A Study of Constructing Knowledge Ontology of Customer’s Questions in Telecom Corporation

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Abstract

Due to represent the semi-structure of domain knowledge, many studies are starting to research on ontology building and seldom implementing an overall structure of their domain knowledge. Recently, there are many corporations using knowledge management (KM) to improve their business model, but most of them are not using knowledge ontology. In this case, it needs some vocabularies to represent domain knowledge and sharing information; hence, we bring out some concepts of construct knowledge ontology model. For building knowledge ontology efficiently and realizing knowledge ontology in this physical environment, we attempt to use ontology building tools such as protégé software to implement our study. In this paper, we also propose a methodology to develop ontology with real case study. An example of ontology can be found in Telecom Corporation of customer’s questions. This will be used to illustrate the concept of development of knowledge ontology through using Protégé.

Keywords: Domain Knowledge, Knowledge Management, Knowledge Ontology

1. Introduction

Today knowledge management is viewed as one of the most important fields for academic research and industrial implementation. In recent work, there are many studies are discussing with knowledge management and most of them focusing on developing knowledge management model. Although there are plenty of methods to develop KM model, the ontology is the most efficiency way of them [1, 2]. Ontology defines some vocabularies to represent domain knowledge and shares information in that domain. People or software agent can understand the meaning of ontology and reuse ontology [2]. In this research, we develop a methodology to implement ontology and use it to build domain knowledge such as customer’s Q&A, travel planning and so on. Knowledge ontology is a set of rules with vocabularies, semantic interconnection inference and logic. It also represents domain knowledge in our ontology.

A number of tools have been invented to build ontology, assisting developer to implement knowledge ontology [9]. These tools contain much information about the real world and how it operates. These tools are Ontolingua, WebOnto, Protégé, OntoSaurus, ODE, KADS22, etc. In order to build knowledge ontology efficiently and realize it in this physical environment, we will evaluate the difficulty of these tools and adopt ontology building software to implement our system. According [9] and Figure 1.1, the difficulty of learning and foreknowledge needed of underlying knowledge representation language show the Protégé is the best building tool.

Figure 1.1: Evaluation of ontology building tools
Therefore, we propose knowledge ontology through using Protégé software. Besides, we had interviewed several specialists in telecom corporate of Customer Relationship Management Department and collected some customer frequently asking questions. Then, we have categorized these questions and tried to build its ontology. We also invent a taxonomy methodology and discuss it with these experts. This research process could be drawn as Figure 1.2.

Before discussing the methodology for the construction of ontology, the authors need to explain various definitions of the term “ontology”:

- “An ontology is an explicit specification of a conceptualization” claimed by Gruber (1995)
- “A (AI-) ontology is a theory of what entities can exist in the mind of a knowledgeable agent” by Wielinga and Schreiber (1993)
- “Ontology for a body of knowledge concerning a particular task or domain describes taxonomy of concepts for that task or domain that define the semantic interpretation of the knowledge” by Alberts (1993)

To summarize those definitions of ontology, it can be treated as conceptual, knowledgeable and taxonomy methodology. Ontology is also agreement of knowledge sharing.

In [3, 4] had divided ontology into three categories: descriptive, formal and formalized ontology. Each of those ontology can be contained two guises: domain-dependent and domain-independent. Descriptive ontology collects information about many entities. Formal ontology will filter, codify and organize the result of descriptive ontology. The formalized ontology relates to evaluation of the adequacy of the various formalisms and to the problem of their reciprocal translations [3]. Therefore, the taxonomy of ontology can be showed in Figure 2.1
The recently usage of ontology represents conceptual model and entrenches in many information systems [5]. Ontology is sometimes equated with hierarchies of real environment objects and not limited to conservative object definitions. To specify a conceptual model needs to state axioms that do constrain the possible interpretation for the defined some terms.

2.2 Application of Protégé

In order to implement an ontology methodology into information system, the academic researchers start to invent software package such as Protégé [6]. Protégé was invented and developed by Stanford Medical Informatics at the Stanford University School of Medicine. It also supports by several agencies of Stanford University. The Protégé is an ontology development tool and supporting multi operational platforms such as windows, Mac OS and UNIX. The Figure 2.2 is the initial screen of Protégé. Applications developed with Protégé are used in problem-analysis, decision-making and ontology establish in a specify domain. All of Protégé’s commands can be operated in GUI (graphical user interface). Protégé is currently being used in clinical medicine and the biomedical sciences [6]. But it also can be used in any field where the concepts can be modeled as a class hierarchy.

