2009

Enhancing the reusability of inter-organizational knowledge: an ontology-based collaborative knowledge management network

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Publication Details

Leung, N. K Y., Lau, S. K. & Fan, J. P. (2009). Enhancing the reusability of inter-organizational knowledge: an ontology-based collaborative knowledge management network. Electronic Journal of Knowledge Management, 7 (2), 233-244.

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Abstract
Researchers have developed various knowledge management approaches that only focus on managing organizational knowledge. These approaches are developed in accordance with organizational KM strategies and business requirements without the concern of system interoperation. The lack of interoperability means that heterogeneous Knowledge Management Systems from different organizations are unable to communicate and integrate with one another, this results in limitation to reuse inter-organizational knowledge. Here, inter-organizational knowledge is defined as a set of explicit knowledge formalized and created by other organizations. In this research, a collaborative inter-organizational KM network is proposed to provide a platform for organizations to access and retrieve inter-organizational knowledge in a similar domain. Furthermore, ontology and its related mediation methods are incorporated in the network. The concept of ontology enables organizations to explicitly represent their knowledge of a specific domain with representational vocabulary in terms of objects and their interrelated describable relationships. Although different organizations may possess their own set of ontologies, the mediation methods that include mapping, merging and integration are capable of reconciling the underlying heterogeneities of ontologies. In this way, it is possible for the participant organizations to reuse inter-organizational knowledge within the network even though there are fundamental differences among organizations in terms of KMS structures and knowledge formats. The retrieved inter-organizational knowledge could then be used to support knowledge creating, storing, dissemination, using and evaluation of the organizational KM process. In additional, a selection framework is also proposed to assist organizations in choosing suitable ontology mediation approaches, ranging from mapping approaches. levels of automation, mediation methods to matching techniques. While knowledge engineers could reuse inter-organizational knowledge to create and evaluate organizational knowledge, general users are benefit from the effectiveness and efficiency in searching for relevant inter-organizational knowledge within the network.

Keywords
knowledge, inter, organizational, ontology, reusability, collaborative, management, network, enhancing

Disciplines
Business

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Enhancing the Reusability of Inter-Organizational Knowledge: an Ontology-Based Collaborative Knowledge Management Network

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Abstract: Researchers have developed various knowledge management approaches that only focus on managing organizational knowledge. These approaches are developed in accordance with organizational KM strategies and business requirements without the concern of system interoperation. The lack of interoperability means that heterogeneous Knowledge Management Systems from different organizations are unable to communicate and integrate with one another, this results in limitation to reuse inter-organizational knowledge. Here, inter-organizational knowledge is defined as a set of explicit knowledge formalized and created by other organizations. In this research, a collaborative inter-organizational KM network is proposed to provide a platform for organizations to access and retrieve inter-organizational knowledge in a similar domain. Furthermore, ontology and its related mediation methods are incorporated in the network. The concept of ontology enables organizations to explicitly represent their knowledge of a specific domain with representational vocabulary in terms of objects and their interrelated describable relationships. Although different organizations may possess their own set of ontologies, the mediation methods that include mapping, merging and integration are capable of reconciling the underlying heterogeneities of ontologies. In this way, it is possible for the participant organizations to reuse inter-organizational knowledge within the network even though there are fundamental differences among organizations in terms of KMS structures and knowledge formats. The retrieved inter-organizational knowledge could then be used to support knowledge creating, storing, dissemination, using and evaluation of the organizational KM process. In additional, a selection framework is also proposed to assist organizations in choosing suitable ontology mediation approaches, ranging from mapping approaches, levels of automation, mediation methods to matching techniques. While knowledge engineers could reuse inter-organizational knowledge to create and evaluate organizational knowledge, general users are benefit from the effectiveness and efficiency in searching for relevant inter-organizational knowledge within the network.

Keywords: knowledge management, ontology, mapping, merging, integration

1. Introduction

Knowledge is recognized as one of the most important management assets in organizations because knowledge enables organizations to utilize and develop resources, enhance competitive ability and develop substantial competitive advantage. Failure to manage knowledge effectively would result in the loss of organizations' priceless inspiration and creativity (Coulson-Thomas 1997). Knowledge Management (KM) has emerged under this circumstance with the purpose of preserving and capitalizing on organizational knowledge. As illustrated in Figure 1, KM is achieved by organizing formal, direct and systematic process to create, store, disseminate, use and evaluate organizational knowledge using the appropriate means and technologies (Leung and Lau 2006). There are four methods to create organizational knowledge by means of interaction between explicit and tacit knowledge, namely, socialization, externalization, combination and internalization (Nonaka et al. 2001). The second and third stages of KM, store and disseminate, are often linked with technologies. Explicit knowledge created is collected and stored in some sort of database or knowledge base in which the users can access using "search and retrieve" tools (Alavi and Leidner 1999). The retrieved knowledge can then be used by knowledge workers to add value to current business process, create new knowledge and solve existing problems (Bailey and Clarke 2001). The fifth stage of KM is knowledge evaluation; incorrect or outdated knowledge is either eliminated or replaced by valid knowledge.

