Technological Knowledge Diffusion in Customers' Community: Case of Tire Technology

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Abstract--**Diffusion of technological knowledge among customers is a big issue due to technology's complexity. This opens up a communication gap between providers and customers who do not have technological knowledge. This gap often leads customers to choose lesser quality goods and services. Therefore, the gap needs to be reduced by diffusion knowledge and finding way to interact with customers to share that knowledge. The aim of this paper is to identify the key factors of technological knowledge diffusion in the customer community. We selected the tire industry as a sample. This is because, in the tire industry, companies often face a communication gap with consumers who do not understand of tire technology. Tire technology knowledge and medical knowledge has a similarity from the viewpoint of safety, hazards, and sensitivity in terms of technology. We have analyzed drug knowledge diffusion in customer community in our previous work as diffusion research. In this paper, we proposed three hypothetical perspectives to diffuse tire technology knowledge on the basis of the findings of drug knowledge diffusion. In addition, we will identify how manufacturers and dealers in sharing tire technology knowledge with customers through direct contact, which will help customer with their buying decision. Focusing on the customer community as a unit analysis is a new perspective for understanding the mechanism of technology knowledge diffusion in the global tire business.**

I. INTRODUCTION

Automobiles are one of the dominant modes of modern transportation [1-2] and demand for them continues to increase. Similarly, demands for automobile tires have also increased as they are necessary for automobiles. Manufacturers produce two categories of tires - original equipment (OE) tires and replacement tires [3, 4, 5, 6]. The demand for OE tires is directly related to the number of new automobiles produced by automobile manufacturers. On the other hand, the demand for replacement tires depends on the number of automobile on the road, average kilometers run by per automobile, and the life of tire tread. It has been estimated that, an automobile needs two to six sets of replacement tires during its life-time. Therefore, the demands for replacement tires are increasing.

Customers have long needed to choose replacement tires by themselves for their automobiles. However, the automobile tire is not like a general commodity; it is produced with complex technological knowledge. Due to this, customers often become confused as to the right one to choose. Considering tire complexity, tire manufacturers have needed to diffuse their technological knowledge to the customer's so that they can choose appropriate tires. On the other hand, the automobile tire market is highly competitive and the diffusion of technological knowledge among the customers community is a big issue due to complexity of technology. Therefore, customers' have needed to gain insight into technology before deciding to purchase.

After being launched on the market, a new product does not become familiar to the customer community. After a few years, sales may peak due to marketing, sales, and diffusion strategies. These strategies of course differ from company to company and, product to product on the basis of their characteristics and customers. Of course, technical products have many characteristics different from and fewer customers than consumer products. Therefore, correct technological knowledge needs to be diffused dynamically in order to keep and increase customers.

The above background shows that, the tire manufacturing industry often faces a communication gap with tire customers who do not understand tire technology. As a result, this gap often leads to customers choosing lesser quality tires and related services. Thus, the gap needs to be reduced by promoting tire technology knowledge diffusion to the customer community.

The aim of this paper is to propose three hypothetical perspectives to diffuse tire technology knowledge on the basis of the findings of medical knowledge diffusion. Medical knowledge is based on the science and technology used in the maintenance of health, as well as in the prevention, diagnosis, improvement, or treatment of physical and mental illness. This is similar to tire technology knowledge, which is also based on science and technology used in the maintenance of tires, as well as prevention and protection from traffic accidents.

II. KNOWLEDGE DIFFUSION

A. General concept

Many diffusion scholars have argued the idea of the diffusion of innovations to analyze the spread of new ideas and practices within groups, communities, and societies [7]. Diffusion is defined as "the process in which an innovation is communicated through certain channels over time among the members of a social system" (p. 5)[8]. This definition focused on three main elements and communication is one of that. In marketing and communication, diffusion typically has come to mean the communication of an innovation through the populations [8-10]. And, communication is a valuable element in marketing when increase interactivity between two disciplines [11]. In terms of knowledge of a product, it can not be transferred by itself [12]. It can be transferred with new technologies by promoting to customers directly or through other channels. Thus, we are talking about technological knowledge diffusion. Technological knowledge

diffusion is a direct transfer of entire technical knowledge to a customer community is the two slides of the medal as Klarl [13] has argued (also relevant sduties in Stoneman [14]). Previously, there are pioneer studies about knowledge diffusion including organizational aspects [15], individual aspects [16], and interfirm aspects [17]. However, there has been insufficient systematic conceptualization assessment of a dynamic way to diffuse technological knowledge and its impact on the customer community as well as the organization's performances over time. Marinova [18] notes that shared market knowledge helps firms actualize better returns for their innovation efforts and may be a source of competitive advantage, but little conceptual or empirical work has explained the dynamic processes that motivate market knowledge diffusion for performance over time.

