A Knowledge Management System Architecture for Clusters: a Thai ceramic cluster case study

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PRADORN SUREEPHONG[1,2], YACINE OUZROUT[2], ABDELAZIZ BOURAS[2]

[1] COLLEGE OF ARTS, MEDIA AND TECHNOLOGY, CHIANG MAI UNIVERSITY
239 Hauykaew Rd., T. Suthep A.Mueang, Chaing mai, 50200 Thailand
dorn@camt.info

[2] LIESP LABORATORY, UNIVERSITY LUMIERE LYON 2
160 Boulevard de l'Université 69676 Bron Cedex, Lyon, France
prenom.nom@univ-lyon2.fr

***Résumé* - l'économie basée sur la connaissance oblige les entreprises, situées à l'intersection de différentes chaînes logistiques, à se regrouper en « clusters » (groupement d'entreprises) pour maintenir leur compétitivité dans un contexte économique de plus en plus concurrentiel. Dans le cadre de ces travaux de recherche, nous allons proposer un système de gestion des connaissances pour soutenir les activités collaboratives dans le cadre de ces groupements d'entreprises. Les principaux facteurs clés de succès de ces types d'organisation sont le partage d'information et de connaissances et la collaboration entre les acteurs. L'objectif principal de cet article est donc de présenter une méthodologie pour l'analyse des principaux processus du cluster, l'extraction et la formalisation des connaissances liées à ces processus, ainsi que la définition de l'architecture du système de gestion de ces connaissances (KMS) associée. L'approche proposée a été validée sur le cas d'un cluster industriel en Thaïlande, cluster qui regroupe un certain nombre de PME artisanales du secteur de la production céramique.**

***Abstract* - Knowledge-based economy forces Small and Medium Enterprises (SMEs) in the same industry to group together as the industry cluster in order to maintain their competitiveness in the global competition. These companies gain advantages, knowledge and opportunities from being a member of cluster. However, many industry clusters have failed to achieve their goal in developing phase. The two internal key success factors for the industry cluster to maintain their competitiveness are collaboration and knowledge sharing among the members. Thus, this study is aimed at assisting the industry cluster to improve collaboration and knowledge sharing by adopting the concept of knowledge management. Knowledge Management System (KMS) architecture was implemented for improving the knowledge exchange activities in the cluster. In order to design the knowledge system to suit our case study, the CommonKADS methodology was used as the knowledge elicitation and modeling technique. Then, the main knowledge activities i.e. knowledge creation, sharing and reuse which are considered as the core of the system architecture were depicted. The application of the knowledge system to Thai ceramic cluster proved that the knowledge system is able to improve the competitiveness of the industry cluster.**

***Mots clés* - Gestion des connaissances, cluster et réseaux d'entreprises, architecture d'échange de connaissances**
***Keywords* - Industry Cluster, Knowledge Management System, Knowledge Card, Knowledge Modeling.**

1 INTRODUCTION

Since the concept of industry cluster [Porter, 1990] was widely implemented to SMEs in many countries in order to improve their competitiveness, governments have tried to support these SMEs clusters in many ways such as export promotion, tax reduction, or financial support. Even though many clusters have a great success and became the major industry of the country such as Silicon Valley (USA), electronic industry (Taiwan) and leather industry (Italy), but a large number of established clusters could not develop themselves as the competitive cluster. Hence, many methodologies have been proposed to analyze, assess, and evaluate the industry cluster in initializing phase such as the HHH framework [Hubert H. Humphrey Institute of Public Affairs, 2008], Porter's diamond model [Porter, 1990], UNIDO's model [UNIDO, 2008], etc. Nevertheless, the methodology for developing the industry cluster in the development phase is still ambiguous.

Unsuccessful clusters are mostly broken down after the establishing stage when the supports from initiators or government were declined. The study of DTI [dti, 2005] stated that the three key success factors for industry cluster development are networks and partnerships, strong knowledge base, and innovation from R&D. Successful clusters tended to have a strong embedded networks, trust and relationship system. These values provided the clustering with a strong degree of social capital. The network generated formal and informal flows of knowledge and information throughout the cluster. Access to explicit and tacit knowledge supports collective learning and competitive performance of the cluster over time.

Although there is a consensus in all studies [dti, 2005] [Porter, 2000] about the significance of knowledge sharing in the cluster, but none of study proposed any methodology to create, represent, share and maintain the knowledge in the cluster.

However, most of the researches depicted that knowledge sharing process is embedded in the process of collaboration. Firms will share their knowledge when they work together as a partner.

Thus, this study will focus on improving the collaboration and knowledge sharing process of the industry cluster. Moreover, the processes of knowledge creating, representing and utilizing were taken into account for enhancing competitiveness of the industry cluster. In order to achieve the intention of this study which is supporting and improving the development of industry cluster; these factors i.e. collaboration and knowledge sharing, were considered as the major domain of the research. The details of two key success factors will be discussed in the following part.