However, it is shown that some of the KM approaches, ranging from industrial specific to theoretical, are incapable to cooperate with the current distributed knowledge environment, especially those that are designed to manage organizational knowledge, for example, the re-distributed KM framework

Reference this paper as:
Leung N, Lau S.K, and Fan J. "Enhancing the Reusability of Inter-organizational Knowledge: an Ontology-Based Collaborative Knowledge Management Network" *Electronic Journal of Knowledge Management Volume 7 Issue 2, (pp233 - 244), available online at www.ejkm com*

developed to manage organizational help desk knowledge (Leung and Lau 2006). These approaches are tailor-made according to individual organizational KM strategies and business requirements without the concern of system interoperation. The lack of interoperability means that heterogeneous knowledge management systems (KMSs) from different organizations are unable to communicate, cooperate and reuse knowledge with each other. Wagner and Buko (2005) argue that knowledge-sharing in an inter-organizational network allows a richer and more diverse body of knowledge to be created compared to sharing knowledge in one single organization.

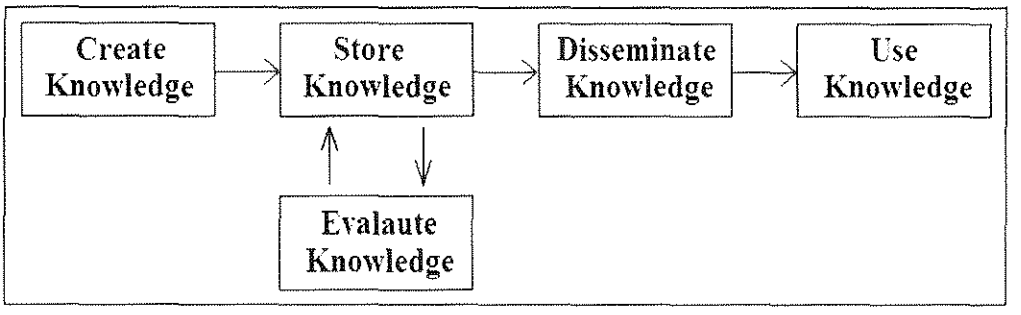

Figure 1: Knowledge management process

The non-collaborative KMSs have several disadvantages. In terms of knowledge workers, they have to spend a lot of time and effort to look for relevant knowledge from different KMSs because they are often required to access knowledge from other knowledge sources in order to complete their works. In terms of knowledge engineers, they have to spend a lot of resources in creating and updating organizational knowledge even though same knowledge is available in other KMSs. As external source of knowledge is essential for organizational performance, a new inter-organizational KM practice is required to enhance the interoperability among independent KMSs and to encourage the sharing of knowledge across organizational boundaries in their business networks (Oinas-Kukkonen 2005).

Unfortunately, the absence of a common language or standardization has created a barrier to prevent the collaboration of KMSs (Sheth 1999). Hence, this research proposes the use of ontology and its related mediation methods which possess knowledge reusability and mismatches reconcilability to fill this gap. This paper describes the concept of ontology and its related mediation methods. We investigate the application of the above concepts in the development of the proposed collaborative inter-organizational KM network that provide mechanisms of reconciling inter-organizational knowledge. The investigation includes the reusability of the reconciled inter-organizational knowledge in supporting the organizational KM process. The rest of the paper is organized as follows. Section 2 discusses the background of ontology and its mediation methods. Section 3 presents a detailed review of ontology mediation methods. An ontology-based inter-organizational KM network is proposed in Section 4. Finally, conclusion is given in Section 5.

2. Background of ontology and mediation methods

The concept of ontology can be applied to solve the interoperation problem in the distributed KMS environment. Ontology, a branch of philosophy, was borrowed by artificial intelligence community and defined as an explicit specification of a conceptualization while a conceptualization is an abstract, simplified view of the world that we wish to represent for some purpose (Gruber 1993). By representing domain specific knowledge with vocabularies in terms of objects and their interrelated describable relationships in a common ontology, one KMS can communicate with others in spite of the underlying system, syntax and structural heterogeneities, thus allowing the involved systems to understand incoming request and the returned knowledge because they are using the same set of vocabularies in the ontology (Mentzas et al. 2001).

Unfortunately, it is problematic to expect all individuals and organizations to agree on using one or even a small set of ontologies (de Bruijn et al. 2006). On one hand, it is lengthy and non-trivial to define and maintain a large globally shared ontology; on the other hand, this approach may hinder a system from reflecting its actual business requirements due to the fact that design of the system is restricted by terminologies defined in the ontology (Visser et al. 1998). Researchers such as Berners-Lee et al. (2001) state that there would be a large number of small domain specific ontologies developed by communities, organizations, departments or even individuals. While multiple ontologies

approach allows system to be designed according to its actual requirements without committing to a particular set of terminologies, the heterogeneity caused by multiple ontologies has become an obstacle for the interoperation of systems (Visser et al. 1998). As organizations and individuals are expected to develop their own ontologies of different languages, scopes, coverage and granularities, modelling styles, terminologies, concepts and encodings, it is therefore unfeasible for one system to understand and reuse other ontologies unless the ontologies are reconciled in some form. The above inconsistent problems caused by multiple ontologies are commonly termed as ontology mismatches.

To reuse other ontologies of different types, ontology mediation is required to reconcile mismatches between heterogeneous ontologies so that knowledge sharing and reuse among multiple data sources can be achieved (Predoiu et al. 2006). There are three major kinds of ontology mediations: mapping, merging and integration. Ontology mapping is a process of relating similar concepts and relations from different ontologies to each other in which the correspondences between different entities of the two ontologies are formulated as axioms in specific mapping language (de Bruijn et al. 2006). Three are two common approaches used to establish mapping between ontologies. The first approach is to relate all ontologies to a common top-level ontology so that different ontologies are mapped together indirectly by the top-level ontology as illustrated in Figure 2a (Wache et al. 2001). Conflicts and ambiguities can be resolved since concepts used in different ontologies are inherited from the common ontology. However, this approach has three major drawbacks. First, constructing a large-scale common top-level ontology from scratch is never a simple task. Second, this approach can only be adopted in a relatively stable environment where maintenance is minimal because a substantial amount of resources and overheads are required to maintain a common top-level ontology. Third, established mappings between local ontologies and top-level ontology can easily be affected by the elimination and addition of local ontologies as well as modification in either local or common ontologies because local ontologies are related indirectly with each other through the common ontology.

