Chapter IV
Analysis and Results

IV.1. Introduction

This chapter mainly focuses on the analysis and results from applying the research framework to a ceramic cluster in Thailand. It concerns the first three levels of the framework: context, concept and design. The first part of this chapter will present the results from the context analysis. The investigation has been carried out with the members of the Cera Cluster e.g. core cluster, CDA, academic institute, government agency, etc. The second part of the chapter focuses on the concept level, which aims at eliciting the knowledge model from the experts regarding a list of knowledge-intensive tasks that is derived from the previous level. In addition, it also concerns the collaboration model of the cluster. The last part of this chapter will propose the design and specification of the knowledge system for this ceramic cluster. A set of software engineering documents are used as protocol between the knowledge engineer and system developer. The following figure presents the structure of chapter 4 and 5 with regard to the proposed framework.

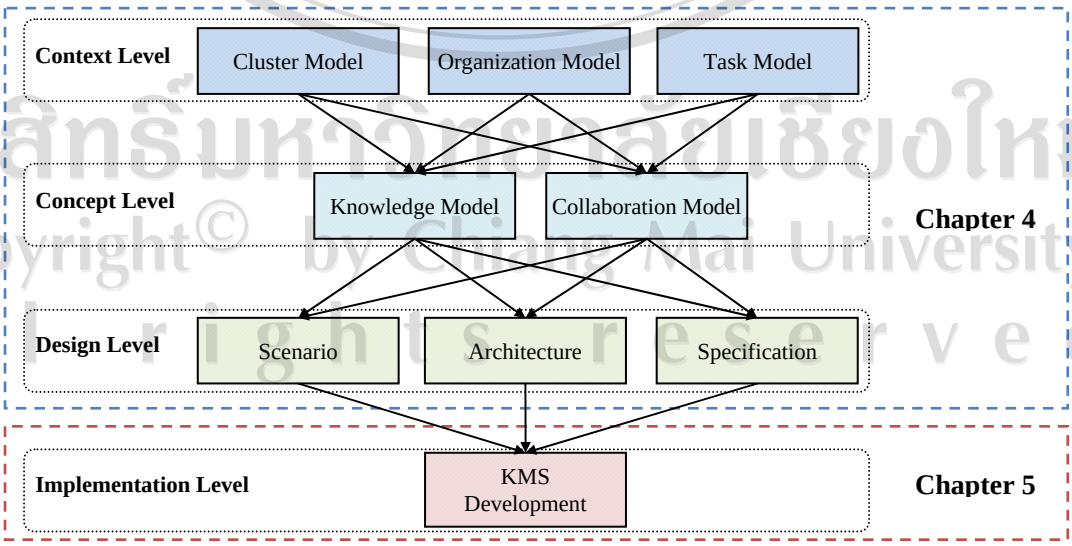


Figure IV.1: The organization of chapters

IV.2. Context Level

The main objective of the context level in our framework is to analyze the characteristic of the industry cluster in different aspects e.g. physical network, characteristic of cluster, tasks, knowledge assets, etc. Although this level does not analyze the knowledge itself, it provides a global view of the organization regarding the knowledge management project. The context level comprises three models: cluster model, organization model, task mode. The cluster model is the first analysis that focuses on physical network of the members and stakeholders of the industry cluster. The organization model focuses on the feasibility of the knowledge management project. Finally, the task model aims at analyzing the processes which were broken down from the knowledge intensive tasks of the ceramic cluster. This model also analyzes the quality of the knowledge itself in terms of nature, form, and availability of the knowledge. In order to visualize the interconnection within the context level, the input/output model of the context level is presented as follows:

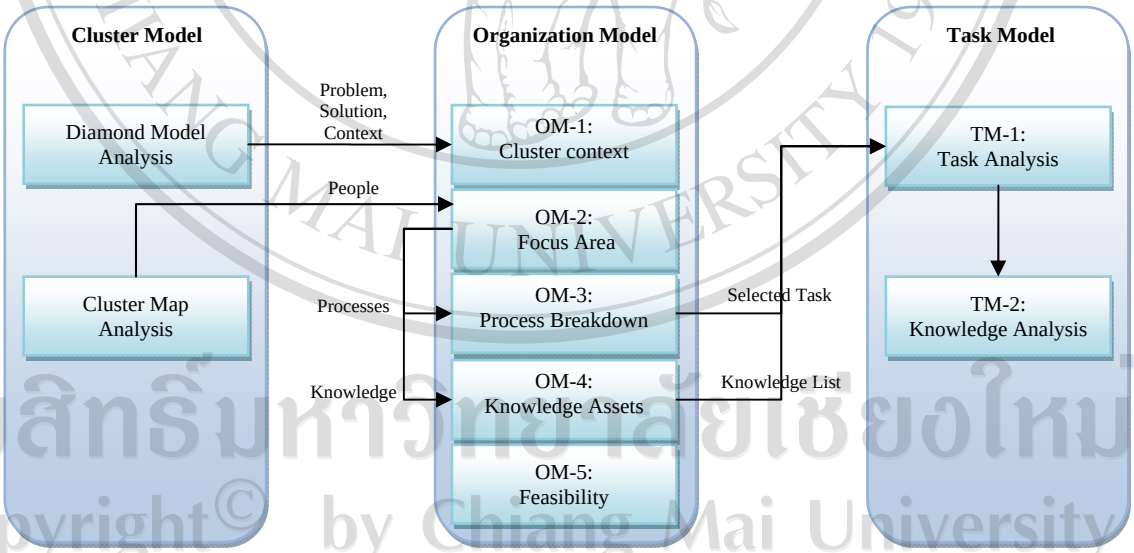


Figure IV.2: Input/Output model of the context level

IV.2.1. Cluster Model

The objective of cluster modeling is to identify the competitive strengths, weaknesses, and organization of particular industry clusters. Two techniques that are

widely used for cluster modeling are *diamond model* and *cluster map* analysis. Diamond model [Porter 90] mainly focuses on the cluster analysis in the business aspects such as the present situation of the industry, demand from the markets, value chain, strategy and infrastructure of the industry cluster. In contrast, cluster map focuses on collaboration and organization of the industry cluster. It aims at examining the network around the core cluster and accessibility to supporting organizations. These approaches are necessary for the initial stage of developing a KMS for the industry cluster. The integration of these two techniques provides a better understanding of both aspects for the knowledge engineer and government agency involve in cluster development. The following parts will present the results obtained from applying these techniques to the ceramic cluster in Thailand.

IV.2.1.1. Diamond Model Analysis

The National Economic and Social Development Board of Thailand (NESDB) have studied the competitiveness of this ceramic cluster in 2004. One of the selected tools in this study is the diamond model. The results from this study showed that this cluster is one of twenty potential industry clusters in Thailand. It was promoted as the most competitive ceramic cluster in Thailand. The summary of the diamond model analysis by NESDB is presented in the table IV.1. The analysis gives two aspects of the results, the positive forces (+) which were factors created advantages to the cluster, and negative forces (–) which may created disadvantages to the cluster.

Criteria	Analysis
Government	(+) Local government set provincial strategy as the ceramic center of Asian. (–) Lack of continuous supports from government to improve product, design and market.
Firm Strategy, Structure and Rivalry	(+) Most are SMEs which manufacture by OEM and ODM. (+) Large enterprises focus on exporting to client's order. (+) Much supports from organizations to develop dynamic and sustainable cluster. (+) Focus on niche market rather than mass market. (+) Cross-linked between food, hotel and ceramic industry. (+) Establishment of National Ceramic Center in Lampang. (–) Strong rivalry in small enterprises by cutting price and copying designs. (–) OEMs are not motivated to develop their designs. (–) Lack of own branding in ceramic industry (–) Production costs such as raw material, logistics and fuel are increasing. (–) SMEs lack of knowledge and experience in export field.

Criteria	Analysis
Factor Conditions	(+) Largest source of high quality white clay in the country. (+) Availability of LPG factory in the area, which is the main fuel for production. (+) Availability of local highly-skilled craftsmen and designer. (+) Located in the middle of northern Thailand, connected to many provinces which provide advantages in terms of logistics. (+) 17 electrical substations are in service for the factories. (+) Most raw materials can be purchased in the province. (–) Most machines have to be imported from foreign countries. (–) Lack of labor responsibility in their tasks. (–) Entrepreneurs' lack of awareness in industrial and production standard.
Related and Supported Industries	(+) The correlation between related industries exists, e.g. tourism, handicrafts, construction and decoration. (+) Availability of ceramic association and ceramic center in the province. (+) Supported by National Innovation Agent (NIA) to create own branding. (+) Distributed production process to the competent factories in the cluster. (–) Low degree of relations with academic institutes. (–) Lack of industry and academic institute to develop technology and machine for production in the supply chain. (–) Weakness of linkage of supply chain in ceramic industry. (–) Clustering in ceramic enterprises in Lampang still lacks strong collaboration.
Demand Condition	(+) Demanding in the country still has good trends, major market is in Bangkok. (+) Medium to high level customers, and foreign customers, emphasizes importance of product quality. (+) Large enterprises keep track of the preference of customers via many channels. (–) Foreign market is effect from the termination of GSP (Generalized System of Preferences) privilege by European Union (EU). (–) Small enterprises could not access the information about trend and preference of customers. (–) Domestic customers do not appreciate the quality of the product; feels that Lampang's ceramic products are low to medium quality.

