Adoption of Semantic Web from the perspective of technology innovation: A grounded theory approach

Jaehun Joo*

Information Management Department, College of Business and Tourism, Dongguk University, 707 Sukjang-dong, Gyeongju-si, 780-714 Gyeongbuk, Republic of Korea

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Abstract

This paper examines the factors that affect the adoption and diffusion of the Semantic Web by using a grounded theory approach. Grounded theory, a qualitative research methodology, is appropriate to achieve this, because the Semantic Web is currently at an early introduction stage. Data was gathered through in-depth interviews with fifteen informants from user organizations that adopted the Semantic Web and suppliers that supported the implementation of the projects. The interview transcripts were analyzed by using the open coding scheme of grounded theory. Five factors affecting the adoption and diffusion of the Semantic Web were identified. The first factor is demand pull including requirements for solving search and integration problems of existing systems and for creating new services. Second, such things as environmental conduciveness, potential business value, government sponsorship programs, active roles of suppliers, etc. affect the adoption of the Semantic Web from the perspective of technology push. Third, organizational competence including communication and absorptive capacity plays an important role in its adoption. Fourth, user’s over-expectation has a negative impact on its adoption. Finally, various factors affect the diffusion of the Semantic Web, such as additional investment budget for extending systems based on the Semantic Web, sharing ontologies, and demonstrable effects.

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1. Introduction

Internet computing is a disruptive IT (information technology) innovation that offers subsequent pervasive and radical impact on development processes and their outcomes (Lyytinen and Rose, 2003). Semantic Web (Berners-Lee et al., 2001) can be considered as an IT innovation because Semantic Web technology possesses the potential to reduce information overload and to enable semantic integration.

How should organizations adopt the Semantic Web? What factors affect the adoption and diffusion of Semantic Web innovation? Most studies on the adoption and diffusion of innovation use empirical analysis as a quantitative research methodology in the post-implementation stage. There is criticism that the positivist requiring theoretical rigor can sacrifice relevance to practice (Bharadwaj, 2000; Rosemann and Vessey, 2008). Rapid advances in technology require studies relevant to practice. In particular, it is realistically impossible to conduct a quantitative analysis of the factors affecting the adoption of the Semantic Web because the Semantic Web is in its infancy in terms of the application of Semantic Web technologies beyond the R&D arena (d’Aquin et al., 2008, p. 27). In areas of computer and information science, ontologies have been well known as a method for representing explicit knowledge of computer software (Mike and Michael, 1996). Ontology as a layer of building the stack of the Semantic Web supports richer knowledge inference as well as knowledge representation. However, as the Semantic Web is currently at an early stage of introduction, it would be necessary to have some guidelines for its adoption and diffusion for practitioners and
researchers. Thus, the purpose of this study is to present a framework for the adoption and diffusion of the Semantic Web and to offer potential guidelines for its successful application through the use of grounded theory, a qualitative research methodology.

Although there have been many studies on the adoption and diffusion of information technology innovation (Brancheau and Wetherbe, 1990; Fichman, 1992; Premkumar et al., 2001; Ranganathan et al., 2004; Rogers, 2003; Scaglione et al., 2009; Staab et al., 2001; Yu and Tao, 2009), the researcher has not found any study regarding the adoption and diffusion of the Semantic Web technology. This may be because of its early development phase and a limited scope of application area at present.

Most of the studies on the diffusion of technology innovation have been conducted from the perspective of users who had accepted the innovation. In this paper, the perspective of suppliers who develop Semantic Web technology and implement information systems as its applications is considered, along with the perspective of user. According to Nambisan and Wang (2000), the higher the barriers of knowledge, the later the adoption of Web technology. If user organizations adopting web technology face knowledge barrier problems, it would be important for suppliers to offer services for users to help them overcome such problems (Attewell, 1992; Nambisan and Wang, 2000). Organizations having close relationship or frequently interacting with suppliers adopt technology innovation faster than those that do not. Supplier plays a role of a knowledge intermediary, helping users understand new technology and enabling them to cultivate analytical capabilities. Thus, it is important to include suppliers, in addition to users, as a sample in the analysis regarding the adoption of the Semantic Web.

This paper is organized as follows: Section 2 reviews previous studies related to the Semantic Web and the adoption of IT innovations. Section 3 presents the research design of this study, including grounded theory approach, sampling and data collection. Section 4 discusses the results of analysis and proposes propositions that can be considered as guidelines for theorists and practitioners. Section 5 presents the conclusion of this study.

2. Semantic Web technology innovation and related studies

The Semantic Web has generated substantial research interest since it was introduced by Berners-Lee et al. (2001) because it has shown its potential to bring about semantic integration and reduce information overload through its capability such as semantics and machine-processability (Antoniou and Harmelen, 2008). Previous research on the Semantic Web can be classified into three areas: infrastructure, architecture, and tool developments; killer applications; and business management and social issues (Joo and Lee, 2009). Table 1 shows the areas of research on the Semantic Web and related studies (business management and social issues are excluded because no research exists on these topics).

<table>
<thead>
<tr>
<th>Research areas</th>
<th>Detailed areas</th>
<th>Examples of previous works</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tools for editing ontology, annotating, browsing, searching, and reasoning</td>
<td>Protégé (Noy et al., 2001), TopBraid, Swoogle (2007), Sindice (Tummarrello et al., 2007), Tabulator (Berners-Lee et al., 2006), SWOOP, Jena, KAON, OntoBroker, Pellet, Abu-Hanna et al. (2005), Oren et al. (2008), Benjamins et al. (2005), Gennari et al. (2003), Dzbor et al. (2007)</td>
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<td>Applications</td>
<td>Retrieval and search</td>
<td>Ding et al. (2004), Tamma (2010)</td>
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<td>Social web and collective intelligence</td>
<td>Bojars et al. (2008), Gruber (2008), Mika (2005)</td>
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<td>Semantic desktop</td>
<td>Gnousis (Sauermann, 2005), Iturrioz et al. (2008), Quan et al. (2003), Tummarrello et al. (2006)</td>
<td></td>
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<tr>
<td>Web services and ubiquitous computing</td>
<td>Christopoulou and Kameas (2005), Forte et al. (2008)</td>
<td></td>
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<tr>
<td>E-commerce and e-business</td>
<td>D’Aubeterre et al. (2008), Fensel et al. (2001a, 2001b)</td>
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According to Roberta et al. (2007), the value chain of the Semantic Web consists of many stakeholders ranging from Semantic Web researchers to end users. There are many facilitators or drivers such as researchers, consortiums of standardization, software developers, and intermediaries transferring technology and knowledge from researchers to practitioners who are working in innovative enterprises catching new opportunities from the Semantic Web and developing new business models (Roberta et al., 2007). They contribute to the diffusion of Semantic Web technologies.