The second approach is one-to-one mapping. This approach requires mappings to be created between each pair of ontologies as shown in Figure 2b (Predoiu et al. 2006). The lack of a common top-level ontology in this approach makes it possible to adopt in a highly dynamic environment. This advantage may be offset by the lack of common terminologies, thus increasing the complexity of defining mapping between local ontologies.

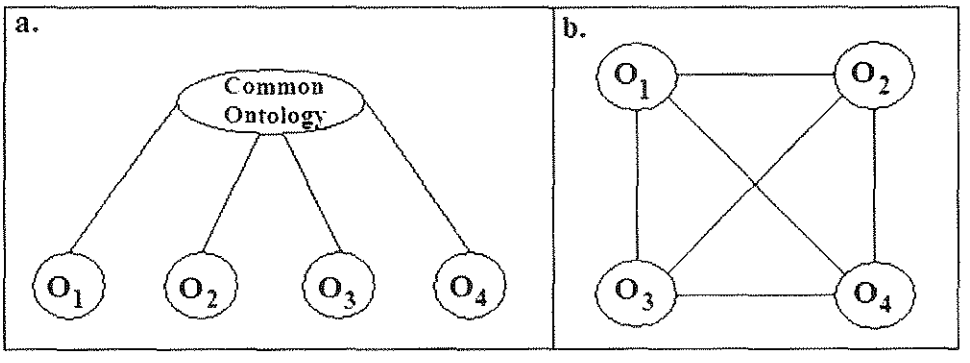

Figure 2: Two mapping approaches

The second type of ontology mediation is merging. Unlike mapping that links two separate ontologies together in a consistent and coherent form, ontology merging creates a new ontology (in one subject) by unifying two or more different ontologies on that subject and it is usually hard to identify regions of the source ontologies from the merged ontologies (Pinto and Martins 2001). As compared with mapping that keeps the original ontologies unchanged, merging requires at least one of the original ontologies to be adapted so that the conceptualization and the vocabulary match in overlapping parts of the ontologies (Ding et al. 2002). Theoretically, it is more efficient and effective to merge existing ontologies than to build a large ontology from scratch. Practically, the process of ontology merging is more than just simple revisions, improvements or variations of the source ontologies.

One of the most important phases in the process of ontology mapping and merging is ontology matching. In general, ontology matching can be defined as the process of discovering similarities between two ontologies with the purpose of establishing semantic relationships in between (Predoiu et al. 2006). It determines the relationships holding between two sets of entities that belong to two

discrete ontologies. In other words, it is the process of finding a corresponding entity in the second ontology for each entity (for example concept, relation, attribute) in the first ontology that has the same or the closest intended meaning. This can be achieved by analysing the similarity of the entities with the "compared" ontologies in accordance with a particular metric (Ehrig and Sure 2004). Ontology matching can be processed exploiting a number of different techniques, for instance, string-based, language-based, constraint-based, linguistic resources, alignment reuse, upper level formal ontologies, graph-based, taxonomy-based, repository of structures and model-based technique (Shvaiko and Euzenat 2005).

Finally, the third type of ontology mediation is integration. Pinto and Martins (2001) define ontology integration as a process of building an ontology in one subject reusing one or more ontologies in different subjects. It is always possible to identify regions of the source ontologies from the integrated ontologies. Source ontologies may need some sort of refinements before they can be aggregated, combined and assembled to form the resultant ontology. It is also important to include ontology integration in the early stage of the ontology building process, preferable during conceptualization and formalization, so as to simplify the overall ontology building procedure.

3. Ontology-based collaborative inter-organizational knowledge management network

Knowledge created from external source plays a very important role in supporting organizational activities but many KMSs as well as KM frameworks and practises are designed simply to manage organizational knowledge. The collaboration problem of heterogeneous KMSs could be resolved by annotating explicit knowledge in the form of machine processable metadata using ontology. Although individual organizations possess their own set of ontologies, the mediation methods are able to reconcile the underlying heterogeneities of ontologies. In this way, the concept of ontology and mediation enables organizational KMSs to understand incoming request and the returned knowledge, thus making it possible for them to collaborate and communicate with each other. We propose to develop an ontology-based collaborative inter-organizational KM network to provide a platform for organizations to access and reuse inter-organizational knowledge with a similar domain. Here, inter-organizational knowledge is referred to as a set of explicit knowledge formalized and created by other organizations. In the network, the formalized inter-organizational knowledge is reusable such that it can be retrieved by any organizations to support individual KM processes in terms of creating, storing, disseminating, using and evaluating knowledge.

Each network should only contain knowledge of a specific domain to ensure the knowledge workers can retrieve relevant any knowledge effectively. For example, an IS network should only provide knowledge in the domain of IS. Once an organization recognizes the need for a particular type of knowledge, the organization can invite other organizations that possess the knowledge of similar domain to establish a network together. When this network of knowledge has matured, other organization which needs to use the knowledge may choose to join the network instead of establishing its own individual knowledge network. Within a network, each organization must commit to a mutual agreement to allow other participants to access an agreed portion of ontology and the associated knowledge reposited in its knowledge base. Besides, a single organization can commit to more than one network of different domains. For instance, library A may choose to commit to networks of IS, economics, mechanical engineering, education and chemistry.