2 PROBLEMATIC

Although inter-organizational knowledge sharing is a general topic in the knowledge management field, the knowledge sharing in the domain of industry cluster is never existed. Examining knowledge sharing in the industry cluster is a delicate work. Many cluster development practitioners tried to improve the collaboration and knowledge activities in the cluster by using different industrial management techniques such as value chain management or supply chain management. However many studies are failed due to lack of awareness of unique relationship among the cluster member. We could discover both *competitor-likes* and *collaborator-likes* relationships in the core cluster. This means that the members of the cluster collaborated as the competitor and collaborator in the same time, unlike in supply chain which is always be collaborator. This type of relationship called "*co-opetition*" [NESDB, 2005]. This characteristic of relationship sometimes brought a dilemma to the members of the cluster to share their knowledge in the cluster or avoid the sharing. This problematic induced us to focus on the characteristic of knowledge sharing in the cluster.

Hence, we have investigated 50 companies in the largest ceramic cluster in Thailand, named Lampang ceramic cluster, by using the questionnaire and interview in order to understand the characteristics of collaboration, knowledge and information sharing among the members, as well as the expectation and satisfaction of members of the cluster. From the analysis, we found that most of knowledge and information that are shared within the cluster can be divided into 4 levels called Info-Structure; as shown in figure 1.

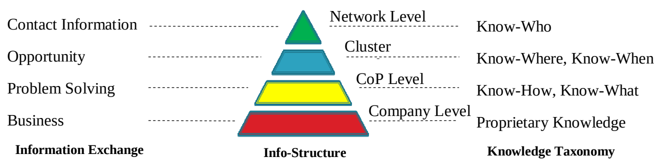


Figure 1. Info-Structure of knowledge sharing in the industry cluster

The Info-Structure was compared with knowledge taxonomy (i.e. know-who, know-where, know-when, know-how and know-what). The result of analysis indicated that the first three levels of Info-Structure [Sureephong et al., 2008] (i.e. contact information, opportunity and problem solving) are the knowledge that members in the cluster expected to attain/share in the industry cluster. However, the knowledge in the last level of Info-Structure is proprietary knowledge (such as production cost, inventory, design drawing, etc.) which can be shared in the cluster only with specific condition. These types of knowledge are shared when companies in the cluster are working together as strategic partners (ex. being in the same supply chain). Thus, in this study, we are interested in the exchanged knowledge in the first three levels of the structure (i.e. network, cluster and CoP level) which are the essential knowledge for the cluster development.

From this point, we have done further analysis on the objective of collaboration of this ceramic cluster by comparing the expectation and satisfaction in collaboration of the members. We found that this cluster is not satisfied with the market opportunity and problem solving that are acquired from being a member of the cluster. Based on the comparison, this cluster highly expected to obtain new market opportunity and has a better problem solving for their business. But, they claimed that they did not receive adequate information from cluster. However, the benefit of the cluster still satisfied them in other points. These benefits attract the members to maintain this collaboration.

The result of questionnaires also shows that the characteristic of cluster collaboration is very fragile. 96% of members considered that the cost of establishing the relationship is low and easy to abort from the collaboration. 81% of members trends to avoid the conflict rather than solving the conflict together. In contrast, the cost of establishing collaboration as in the supply chain is much higher. The collaboration between two partners is bounded by the legal contract with a specific period. This makes the supply chain relationships stronger. The partners have to face the conflict when it occurs [Vanpoucke et al., 2007].

In order to gain better understanding about the problem/difficulty of knowledge sharing in the cluster, the in-depth interview with leaders of a ceramic cluster has been done. We realized that the relationship as a competitor makes experts feel uneasy to share their knowledge in a direct way (face-to-face). However, the knowledge sharing process was done by indirect way e.g. acquiring the knowledge through third-person (e.g. cluster development agent). Although indirect sharing made possible for knowledge sharing in the cluster, the quality of the knowledge was declined. Moreover, the indirect sharing makes the Cluster Development Agent (CDA), as a cluster's facilitator, be an important ingredient for the knowledge sharing within the cluster.

For this reason, the knowledge management system was concerned as a tool for improving the knowledge sharing and collaboration in the industry cluster context. The system acts like a medium for the members to represent, share, store and reuse the knowledge. The system can also improve the quality of exchanged knowledge in term of transferring the right information to the right person in the right time and right format. In addition, knowledge management system will assist CDA in facilitating the cluster.