Until recently, most research has dealt with technical issues regarding architecture design, building infrastructure, developing tools related to the Semantic Web and their applications as shown in Table 1. The standards and recommendations for Semantic Web technologies were provided by the World Wide Web (W3C) consortium. The typical examples of the standards and recommendations are RDF (Resource Description Framework), RDFa, RDF Schema (RDFS) and so on as shown in Table 1.

Semantic Web methodologies and tools are in their inception phase (Janev and Vrančić, 2009, p. 15). The development methodology employing Semantic Web technologies plays a critical role in diffusing the Semantic Web. Cardoso (2007) surveyed methodologies used to develop ontologies. Many researchers studied techniques or methods for editing, evolving, versioning, mapping, and extracting ontology (Du et al., 2009; Kalfoglou and Schorlemmer, 2003; Kaza and Chen, 2008; Noy and Klein, 2004). Research on ontology is important to the introduction and diffusion of the Semantic Web. There are a variety of areas ranging from general purpose ontologies like FOAF (Friend of a Friend) to domain-specific ontologies like the GAS for supporting communication among ubiquitous devices (Christopoulou and Kameas, 2005).

Many tools have been developed to help developers implement a variety of information systems based on the Semantic Web technology and improve their productivity. Protégé (Gennari et al., 2003) and TopBraid are typical examples of ontology editing tools. For example, Protégé was employed as a tool for developing a framework for understanding terminological systems in a medical care domain (Abu-Hanna et al., 2005). Nowadays, various semantic search tools are available at websites such as Hakia, Swoogle, and Sindice. The comparison of semantic search tools is summarized by Dietze and Schroeder (2009).

Semantic annotation tools such as OntoMat-Annotationizer including CREAM (Handschuh and Staab, 2002) and ONTO-H (Benjamins et al., 2005), facilitate the diffusion of the Semantic Web technologies (see http://annotation.semanticweb.org for well known annotation and authoring tools). Uren et al.’s (2006) study summarized the characteristics of annotation tools.

According to Alani et al. (2008), many organizations still view the Semantic Web with some skepticism and are wary of being early adopters, although there are many opportunities for applications using the Semantic Web. Many users in the Semantic Web community are waiting for a killer application because it would provide guidelines to patterns of behavior for successfully adopting the Semantic Web (Alani et al., 2005). One of the most promising killer applications is the intelligent search service on websites such as Swoogle, Hakia, and Medstory. For examples, Swoogle allows users to search Semantic Web documents and Medstory enables intelligent search topics in health and medicine.

The Semantic Web technology contributes significantly to improving performance of knowledge management (Davies et al., 2007). Integrated semantic knowledge technologies were developed and exploited by the Semantic Knowledge Technologies (SEKT) project. An architecture for ontology-based knowledge management was introduced (Fensel, 2002; Davies et al., 2003). Recently, Witte et al. (2010) demonstrated a system converting a historical encyclopedia into a semantic knowledge base by applying the Semantic Web technologies and natural language processing. In addition, d’Aquin et al. (2005) presented a system architecture based on the Semantic Web in the medical field of oncology. This system provided knowledge representation, reasoning and visual editing used in the treatment of cancer patients.

A combination of Web 2.0 and the Semantic Web gives birth to Web 3.0 (Hendler, 2009). Web 2.0 has been used in several applications such as Flickr, Facebook, Twitter, Wikipedia, and Youtube. Social web includes the concept and philosophy of Web 2.0, and is also an area of its application. Social Semantic Web as a combination of social web and the Semantic Web is referred to as Web 3.0 which is a major application area of the Semantic Web technology (Gruber, 2008). Semantic desktop refers to the application of Semantic Web technologies to the desktop computer to improve personal information management and collaboration. There are several systems applying the semantic desktop approach such as Haystack (Quan et al., 2003), Gnowsis (Sauerermann, 2005) and DBG (Tummarrello et al., 2006). Semantic Web technologies have been applied to a wide range of areas, including Web services, ubiquitous computing, and e-commerce aiming to provide intelligent and personalized services.

Finally, Semantic Web portals such as KnowledgeWeb, Semantiev.org, and Web4Web play an important role in introducing and informing the technologies. Many communities including journals and conferences related to the Semantic Web enable organizational practitioners to understand and introduce the Semantic Web technologies. The following groups are typical examples of such communities:

- **Semantic Web Initiatives**: W3C, Dublin Core, FOAF (Brickley and Miller, 2007), SIOC, and SKOS.
- **Research institutions**: DERI (Digital Enterprise Research Institute), etc.
As Orlikowski and Iacono (2001) pointed out, it is necessary to study the complex ensemble of people, culture, and technology embedded in social contexts as well as at a specific organizational level. According to Hevner et al.’s (2004) dichotomy of research on management information systems, studies of the infrastructure or architecture and killer applications refer to design science while other issues are behavioral science. In the early introduction stage of the Semantic Web, research on behavioral science enables developers to reflect user or market needs in technology development or its application. This can help improve IT investment performance. Most behavioral science studies have been conducted at the post-adoption stage of a specific technology. A study of the Semantic Web, as an IT innovation dealing with social and business issues is important, especially in the environment of rapid IT development. However, no research seems to deal with the managerial issue addressed in this paper.

There have been a few studies that applied grounded theory to the examination of the adoption of IT innovation. Crook and Kumar (1998) presented a grounded theory based framework for understanding the use of EDI (electronic data interchange) based on data collected from twelve interviewees of multiple industries. Dedrick and West (2003) applied grounded theory approach to explain why firms adopt open source platforms. The grounded theory was used to study other areas of IT except its adoption. Pace (2004) applied grounded theory to build a theory of the flow experiences of Web users engaged in information-seeking activities. Lee and Kim (2007) interviewed informants of twenty-six government authorities and analyzed the interview transcripts using the open coding of grounded theory to reveal their understanding and perceptions about IT initiatives.

3. Research design

It is difficult to gather data by using survey questionnaire for an empirical study in a quantitative approach because the Semantic Web is at an early stage of adoption. In general, a qualitative approach is better suited to answer the how and why questions through in-depth interviews in early research stage (Creswell, 1998). Grounded theory, one of qualitative research methodologies including phenomenology, ethnography, biography, and case study, is employed in this study. The researcher chose multiple cases to avoid the generalization limitations of single case study in data collection.