We mentioned before that a technical product is made using complex knowledge and customers have needed to gain some of this knowledge before deciding to purchase. Manufacturers are responsible for diffusing such technological knowledge to their customers. When a manufacturer cannot diffuse technological knowledge of a technical product, a communication gap may open up between providers and customers about technological knowledge. This gap often leads customers to choose a less quality goods and services.

At the most fundamental level, two factors inform innovation diffusion research. One dominant diffusion factor is the process of communication. Communication influences the potential users and informs them about the availability of new technology. Moreover, communication persuades users to adapt themselves to the new technology [9]. This suggests that forms of adoption differ across the customer community and reflects the forms of communication flow. The second factor is an economic aspect that views diffusion primarily in terms of cost and benefit. Mansfield [19] hypothesized that the higher the cost, the slower the diffusion but, the higher the perceived profit from an innovation, the faster the adoption.

B. Tire technology knowledge diffusion

Tire manufacturers develop and market tires with new technology. To produce and promote tires, tire manufacturers companies spend more time and utilize their resources to generate, gather, and disseminate tire technology knowledge. This is because, technological knowledge of tires is very important for the business interests of companies, but only a small part of it diffuses to the customer community to influence them to purchase and use a specific brand of tire. This includes how to use the tire, price and benefits, and advantages and disadvantages. Tire technology knowledge is relevant to automobile engineering. Therefore, automobile engineers as well as marketing professionals are responsible for transferring and diffusing tire technology knowledge.

Tire manufacturers compete in a highly competitive market. Dealers and agents, a vital part of tire supply chain, are geographically scattered all over the world, and manufacturers sell through their depots. Similarly, tire manufacturers also have exclusive retail distribution outlets. Therefore, it covers supply sides tire diffusion to customer community.

Dealers and agents are responsible for not only supplying tires to the customers from the various companies but also diffusing tire technology knowledge in the customer community. In the agent based supply chain network of the tire industry, most of the dealers and agents handle various brands of tires. Thus, dealer/agent-based diffusion of tire technology differs from brand to brand and some factors affect it directly and indirectly. For example, proper diffusion of tire technology to the customer community is related to sales turn over, which in turn is related to the economic benefits. Dealers/agents will be willing to diffuse, promote, and sell those tires that have comparably high profit margins. Dealers/agents are concerned with the promoting and diffusing tire technology as well as selling tires that generate higher sales turnover. Diffusion of tire technology knowledge is mostly about expertise, safety, and brands.

III. DRUG KNOWLEDGE DIFFUSION

A. Structure

Medical Representatives (MRs) are responsible for diffusing drug information through direct meetings with General Physicians (GPs). They do not find or diffuse information by using the Internet. MRs have to diffuse various kinds of information about drugs to their customers by face-to-face communication [20]. At the same time, they have to inform the head office of their daily performances via their branch offices. In this communication process, MRs perform as mediators to make a communication bridge between manufacturers, GPs and patients. Through this communication, they must stay close to their customers.

Pharmaceutical services have multiple knowledge diffusion channels including sales and marketing teams, academic conferences, and ICT. Most GPs are allowed to meet with MRs no more than four times a month. Among the GPs, no one obtains their prescription information directly from the Internet, video conferences, or interactive voice response. Some GP's only have experience of using closed loop marketing. Many GPs use the Internet for personal rather than professional use. They are allowed to receive small gifts like gimmicks [21] and are very interested in continuing medical education (CME) at their workplace or outside [22-24].

The most notable thing is that almost all GPs are very keen to know about new drug molecules manufactured by various pharmaceutical companies. Hence, they often try to participate in various kinds of academic seminars and meetings sponsored or hosted by the pharmaceuticals manufacturers [25]. For the successful transmission of medicinal information to GPs, MRs undergo internal training periodically provided by their affiliated companies [26]. Hence, almost all MRs undergo professional training at least once a month for 6-12 hours.