In the next section, we propose a framework for designing the knowledge management system for SMEs cluster. This is developed from the unique objectives, specific requirements and characteristic of the industry cluster that was mentioned. The objective of this knowledge system focuses on improving collaboration and knowledge sharing activities among the members of industry cluster.

3 RESEARCH FRAMEWORK

Creating the Knowledge Management System (KMS) is a complex task which could not be done without analyzing the organization carefully. Many knowledge management projects are failed due to disregarding this process. Thus, this study adapted the CommonKADS methodology [Schreiber et al., 1999] for analyzing organization, knowledge intensive tasks, and knowledge model from the experts in the industry cluster. The outputs from the methodology provide us a set of specification/requirements for designing the KMS for the ceramic cluster.

However, the CommonKADS methodology could not be instantly applied to the industry cluster context due to the difference of characteristic of the cluster and ordinary organization. Thus, we have proposed the research framework for designing the KMS for the industry cluster as shown in figure 2. The framework was separated into 4 levels, called the model suite i.e. context level, concept level, design level and implement level. This framework called the model suite provides a step by step guide for knowledge engineer from analyzing, modeling, designing until developing the knowledge management system.

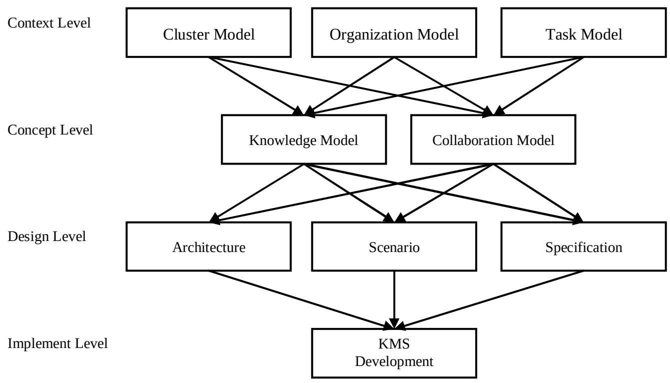


Figure 2. Adapted CommonKADS methodology

The objective of the model suite is constructing the knowledge system for the organization. Each level focuses on extracting information from the experts in different aspects. *Context level* aims at providing better understanding about the context of the cluster, knowledge intensive tasks and archetype of the industry cluster. The various types of worksheet which provided in CommonKADS model were used for the analysis in this level. Cluster model aims at analyzing the actors in the industry cluster, called cluster map. The organization model focuses on organizational context of the cluster. And, task model furnish a set of knowledge intensive tasks in the industry cluster.

Concept level aims at modeling the required knowledge, type of knowledge, pattern of sharing, and characteristic of collaboration in a particular cluster. In this level, the knowledge acquisition templates [Schreiber et al., 1999] and questionnaire are used for analyzing these models. The knowledge templates which are a kind of knowledge engineering tools were applied to the members of the industry cluster in order to model their knowledge into explicit form. The details of this method will be described in section 4. Then, the questionnaire was used for analyzing characteristic of the collaboration in the industry cluster. The results of this level are technical requirements for designing knowledge system in the next level.

Design level aims at converting requirements from the previous models into system specification. The architecture is an outline of the system which indicates type of services to be supported. Then, scenario model is a set of UML diagrams that show the system in different view such as logical view, development view, process view, physical view, etc. Finally, system specification model adopt the SRS standard [IEEE-830] in order to describe the specification of the system. The outcomes from this level are UML diagram, system architecture and specifications for system development process.

Implement level is selecting information system tools to match with requirements and specifications that were defined in the design level. The outcome of the model suite is the knowledge management system that complies with the organizational context, collaboration behavior, requirements and conditions of the industry cluster.

This article will focus on the system architecture of the knowledge system and the knowledge management services on the system. In next section, we will present system architecture as result from the design level. This architecture was created a set of requirements from specific industry cluster and will be considered as an outline for the knowledge system development.

4 KNOWLEDGE SYSTEM ARCHITECTURE

The objective of the general knowledge system is supporting knowledge activities of the organization i.e. create, represent, share, and reuse the knowledge. However, there is no single solution for designing the knowledge system architecture [Tiwana, 2002]. The knowledge system could be as a simple system as a file folder until a complex business intelligence system which use an advance data visualization and artificial intelligence. Thus, the designed system architecture must suit the organizational culture and business needs.

Thus, this study had analyzed the requirements from the stakeholders in the ceramic cluster in order to propose appropriate knowledge system architecture which consent to the characteristic of the cluster. The result from the design level in the research framework provides us the architecture for knowledge management system which suits with requirements of the industry cluster in the case study. The proposed architecture was divided into three layers of service, so called *three-tier model* [Chua, 2004]. Each tier represents major service for the cluster development i.e. knowledge management, collaboration and CDA's tools. The figure 3 represented the proposed Collaborative Knowledge Management System architecture for industry cluster.