Figure 2.2: The interface of Protégé software

3. Developing ontology for knowledge representation

Ontology is a formal, explicit specification of a shared conceptualization. The following points present a set of terms used in ontology design for building ontology [7, 8] :

- **Taxonomy** consists of a set of terms that alongside their definitions and relations among them form ontology.
- **Concepts/Classes** are general, abstract or concrete notions within a domain of discourse. Ontology is formally describing a domain by describing its concepts.
- **Relations** represent “a type of interaction between concepts of the domain”
- **Slots/Roles/Properties** represent the various features and attributes of a concept.
- **Facets** describe restrictions on slots.
- **Instances** represent elements.

One methodology proposed by Uschold and King is based on the experience gained within the Enterprise Ontology project. It provides guidelines for developing ontology as follows [2] :

- Identify purpose — why the ontology is being built and what its intended users are.
- Building the ontology

- Ontology capture — a middle-out approach for identifying the most important concepts rather than most general or most particular ones, followed by generalization and specialization process in order to obtain the remainder of the hierarchy.
  - Identification of the key concepts and relationships in the domain of interest.
  - Production of precise unambiguous text definitions for such concepts and relationships.
  - Identification of the terms to refer to such
Coding — explicit representing the knowledge conceptualization captured at the sub-step above, in a formal language.

Integrating existing ontology — during either or both of the capture and coding processes, there is the question of how and whether to use ontologies that already exist.

3.1 Interview with Telecom’s specialists

Before constructing the ontology, we start to interview with employee of Telecom Corporate and collect various kinds of FAQs such as Product Services, Product Properties, Operation Guides, Operation Instructions and Other Issues. Each kind of FAQ has more than 30 questions, and then we try to understand their FAQ scenario and architecture from the interview.

Taking Product Services for example, there are 35 issues to describe this kind of FAQ and they have divided it into five parts. The issues can be shown in Table 3.1 without any classification. The user is also not easy to search from it; hence they have divided it as Figure 3.1. In Figure 3.1, it can be viewed as simple classification. The Telecom Corporate also built a website to represent it and tried to use this architecture to explain their FAQ of Product Services. But the result does not satisfy them.

The suitable question cannot be found exactly because of their system.

![Table 3.1 FAQ of Product Service](image)

<table>
<thead>
<tr>
<th>Question</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Are you bandwidth over the upper of usage of internet and dial-up activities in the same time?</td>
<td>The user is also not easy to search from it; hence they have divided it as Figure 3.1. In Figure 3.1, it can be viewed as simple classification. The Telecom Corporate also built a website to represent it and tried to use this architecture to explain their FAQ of Product Services. But the result does not satisfy them.</td>
</tr>
</tbody>
</table>

3.2 Constructing Domain Ontology

According to those ontology methodologies of building ontology, we will follow Identify purpose, Ontology capture and Coding to accomplish parts of customer’s queries of FAQs in Telecom Company for implementing domain ontology.

Ontology is useful method in creating FAQs models of knowledge represent in the domain of Telecom Company. Ontology are managed by translation and mapping between different types of entities and attributes. Various ontology for an entity describes its unique characteristics in context with the relationship acquired for a specific purpose or problem. By the following procedure we started to develop ontology for the FAQs using Protégé as the fundamental background knowledge for searching support. In this case, we will use the Product Service to illustrate process of constructing ontology.

From the Table 3.1, we use literatures [3, 7, 8] and discuss with Telecom Specialists, then conclude the result.
as Table 3.2. In Table 3.2, we divide the result into nine parts. They are e-Business, Local LAN Community, Frame Relay, Packet Switched, Fixed Connection, Dial-up Network, ISDN, VPDN and Others. Although each of them has several issues but it does not enough to illustrate our ontology framework.