3.1. Research methodology

Grounded theory aims to build or discover a theory as an abstract and analytical scheme describing a specific situation and relevant phenomenon from data (Strauss and Corbin, 1994; Creswell, 1998). Researchers applying grounded theory usually collect data through in-depth interviews, find categories of information, and draw hypothesis, a visualized type of theory, or propositions by relating the categories. The research process of grounded theory involves research questions, data collection from interviews or field observations, transcription, and coding. The procedure of coding, a process of classifying and analyzing data, consists of open coding and axial coding followed by selective coding.

The first and most important phase of grounded theory is open coding in which concepts from data such as texts and sentences are found, and categorized. Axial coding refers to the identification of a central phenomenon as a central category holding the most conceptual interest, the integration of subcategories into categories, and the relation of categories to the central phenomenon category. In this study, the researcher identifies factors affecting the adoption and diffusion of Semantic Web technology and builds some propositions through the use of grounded theory.

3.2. Sampling and data collection

In this study, the researcher selected both users and suppliers as samples for interviews. Users are organizations that adopted applications based on Semantic Web technology while suppliers are organizations that develop Semantic Web technology and/or build applications for their users. Suppliers are no less important than users because suppliers play a critical role in the diffusion of the Semantic Web, particularly at the early stage of its introduction. It is possible to identify the determinants of innovation adoption and diffusion at the level of industry beyond that of individuals or specific organizations by analyzing data collected from both suppliers and users (King et al., 1994; Melville and Ramirez, 2008).

Information about the adoption of Semantic Web was collected from a variety of sources prior to the selection of organizations suitable for study. These sources include Internet search, newspapers, journals, proceedings of conferences and other documents. The nine user organizations shown in Table 2 have been offering services entailing information systems based on the Semantic Web. They introduced the Semantic Web from 2005 to 2007. The primary objectives or motives have been to offer semantic search services or integrated intelligent services.

The user organization DA is one of the largest telecommunications companies in Korea. DA introduced a database system based on ontology to provide intelligent and personalized services on mobile devices by analyzing customer data. The system has been used for a mobile navigation service (a location-based service called K-ways). The user DE is a national research fund organization specializing in research funding and management. DE wanted to introduce an automatic recommendation system of candidates for evaluating research proposals, aiming to achieve fair and reasonable reviewing process of proposals. The system was developed by the supplier SB in Table 3, which applied probabilistic ontology to measure the related terminology in the classification of academic domains, to increase the number of review candidates, and to evaluate them according to their expertise.
Table 3 shows suppliers that implemented information systems based on Semantic Web technology to user organizations shown in Table 2. For example, the information systems based on the Semantic Web in user organizations (DA, DC, DD, DG, DH, and DI) were developed by the supplier SA. SA, a medium-sized enterprise specializing in the Semantic Web and information retrieval technologies, has various solutions based on the Semantic Web, such as an ontology editing tool, a DL reasoning engine, and semantic annotation tools. The user organization DB in Table 2 developed its system by itself without the support of a supplier. The supplier SB implemented the recommendation systems of reviewing candidates for the user organization DE. SB possesses a solution called OntoFrame-K, a Semantic Web-based service platform with an RDF query and inference engine.

Semi-structured interview protocols were written to make systematic progress with respect to in-depth interviews. Protocols were used as a guideline to maintain interview purpose by minimizing digression into trivial conversations. Table 4 shows two key questions and details related to the questions. However, the interview process was open ended to allow the interviewees to reveal their underlying concepts and statements.

Nine interviewees from seven of nine user organizations (the exceptions being DH and DI) responded to questions about the adoption and diffusion of the Semantic Web. DH and DI did not accept interview request. Six interviewees from three suppliers responded to questions: three from SA, one from SB, and two from SC. The researcher conducted semi-structured and in-depth interviews that were open-ended. The interviews were face-to-face and conducted at the office of their workplace. The interviews were recorded and transcribed verbatim into word processing documents. Two graduate students who assisted the author in the interviews transcribed the recorded data in consultation with the researcher. A total of 196 pages of transcripts were obtained from about 12 h of interviews with 15 interviewees. Respective transcripts were sent to the interviewees. 13 interviewees provided additional feedback, resulting in draft revisions.

Triangulation promotes the reliability and validity of qualitative research (Creswell, 1998; Denzin and Lincoln, 1994). Data triangulation involves corroborating evidence from different sources. In this paper, data triangulation was achieved by examining the websites and various documents.
such as brochures and white papers, and by comparing such data to transcripts.

4. Analysis

4.1. Coding process

Data analysis method plays an important role in overcoming the drawbacks of qualitative research. The researcher used the data analysis spiral presented by Creswell (1998). This process includes data collection, data managing, reading and writing notes, classifying, interpreting, and comparing categories as well as the procedure of reducing data to develop categories.

First, the researcher read the transcripts several times and underlined core words, phrases, or sentences. Then, an open coding procedure, where initial categories of information about the phenomenon being studied are formed by segmenting information, was used in the data analysis. NVivo version 8.0 was used to efficiently and systematically support the classification and arrangement of categories with same or similar concepts. NVivo is a program usually employed in qualitative research. Line by line or sentence and context analysis is a method of conducting open coding (Strauss and Corbin, 1994). The researcher looks closely at words, phrases, and sentences, and draws concepts by underlining and writing notes during the process of analyzing statements. As shown in last column of Table 5, a total of 51 initial categories were identified by aggregating and renaming similar concepts.

Two procedures for verifying the categories were used. First, a research draft with categories and statements related to each category as shown in the Appendices as samples was sent to the interviewees to verify whether or not the categories and the classification are supported by the data collected from them. Five interviewees gave feedback expressing their views about categories and classifications. Second, two experts, one having experience in qualitative research and the other who worked in the areas of the Semantic Web, read the research draft and gave comments. The researcher had met these two experts to explain the initial categories before they were asked to review the categories.

Table 5 shows the initial categories, categories, and super-categories identified through the process of coding for data collected from suppliers. The researcher aggregated 51 initial categories into 14 subcategories and then reduced them to four super-categories. For example, eight comments shown in Table A1 of Appendix A refer to the concept of context-aware and intelligent service, which is an initial category. The bold-faced words in comments indicate the important role they have on the identification of the concept.