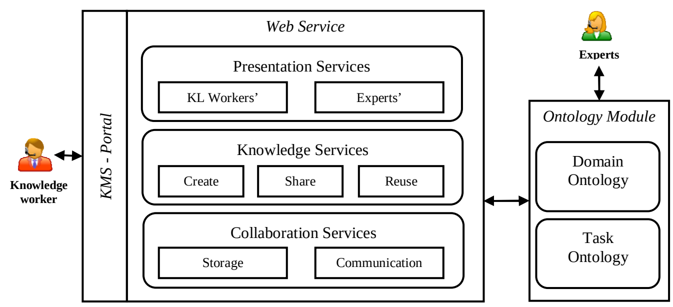


Figure 3. Collaborative Knowledge Management System Architecture

The first tier in this model comprises the collaboration services which focus on storage and communication technology. Storage technology is a part of repository in the general model, is typically the basis for supporting KM processes, particularly knowledge creation and knowledge reuse. The communication technology make possible for the KMS to support knowledge transferring activity among the users.

The second tier is the knowledge services which focus on technologies for creating, sharing, and reusing of knowledge.

The technology for knowledge creation helps users to convert their tacit knowledge in to codified (explicit) knowledge. Knowledge sharing technology refers to the flow of knowledge from one part of the organization to other parts. The knowledge reuse helps users to retrieve required knowledge from the system when they need.

The third tier is presentation services which mainly focus displaying the suitable information for users and CDA in order to support their decision-making. Technologies that provide presentation services are primarily concerned with enhancing the interface between the user and the information/knowledge sources. This part is related to the culture of knowledge usage of the organization by visualizing and personalizing all services in the KMS to suite with organizational culture.

Finally, the ontology module is designed to attach with knowledge service for maintaining organization knowledge in form of domain and task ontology. This ontology was manipulated by the experts in the industry cluster and acquired by knowledge worker through the presentation service. The objective of this service is to support the knowledge map representation and searching, which will be discussed in the next section.

In summary, the knowledge management system in this case study mainly focuses on improving the collaboration and knowledge sharing of the cluster member. Thus, collaborative information technologies were taken in to account for supporting collaboration services in our system such as (c-calendar, live chat, discussion, etc.). However, this paper will concentrate on the core of the knowledge system which is the *Knowledge Services*. The primary goals of these services was to promote the process of generating new knowledge, encourage the flow of knowledge among organization members and ensure the ease of access to knowledge repositories [Martin, 2000]. The next section, the knowledge card which is a major element of the knowledge service will be described.

4.1 Knowledge Sharing

In order to permit cluster members to share their knowledge across the cluster, the notion of Knowledge Card [Buzon et al., 2003] was adopted as a medium of exchange. A knowledge card explains about a specific knowledge topic which is linkable to other cards via the knowledge map module. The elements in the knowledge card were structured as shown in figure 4.

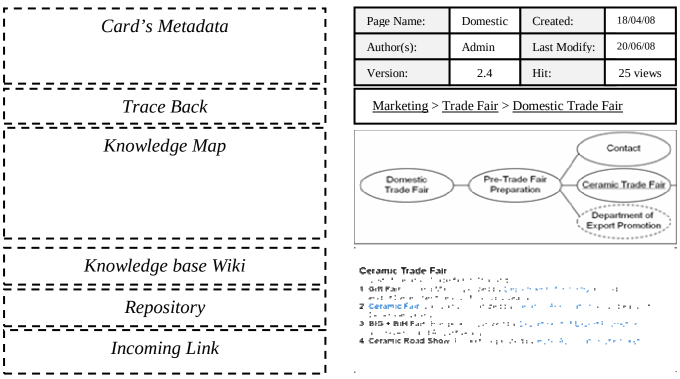


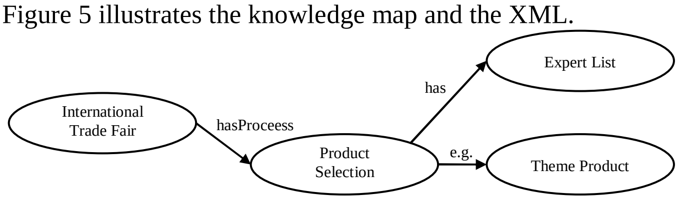
Figure 4. Knowledge Card elements with an example

A knowledge card comprise several elements i.e. card's metadata, trace back, concept map, knowledge-based wiki, repository and incoming link. These elements help knowledge workers to comprehend and search required knowledge through the KMS.