**Table 3.2**

<table>
<thead>
<tr>
<th>e-Business</th>
<th>Local LAN Community</th>
<th>Frame Relay</th>
<th>Packet Switched</th>
<th>Fixed Connection</th>
<th>Dial-up Network</th>
<th>ISDN</th>
<th>VPDN</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Where can I find relevant terms of e-business on the website and how to acquire it?</td>
<td>How could we apply for setting up the broadband of local LAN community?</td>
<td>What kind of facilities do we prepare when we set the transmission of frame relay network mechanism?</td>
<td>What is the web address and telephone number of the frame relay network virtualization?</td>
<td>How do you change the service of packet switched network and virtual private network?</td>
<td>How do you change the service of frame relay?</td>
<td>How do you change the service of ISDN?</td>
<td>How do you change the service of VPDN?</td>
<td>How could we apply for the service of ISDN?</td>
</tr>
</tbody>
</table>

Hence, we consider literatures [2, 3] and discuss with specialists to segment all issues. The Fig 3.2 shows part of the ontology taxonomy. From the interview with experts of Telecom Company, we decided the nine classes of queries. The original FAQs (Fig 3.1) contain five classes less than classes of telecom ontology taxonomy. The main different is the aspect of classification by ontology design between Fig 3.1 and Fig 3.2. It’s the resource of knowledge representation base on the outcomes of many times interviews with a number of experts in Telecom Company.

![Fig.3.2 Telecom ontology taxonomy](image)

The taxonomy represents the concept of telecom productions as classes and their parent-child relationships as "is-a" links, which allow inheritance from parent classes to child classes. Domain experts help us selecting the class that describes domain concepts, slots from attribute and property of concept, facet that describe the restriction of attribute, and instance made up from class. It has inheritance relationship between super and sub classes. Subclass might inherit the slot and its relationship from super class. We create this domain ontology by Protégé software for the ontology-driven searching.

**4. System Implement**

This section applies the collecting data from domain experts and then implements it to protégé software. According to product service attributes, this paper combines the similar characteristics and then named it for a uniform name. For instance, we bring out 9 class catalogues for Product Service. Next, we continue to define the subclass + slot and facet. The following section defines the elements of this ontology.
4.1 Definition of ontology

According to the framework in the figure 3.3, this paper presents a definition of class, subclass and slots. First of all, class is composed by 9 catalogues in terms of suggestions that we interview the related employees of telecom corporate. Besides, these classes consist of eBusiness, Local LAN Community, VPDN, Frame Relay, Packet Switched, Fixed connection, ISDN, Dial-up Network and others. Taking eBusiness class for example, it contains all of the activities on e-business of Product Service. Table 4.1 is the class description of telecom ontology.

Table 4.1: Class definition of telecom ontology

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-Business</td>
<td>About e-commerce of Corporate</td>
</tr>
<tr>
<td>Local LAN Community</td>
<td>About local community network</td>
</tr>
<tr>
<td>VPDN</td>
<td>About Virtual Private Dial-up Network, VPDN</td>
</tr>
<tr>
<td>Frame Relay</td>
<td>About Frame Relay Transmission</td>
</tr>
<tr>
<td>Packet Switched</td>
<td>About Packet Switched Transmission</td>
</tr>
<tr>
<td>Fixed Connection</td>
<td>About Fixed Connection network</td>
</tr>
<tr>
<td>ISDN</td>
<td>About Integrated Service Digital Network, ISDN</td>
</tr>
<tr>
<td>Dial Up Network</td>
<td>About Dial Up network</td>
</tr>
<tr>
<td>Others</td>
<td>Other items</td>
</tr>
</tbody>
</table>

Then, we conclude the related characteristic of class and discriminate eight sub classes from Product Service. These subclasses are activity messages, business messages, question of product, question of applying, enterprise fee, service, apply for installation and equipment. Besides, the subclass of eBusiness consists of "Activity Messages" and "Business Messages". Then, Frame Relay class composes by "Services" and "Equipment". Similarly, Local LAN Community class consists of "Question of Product" and "Question of Applying". Finally, the VPDN class composes of "Enterprise Fee" and "Apply for Installation". The facet of above subclass is “one to many” relation. These subclasses describe as table 4.2.