Samples data collected from the interviewees of user organizations are shown in Tables B1 and B2 of Appendix B. Six initial categories shown in Tables B1 and B2 were grouped into two categories which represent improvements for existing services and requirements for new services, respectively. The initial categories developed by using data collected from suppliers shown in Table 5 include the initial

<table>
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<tr>
<th>Table 5</th>
<th>Categories derived from supplier data.</th>
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<tbody>
<tr>
<td>Super-categories</td>
<td>Categories</td>
</tr>
<tr>
<td>Demand pull</td>
<td>Improvement of existing services</td>
</tr>
<tr>
<td>Technology push</td>
<td>Environmental conduciveness</td>
</tr>
<tr>
<td>Complexity</td>
<td>Trialability</td>
</tr>
<tr>
<td>Uncertainty</td>
<td>Maturity of technology</td>
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<tr>
<td>Potential value</td>
<td>Outlook for market and technology</td>
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<tr>
<td>Government sponsorship</td>
<td>Government sponsorship for projects</td>
</tr>
<tr>
<td>Competence</td>
<td>Communication and user training</td>
</tr>
</tbody>
</table>

Reference models | Reference model |

Success cases | |

Killer applications | |

Uncertainty of cost projection and quality | |

Maturity of technology | |

Technology standards | |

Government sponsorship | |

Negative technology outlook | |

Positive market outlook | |

Positive technology manpower | |

Positive outlook of technological potentials | |

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4.2. Analysis results and propositions

In this section, the researcher analyzes the factors or categories affecting the adoption of the Semantic Web which is a central phenomenon and presents propositions derived from the relationships between the central category and other categories.

4.2.1. Requirements for improving existing services

What relationship exists between the users’ requirements for improving existing services and the Semantic Web adoption? From the perspective of the users and the suppliers, what are their opinions on the introduction or adoption of the Semantic Web technology? What are the differences between their opinions or experiences?

Table B1 in Appendix B shows comments collected from informants who have adopted the system based on Semantic Web technology. They had some difficulties in the search and integration of information from existing information systems. Their need to overcome the limitations of existing systems in user organizations gave rise to the adoption of applications applying Semantic Web technology.

According to Chau and Tam (2000), the higher the user’s satisfaction with existing system, the lower the likelihood that he or she will adopt a new information technology. That is, when the existing system is unsatisfactory, the user’s need to improve the existing system is strong.

From the perspective of suppliers, informants described Semantic Web technology as a solution to the problem of existing systems offering benefits such as information search and integration service, association analysis service, and information distribution service. In some cases, users first required an introduction of applications of Semantic Web technology and then suppliers participated in its development project. On the contrary, in many cases, suppliers promoted the improvements of services through the implementation of information systems applying Semantic Web technology. Comparing the category of the improvement of existing services in Table 5 with that in Table B1, informants working in supplier organizations provided much more concepts (or initial categories) regarding improvements of existing services than respondents of user organizations. This fact shows that suppliers are more proactive than users at the early introduction of technology. The following proposition is derived through the analysis of data collected from both suppliers and users:

**Proposition 1.1.** The stronger the degree of requirements for improving existing services, the more the Semantic Web is adopted.

4.2.2. Requirement for providing new services

As shown in Table B2 of Appendix B, informants from user organizations stated that the requirements for providing intelligent or personalized services and recommendation services, which were difficult or impossible previously, became the motive for adopting applications based on Semantic Web technology. The Semantic Web technology was also introduced to devise business models for new services.

From the perspective of suppliers, the adoption of the Semantic Web resulted from user requirements such as context-aware and intelligent service, personalized recommendation service, visualized service, mobile service, collaborative service, and various services required by industrial domains. Table A1 in Appendix A shows sample comments regarding context-aware and intelligent service. In a variety of industrial areas including military defense, telecommunications, and U-city, user requirements for advanced intelligent and context-aware services beyond simply providing information became the motive for the adoption of Semantic Web. Therefore, the researcher presents following proposition:

**Proposition 1.2.** The stronger the degree of requirements for new services, the more the Semantic Web is adopted.

User requirements for improving existing services or new services involve demand pull. As shown in Table 5, two categories are grouped into a super-category expressed as demand pull. Demand pull is defined as pull forces driving the adoption of Semantic Web technology arising from user requirements. Chau and Tam (2000) suggested the satisfaction with existing computing systems and market uncertainty as need pull forces. The degree of task independence related to the need for coordination and joint problem-solving is a demand pull as a force driving technology adoption and its performance. Demand pull is a key driver of technology adoption (Munro and Noori, 1988; Chau and Tam (2000); Shih, 2006) and arises from the willingness of potential users to use the technology innovation (King et al., 1994). Our study supports results of previous research.

<table>
<thead>
<tr>
<th>Super-categories</th>
<th>Categories</th>
<th>Initial categories</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Ability of analyzing requirements</td>
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<td></td>
<td></td>
<td>User participation and persuasion</td>
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<td></td>
<td>Absorptive capacity</td>
<td>Learning and acquiring new knowledge</td>
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<td></td>
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<td>Developer’s ability</td>
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<td></td>
<td></td>
<td>Reinforcing strength and competence</td>
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<td></td>
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<td>Efforts and willingness to introduce technology</td>
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<td>Supplier’s reputation</td>
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<td></td>
<td></td>
<td>Cooperative systems</td>
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<td>Supportive systems</td>
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<td></td>
<td>Over-</td>
<td>Gap between expectation and performance</td>
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<td></td>
<td>expectation</td>
<td>Expectation</td>
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<tr>
<td></td>
<td></td>
<td>Lower performance compared to expectation</td>
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<td></td>
<td></td>
<td>Overstating benefits</td>
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</tbody>
</table>

categories represented in Tables B1 and B2. This illustrates theoretical sampling indicating that the categories of information become saturated (Creswell, 1998).
although their demand pull factors differ slightly from those of our study.

**Proposition 1. Demand pull has an influence on the adoption of the Semantic Web.**

4.2.3. Environmental conduciveness

Many informants from user organizations insisted on the importance of fostering and expanding conducive environment. As stated in the following comment, such environmental condition is not yet conducive to the awareness for the Semantic Web, and insufficiency of experts also deters the adoption of Semantic Web technology.

“The domestic market was not quite ready to bring about a conducive environment for the Semantic Web. Supplier technology, system analysis, and development abilities were not yet robust. It is regrettable, but there was no system-wide conducive infrastructure at all. More demand must be created to induce additional supply”.