- *Card's Metadata* shows general information about the knowledge card such as author, version, last modify date, etc. This part notifies reader about the popularity, version, and permission of the user on the specific card.
- *Trace back* shows the previous the knowledge cards that the users have visited. This part reminds user about the origin of the knowledge and links back to the previous one.
- *Knowledge Map* displays concept of a knowledge card in form of semantic map. This part is a core of the knowledge card because it allows machine and human to browse over the cards. It also aims at representing the experts' knowledge into semantic map form in order to facilitate knowledge sharing, and reuse. The details of this part will be discussed in the following part.
- *Wiki* displays collaborative knowledge base that is created and modified by experts in the same community of practice. This part allows users to share their knowledge which could not be represented by the knowledge map module.
- *Repository* displays a list of documents (files, databases, images, videos, etc.) that supports or related to the knowledge card.
- *Link back* part displays the incoming, outgoing, and popular links which are obtained from the metadata of knowledge cards.

The knowledge map module is connected to the ontology module as shown in the figure 3. The objective of this module is enabling the cluster members to add their knowledge or experience on others' knowledge in the graphical approach. The ontology module also increases the efficiency of the system's search engine. This means that the knowledge map is a user graphic interface module that readable by both machine and human. The concept of the knowledge map is the combination between the topic map and the semantic map.

Topic map is a standard for representation and interchange of knowledge, with emphasis on the findable of information. The ISO standard formally known as ISO/IEC13250:2003. It represents the knowledge in term of topic (node) and association (reference). Semantic map improve the topic map by including the semantic relationship between two concepts. The semantic relationship provides capability to search engine to give more precise search result via the inference engine. Figure 5 illustrates the knowledge map and the XML.




```
<nodes>
    <node id=0>
        <type> Task </type>
        <content> International Trade Fair </content>
        <relation>
            <forward_relation id=1> hasProcess </forward_relation>
            <backward_relation id=1> isProcessOf </backward_relation>
        </relation>
    </node>
<nodes>
```

Figure 5. Example of knowledge map and XML

The knowledge map composed of two parts i.e. node and relationship. The node part contains the domain knowledge of a specific task. Each knowledge card begins with the task node. This node represents the focused knowledge task while the other nodes represent domain knowledge of the task. Then the relationship part, called inference, shows the semantic relationship between two nodes. The relationship could be identified as uni-direction or bi-direction. The knowledge model was stored in the XML format in order to make easy for reusing in future request.

One advantage of the knowledge model is easy to mange the concept. Expert can share their ideas on the same topic by putting less effort than editing text or wiki content. However, experts are able to describe more idea about particular knowledge in the knowledge-based wiki section which will provide the complete information.

This part explained about the methodology for enabling the knowledge sharing for the industry cluster. The knowledge card was considered as the medium for transferring the knowledge from the experts to knowledge users. However, in order to generate the knowledge card, knowledge engineering methodology is required for extracting the knowledge from the experts in the knowledge creation process. In the next part, we will illustrate the processes of knowledge elicitation and modeling. Then, the utilization of the knowledge card will be present later on.

4.2 Knowledge Creation (Engineering)

The contents of the knowledge cards are derived from the knowledge model in the model suite. We adopted CommonKADS methodology [Shadbolt et al., 1999] for our knowledge modeling process. The CommonKADS knowledge elicitation method has been used to obtain the required information for solving the problems. It has provided several knowledge templates to deal with different type of knowledge intensive tasks (i.e. analytic task and synthetic task). The main objective of these knowledge templates is to help knowledge engineer to reuse a combination of model elements. For illustration, classification template was used to model the knowledge from experts in the ceramic cluster about "product selection for exporting" as shown in figure 6.