3.1 Selection framework for ontology mediation

Before we continue to describe the proposed network, the participant organization first needs to make four important decisions related to ontology mediation. Figure 3 shows a way to select ontology mediation method. The first decision is to decide whether to adopt top-level ontology or one-to-one method as the network-level mapping approach. As this decision is based on network level, the organizations as a whole may need to negotiate and compromise in order to select the most appropriate mapping approach for the benefit of the entire network. The decision process should include a thorough assessment in the aspects of resources, expertise and frequency of modification. The top-level ontology approach can only be applied to an environment where the maintenance effort is minimal. Whenever a modification is performed in one of the ontologies in the network, the shared ontology at the top-level ontology approach may require a complete reconstruction. The organizations must also ensure that they have sufficient resources and expertise to build the shared ontology; otherwise, the one-to-one approach should be selected.

The second decision is to determine whether to perform mediation automatically or semi-automatically. Mediation can be performed semi-automatically which requires the support of automatic tools as well as human intervention. Examples of support that can be provided by automatic tools include post-mediation verification, validation, critiquation as well as conflicts recognition and resolution. Although semi-automatic mediation could have a better performance than the manual approach in terms of accuracy, it still substantially relies on human efforts and can be time consuming. As semi-automatic tool is not capable of supporting mediation on-the-fly, it would be ideal to perform mediation automatically. Unfortunately automatic tools are unable to detect and interpret concepts that do not have a close correlation, and it may also fail to handle any unforeseeable situations as the tool is designed to perform mediation under specific pre-defined condition.

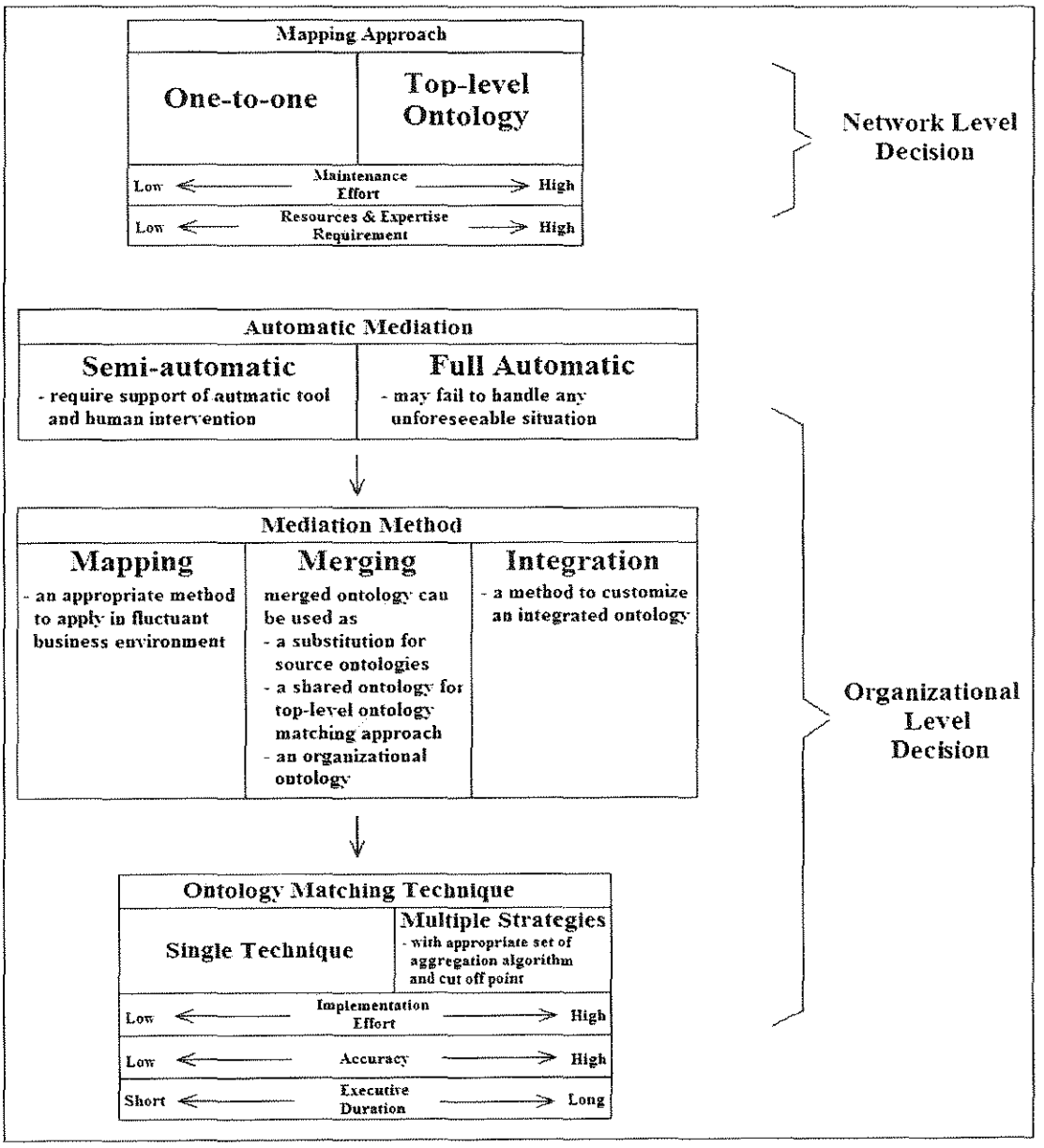

Figure 3: Selection matrix for ontology mediation

The third decision is to decide whether to adopt merging, mapping or integration as the chosen mediation method for each organization. Each organization can choose one or more methods based on its own need. The concept of mapping enables ontology to be developed in response to its actual business requirement and is more suitable to be applied in a dynamic business environment where ontologies are required to modify frequently. Unless ontology has undergone major modification, otherwise simple modification such as deleting concepts from an ontology, may only be needed to