As shown in Table 5, informants from suppliers stressed the necessity of the following factors for fostering conducive environment:

- Proactive marketing activities for promoting the potential of the Semantic Web and positive recognition among users.
- Collaborative efforts to expand the market and to cultivate ontology experts.
- User-friendly modeling tools and procedures.

The total number of comments regarding environmental conduciveness is 21, where 19 comments are from suppliers. Although the Korean government and suppliers have made efforts to foster environmental conduciveness, suppliers felt the need more strongly than users.

According to Hovav et al.’s (2004) study of the adoption of internet standards, environmental conduciveness such as the presence of positive network externalities, the existence of related technologies, and the state of the current infrastructure has an impact on the adoption of internet standards. Even though their study describes the environmental conduciveness as a broad concept addressing the environment in which the adopter operates, it supports the following proposition.

**Proposition 2.1. Environmental conduciveness has a positive impact on the adoption of the Semantic Web.**

4.2.4. Reference models and trialability

Informants from user organizations stated that it is not easy to find reference models at the early stage of the adoption of the Semantic Web. As indicated in following comments, killer applications, or successful cases, become an excellent guideline for the successful adoption of the Semantic Web:

“The common opinion is that a killer application must be identified and emerged for various applications of this technology. Many people interested in the Semantic Web need some killer applications. The Semantic Web will proliferate when it is highly successful in a certain area.”

“It is highly necessary to find the best business model of Semantic Web applications and to address a service where it can get all the public attention it deserves.”

“Find a killer application of the Semantic Web, and demonstrate that at least it can have viability in a particular area and then become the best alternative for that area.”

“Actualization of market: in order for Semantic Web technologies to enjoy a long-term success, a good killer application must be identified.”

Users want to demonstrate systems or predict test results before they adopt the Semantic Web technology. Unfortunately, suppliers suffer from problems regarding demonstration, observation, and verifiability of the system because reference models and killer applications are lacking.

Middleton (2003) proposed that the widespread adoption of broadband is dependent on the development of a killer application. Karahanna et al. (1999) defined trialability as the degree to which the user can experiment with an innovation on a limited basis. Trialability has an influence on the pre-adoption of a new technology rather than its post-adoption (Karahanna et al., 1999; White et al., 2007). Their studies support the following proposition.

**Proposition 2.2. Reference models for Semantic Web technology and its trialability have a positive impact on its adoption, the lack of reference models and lower trialability have a negative impact on its adoption.**

4.2.5. Complexity, uncertainty, and technology maturity

Informants felt that the Semantic Web is complex to understand in terms of its application process as reflected in the following comment.

“In situations with specific time restrictions, the time to establish ontology could be very time-consuming. Unless I specify a specific domain for it, it is a technology with no beginning and no end.”

Such complexity makes users feel uncertain about the result of system adoption as reflected in following comment:

“Could this really work? I thought this way, and actually, I reported to my boss that utilizing such engines based on ontology might be rather erroneous. And with so many difficulties, it might be highly implausible for it to become a real business. That’s what I said. It was just a year ago; it was not optimistic at all back then. I had my own doubts as to whether it could really work.”

According to Roberta et al. (2007), practitioners have a low opinion of the maturity level of Semantic Web-based tools as a result of the perceived gap between researchers’ and practitioners’ perspectives on Semantic Web technologies. Thus, user
groups are not convinced of the maturity of the Semantic Web technologies.

Informants thought that solutions based on Semantic Web technology did not easily process large-scale data or knowledge on various domains as reflected in the following statement:

“Querying was limited for hundreds of millions, fewer than one billion. It requires too much time to query, and, thus, it is impossible to do it within appropriate response time. I just can’t put all them in infinitely. It is too problematic to handle large quantities.”

According to Fensel et al. (2008), current Semantic Web reasoning systems have difficulties processing large-scale data. It is necessary to study continually Semantic Web technologies such as querying huge numbers of decentralized ontologies and reusing them, although many Semantic Web-related technologies have been developed and become elaborate in the last decade (Janev and Vranes, 2009; Shadbolt et al., 2006). The previous studies support our survey’s result.

As shown in Table 5, from the perspective of suppliers, complexity and lower maturity of the technology causing user uncertainty resulted from the followings: lack of technology standards and solutions or tools supporting project development, difficulty in cost projection and quality assurance, requirements for greater intensive knowledge on domains as well as development methodologies, etc.

Proposition 2.3. High level of complexity and uncertainty, and low level of technology maturity have a negative impact on the adoption of the Semantic Web.

4.2.6. Potential value and outlook

The reason behind the effort for Semantic Web adoption is the expectation of improving services and its utilization in the near future rather than immediate increase in productivity, such as cost reduction and high efficiency. The following two comments came from informants representing user organizations:

“Comparing existing technologies and the Semantic Web, I think, the former could achieve as little as 50%, while the latter could enable us to achieve up to 70~80%”

“Once I adopt the Semantic Web, and when intelligent and personalized services are possible, I will probably have better services than with existing technologies. That’s what I had in my mind and why I got started.”

The perception of benefits is a push force to accept new technology (Munro and Noori, 1988; Chau and Tam, 2000). According to Shih (2006), the perceived usefulness and ease of use of a new technology facilitate its adoption as a push force. The potential value of a new technology is associated with the perception of its benefits because the likelihood that the user perceives the benefit of new technology having potential value is high.

As shown in Table 5, informants from suppliers indicated that the development or implementation of Semantic Web projects resulted in the recruitment of high quality employees and had the effect of enhancing incumbent employee morale. They also predicted that the outlook for the market of Semantic Web and technological potentials will be positive.

Proposition 2.4. The potential value of Semantic Web technology including recruitment of high quality employees and enhancement of incumbent employee morale and positive outlook for market have a positive impact on its adoption.

4.2.7. Government sponsorship

As illustrated in the following comment, government sponsorship facilitated the adoption of the Semantic Web:

“The project for intelligent service was done through government sponsorship. Developing intelligent systems is part of national policy projects. Since existing technologies have failed to offer such services, I need to experiment with ontology and Semantic Web technologies.”

Both users and suppliers indicated that government sponsorship for the projects and proactive roles of the relevant agencies including associations related to the Semantic Web led to increased focus on the Semantic Web and its adoption.