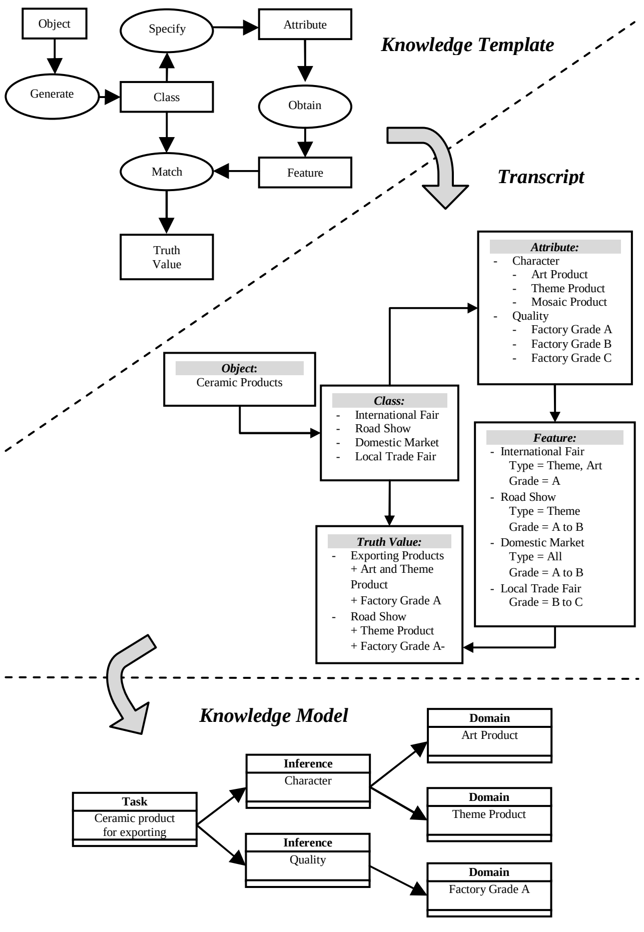


Figure 6. Classification Template and Knowledge Model

The process of knowledge modeling was separated into three steps i.e. elicitation, transcription, modeling. Knowledge elicitation is capturing the knowledge on specific task from the expert by using CommonKADS knowledge template. In the figure 6, classification template was presented as an example. The output from the knowledge elicitation process was recorded in format of transcript. The transcription process allows knowledge engineer to append new element from another expert to the knowledge map. Finally, the transcript was transformed to knowledge model during the knowledge modeling step.

From the example, the goal of this task is classifying ceramic product for exhibiting in the (foreign/local) trade fair.

- *Object* is the object for cauterizing which is a ceramic product.
- *Class* is category of exhibition for ceramic products such as international trade fair, road show, domestic market, local trade fair, etc.
- *Attribute* is characteristic of ceramic product that usually defined in the cluster such as grading A, B, and C or art product, theme product, etc.
- *Feature* is an attribute-value pair that holds for a certain object e.g. "international trade fair = 'art product' *and* 'theme product' which has factory grade = 'A' only".
- *Truth value* is the categorized products that match with required class.

The transcript shows the result from the knowledge elicitation process which is ready to convert into the knowledge model. The CommonKADS knowledge model composes of three types, each capturing a related group of knowledge structures (knowledge category) i.e. domain knowledge, inference knowledge, and task knowledge. Domain knowledge specifies the domain-specific knowledge and information types that mentioned in the KMS. The example of domain knowledge in the industry cluster is "cluster organization model" or "cluster tasks model". Inference knowledge describes that how to make use of domain knowledge. It gives a primitive reasoning step for a knowledge model. For example, for selecting ceramic products for exhibitions, "match" inference can be used for matching class, attribute and feature of objects to meet the goal of classification. Task knowledge describes goals and strategies which were used for realizing goals. Task knowledge can be decomposed into sub-tasks. This task knowledge is required by cluster members for achieving the knowledge intensive tasks in the industry cluster.

In the knowledge modeling/visualizing stage, Unified Modeling Language (UML) was proposed as a standard notation for CommonKADS methodology. It comprises activity diagram, state diagram, class diagram and use-case diagram. However, the methodology is not depending only on UML, the "topic map" which is a standard for the representation and interchange of knowledge can be used in the methodology. The advantage of topic map is that it is easy to read and understand by human than the UML diagram. The following part will explain the employment of the knowledge card and the knowledge model.

4.3 Knowledge Reuse

Knowledge reuse or knowledge retrieval is the make use of existing knowledge which are stored in the knowledge card format. The major module that supports this activity is the system search engine. The knowledge search could be divided into two approaches i.e. text search and ontology search. Text search is an ordinary type of search. It allow user to explore the knowledge cards that contains the keyword in the card's name or the wiki content. The cluster member can retrieve required knowledge card by using this type of search. For example, if knowledge user searches with the keyword "International trade fair", the search engine will show the knowledge card of international trade fair if available. If the specified knowledge card is not available in the system, the list of knowledge card which contain this keyword in the knowledge map and wiki will be displayed.

The ontology search is an advanced search engine which is enhanced by the ontology module and knowledge card. The ontology module allows machine to browse over the concepts and relationships in the knowledge cards. The new knowledge map is generated from the search result. Two techniques that allow search engine to browser the knowledge cards i.e. forward and backward reasoning.

Forward reasoning allow knowledge user to search over the domain knowledge with a keyword and inference in the knowledge card. The forward reasoning in this system is a bit differ from forward chaining due to there is no inference rule. The result from the search engine is a knowledge map that contains the domain knowledge elements which relate with the keyword. In algorithmic view, the inference engine browses all knowledge cards in the system and search for the domain knowledge which matches with the keyword. Then, the related nodes and their relationship from different cards are integrated in order to create a new knowledge card which explains the keyword.

Backward reasoning is an inference method which intends to find the consequent from the list of goals. For example, knowledge user searches with a set of keywords. Then, the inference engine looks for possible consequent (node) which relate to the search keywords. Finally, the node that exactly matches with the keywords will be raked on the top of the list while the partial match consequent will be listed later on.