update the mappings accordingly. Alternatively, merging is an appropriate method for creating an ontology that combines common views of multiple source ontologies. The merged ontology could act as 1) a single ontology used to substitute individual source ontology, 2) a shared ontology used in top-level ontology mapping approach, or 3) an organizational ontology that includes all possible views of other organizations' ontologies. Unlike merging, integration selects only appropriate modules from individual source ontologies to form an integrated ontology. Thus, integration is an appropriate method for organizations to construct tailored ontologies based on individual needs.

The final consideration is to decide whether to adopt single or multiple matching techniques. Organization must take into consideration the executive duration, the level of acceptable matching accuracy and the level of resources for implementation. In general, multiple strategies are expected to generate more accurate result than single matching technique. The choice of aggregation algorithm and cut off point also plays an important role in determining the level of matching accuracy. When choosing multiple strategies as its matching technique, the organization must conduct a series of experiments with the purpose of finding a combination of multiple strategies, aggregation algorithm and cut off point in order to produce the most accurate result. Compared to single matching technique, multiple strategies are relatively difficult to design and implement and it also requires longer execution time.

3.2 Operation of the Inter-organizational knowledge management network

Conventionally, technology has very limited contribution in knowledge creating stage, but ontology merging tool provides a practical way to create knowledge by combining two or more ontologies together in the network. This can be achieved on both network and organizational level. On the former level, merging tool is capable of creating a shared ontology for top-level mapping approach that contains common views of all organizational ontologies in the network. On the latter level, organization can create its own domain specific ontology by merging relevant ontologies from other organizations within the network. Other than that, ontology integration tool allows an organization to create its own knowledge by integrating relevant parts of ontologies from other organizations into its own ontology building process. As a result, both merging and integration tool enable organizations to reuse not only the contents of other ontologies but also their associated inter-organizational knowledge which were stored in other knowledge bases.

Knowledge dissemination tool allows user to retrieve and use knowledge from organizational knowledge repository. If user cannot find suitable organization knowledge, s/he has to seek from other external sources. This can be achieved by creating mappings among ontologies of different organizations either semi- or automatically with the support of ontology mapping tool. The established mappings allow one KMS to access KMSs of other organizations in the same network in order to search for relevant knowledge. In addition, inter-organizational knowledge can be reused to support knowledge evaluation process in KM. This is accomplished by setting up dedicated mappings between two or more ontologies. Once a piece of the inter-organizational knowledge is updated, this inter-organizational knowledge will be translated into a suitable format and delivered from source knowledge base to the target automatically via the pre-established mappings. To demonstrate the reconcilability of ontology mediation and reusability of inter-organizational knowledge in the network, let us take a look at the following example.

Assuming University A realizes that there is an increasing demand for IS related knowledge. However, this demand cannot be satisfied with current collection of publications in the library. Consequently, University A decides to invite knowledge providers and libraries of other organizations to establish a network that contains IS related literatures. Among all, libraries from University B, University C and University D as well as Publisher ABC and Publisher XYZ agree to join. Except for University D, all other participating organizations possess ontologies. Figure 4a shows a partial view of the classification ontology adopted in the library of University A. In this ontology, the publication concept has concepts that include book, journal, proceeding and thesis as its subclasses and each subclass is described by a set of properties such as International Standard Book Number (ISBN), International Standard Serial Number (ISSN), and publisher. Concept category and its subclasses are used to distinguish publications into different subjects such as concept computer, medical, commerce, computer science and so on. Given that this network only supports IS related knowledge, therefore the library of University A is willing to share publication that belongs to concept computer and its subclass information systems. As a publication may contain chapters written by different authors, the ontology reflects it by including concept book chapter, journal paper as well as conference paper and

their related properties as an extension of concept book, journal and proceeding respectively. Figure 4b shows a partial view of the classification ontology in Publisher XYZ. There are three major concepts in this ontology, that is, concept book, journal and proceeding. Each concept has a set of publication details (such as issue and edition), contains a set of literatures and belongs to one discipline (such as information systems). The above three components are represented by concept publication details, literature and discipline respectively. Similar to University A, Publisher XYZ has also agreed to share literatures that are classified under the concept information systems.