According to Bessant (1982), government policies supporting the promotion of new technology and its sponsorship are a driving force behind its adoption. Technology push forces for innovation adoption include government sponsorship programs for spreading technologies which are assessed by having high potential value and positive outlook. Projects for technology development and its applications that are supported by the government deploy knowledge necessary to technology innovation and become a driving force for innovation diffusion (King et al., 1994).

Proposition 2.5. Government sponsorship for projects related to the Semantic Web has a positive impact on its adoption.

The categories such as environmental conduciveness, reference models, trialability, complexity, uncertainty, technology maturity, potential value and outlook, and government sponsorship are related to the technology itself, or to its development and supply, rather than to the perspective of user requirement. Thus, nine categories are identified in this study as technology push.

Proposition 2. Technology push has an influence on the adoption of the Semantic Web.

4.2.8. Communication and training

Many suppliers have provided educational programs for users who do not have enough understanding or knowledge of the Semantic Web, tried to frequently communicate with users, and persuaded them to participate in the programs. Such efforts help users to better understand the Semantic Web and become more assured of its strength. On the other hand, things such as meeting, seminars, and workshop with
users enabled suppliers to better understand domains and user requirements:

“Many users asked following types of questions: What is this? How long does it take to complete a project based on the Semantic Web? When and how can we achieve potential benefits? In particular, the distinctive difference the Semantic Web project and other general projects developing information systems tended to result from users’ lack of knowledge about the Semantic Web and ontology.” “We had many meetings with team members related to recommendation systems for choosing review candidates. User groups did not have a clear understanding of the Semantic Web and ontology in terms of their applicability to the tasks. On the other hand, we did not know the domain-specific terminology such as PM and panel for reviewing research proposals, although such concepts and the lexicon are important in building domain ontology. It took over three months to communicate with and understand each other through seminars and training.”

The interviews with the informants from user organizations did not provide the initial categories reflecting the concept regarding communication and training. Thus, Proposition 3.1 was derived from the perspective of suppliers. In general, the degree of suppliers’ knowledge of emerging technologies such as the Semantic Web is higher than that of user organizations. The Semantic Web is still in its initial stage in terms of commercialization, its maturity is not high, and the level of uncertainty associated with its applications is relatively high. Under such environment, suppliers’ efforts to communicate with users and train them can enable the users to overcome their knowledge gap and can align the capability of the Semantic Web with the needs of users.

The research on the relationship between Web technology adoption and knowledge barriers by Nambisan and Wang (2000) proposed that the differential opportunity to adopt technology innovation originates from knowledge barriers. Their research supports the following proposition because the supplier’s educational programs and communication help the user to overcome knowledge barriers.

**Proposition 3.1.** In the initial stage of the Semantic Web, proactive communication between suppliers and users, and training for users through frequent meetings and seminars have a positive impact on the adoption of Semantic Web.

### 4.2.9. Absorptive capacity

One of the common characteristics described by the nine informants from user organizations is their proactive attitude in analyzing trends or technological features and a determined will for a successful introduction. Here are two comments representing such efforts:

“For instance, seminars are held by the Information Engineering Society, the Artificial Intelligence Research Society and so on. With initial interests in such areas and more contacts as well as meetings and presentations from companies or such organizations, I prepared business plan while checking on the technical development levels of those people.”

“I read a lot of papers and theses before planning any business. I go to different seminars and meet with different business people for that matter.”

In addition to their efforts in analyzing technological trends, they persuaded their department heads and resolved any conflict with managers who have a negative opinion of the Semantic Web:

“My organization should accept it at the level of my departmental head. I should gather some people who are against our plan, and talk with them. I have had many meetings with them. In the beginning, I probably had a meeting at least once a month. The more frequently we met, the more positive they became, while becoming enlightened and convinced in the process.”

The support systems of user organizations including educational or consulting programs, formal research institutes, and positive organizational atmosphere for new technology are positively associated with the adoption of Semantic Web:

“My organization recommends that I attend academic seminars or workshops. My organization even assists with business trip and other related expenditures.”

“In my company, there are three different research institutes, and here I mainly involved in analyzing new technology trends.”

The categories such as the manager’s passion, the supportive system, and the ability to analyze new technology are summarized as user’s absorptive capacity. Calderia and Ward (2002) analyzed the relationship between CEO attitude and IT competency in twelve cases of small and medium-sized companies. The results showed the existence of a positive relationship between them.

From the perspective of suppliers, informants stressed the following: First, they conducted activities cultivating developer’s capabilities for analyzing domains and developing ontology through learning new technology and acquiring of new knowledge. “We participated in the SIOC (Semantically Interlinked Online Communities), which provides the Semantic Web ontology for representing rich from Social Web in RDF, and also partnered in LarKC project, a platform for distributed reasoning in large-scale triple data. The efforts to learn and acquire emerging semantic technologies by participating in the ISWC conference and the Semantic Technology Association helped our customers to adopt the Semantic Web.” Second, they made efforts to reinforce their strengths and competences. “My company had originally focused on natural language processing and information retrieval areas. Nowadays, the core business areas are semantic search and semantic annotation. Although my company uses reasoning and ontology editing tools through contracts with foreign companies, our
semantic annotation capability is superior to that of other Semantic Web-specific firms because our strength lies in Korean language processing and retrieval areas.” Third, their organizations built cooperative systems with agencies or associations related to the Semantic Web and had formal systems supporting participation in seminars or workshops. Finally, they stated that reputations and images of their organizations are associated with the partnership with user organizations that adopted the Semantic Web.

Categories such as learning and acquiring new knowledge, developer’s ability, reinforcing strength and competence, supplier’s reputation, and cooperative systems are represented as supplier’s absorptive capacity.

Cohen and Levinthal (1990) defined absorptive capacity as the ability of firms to recognize the value of new, external information, assimilate it, and apply it to commercial ends. In other words, absorptive capacity means the ability to evaluate, accept, and apply innovation to achieve organizational objectives. Absorptive capacity depends on knowledge source and prior knowledge, and it influences innovation adoption (Cohen and Levinthal, 1990; Todorova and Durisin, 2007). Thus, previous works support the following proposition:

Proposition 3.2. The absorptive capacities of both users and suppliers have a positive impact on the adoption of the Semantic Web: The passion, ability, and effort of managers in user organization to analyze emerging technology, and support systems are associated with a positive adoption of the Semantic Web: Suppliers’ ability to learn and acquire new knowledge, developers’ ability to reinforce their strength and competence, suppliers’ reputation, and cooperative systems play an important role in users’ adoption of the Semantic Web.