The next section will present the scenario of the knowledge sharing in the ceramic cluster with an example of knowledge card usage.

5 APPLICATION AND CASE STUDY

In the present situation of ceramic cluster in our case study, there is neither tool nor system that supports collaboration and knowledge sharing in the organization. However, the collaboration of the cluster is maintained by the capability of the facilitators, supports from the government, and the opportunities inside the industry cluster. Although these factors keep the members to group together, they still face the problems of knowledge sharing among the members. For example, the ceramic trade fair exhibition is one of the most important activities of the ceramic business in this cluster. The exhibition provides an opportunity to the company for accessing the new markets and new customers. In order to achieve this, various type of knowledge are required for making decision for this event such as product selection for the exhibition, logistic planning, acquiring support from the government, booth preparation, etc. Thus, ceramic cluster had organized the meeting for sharing information and making decision for this activity. Unfortunately, the required knowledge and information are never satisfied the members due to many reasons e.g. the experts is absence from the meeting, the knowledge or experience from the previous trade fair were not in explicit form, the document have mislaid, etc. These are the obstacles to the achievement of the industry cluster. Hence, the proposed KMS is considered as a solution for solving these problems. This section will clarify how the knowledge system will ameliorate the situation of the ceramic cluster.

The proposed system architecture was designed based on the web services concept which supports the interoperability between machine to machine interactions over a network. This concept is quite useful to our knowledge system in order to retrieve the information from another web service server and represent to the cluster member. For example, the collaborative calendar service in the knowledge system exchanges information with Yahoo's server by using iCalendar standard (RFC 2445). Another advantage of the web service is that the cluster members do not need to invest new information system infrastructure.

The Knowledge services were developed by using FLEX technology [Adobe, 2008] which is Rich Internet Application (RIA). The knowledge card module was plugged with Wiki's engine [phpWiki, 2008] in order to manipulate wiki functions. The integration of CommonKADS knowledge modeling, knowledge card concept and Wiki helps experts and users to exchange their knowledge and illustrate their ontology about each concept liberally. To illustrate the usability of this system, we represented our scenario of our case study in format of UML. A use case diagram in figure 7 shows the functionality of the Collaborative KMS and users that are involved in our system.

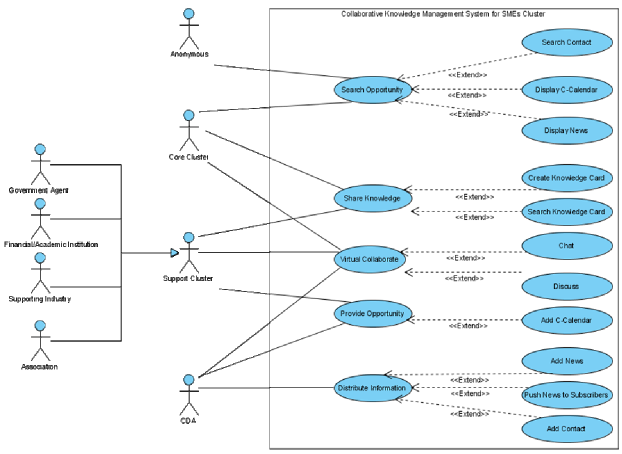


Figure 7. UML Use case diagram of Knowledge Management System

This diagram shows all members that are interacting with the system. They can be categorized into 4 groups of users. Firstly, Anonymous user is not a member of cluster that accesses to a system to gather some general information about cluster and member of cluster such as search contact, read news, and see cluster events in c-calendar. Secondly, Knowledge providers (i.e. government agents, financial and academic institutes, associations, and supporting industry) are members of a cluster which usually has both direct and indirect benefit from the cluster. Thirdly, Knowledge users are companies in the core cluster who use the knowledge to improve their competitiveness in different ways. This user could also be a knowledge provider in case that they are experts in each Community of Practice (CoP). Lastly, Knowledge facilitator is a CDA (Cluster Development Agent) in the cluster that motivate all users to exchange their knowledge. In some case, skilled CDA is able to act like a knowledge engineer to capture tacit knowledge from the experts and transform them into explicit knowledge for knowledge users.

In the beginning of the scenario, government agency offered opportunity of SMEs in the ceramic cluster to join the international trade fair with some subsidies from the government. Collaboration services are used to present this opportunity to the cluster. In the mean time, the CDA push a message to all members for inviting experts to create new knowledge base in this CoP. The process of communication is illustrated in form of sequence diagram in figure 8.