GPs prescribe drugs from the companies that provide information through MRs rather than drugs from companies - that do not provide information by MR's. Face-to-face communication is an important means for pharmaceutical marketing [27]. GPs are influenced to change their prescription decisions after direct promotion by MRs through face-to-face communication. Though most GPs prefer to prescribe brand medicine after face-to-face contact with MRs, a few GPs are willing to prescribe new drugs after they have been on the market for one or two years. The single most effective way that pharmaceutical companies can influence GP's decisions is through the use of face-to-face communication by MRs that persuade GPs to choose a one of many brand medicines.

Many GPs in Japan are involved in pharmaceutical promotional activities. In the ICT era, the pharmaceutical industry's promotional performances provide prescription information through face-to-face communication that is superior to other means such as professional society-sponsored continuing medical education, peer reviewed medical literature, and other nonbiased sources of drug information [28, 29]. As for the effectiveness of communication, most GP's can gain more useful information from 5 to 10 minutes talking with MRs than from reading reference material after searching various sources like the Internet.

The application of communication strategies enhances marketing, retail capabilities, and product reliability, resulting in better services and market performance. Communication has always played a significant role in attracting and keeping customers (and other stakeholders), but with advances in new media and computer technologies, the benefits of understanding and applying communication theory and strategies to marketing have never been greater. Though e-detailing is more cost effective than face-to-face communication (40 times the cost benefit), the traditional ways of detailing is still commonly used. E-detailing is only used for re-enforcing the promotional tools of face-to-face communication. Face-to-face marketer-customer interaction such as personal selling has been said to be the most important element in marketing communication.

B. Drug knowledge

According to Webster dictionary [30], drug is "a substance used in dyeing or chemical operations." The primary function of the drug is to prevent and cure disease, and GPs are responsible to provide specific medicine to patients through written prescriptions. But, a written prescription has not been shown sufficient knowledge to understand about drugs mechanism. So that, GPs have to provide verbal consultation to patients on written prescriptions. In order to provide a fruitful consultation, GPs spent more time to generate and gather drug knowledges. Because, drug knowledges are very important for GPs and patients also.

Drug knowledge also important for pharmaceuticals companies in order to influence on prescribing practice. Because, pharmaceutical companies diffuse drug knowledge to GPs and to patients community. However, drug knowledges are includes drug pharmacological knowledge, drug how to use knowledge, drug clinical knowledge, and drug accessibility knowledge.

Drug pharmacological knowledge explains drug effects on body after the drug uses. Drug pharmacological knowledges are encompasses drug composition and properties, synthesis and drug design, molecular and cellular mechanisms, organs/systems mechanisms, signal transduction/cellular communication, molecular diagnostics, interactions, toxicology, chemical biology, theraphy, and medical applications and antipathogenic capabilities [31].

C. Medical knowledge diffusion

The medical knowledge diffusion model shown in Fig. 1 has four segments. In the first segment, "information exchange", MRs provide medical knowledge through face-to-face communication in order to change GPs prescription decisions and convince GPs to prescribe their company's brand of medicine, even if this is a first meeting between the MRs and GPs. Through continued face-to-face communication over time, MRs are in a position where they can build relationships and trust with GPs, which make them able to exert significant influence on the GP's prescription decisions for certain type of drugs.

In the second segment, "information evaluation", GPs also obtain prescription information through ICT (telephone, e-mail, personal mail, video conferences, and other web sites provided by manufacturers or professionals), academic seminars, and academic journals. GPs evaluate and find the similarities and dissimilarities between prescription information they receive from MR's through face-to-face communication and through ICT. If GPs have found the similarities between information they obtain through both channels, their interest in certain brands of medicines grows and they prescribe these medicines to their patients.

In the third segment, "observation and application", GPs observe the detailed brand image in the market and its acceptability to other GPs. In the meantime, MRs continue their periodic face-to-face communication with GPs. Due to this communication, GPs start to prescribe the new brand of medicine instead of the previous one from the same group of medicines.

In the fourth segment, "decision change", GPs obtain product information and explicit knowledge through prescribing the medicine to their patients. GPs change their prescription decisions in this stage and prescribe the new brand of medicine instead of the previous brand.

We therefore find some different characteristics between medical knowledge and tire technology knowledge shown in table 1. These characteristics may differ during the knowledge diffusion.