Table IV.1: Diamond model analysis of Lampang's ceramic cluster [NESDB 04]

The results from examining the impact of government on the industry cluster revealed that national and local government give importance to the ceramic industry, especially Lampang's ceramic industry cluster by providing infrastructure and support in terms of finance and policy. This is a significant advantage for this cluster. However, continuality of supporting from the government is still deficient. Rivalry of the cluster can be separated into two obvious levels. The first level is the competition in the large enterprises. The main markets of this group are EU, Japan, USA and East-Asia. These companies have experience in foreign markets, continuous order from customers, and their own brands. Thus, the competition in this level is product development and human resources. Another level of rivalry is competition in the

SMEs level, which presents the major portion of manufacturers in the ceramic cluster. In this level, there are many factors in competition, e.g. price, design, market, etc. There are many positive factors which supports this cluster. Negative factors are technologies, standards, and human resources. Although there are many industries which are supporting this cluster, the linkage between cluster and supporting industries is required. The domestic demand is on a good trend but ranges of product are only low to medium quality. Moreover, although there is an opportunity for Thai ceramic products in the global market, SMEs still lacks of the knowledge to access these markets.

In brief, the analysis provided us with an overview about the positive and negative forces from both inside and outside the industry cluster. It revealed that even though Lampang's ceramic cluster is facing the problems about accessing to the local and global markets, there are many positive factors which support the manufacturers to be able to compete in the markets.

IV.2.1.2. Cluster Mapping

In order to visualize the industry cluster network, one of the knowledge elicitation techniques (called *structured interview*) is introduced to this study. The interview comprises 10 questions as described in chapter 3. In this study, we start from the ceramic cluster committee, then extended to supportive organizations, CDA, and so on. The complete cluster map is generated by combining different viewpoints from cluster members.

- The first cluster map is generated from interviewing the president of the ceramic cluster committee. The primary result gives us a list of 60 organizations in the ceramic cluster, 27 organizations in the core cluster and 33 organizations in the cluster support. The map obtained is a kind of preliminary view of the core of the cluster due to this map indicates the key persons of the cluster development. Then, the next interview will be repeated with one of the enterprises from this map.
- The second cluster map is generated from interviewing the leader of a former ceramic cluster in Lampang, called "Trust Group". The result gives a list of 61

organizations, 26 in the core cluster and 35 in the cluster supporter. From the second cluster map, there are 26 new defined organizations which were comparable to 46% of the cluster map. These elements will thus be appended to the previous cluster map.

- The third map is generated from interviewing the cluster's association. The interview with the president of Lampang Ceramic Association shows 68 organizations. From this list, there are 15 new defined organizations. Thus, about 22% of the total organization in the cluster map is appended to the third map.
- The forth map is generated from interviewing peoples in the supplier side of the ceramic cluster. The interview with one of the biggest white clay suppliers in this cluster provided 65 organizations, but only 6 new organizations are defined. Thus, we finished the interview at the fourth mapping due to the percentage of new defined organization being less than 10%.

In practice, the cluster mapping can be continued again later on in order to build up the list of users and member of the system. The results from these four interviews are combined and visualized as follows:

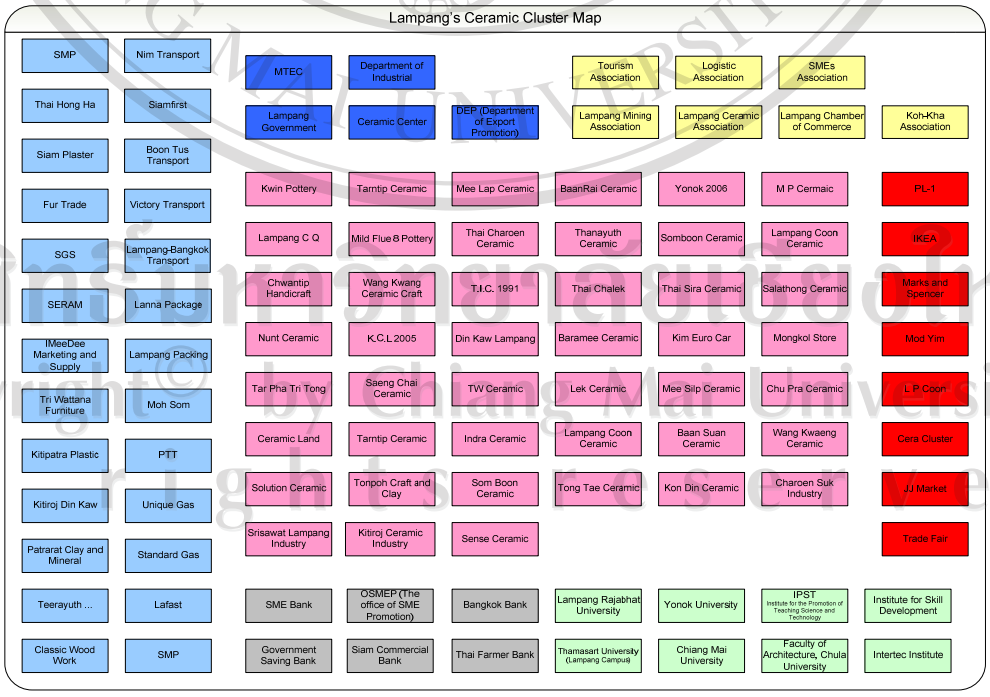


Figure IV.3: Cluster map of Lampang's ceramic cluster

The ceramic cluster map above shows that there are at least 105 organizations which influence the development of this cluster. The elements of the cluster map are categorized into 7 groups. The first group, located on the middle of the map is the core cluster. This group comprises 45 ceramic manufacturers in Lampang and nearby areas. The second group, located on the left side of the map is supporting industries (or up-stream industries). It is composed of 26 enterprises which supplies raw materials and services to the cluster. The third group (down-stream industries) is located on the right side of the map. It is composed of 8 enterprises involved with the end of the ceramic supply chain. The fourth group is composed of government agencies and is located on the top-left of the map. This group represents 5 agencies which have direct impacts on the ceramic cluster. The fifth group, which is cluster's association, is located on the top-right of the map. This group indicated 7 associations that always provide support to the cluster. The sixth group, financial institutes, is located on the bottom-left of the map, comprises 6 institutions that provide financial support for the ceramic cluster. Finally, the seventh group (bottom-right of the map) is academic institutions who support the ceramic cluster in terms of fresh knowledge and innovation.

In this state, the cluster model provides two primary views of the ceramic cluster. The first view is a conceptual view which is examined by diamond model analysis. This view presents both positive and negative forces which affect the ceramic cluster from various aspects. On the other hand, the cluster map analysis provides a physical view of the ceramic cluster. It reveals the agents who are involved and also their roles in the system. Both views are not only essential for the knowledge engineer to get 'the big picture' about the particular cluster, but also important for the analyzing in subsequent models. The list of actors in the ceramic cluster map will be referred by the organization model in the next part.

IV.2.2. Organization Model

The organization model is he core model of this level. There are two main objectives for implementing the organization model in this study. The first one is to provide better comprehension about the ceramic cluster to the knowledge engineer.

The second one is to explicate the cluster members about how the knowledge management project will improve the cluster. The process of organization model analysis was divided into five parts. Each part is supported by different worksheets which are provided within the CommonKADS methodology. The processes of the organization model analysis are illustrated in the following figure.

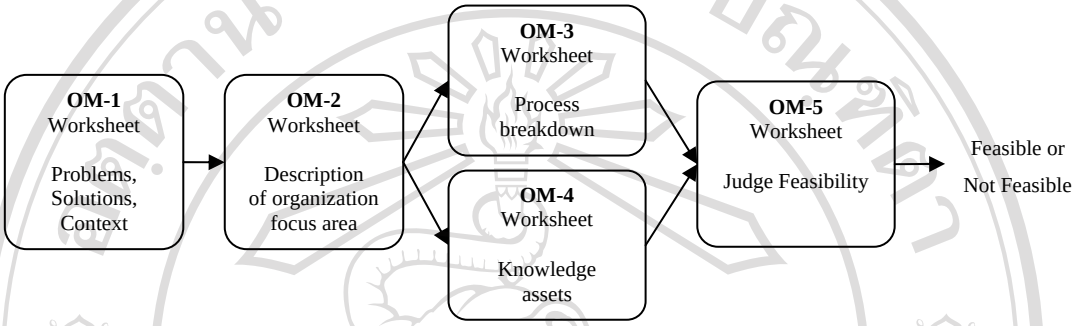


Figure IV.4: Five steps of the organization model analysis

The first worksheet (OM-1) focuses on a global view of the ceramic cluster. In this study, we use this worksheet for interviewing the cluster committee in order to investigate problems, solutions, and the context of the ceramic cluster. Then, the second worksheet (OM-2) provides deeper view of the ceramic cluster by focusing inside the cluster on aspects such as structure, process, people, resource, and knowledge. The elements in this worksheet were examined and designated with unique identity codes for ease of reference by other worksheets. These elements are considered as the basis component of the ceramic cluster. Then, the output from OM-2 will be analyzed in two aspects, process aspect (OM-3) and knowledge aspects (OM-4). The OM-3 worksheet brakes down main processes of the ceramic cluster into tasks and subtasks. The objective of this worksheet is to identify and rank the knowledge-intensive tasks within the ceramic cluster by using the specified criteria. On the other hand, OM-4 worksheet aims at analyzing knowledge assets of the ceramic cluster in term of place, time, form, and quality of the knowledge. The results from this worksheet tell us how the knowledge assets can be improved. Finally, OM-5 worksheet provides the knowledge engineer with a feasibility decision checklist in different points of view i.e. business, technical, and project feasibility. This worksheet is filled in by the knowledge engineer in order to propose the actions for the

knowledge management project of the ceramic cluster. It is considered as a decision support document for the stakeholders to continue or to terminate this project. In this section, we will present the results from applying each worksheet in the ceramic cluster.