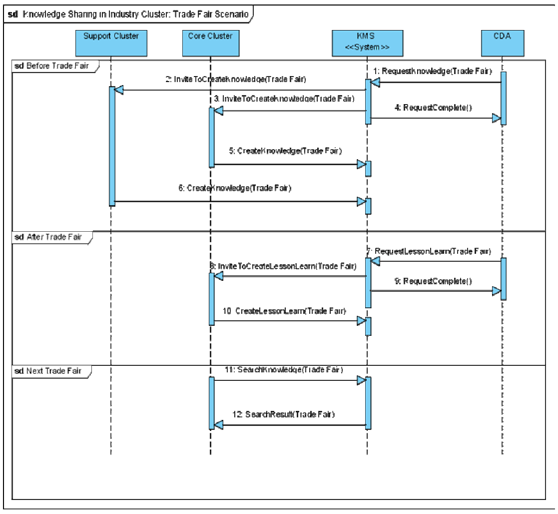


Figure 8. UML Sequence diagram of knowledge exchange in ceramic cluster

Before the trade fair, the CDA created a Community of Practice (CoP) called "Trade Fair CoP" and invited experts from core cluster and support cluster to share their knowledge about "Trade Fair". Then, experts created new knowledge about the trade fair by giving the knowledge in different points of view in order to help companies who are going to go to the trade fair. After the trade fair, CDA invited these companies to come back and add the knowledge from their experience in Trade Fair CoP. This knowledge is stored in the KMS for company to search knowledge for the next trade fair.

The main objective of this system is to facilitate companies and organizations to collaborate in the business environment. The advantages of the collaborative knowledge card make it easy for experts to explicate their knowledge by utilizing the conceptual diagram similar to the notion of MindMap [Buzon, 2006], share knowledge with other experts in different point of view, and reuse the knowledge when referred by other level of expertise. Figure 9 shows the interface of KMS in knowledge service layer.

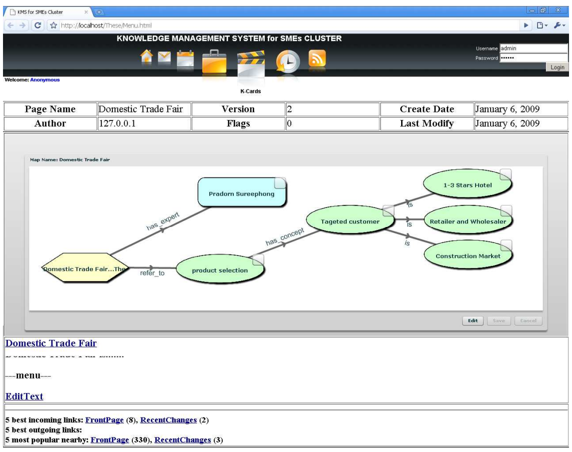


Figure 9. The interface of knowledge system

According to Wikinomics [Tapscott et al., 2006], a wiki system is based on four ideas: openness, peering, sharing, and acting globally. The way of collaboration in business context is changing by mass collaboration which was a major force that creates Web 2.0 [McCormack, 2002]. Web 2.0 is enabling users to have more power of manipulating contents and to collaborate with other users in the same community. Accordingly, maintaining the KMS is allowing the community (cluster members) to collaborate, create, share, and change knowledge base in their knowledge management system.

6 Conclusion and Perspective

The KMS prototype was developed for the largest ceramic cluster in Thailand (Lampang Ceramic Cluster) [CeraCluster, 2008]. This proposed system was applied to a small group of enterprises to facilitate the knowledge sharing among this group. The exercise of knowledge sharing between actors was applied in the scenario of BIG (Bangkok International Gift) fair, Thailand. In the initial stage, a community of practice about "accessing ceramic market opportunity" was created by the CDA. Then, the cluster committee (core cluster) create first knowledge card about the methodology for accessing the market. Then, department of export promotion who is government agency append the knowledge about supporting the government for the international trade fair exhibition. Next, Lampang ceramic association provides the knowledge about booth decoration and management for the trade fair. Finally, CDA upload all supportive documents about the task into system repository for further reuse. Each of domain knowledge that added to the system in the knowledge card format will complete the knowledge for achieving the task.

In practical, the heart of the knowledge management is conveying the right information to the knowledge users at the right place, right time and right form. Thus, the knowledge reuse module takes an important role on this matter. In our perspective, the mobile technology is an effective tool which allow knowledge user to retrieve the knowledge from the knowledge system anywhere and anytime. Thus, the mobile service can be integrated with the proposed KMS architecture in order to usability of the knowledge reuse module. For example, knowledge user sends the request (e.g. search keyword) via short message service or push mail from their mobile device. Then, the inference engine generate new knowledge card which related to the search keyword and send the result back to the knowledge user. Integrating the mobile technology allow knowledge user to retrieve the knowledge from the knowledge system whenever they require.

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