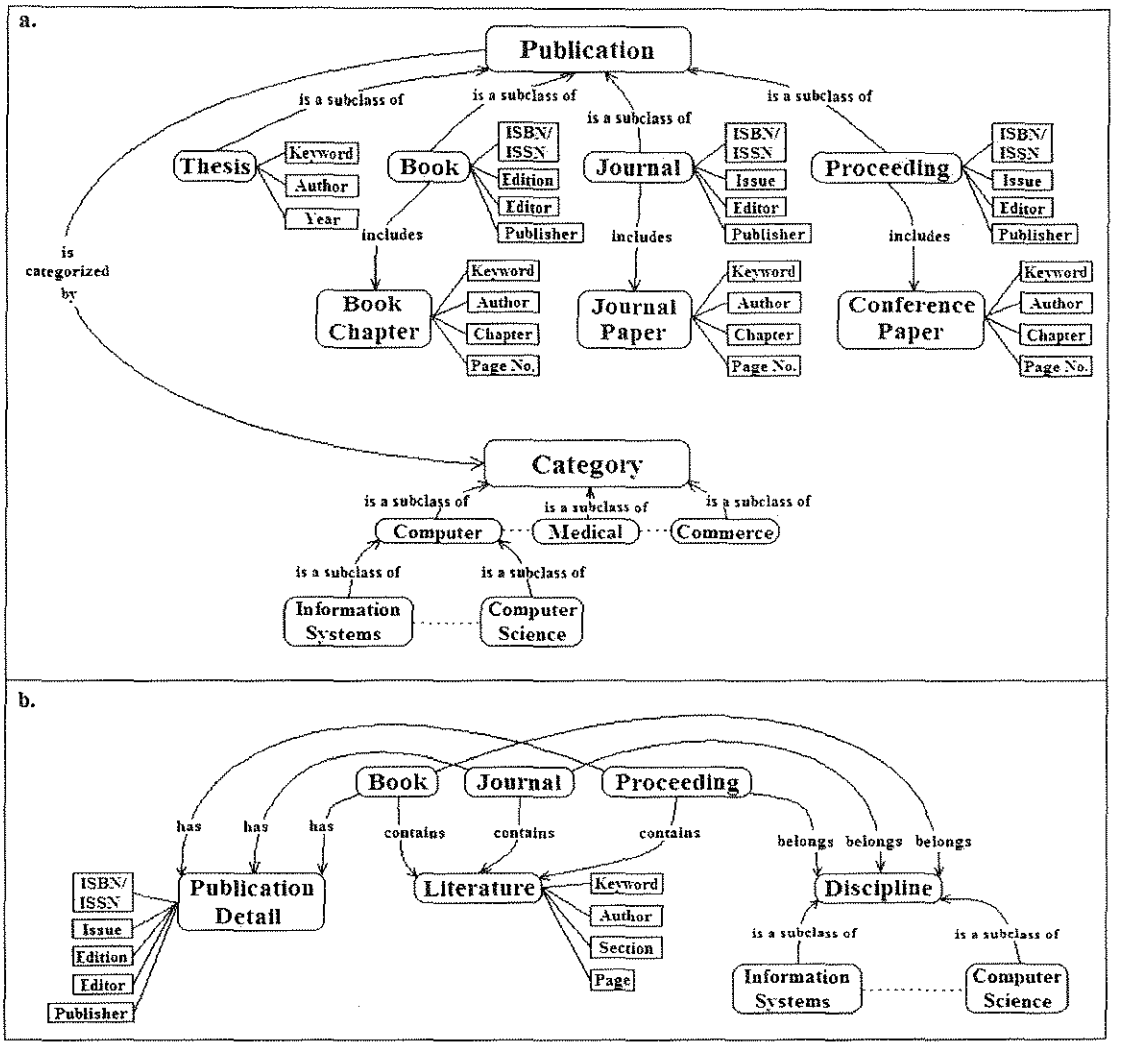

Figure 4: Partial view of the classification ontology adopted in (a) library of university A and (b) publisher XYZ

Round rectangular nodes represent concepts.

Rectangular nodes and labels arcs represent properties.

After careful consideration, the six organizations have reached a mutual agreement not to adopt top-level ontology as the network-wide mapping approach. This decision is based on the fact that there will be other organizations which will join the newly established network, so the shared ontology built for the top-level ontology mapping approach may require to undergo a series of reconstructions. At this moment, the organizations prefer to use one-to-one mapping approach but they agree to review the mapping approach once the network becomes stabilized. Although they have sufficient expertise and resources to build and reconstruct the shared ontology, it is not cost effective to do so. In addition, the reconstruction works will definitely affect the stability and performance of network-wide mediation because the shared ontology will be mapped by all other ontologies as a reference point.