IV.2.2.1. Problems and opportunities worksheet (OM-1)

The first part of the organization model focuses on problems and opportunities in the wider view of the organizational context. Then, it focuses onto specifies of the organization such as vision, mission, strategy, value chain, etc. At the end, the potential solutions from the industry cluster point of view are examined in order to get a real and explicit understanding of the ceramic cluster context. In this study, we used this worksheet for interviewing the ceramic cluster committee in order to get the perspective of the cluster. The results from the interview are displayed in the following table

Organization Model: OM-1	**Problems and Opportunities Worksheet**
Problems and Opportunities	**Problems** 1. Supply in the country exceeds demand, causing negative rivalry in small enterprises by cutting prices and copying designs. 2. Invasion of low cost products from neighboring countries. 3. Lack of own branding and designs in the SMEs. 4. Lack of knowledge and experience about the global market. 5. Production costs are increasing, causing pricing to become less competitive. 6. Weakness of collaboration in the supply chain. 7. Small enterprises could not access necessary information, such as global ceramic trends. **Opportunities** 1. Support from the government in terms of finance and policy. 2. Wide variety of targeted customers, from high-end to low-end consumers. 3. Location in the center of ceramic production of Thailand. 4. Availability of the largest source of high quality white clay in the area. 5. Most raw material suppliers are situated in the area. 6. Availability of local highly-skilled craftsmen and designers.

Organization Model: OM-1	Problems and Opportunities Worksheet
Organizational Context	**Vision** "Lampang Ceramic City" *Asian ceramic hub in 2012* **Mission** 1. Develop strength of cluster organizations in order to create dynamic and sustainable conditions for the ceramic industry cluster. 2. Enhance quality, design, innovation and branding of the product to reach standards recognized in the global market. 3. Support and create market opportunities for the cluster. **Strategy** 1. **Improve collaboration** among the people responsible in the area by developing integrated collaboration between B2B, B2S, B2C, B2G, etc. 2. **Revolution of strategy** of enterprises and supporting organizations from old style business e.g. cost-focused products, to high value-added product. This can be done by concentrating on quality development, designing, branding, and marketing using e-commerce, and trade fair and exhibition. 3. **Enhance network** of supporting organizations in the area such as ceramic producers' association, academic institute, government agencies, etc. These will develop beneficial activities and add fresh knowledge to the business strategy.
Solutions	1. Exchange information/knowledge and enhancing of the business network. 2. Consult and solve the problems together. 3. Increase the opportunity to acquire support from government. 4. Reduce production costs, using aggregate purchase quantity and negotiations with the supplier. 5. Reduce marketing costs, using co-investment in ceramic trade fairs and exhibitions. 6. Reduce Research and Development (R&D) costs, using co-investment in developing new formulae of ceramic products. 7. Reduce Human Resource Development (HRD) costs, by organizing training together. 8. Reduce costs of building the infrastructure by requesting supporting investment from the government. 9. Improve innovation for products and services together.

Table IV.2: Problems and opportunities worksheet (OM-1)

From the analysis, this cluster has many positive factors for cluster development. However, weakness of collaboration and lack of knowledge seem to be the major obstacles of the development. Thus, the main strategies of the ceramic cluster were set for improving the networking and business practices of the members. The solution proposed by the cluster committee can be considered as planned activities for supporting the strategy. The next worksheet will present the elements inside the ceramic cluster.

IV.2.2.2. Variant aspects worksheet (OM-2)

The second part of organization model concentrates on specific aspects of the ceramic cluster. This worksheet comprises six aspects: structure, process, people, resources, knowledge, and culture and power. The structure aspect focuses on the department, unit, or group involved in the core activity of the ceramic cluster. The process aspect focuses on business process which is relevant to the value chain of the cluster. The people aspect indicates the actors who are involve with process mentioned. The groups of actors in the cluster are derived from the cluster map in the previous model. The resource aspect can be any information system, equipment, or technology which is used within the ceramic cluster. The knowledge aspect represents the knowledge element which is required to accomplish the task. Finally, culture and power pay the attention to the "unwritten rules" of the cluster organization. The results from the analysis in these aspects are showed in table IV.3. It describes the basic elements of the organization and is considered as an outline for the following parts. These components are identified by particular codes in order to be referred to accurately by other worksheets.

Organization Model: OM-2	**Variant Aspects Worksheet**
Structure	1. Core Cluster 2. Government Agency 3. Association 4. Financial Institute 5. Academic Institute 6. Supporting Industry 7. Downstream Industry 8. Cluster development agent (CDA)
Process	**First Phase** [P-1] Obtain information about new global trends [P-2] Design new products **Second Phase** [P-3] Find market opportunities [P-4] Contact customers [P-5] Product developments [P-6] Manufacturing [P-7] Logistics and Exporting (Shipping) **Third Phase** [P-8] After sales service [P-9] Inventory Clearance (Sales mosaic, B and C grade products) (See one-year cycle of ceramic business in Lampang in Annex A)