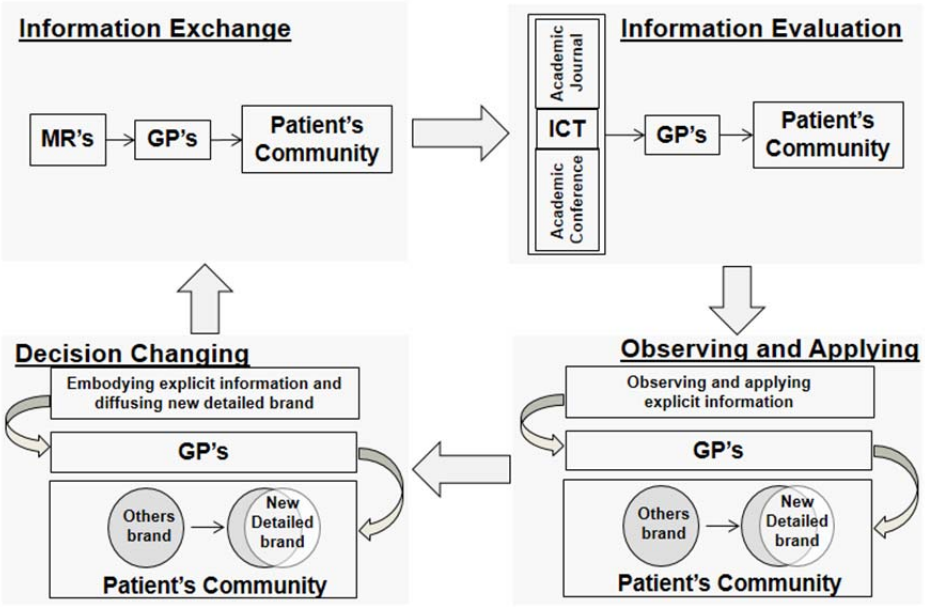

Figure 1 Medical knowledge diffusion process in the customer community.

TABLE 1: DIFFERENT CHARACTERISTICS BETWEEN MEDICAL KNOWLEDGE AND TIRE TECHNOLOGY KNOWLEDGE.

Characteristics of knowledge	Medical Knowledge	Tire Technological Knowledge
Elements	Consists of pharmacological, pharmacodynamics, and pharmacokinetic knowledge.	Consists of knowledge about basic structure of tire, how to read sidewall, how to designate tire size, types of tire, tire care, knowledge on tire aspect ratio.
Holders	Usually known by medical practitioners.	Usually known by automobile engineers.
Diffusion channel	Can not be diffused through mass media. However, some countries have their rules and laws saying some such knowledge must be made public.	Can be diffuse through mass media.
Providers' role	Providers of medical knowledge must consider its safety and hazards.	Depends on particular customers.
Triggers for knowledge acquisitions	Brand awareness not always important for customer community.	Brand and price awareness important for customer community.

VI. TIRE TECHNOLOY KNOWLEDGE DIFFUSION

A. Propositions

We propose three propositions for tire technology knowledge diffusion based on the medical knowledge diffusion.

Proposition 1: Tire technology knowledge diffusion through direct communication in which the dealers enhance the relationship between manufacturers and customers.

Direct communication can be reflected as a dominant communication process that leads to enhancing the relationship between two entities. This is similar to medical knowledge diffusion through direct communication with GPs where two parties are involved. Communication creates relationships and serves as a way to develop, organize, and disseminate knowledge. Thus, it is impossible to think about relationships without communication. On the other hand, technological knowledge is sensitive and is not always easy to diffuse tacitly. Therefore, direct communication facilitates the proximity and ease to diffuse tire technology knowledge explicitly. Proximity facilitates human interaction smoothly and improves relationships among manufacturers and customers.

Propotision 2: Tire technology knowledge diffusion through ICT re-enforces the direct communication and should increase brand awareness of specific tires.

Direct communication is the traditional and dominant communication process of medical knowledge diffusion, and ICT is only used for re-enforcing diffusion tools of direct communication. There are dissimilarities among ICT tools

that diffuse tire technology knowledge among customers. To diffuse medical knowledge among GPs, electronic and paper mail services are used. However, to diffuse tire technology knowledge among customers, mass media such as television, radio, and newspapers are used. By diffusing tire technology knowledge through mass media, the customer community can become aware of tire brands while not always understanding the technology. Therefore, tire technology knowledge through ICT and the media increases brand awareness of specific tire brands.

Proposition 3: Tire technology knowledge diffusion through periodic face-to-face communication increases technological knowledge among dealers, leading customers choosing appropriate tires.

