user's need specificity, user's technology specificity, and user expected benefit, I sent the questionnaire shown in Table 3 to SEJ's CIO and asked him to rank each innovation in my sample on a scale of 1-4, 1-6, and 1-4 respectively. He has been involved in SEJ's information system development related to store inventory management almost from its inception.

In terms of user's need specificity, user's technology specificity, and manufacturer expected profit, I also sent the questionnaire shown in Table 3 to an expert at NEC and asked him to rate each innovation in my sample on a scale of 1-4, 1-6, and 1-4 respectively. He had also been involved in the information system development for SEJ from inception (he is not involved in the current project for SEJ). With regard to user's need specificity and technology specificity, the respondents from SEJ and NEC answered the same questionnaire separately. Interrater reliability was then assessed for user's need specificity and user's technology specificity by calculating of Cronbach's alpha. The values were .9697 for the judgment of user's need specificity and .9025 for user's technology specificity.[4]

4. Results

In this section, I attempt to test several hypotheses mentioned earlier. They are:

H1. The stickier the user information is, the more of the need design is done by the user.

H2. The stickier the technology information is, the less of the technology design is be done by the user.

H3. The amount of the user's expected benefit from using the innovation is not correlated with the amount of the need design done by the user.

H4. The amount of the user's expected benefit from using the innovation is not correlated with the amount of the technology design done by the user.

H5. The amount of the manufacturer's expected profit from selling the innovation is not correlated with the amount of the need design done by user.

H6. The amount of the manufacturer's expected profit from selling the innovation is not correlated with the amount of the technology design done by user.

To test these hypotheses, I conducted correlation analysis. Table 4 shows the variables analyzed in this study and their descriptive statistics. Table 5 shows Kendall's tau-b correlation coefficients with their significance levels.

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[4]In the later analysis, I use the scores obtained from the SEJ's respondent with regard to user's need specificity and user's technology specificity, but the result did not change even when I used the scores obtained from the NEC's respondent.

Table 4. Description, means, and standard deviations (S.D.) of the variables analyzed in this study (N = 24)

Variable Name	Description	Mean	S.D.
USEPROF	user's expected benefit: the extent to which SEJ had expected a benefit from (developing) purchasing and using the innovation.	3.63	.58
SEVEN	manufacturer's expected profit from selling the innovation to SEJ: the extent to which NEC had expected profits from developing and selling the innovation to SEJ.	2.25	.44
CVS	manufacturer's expected profit from selling the innovation to other CVS companies: the extent to which NEC had expected profits from developing and selling the innovation to other CVS companies.	2.83	.76
OTHERS	manufacturer's expected profit from selling the innovation to companies of other retail types: the extent to which NEC had expected profits from developing and selling the innovation to companies of other retail types.	3.00	.88
CVSOTHER	manufacturer's expected profit from selling the innovation to other companies than SEJ: the extent to which NEC had expected profits from developing and selling the innovation to other companies than SEJ; (the score of CVS) + (the score of OTHERS) for each innovation.	5.83	1.61
MPROF	manufacturer's expected profit: the extent to which NEC had expected profits from developing and selling the innovation; (the score of SEJ) + (the score of CVS) + (the score of OTHERS) for each innovation.	8.08	1.72
UNEEDSPC	user's need specificity: the amount of problem solving done by the user with regard to user need design to define the innovation.	3.42	.83
UTECSPC	user's technology specificity: the amount of problem solving done by the user with regard to technology design to define the innovation.	1.67	.92
USESTICK	stickiness of user need information: the expenditure required to transfer the user need information to define the innovation from the user-site to the manufacturer-site in a usable form.	1.13	.85
TECSTICK	stickiness of manufacturer's technology information: the expenditure required to transfer the technology information to define the innovation from the manufacturer-site to the user-site in a usable form.	.79	.98

Table 5. Kendall's tau-b correlation coefficients between user's need specificity (UNEEDSPC), user's technology specificity (UTECSPC), stickiness of technology information (TECSTICK), stickiness of user need information (USESTICK), manufacturer's expected profit (MPROF), and user's expected benefit (USEPROF). (N= 24)

	1. UNEEDSPC	2. UTECSPC	3. TECSTICK	4. USESTICK	5. MPROF
2. UTECSPC	.1421				
3. TECSTICK	- .1711	- .4789*			
4. USESTICK	.5784**	- .1007	.2145		
5. MPROF	- .1449	- .1677	- .1170	- .3991*	
6. USEPROF	.1659	.1059	.0564	.3944*	- .3170

** p <.01, * p < .05

According to Table 5, the results support my hypotheses with regard to relationships between the "stickiness of innovation-related information" and the "amount of problem solving done by the user." As Table 5 shows, I reject the null hypothesis that the amount of stickiness of user need information (USESTICK) is not correlated with the amount of problem solving done by the user with regard to user need design to define the innovation (UNEEDSPC) (Kendall correlation coefficients = .5784, P< .01). This result suggests that the stickier the user need information is, the more of the need design is done by the user (H1).