Organization Model: OM-2	Variant Aspects Worksheet
Peoples	[A-1] Core Cluster [A-2] Government Agency [A-3] Association [A-4] Financial Institute [A-5] Academic Institute [A-6] Supporting Industry [A-7] Downstream Industry [A-8] Cluster development agent (CDA) See details in the Cluster Map (Figure IV.3)
Resource	1. Ceramic cluster website and e-commerce system 2. Mail, E-mail, Fax, Telephone 3. Cluster development agent (CDA) 4. Facilities at Ceramic Center
Knowledge	[K-1] Accessing global trends [K-2] Product development [K-3] Accessing new market opportunities [K-4] Customer Relationship Management (CRM) [K-5] Ceramic Manufacturing [K-6] Logistics and Exporting [K-7] Acquiring support from the government [K-8] Ceramic Research and Development (R&D) [K-9] Human Resource Development (HRD) [K-10] Ceramic Branding
Culture and Power	1. **Trust** in the ceramic cluster is in the low to medium level. Thus, we can see many small groups of enterprises in a single industry cluster, such as IFCT cluster which includes 5 small groups called *trust*, *active*, *believe*, *harmonize* and *sila Lampang* group . These small groups contain 5-10 enterprises from upstream to downstream industries. Trust within the group is at a high level. They tend to share proprietary knowledge and some business secrets among each other. However, this knowledge and information are exchanged less often in the cluster level. 2. **Structure of cluster organization** is flat. The cluster committee and CDA are selected for facilitating the cluster. However, they often face problems when decision making is required. This is caused by uncover (uneven?) information sharing; e.g. some member did not obtain the same information as the cluster committee. Sometimes, it is apparent that the committee lacks experience and knowledge to make the right decisions. Trial and error on the part of the committee creates disagreements and diminishes trust in the cluster. 3. **Direct sharing** of knowledge and information in the cluster is still at a low level. The special collaboration between competitors makes the members uneasy to enquire about and share knowledge when they are face to face. Thus, the CDA who is the cluster facilitator, has sometimes taken responsibility as 'the middle man' by transferring knowledge from one member to another. This process, called *Indirect sharing*, may improve the knowledge exchange in the cluster, but the quality of knowledge may be distorted. With the limitations of the CDA, this method of sharing may be unsustainable.

Table IV.3: Variant aspects worksheet (OM-2)

The details of each group or people were described in the cluster map in the previous part. The process aspect showed the major business activities of Lampang's ceramic industry in a one-year cycle. The activity starts from obtaining design information until inventory clearance which can be divided into nine processes. Then, the resource aspect shows the available facilities within the cluster. From this aspect, we can see that the ceramic cluster in this case study does not rely on high technology or equipment for their development due to this cluster is composed of SMEs in the handicraft domain. The knowledge aspect shows a list of required knowledge for achieving the goal of each process. Lastly, the culture and power aspect describes specific characteristic of the industry cluster which impact cluster development but have never been discussed. From the interviewing CDA, three major issues (trust, structure of organization, and direct sharing) are concerned. These issues will be discussed again in the collaboration model. The defined processes in this worksheet will be broken down in the OM-3 worksheet, whilst the list of knowledge assets will be examined in the OM-4 worksheet.

IV.2.2.3. Process breakdown worksheet (OM-3)

The defined processes from the previous part are specified in more details within this worksheet. The business process is broken down into smaller tasks for classifying knowledge-intensive task from general task. In order to do this, a consensus from cluster members on the *significance* of each task should be obtained. However, there are no hard rules for assessing task significance [Schreiber 99]. Methods such as ordinal scale can be applied for acquiring a consensus among the cluster members. In this study, we propose a table of criteria for evaluating the significance of the task, as shown in the following table.

Criteria	**(*F*)requency**	**(*I*)mpact**	**(*M*)ission**	**(*C*)ommon**	**(*R*)isk**
1	Yearly	No Impact	Supporting Process	Specific	No Risk
2	Half-Yearly	Low Impact	Supporting Strategy	Narrow Use	Low Risk
3	Quarterly	Moderate Impact	Main Process	Common	Moderate Risk
4	Monthly	High Impact	Main Strategy	Wide Use	High Risk
5	Daily	Very High Impact	Core Competency	Universal	Very High Risk

Table IV.4: Criteria for accessing task significance

This table, designed for assessing the tasks in the ceramic cluster, was composed of five criteria: frequency, impact, mission, commonality, and risk. These criteria were valued with scores from 1 to 5, meaning that the task with the highest score is the most significant task. The method for allocating these scores can be done by allowing the cluster committee to evaluate each task. Then, the average score will portray the significance of each task. The resulting from assessments are showed as follows:

Organization Model: OM-3		**Process Breakdown Worksheet**				
No.	**Task**	**Performed By**	**Where**	**Knowledge Asset**	**Intensive**	**Significance**
P-1	Obtain information about new global trend	[A-1] Core Cluster [A-2] Government Agency [A-3] Association [A-5] Academic Institute [A-7] Downstream Industry [A-8] CDA	Cluster Level	[K-1] Accessing global trends [K-7] Acquiring support from the government	**No**	**(12)** F=2; I=3; M=2; C=2; R=3
P-2	Design new product	[A-1] Core Cluster [A-3] Association [A-5] Academic Institute	Factory	[K-1] Accessing global trends [K-2] Product development [K-8] Ceramic R&D [K-9] Human Resource Development	**Yes**	**(17)** F=2; I=5; M=2; C=5; R=3
P-3	**Accessing market opportunity**	[A-1] Core Cluster [A-2] Government Agency [A-3] Association [A-4] Financial Institute [A-6] Supporting Industry [A-8] CDA	**Trade Fair and Exhibition**	[K-1] Accessing global trend [K-2] Product development [K-3] Accessing new market opportunities [K-7] Acquiring support from the government [K-10] Ceramic Branding	**Yes**	**(20)** **F=3; I=5; M=4; C=4; R=4**
P-4	Contact customer	[A-1] Core Cluster [A-5] Academic Institute [A-7] Downstream Industry	Factory	[K-4] Customer Relationship Management (CRM)	**Yes**	**(11)** F=5; I=2; M=1; C=1; R=2
P-5	Product development	[A-1] Core Cluster [A-3] Association [A-4] Financial Institute [A-5] Academic Institute [A-6] Supporting Industry [A-7] Downstream Industry [A-8] CDA	Cluster and Factory	[K-1] Accessing global trends [K-2] Product development [K-8] Ceramic R&D [K-9] Human Resource Development	**Yes**	**(15)** F=3; I=3; M=4; C=2; R=3

Organization Model: OM-3		Process Breakdown Worksheet				
P-6	Manufacturing	[A-1] Core Cluster [A-3] Association [A-4] Financial Institute [A-5] Academic Institute [A-6] Supporting Industry [A-8] CDA	Cluster and Factory	[K-1] Accessing global trends [K-2] Product development [K-5] Ceramic Manufacturing [K-8] Ceramic R&D [K-9] Human Resource Development	**Yes**	**(18)** F=5; I=3; M=4; C=3; R=3
P-7	Shipping/ Exporting	[A-1] Core Cluster [A-3] Association [A-4] Financial Institute [A-6] Supporting Industry	Factory	[K-6] Logistics and Exporting	**Yes**	**(18)** F=4; I=3; M=3; C=4; R=4
P-8	After sales service	[A-1] Core Cluster [A-7] Downstream Industry	Factory	[K-9] Human Resource Development [K-10] Ceramic Branding	**Yes**	**(9)** F=3; I=3; M=1; C=1; R=1
P-9	Sales mosaic, B and C grade products	[A-1] Core Cluster [A-2] Government Agency [A-3] Association [A-4] Financial Institute [A-8] CDA	Cluster	[K-7] Acquiring support from the government	**No**	**(10)** F=2; I=3; M=3; C=3; R=2

Table IV.5: Process breakdown worksheet (OM-3)

The two factors considered for assessing the task in OM-3 are knowledge-intenseness and the significance of the task. In this worksheet, each task is matched with corresponding elements: participate who perform tasks, places where task were executed, and the knowledge required for achieving the task. The intensiveness of knowledge is examined whether the task relied on the knowledge or not. In order to clarify this statement, the difference between a knowledge intensive task and non-knowledge intensive task will be described. The significance column shows the scores of significance of the tasks which have consensus among the cluster committee. The range of scoring varies from 5 to 25 points. As an illustration, a task which has the highest score (25) means that this task is performed every day; has a very high impact on the cluster; is the core competency of the industry; can be applied along with others; and carries a high risk if not well managed. In our case study, the most significant task in this ceramic cluster is **"accessing the market opportunity**" task. The cluster members agreed that this knowledge-intensive task is critically required for the ceramic cluster under current economic situation. Therefore, the following models will use this task as a case study.

IV.2.2.4. Knowledge assets worksheet (OM-4)

This worksheet focuses on the knowledge elements in the cluster. It provides an overview of the knowledge in terms of form, place, time, and quality. The main objective of this part is to identify which knowledge assets can be improved in different perspectives such as form, accessibility, time, space, or quality. This analysis is not only significant for KMS development but also knowledge management action. The results from analysis of each knowledge asset are presented in table IV.6.

Organization Model: OM-4		**Knowledge Assets Worksheet**				
Knowledge Asset	**Possessed By**	**Used In Process**	**Right Form?**	**Right Place?**	**Right Time?**	**Right Quality?**
[K-1] Accessing global trend	[A-1] Core Cluster [A-2] Govern. Agency [A-5] Academic Institute [A-7] Downstream Ind.	**1**, **2**, **3**, **5** and **6**	-	-	-	-
[K-2] Product development	[A-1] Core Cluster [A-3] Association [A-5] Academic Institute	**2**, **3**, **5** and **6**	✓	-	-	✓
[K-3] Accessing new market opportunity	[A-1] Core Cluster [A-2] Govern. Agency [A-3] Association	**3**	-	-	✓	✓
[K-4] CRM	[A-1] Core Cluster [A-5] Academic Institute	**4**	✓	-	✓	✓
[K-5] Ceramic Manufacturing	[A-1] Core Cluster [A-3] Association [A-5] Academic Institute [A-6] Supporting Ind. [A-7] Downstream Ind.	**6**	-	-	✓	✓
[K-6] Logistic and Exporting	[A-1] Core Cluster [A-3] Association [A-6] Supporting Ind.	**7**	✓	-	✓	✓
[K-7] Acquiring supporting from the government	[A-1] Core Cluster [A-3] Association [A-2] Govern. Agency	**1**, **3** and **9**	-	-	✓	✓
[K-8] Ceramic Research and Development	[A-1] Core Cluster [A-3] Association [A-5] Academic Institute [A-6] Supporting Ind. [A-7] Downstream Ind.	**2**, **5** and **6**	-	-	-	-
[K-9] Human Resource Development	[A-1] Core Cluster [A-3] Association [A-5] Academic Institute	**2**, **5**, **6** and **8**	✓	-	✓	✓
[K-10] Ceramic Branding	[A-1] Core Cluster [A-1] Core Cluster [A-7] Downstream Ind.	**3** and **8**	-	-	✓	✓