Organizational competence includes communication, training, and absorptive capacities. Thus, the researcher presents following proposition:

Proposition 3. The higher the competence of organization, the earlier the adoption of the Semantic Web.

4.2.10. Over-expectation

Informants described that there has been a significant discrepancy in expectations between suppliers and users. Users expect that many more things will be possible through the adoption of the Semantic Web, while suppliers recognize that it is difficult to reveal demonstrable effects that would match user expectations. In other words, there is a gap between the user perspective expecting substantial performance and that of supplier recognizing some limitations due to the early stage nature of the Semantic Web.

The informants from user organizations made many comments, including the following: “It seems that users had an ambiguous feeling that adopting the Semantic Web would guarantee something. Thus, it was like a gold rush last year. From the viewpoint of the user company, I was just bewildered or bewitched by the suppliers’ promotional environment and atmosphere. However, one problem resulting from introduction of the Semantic Web led to other problems because of its immaturity.” “Users should seriously have considered whether the Semantic Web would be helpful for providing intelligent and personalized services beyond its technical aspects. However, they simply believe that their services would improve with the Semantic Web. This is a wrong approach. They should first consider whether the Semantic Web would be appropriate for such services.”

Some suppliers commented on the over-expectation of users: “Users think that the Semantic Web can make something do automatically and conduct it like human although there exists no such killer application.” “I found out that many users misunderstood the Semantic Web because it was promoted as a troubleshooting technology, otherwise it would be impossible to solve the problem.” “For example, the gap resulted from the frequent promotion that the reasoning engine can enable fantastic services that are not possible with existing technologies such as database and data mining. We tried to reduce this over-expectation by users through seminar and training.”

The hyper cycle proposed by the Gartner Group consists of five stages such as the technology trigger, the peak of inflated expectations, the trough of disillusionment, the slope of enlightenment, and the plateau of productivity (Fenn and Linden, 2005). The Semantic Web went from the “technology trigger” stage in 2005 to the “trough of disillusionment” stage in 2007 via the “peak of inflated expectations” stage. The characteristics of the Semantic Web in terms of the hyper cycle support the existence of a gap resulted from the over-expectation of users.

Proposition 4. The greater the gap of expectation between users and suppliers, the later the adoption of the Semantic Web.

4.2.11. Infusion

Even though a system based on the Semantic Web adopted, further efforts will be necessary to make it easier for the system to get diffused in an organization. The level of services in terms of both quantity and quality must not only reach a critical mass, but ontologies must also be shared to be cost-effective:

“From the viewpoints of survey respondents who experienced our system based on the Semantic Web, they said that the system was very helpful. To maximize helpfulness, I need to have more data stored in the systems in terms of quality as well as quantity.”

“It seems possible to develop ontology for each domain. Since we are now in the era of Web 2.0, it is more important to share with each other. Thus, it will be more useful in that aspect.”

An increased investment budget for extending systems based on the Semantic Web enables such systems to offer sustainable services that demonstrate positive results, such as service improvement and productivity:
“I have to share limited budget and resources. As such, I now focus more on efficiency and economy. At least three years of stable budgets are required to help it grow to be an optimum scale and to get demonstrable results from then on.”

According to Zmud and Apple (1989), a stage model of technology diffusion consists of initiation, adoption and acceptance, adaptation, routinization, and infusion. In this paper, diffusion is classified into two stages: adoption and infusion. Adoption refers to the initiation, adoption and acceptance presented by Zmud and Apple (1989), while infusion includes the last three stages.

Proposition 5. The post-adoption activities such as budget allocation, reaching critical mass, and sharing ontology to offer sustainable services are positively associated with the successful infusion of Semantic Web innovation from the perceptive of user organizations.

5. Conclusion

Five factors affecting the adoption of the Semantic Web were identified through the analysis of the data collected from 15 informants who responded to in-depth interviews using a grounded theory approach. The first factor is demand pull, including requirements for improving search and integration services of existing systems and for creating new services. Second, factors such as environmental conduciveness, reference models, uncertainty, technology maturity, potential business value, government sponsorship programs, promising prospects for technology demand, complexity and trialability affect the adoption of the Semantic Web from the perspective of technology push. Third, organizational competence plays an important role in the adoption. Competence includes communication with and training for users, as well as organizational absorptive capacity from both user and supplier perspectives. Fourth, over-expectation, which results in a gap between user’s expectation level and perceived benefits, has a negative impact on the adoption of the Semantic Web. Finally, categories such as critical mass of ontology, budget, and demonstrable or visible effects were identified as determinants affecting infusion.

Our research is distinguished from previous studies on technology innovation adoption or diffusion by two aspects. One is to apply grounded theory to the adoption of Semantic Web technology being in its early stage. The other is to consider suppliers’ viewpoints of technology adoption in user organizations as well as users’ perspectives. Weigelt and Sarkar (2009) conducted a study on the impact of technology solution providers’ experiential diversity on users’ innovation adoption. They found that suppliers’ experiential diversity positively influences their clients’ innovation adoption. The result of their research supports the significance of our research which considers simultaneously both the user’s and the supplier’s perspectives.

Many organizations have tried to adopt the Semantic Web as a core technology extending and upgrading Web 2.0 applications, which is called Web 3.0. A total of fourteen propositions were derived through grounded theory approach and rearranged or summarized into five propositions. Most propositions were supported by a number of studies related to innovation adoption. Although most the propositions appear to be similar to results of previous studies in terms of generalities, the initial categories and the categories embedded in each proposition can provide a better understanding of the factors that diffuse the Semantic Web as a technology innovation. For example, suppliers can increase their potential value which represents the ability to recruit excellent employees and improve their morale, by implementing the Semantic Web as an emerging technology for their customers (user organizations). The potential value which is considered as a technology push force, generally including the expectation of increased revenues and cost savings, highlighted in previous studies. The passion of managers in user organizations can play an important role in their adoption of the Semantic Web. This can be considered to be absorptive capacity, although previous studies have not addressed this aspect. These propositions as well as categories are expected to serve as a guide for further empirical research based on a questionnaire survey, and for practitioners considering to adopt the Semantic Web. The research methodology presented in this study should be useful for examining other emerging technology innovations.