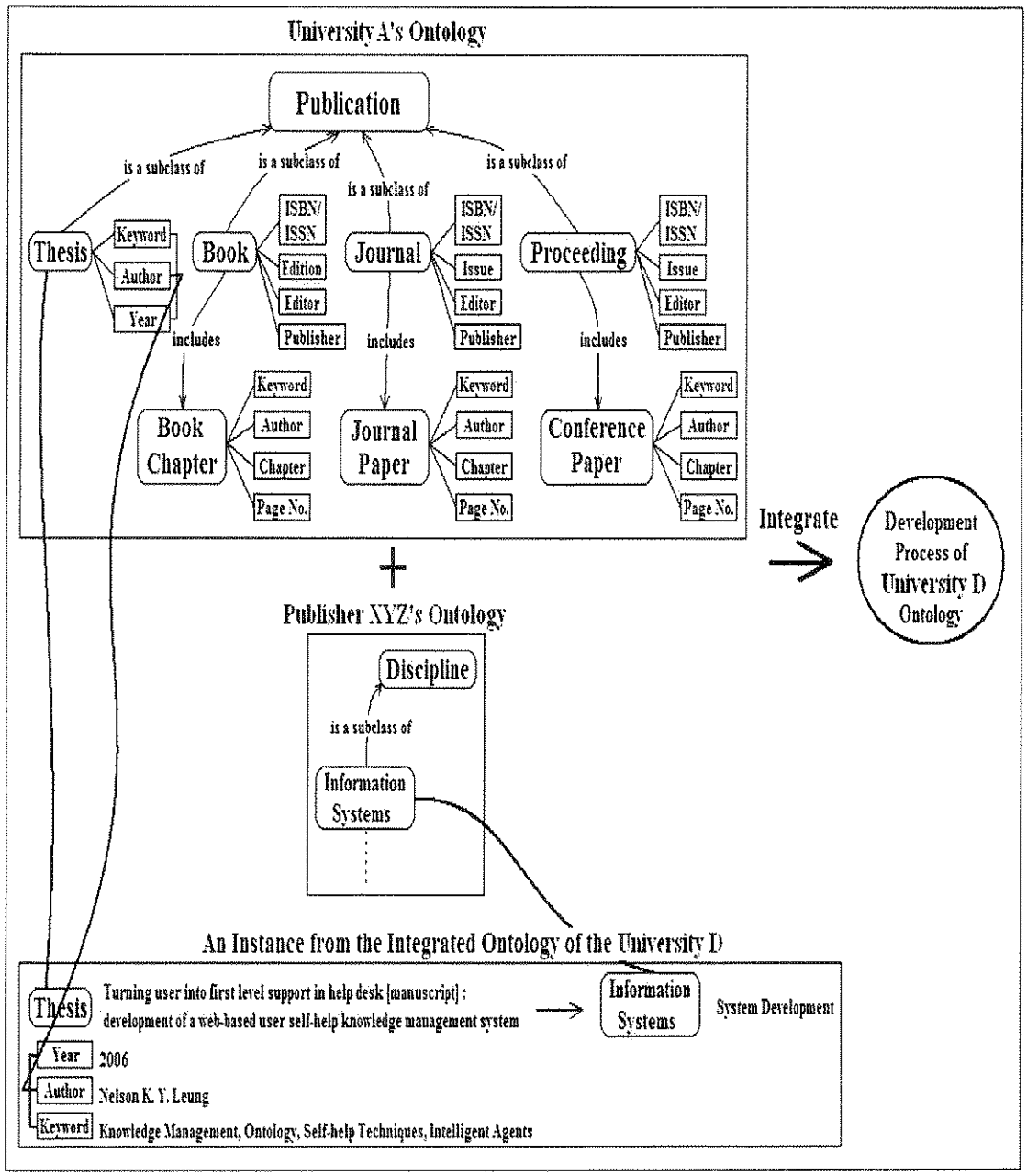

Figure 5: Process to develop university's ontology using integration method

As the library of University D does not possess ontology, the library has to create one in order to fulfil the requirement of joining the network. Instead of building the ontology from scratch, the library decides to reuse ontologies from other organizations and integrate them into its own development process using ontology integration method. However, the chosen ontologies must be similar to the library's actual classification in terms of publication and discipline in order to minimize the degree of modification. For instance, the concept publication and its subclasses in the ontology of University A are more appropriate than those defined in Publisher XYZ as the subclass thesis; book, journal and proceeding defined in the ontology of University A are very similar to the actual classification used in the library of University D. Thus the library reuses only a portion of the two ontologies that include the concept publication and its subclasses derived from the ontology of the University A as well as the concept discipline and its subclasses derived from the ontology of Publisher XYZ (see Figure 5). In the ontology development process, the library of University D can reuse not only the ontologies of other organizations, it can also do so for the inter-organizational knowledge associated with the instance of the integrated ontology. As illustrated in Figure 5, the softcopy of the thesis described by

the instance of the integrated ontology, thesis "Turning User into First Level Support in Help Desk: Development of a Web-based User Self-help KM System" in discipline IS, can be captured from the knowledge base of the University A and stored in the knowledge base of University D. This integrated ontology created by the library of the University D has resulted in additional function. By establishing dedicated mappings between the integrated ontology and its ontology providers (that is, the ontologies of University A and Publisher XYZ), the associated publication captured in the knowledge base of University D can be automatically updated as long as there is an revised version generated from the ontology providers. In this case, when the thesis "Turning User into First Level Support in Help Desk: Development of a Web-based User Self-help KM System" has undergone a minor revision in the knowledge evaluation process, the revised thesis will not only be stored in the knowledge base of University A, it will also be broadcasted to other KMS through the dedicated mappings that includes the knowledge base of University D.

To allow general user to retrieve inter-organizational knowledge, organizations are required to establish mappings between its own ontology and ontologies of other organizations in this network. As shown in Figure 6, each broken line represents a mapping between a pair of concepts or properties that belong to two different ontologies. Making use of string-based and linguistic resources matching techniques, two similar concepts from the ontologies of the UOW and ACM are mapped with each other, for instance, two identical concepts (such as journal) and two properties that are synonyms (such as section and chapter) are mapped together. The mapping details of the two ontologies are summarized in Table 1.

Table 1: Mapping summary of the ontology of the university A and publisher XYZ

	XYZ Ontology	A Ontology	Matching Reason
Concept	Journal	Journal	Identical
	Literature	Journal Paper	Synonym
	Discipline	Category	Synonym
	Information Systems	Information Systems	Identical
Property	ISBN/ISSN	ISBN/ISSN	Identical
	Issue	Issue	Identical
	Editor	Editor	Identical
	Publisher	Publisher	Identical
	Keyword	Keyword	Identical
	Author	Author	Identical
	Section	Chapter	Synonym
	Page	Page No.	Identical

In Figure 6, a user is searching for suitable journal papers by filling in data on title, publisher and keyword fields on the "knowledge searcher" which is designed to be used as a search interface for the KMS at the library of University A. Since the KMS cannot provide journal that satisfies this query, the system begins to search other KMS including Publisher XYZ. The mappings allow the KMS of Publisher XYZ to understand the incoming query. For example, the details provided in the title, publisher and keyword fields on the search interface are similarly referring to the concepts journal, property publisher and property keyword that belong to the ontology of Publisher XYZ. As long as the requested journal is available in the knowledge base of Publisher XYZ, it will be delivered to the search interface of University A. Subsequently, the journal will be displayed as if it is retrieved from its own knowledge base. In other words, the entire inter-organizational knowledge retrieval and displaying mechanism are performed in a "black box" manner.