I also reject another null hypothesis that the amount of stickiness of technology information (TECSTICK) is not correlated with the amount of problem solving done by the user with regard to technology design to define the innovation (UTECSPC) (Kendall correlation coefficients = -. 4789, P < .05). This means that the stickier the information on technology, the less of technology design is done by the user; consequently, more of the technology design is done by the manufacturer (H2).

The above two results also suggest that, when the user need information is sticky and the technology information is also sticky, the need design is likely to be done by the user and the technology design innovation is likely to be done by the manufacturer. Although I rated information stickiness for each innovation on a scale of 0-2 in these analyses, the results did not change even when I rated it on a scale of 0-1 (Score is 0 when the innovation-related information has low stickiness; score is 1 when the innovation-related information has high or medium stickiness).

With regard to relationships between "expected profit" and "amount of problem solving done by the user," the results also support my hypotheses. According to Table 5, I cannot reject the null hypothesis that the amount of user's expected benefit (USEPROF) is not correlated with the amount of problem solving done by the user with regard to user need design (UNEEDSPC) (H3) and with that of problem solving done by the user with regard to technology design (UTECSPC) (H4). Also, I cannot reject the null hypothesis that the amount of manufacturer's expected profit (MPROF) is not correlated with the extent of user's need specificity (UNEEDSPC) (H5) and with that of user's technology specificity (UTECSPC) (H6). As I mentioned earlier, I do not expect to find a link between the amount of user's problem solving (that is, user's need specificity and technology specificity; these also reflect the amount of problem solving done by the manufacturer), the user's expected benefit, and the manufacturer's expected profit because of the agreement between NEC and SEJ on sales to other retailers. Thus, the results are what I hypothesized.

Next, I look at other findings revealed in the correlation analysis. First, Table 5 shows that I reject the null hypothesis that the amount of stickiness of user need information (USESTICK) is not correlated with the amount of manufacturer expected profit

(MPROF) (Kendall correlation coefficients = -.3991, P < .05). This is reasonable because the innovations with stickier user need information are more specific to SEJ, that is, they are less likely to be expected to sell to other retail companies.

To check these relationships, I conducted correlation analysis with regard to manufacturer's expected profit from selling to SEJ (SEVEN), to other CVS (CVS), to companies of other retail types (OTHERS), and to both other CVSs and companies of other retail types (CVSOTHER) and stickiness of user need information (USESTICK).

Table 6. Kendall's tau-b correlation coefficients between manufacture's expected profit from selling to SEJ (SEVEN), other CVS (CVS), or companies of other retail types (OTHERS), or both other CVSs and companies of other retail types (CVSOTHER) and stickiness of user need information (USESTICK) (N=24)