Table 4.2: Sub Class definition of telecom ontology

<table>
<thead>
<tr>
<th>Sub Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity messages</td>
<td>About messages relates to corporate activities</td>
</tr>
<tr>
<td>Business messages</td>
<td>About messages relates to business activities</td>
</tr>
<tr>
<td>Question of Product</td>
<td>About the product question of local community network</td>
</tr>
<tr>
<td>Question of Applying</td>
<td>About applying question of local community network</td>
</tr>
<tr>
<td>Enterprise Fee</td>
<td>About the Expense Fee of VPDN</td>
</tr>
<tr>
<td>Apply for installation</td>
<td>About the questions in applying for installation on VPDN</td>
</tr>
<tr>
<td>Service</td>
<td>About service of frame relay transmission</td>
</tr>
<tr>
<td>Equipment</td>
<td>About equipment of frame relay transmission</td>
</tr>
</tbody>
</table>

Finally, this paper creates slots for each subclass. These slots also describe subclasses’ attribute. Each subclass can be represented in Protégé with seven slots. These slots’ definition can be described in table 4.3.

Table 4.3: Slots definition of telecom ontology

<table>
<thead>
<tr>
<th>Slots</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subject</td>
<td>About the topic</td>
</tr>
<tr>
<td>Keyword</td>
<td>To abstract some words to represent the subject</td>
</tr>
<tr>
<td>Text</td>
<td>The thorough descriptions of subject</td>
</tr>
<tr>
<td>Data Source</td>
<td>The document is stored in which catalog or path</td>
</tr>
<tr>
<td>Document ID</td>
<td>The document number</td>
</tr>
<tr>
<td>Published</td>
<td>Whom publish the document</td>
</tr>
<tr>
<td>Memo</td>
<td>To provide the messages we must pay attention</td>
</tr>
</tbody>
</table>
4.2 Query Examples

According to the telec ontology framework, this paper uses the Definition of ontology to implement it by protégé software. We build the ontology example in Figure 4.1. In the left side is a tree shape of class and subclass. In the right side displays the slots of each class.

![Figure 4.1: Class and Slots](image)

4.2.1 System Display

This paper designs an example to simulate the real situation which occurs. Firstly, when telecom employee receiving a phone call about Querying the 「news information」 by customer, employee inputs the keyword 「news」 quickly and submit the request. This System will be response the results to the employee who submits the request. Then, employee will choose the proper answer to reply to the customer who asking the question with taking down the results.

4.2.2 Query Display

Taking the query function of protégé, for example, we have created 1 record of Activities Messages which contains several slots showing as figure 4.2.

![Figure 4.2: Activity message slots and instance](image)

Because of the inherent relation among classes and subclasses, for instance, we could use the keyword function to query the terms of 「news」. Then, the results which are corresponding to the terms will display. Therefore, we might get the result as figure 4.3 and employee could justify the results whether is satisfying the purpose of customer. Finally, we could store the questions and results for knowledge sharing and reuse it in the future.

![Figure 4.3: The Query condition and result](image)

5. Conclusion

In this research, we try to construct a telecom ontology concept model of customers' Q&A. Then we construct this knowledge ontology by using Protégé software.
This ontology will contain facts and relationships between several categories of customer’s questions. Hence, our objectives of this research are as following:

1. Analyzing what problems were suffered in the telecom company,
2. Proposing a conceptual ontology for customers’ frequency questions domain,
3. Introducing our ontology of customer’s Questions,
4. Implementing this conceptual ontology with Protégé software,
5. Illustrating the effective use of ontology through Protégé.

To support ontology effectively, discussion of its information support system for enterprise is necessary. The ontology is used by employees to navigate the information repository of an organization for the effective coordination. Hence this paper proposes a conceptual model of ontology and implements it by Protégé software. After investigating the ontology research, we successfully create a telecom ontology framework and advanced realize the definition, methodology, language and the creation process of ontology. This paper recreates the ontology framework contrast to the old ones which is implemented by traditional hierarchical framework. The efficiency seems to become more reliable. On the other hand, we realize that employees in telecom corporate are eager to the need of semantic querying. Therefore, this paper presents the telecom ontology and store the framework as the semantic document. It not only supports the exchange of documents across different platform but also improves the application of semantic web in the future.

References