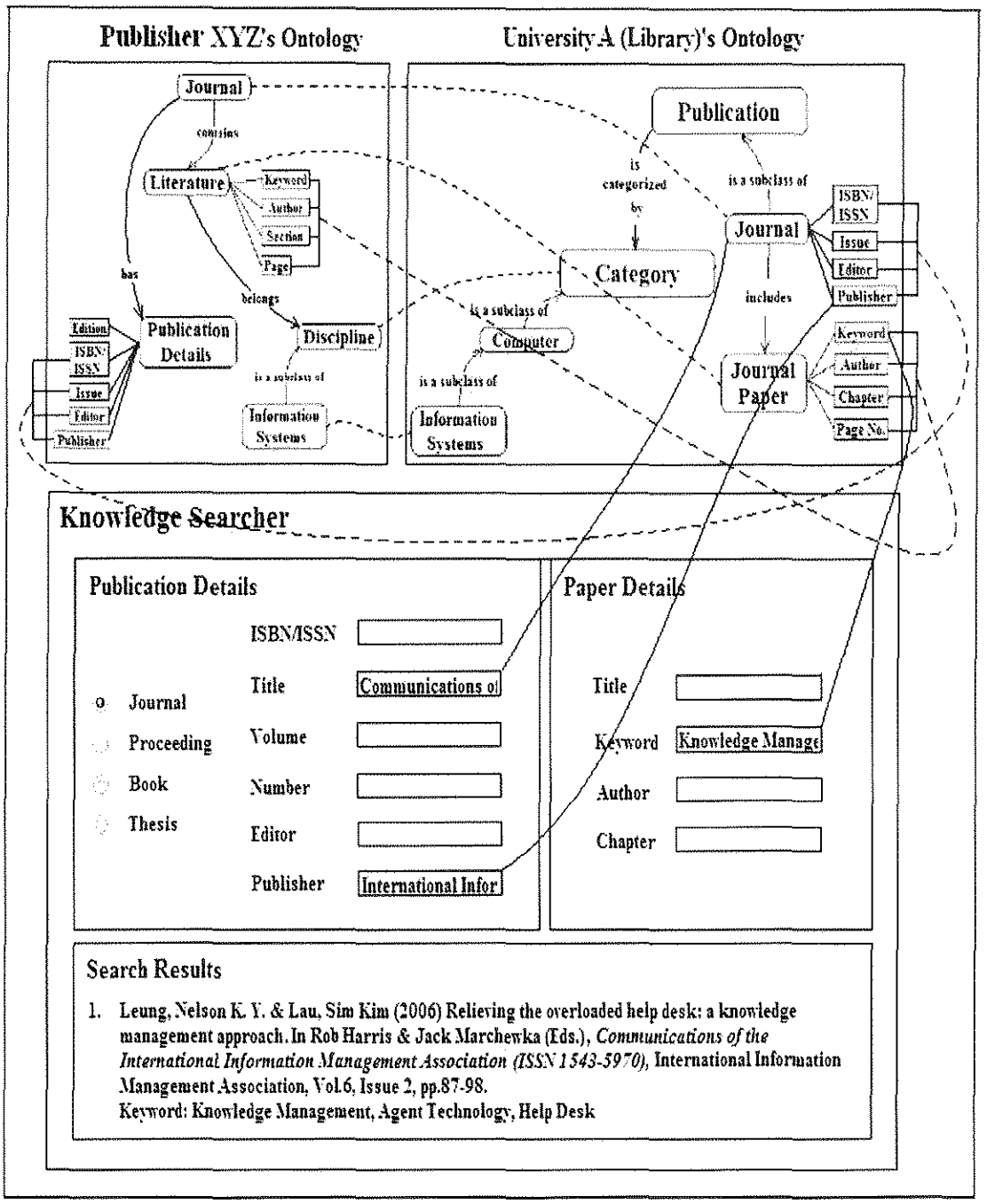

Figure 6: Inter-organizational knowledge retrieval and reusing process

4. Conclusions

The organization based KM approaches have caused collaboration problem in which organization is not capable of reusing inter-organizational knowledge even though the required knowledge is available in other organizations. An ontology-based collaborative inter-organizational KM network is proposed to solve the problems. To establish the network, a selection framework is proposed to assist organizations in selecting suitable ontology mediation approach. The knowledge reusability and mismatches reconcilability of ontology and its related mediation methods enable organizational KMSs to understand incoming request and the returned knowledge, thus making it possible for them to collaborate and communicate with each other. By annotating knowledge explicitly in the form of machine processable representation, organizations joining the network can access, retrieve and reuse domain specific inter-organizational knowledge to support the five stages of organizational KM

process. While knowledge engineers could reuse inter-organizational knowledge to create and evaluate organizational knowledge, general users are benefit from the effectiveness and efficiency in searching for relevant inter-organizational knowledge.

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