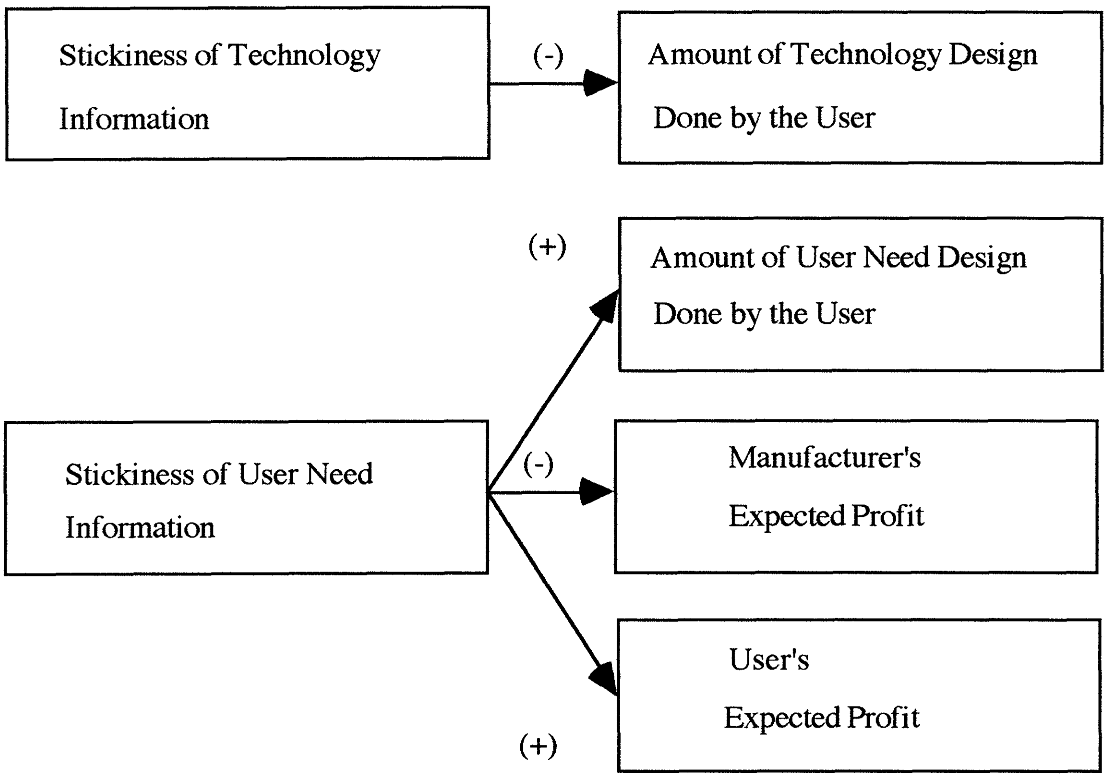
	1. SEVEN	2. CVS	3. OTHERS	4. CVSOTHER
2. CVS	.0479			
3. OTHERS	.3734	.7481***		
4. CVSOTHER	.3488	.7920***	.9748***	
5. USESTICK	- .1820	- .3040	- .4116*	- .3898*

*** p < .001, ** p < .01, * p < .05

According to Table 6, the expected relationship is supported by the results. Table 6 shows that I reject the null hypotheses that stickiness of user need information (USESTICK) is not correlated with the amount of manufacturer's expected profit from selling the innovation to companies of other retail types (OTHERS) (Kendall correlation coefficients = -. 4116, P < .05) and that stickiness of user need information (USESTICK) is not correlated with the amount of manufacturer's expected profit from selling the innovation to other retail companies than SEJ (CVSOTHER) (Kendall correlation coefficients = -.3898, P < .05). These results suggest that when the user need information is sticky, the manufacturer's expected profit from selling the innovation to other users is low.

Furthermore, I reject the null hypothesis that the amount of stickiness of user need information (USESTIK) does not correlate with the user's expected profit (USEPROF) (Kendall correlation coefficients = .3944, $P < .05$) (see Table 5). This result means that, when the user need information is sticky, the user's expected profit from using the innovation is high. This is also reasonable because innovations with stickier need information could affect more user's activities to be streamlined and the reform of the activities with the product innovation could thus make the user a profit. The summary of the findings in this study is shown in Figure 1.

Figure 1. Summary of the findings in this study



+ = positive influence; - = negative influence

5. Discussion

Until now, no empirical research has been conducted to test the hypothesized relationship between the stickiness of innovation-related information and the locus of problem solving in product innovation. In this paper, I explored the hypothesized relationship via a study of 24 innovations developed for the Japanese convenience-store industry. My findings provide empirical support to the hypothesis that the stickiness of innovation-related information plays a critical role in predicting the locus of problem solving. This empirical evidence is important, because as Ducharme (1989) pointed out, another hypothesis with regard to locus of innovation, the "expected profit hypothesis," might not be practicable in sectors where rents do not serve as an incentive (for example, in government laboratories). In this sense, "stickiness of innovation-related information" could be another variable used in predicting the locus of innovation in such sectors.

This exploratory study has been focused on patterns in the locus of innovation for projects carried out between a single user and a single manufacturer in a single industry. I have not yet examined how generalizable my findings are. I suggest that it will be useful to carry out more extensive studies on this topic in a range of industries for a number of reasons. In addition to the information that they can provide on the relationship between sticky information and the functional locus of innovation, such studies can contribute to our understanding of the patterns of cooperation among users and producers during the development process studied by authors such as Rothwell and Gardiner (1985) and Shaw (1985). These authors have pointed out that, especially in the instance of complex and specialized equipment (such as the SEJ inventory management systems we have studied), there is a need for direct cooperation between user and producer during the process of innovation. They also can also directly contribute to our understanding of how the signals regarding innovation-related needs and potential solutions become more specific, resulting in an increase in what Teubal (1976) calls "market determinateness." And, finally, when studies on this topic are extended to cases where multiple users interact with one or more producers, they can provide information bearing on theories of the nature of interactions among multiple users and producers that have been developed by researchers such as Lundvall (1988).

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