Tire manufacturing companies are responsible for diffusing tire technology knowledge among dealers. Most dealers handle multiple brands of tires, so every manufacturer focuses on explaining the tire technology of their respective brands through face-to-face communication and ICT. When tire manufacturers diffuse tire technology knowledge among dealers, they are focused on not only technological advantages but also price. This is very similar to the GPs prescription decisions after collecting medical knowledge as well as medicine prices. As a result, the level of tire technology knowledge improves among dealers. Therefore, dealers should be able to help their customers choose an appropriate tire on the basis of technological advantages and prices. Fig. 2 shows the tire technology knowledge diffusion process based on these hypothetical perspectives.

B. Tire technology knowledge diffusion

The tire technology knowledge diffusion model shown in Fig. 2 has four segments. In the first segment, "information exchange", manufacturers provide tire technology knowledge through direct communication to dealers/agents in order to change dealers/agents decisions and convince dealers/agents to diffuse their company's brand of tires to customer community. Through continued direct communication over time, manufacturers or their marketing personnel are in a position where they can build relationships and trust with dealers/agents, which make them able to exert significant influence on the dealers/agents diffusion decisions for certain type of tires.

In the second segment, "information evaluation", dealers/agents also obtain tire technology knowledge through ICT (telephone, e-mail, personal mail, and other web sites provided by manufacturers or professionals), mass media such as TV, radio, newspapers, and specialized magazines. Dealers/agents evaluate and find the similarities and dissimilarities between tire technology knowledge they receive from manufacturers or their marketing personnel through direct communication and through ICT. If dealers/agents have found the similarities between tire technology knowledge they obtain through both channels, their interest in certain brands of tires grows and they diffuse these tires technology knowledge to their customer community.

In the third segment, "observation and application", dealers/agents observe the promoted brand image in the market and its acceptability to other dealers/agents. In the meantime, manufacturers and their marketing personnel continue their periodic direct communication with dealers/agents. Due to this communication, dealers/agents start to prescribe the new brand of tire instead of the previous or other one.

In the fourth segment, "decision change", dealers/agents obtain tire technology knowledge and explicit knowledge through diffusing the tire technology knowledge to their customer community. Dealers/agents change their diffusion decisions in this stage and diffuse the tire technology knowledge of the new brand of tire instead of the previous or other brand.

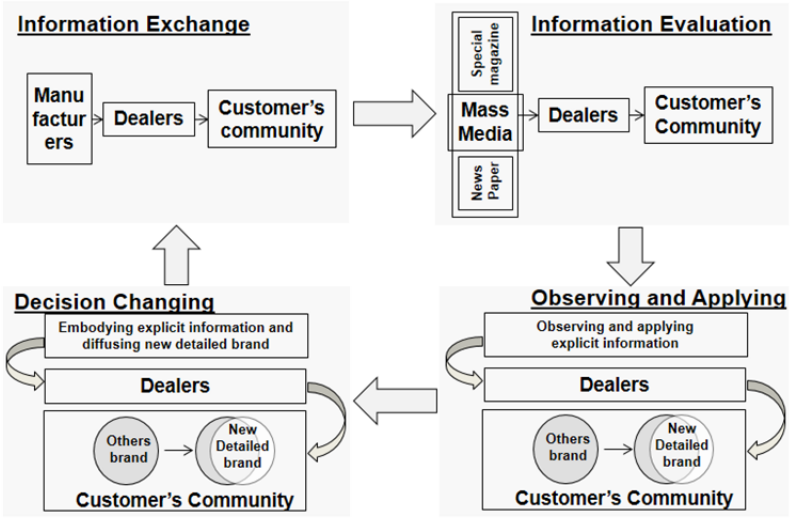

Fig. 2 Tire technology knowledge diffusion process based on medical knowledge diffusion

V. CONCLUDING REMARKS

This paper developed a theoretical framework to investigate tire technology knowledge diffusion to the customer community and hypothesized three ways to spread tire technology knowledge diffusion on the basis of the findings of medical knowledge diffusion from our previous work. These hypothetical perspectives apply the same determinants of medical knowledge diffusion to tire technology knowledge diffusion.

We focused on the medical knowledge diffusion and prescription decision changing model, which is also applicable to the diffusion of tire technology knowledge to the customer community via tire dealers and agents. Our proposed model will help the customer community to learn about tire technology dynamically, which will help them choose appropriate tires and related services.

The model of tire technology knowledge diffusion to the customer community has not been measured empirically. Future research should be undertaken to do this. In addition, we should examin the effectiveness of various diffusion channels in the future research.

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