The following findings provide important implications for researchers and practitioners exploring new technology adoption. First, this research has an effect of integrating findings of previous studies. For example, innovation diffusion theory is separately established by technology push and demand pull, and absorptive capacity. Many previous studies identified that technology push and demand pull are the driving forces of innovation adoption (Chau and Tam, 2000; Munro and Noori, 1988; Zmud, 1984). On the other hand, Teo et al. (2003) analyzed the relationship between absorptive capacity and organizational adoption intention. Our research shows that demand pull and technology push forces, supplier’s competence as well as user’s absorptive capacity, and the interaction and cooperative relationship between them influence the adoption of the Semantic Web technology. Second, many users require reference models including killer applications, trialability, etc. because the complexity of building realistic and large-scale ontologies results from its knowledge-intensive characteristics. Third, reducing the gap between the supplier’s proposal and the user’s experience, and the subsequent financial support to reach the level of critical mass enabling the sharing of ontologies in the area of applications play a critical role in the adoption and infusion of Semantic Web technology. Finally, public organizations have been more active than private corporations into incorporating the Semantic Web in their information systems. The reason is twofold. First, most projects related to the Semantic Web...
have been performed through government sponsorship. Second, many firms, with the exception of only a few leading companies, are still in the evaluation stage with respect to the adoption of the Semantic Web.

Further research is to conduct comparative analyses, including using samples from different countries. Such research could provide a broader view of guidelines for the diffusion of technology innovation and identify the cultural difference among countries from the perspective of such diffusion.

Appendix A
See Table A1.

Appendix B
See Tables B1 and B2.

Table A1
Categorization: examples of supplier interview.

<table>
<thead>
<tr>
<th>Category</th>
<th>Initial category</th>
<th>Example comments</th>
</tr>
</thead>
</table>
| New services              | Context-aware and intelligent service | “Let me provide an example for logistics in the area of national defense. Existing classification systems are rather static. Thus, it is necessary to make classification systems more dynamic using ontology, while making them more intelligent with the application of ontology.”
|                           |                                       | “Regarding data, they were first concerned about how to digitalize paper-based data, then how to find the digitized data, then how to search them more accurately, and then more significantly, and then how to establish better association between data. Nowadays, such things are considered as a must. Furthermore, they even wonder if it is ever possible to make automatic forecasts and to provide the so-called intelligent service.”
|                           |                                       | “Well, in terms of providing more intelligent information for users by using somehow intelligent systems with some applications based on Semantic Web technology, it is necessary to adopt new systems.”
|                           |                                       | “In the area of telecommunication, user demand is not so different from context awareness in some respects; personalization, rather than context awareness, is more commonly utilized in telecommunication. That is, in order to promote the services available with telecommunication users, it is necessary to comprehend users after all. There are needs for the Semantic Web to start understanding not only users, but also the contexts that surround them.”
|                           |                                       | “The basic concept of U-City is to provide all existing services more conveniently in an ubiquitous environment using information technology. Then, it is related to meta-modeling, and subsequently to ontology and Semantic Web technology.”
|                           |                                       | “In the area of home networks, Semantic Web technology has mainly been used for cognitive processing or for the provision of intelligent service to users.”
|                           |                                       | “The general trend is that Web 3.0 comes after Web 2.0, and that it is necessary for Web 3.0 to generate intelligent data. The Semantic Web will absorb such demand to some extent, because all of the standards for such intelligent data service will likely reflect the Semantic Web technology.”
|                           |                                       | “How to provide more context-aware services to users by applying context-aware technology to the analysis of raw data is currently the main interest and concern of telecommunication firms. Well, it has not been plausible at all until now. If someone asks what the closest thing available for that purpose is, telecommunication firms will point to the Semantic Web.”

Bold type words play a critical role to draw core concepts for initial categories.

Table B1
Examples of user interview: improvement of existing services.

<table>
<thead>
<tr>
<th>Initial categories</th>
<th>Example comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improvements of search service</td>
<td>“My organization was in a terrible vicious circle, where one problem gave rise to another. This led to employee inconvenience, and, in turn, big problems in search systems resulted in manual searching along with low productivity. If I need to look for something, I just find it more convenient to search for it off-line. My organization needs something with good search service. I end up adopting search systems based on ontology.”</td>
</tr>
</tbody>
</table>
| Improvements of Integration service | “As heterogeneous catalog standards were used in e-marketplaces, some difficulties occurred in the connection between the current public e-procurement system and B2B e-commerce systems. As a way to solve this problem, I have adopted database systems based on ontology.”
|                           | “After the ERP of SAP was established along with one single access point in the groupware with modules such as CRM, and eHRM, an integrated search service was required as a portal concept.” |
| Improvements of other services | “When I wondered how to utilize data and to improve services, I realized that the Semantic Web would be the best alternative available and that’s why the Semantic Web was adopted.” |

Table B2
Examples of user interview: requirements for new services.

<table>
<thead>
<tr>
<th>Initial categories</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Intelligent service                                    | “I have studied how to enable the so-called intelligent recommendation services and analyzed the technology trends so far. In the meantime, I have pursued the services as a killer application of the Semantic Web.”
|                                                        | “I needed to store subscriber information to enable personalized and intelligent services. I understood that it was necessary to use ontology and that the Semantic Web enables those services.”
|                                                        | “I was wondering, ‘Can I come up with some analytical system based on simple existing relational database? Can I just make some recommendations by analyzing relational database? Can I perhaps figure out some methods to make automatic recommendations by making it more intelligent?’ I thought ontology technology and some other technologies had possibilities; or I could go this way or another....”
| Personalized service                                   | “My company has been trying to provide wireless data services with personalization. Via current user devices, it was realistically impossible to show a lot of information within the limited display space, and customers also found it too difficult to locate the services they wanted.”
|                                                        | “Since my company is engaged in mobile phone service with revenue models, it does provide various kinds of services you may know. But those services were not as popular as I had expected, and so I tried to identify the possible causes for the failure. The biggest cause turned out to be the fact that mobile phone displays are not as big as desktop computers. Display is what matters the most. The best technical solutions available for these listed problems were marked as personalization and intellectualization. As such, I have decided to adopt Semantic Web technologies.”
|                                                        | “The basic motivation for adopting the Semantic Web was to improve existing services. The amount of information has increased considerably, but there is still a lack of information in certain categories. The quality of information is now more appreciated than ever before. The volume of search results does not matter, but the importance of customized information for users is significant.”
| Business models for new services                       | “I think it is highly important to devise a business model first. Users must agree to the marketability of such service models, and proliferation must follow. Then other companies would be willing to adopt them.”

References


Further reading

SIOC (Semantically-Interlinked Online Communities), <http://sioc-project.org>.
SKOS (Simple Knowledge Organization System), <http://www.w3.org/2004/02/skos>.