Table IV.6: Knowledge assets worksheet (OM-4)

The table above implies that none of the knowledge assets have complete attributes. Most s assets are in the right place with the right quality, but few of them are in the right form and accessible at the right time. For example, in the case of knowledge assets for ceramic manufacturing, Lampang Ceramic Center was established for supporting manufacturers to solve their production problems. Thus, knowledge users know where to acquire this knowledge when it is needed. However, most knowledge about ceramic manufacturing is available in tacit form (experts' experience) and thus un-accessible whenever it is needed. Thus, this knowledge needs to be improved in terms of **form** and **availability**

IV.2.2.5. Feasibility decision worksheet (OM-5)

This worksheet contains checklist for producing the feasibility decision document. It focuses on four dimensions: business aspect, technical aspect, project aspect, and proposed actions. Each aspect aims at analyzing the effect of knowledge management project and organization in different dimensions. For example, business feasibility mainly focuses on costs and benefits of the project to the cluster. The technical feasibility focuses on desired technologies for solving the problem. The project feasibility concerns analyzing project risks in term of time, budget, equipment, commitment, etc. Finally, a set of recommendation is proposed to cluster committee for improving the knowledge management in the ceramic cluster. The proposed solutions from the analysis are presented in the following table.

Organization Model: OM–5	**Checklist for Feasibility Decision Document**
Business Feasibility	1. The KMS will improve the quality of knowledge sharing and collaboration among the experts and knowledge workers in the cluster. This will improve the competitiveness of the ceramic industries which make products of global standard quality. 2. Sharing knowledge and experience about new market opportunities, global markets and exporting will support SMEs to find new channels for their markets. This will relieve the price war in the domestic market. 3. The proposed system may reinforce collaboration in the ceramic supply chain. 4. The proposed system will create equality of obtaining information in the cluster.

Technical Feasibility	1. The system might change the way of collaboration of cluster members from face-to-face to virtual communication. The communication via system can be stored as a knowledge base for future use. However, some conservative enterprises may not change their ways of communication. 2. The proposed system should not require advanced technology and specifications, as SMEs cannot afford to invest in additional software or hardware for communicating with the cluster. 3. The system must utilize open standard protocol for communications so that large and small enterprises can communicate with the same system. 4. All experts and knowledge users of the system are in the commercial domain. So knowledge should be shared and represented in human comprehensible format and be effortless.
Project Feasibility	1. The project may be interesting and useful for cluster members, but it still lacks commitment from the participants and stakeholders. 2. The project requires low budget and resources to achieve the objective. However, the processes are time consuming. 3. Some knowledge is not available in the cluster. The CDA and KE should acquire the knowledge from external sources to fulfill the requirement. 4. The project is realistic. The effect of the project may impact macro-economical competency of the country in the long run. Members of the cluster expect to use the system to support their activities. 5. The project organization is well communicated at the beginning of the project (requirement phase). 6. The only risk of the project is lack of acceptance by the cluster. The knowledge in the system may not be adequate in the beginning. CDA is a key person to motivate experts to supply their knowledge to the system.
Proposed Action	The project should have the following criteria; *Focus*: Collaboration and knowledge sharing within the cluster *Target solutions*: 1. Exchange information/knowledge and enhance business network 2. Support the cluster to find new market opportunities 3. Create a place to consult and solve problems together. *Expected results*: Members of the cluster have better quality communications; knowledge workers are able to acquire the required knowledge from the system, and the CDA facilitates the cluster by using the KMS as a tool. *Risk*: The communication via KMS may require changing. The knowledge model may need time to be completed.

Table IV.7: Feasibility decision document (OM-5)

The information in this table is a kind of initial investigative report of the knowledge management project which will be used for making decisions by the project owner (cluster committee). Business feasibility analysis showed how the knowledge management project will bring opportunities to the cluster members. It also addressed whether or not the proposed project complies with cluster activities and strategy. Afterwards, the technical feasibility analysis revealed that the proposed knowledge system should exploit the open standard and be easily operated. In addition, the project feasibility concerned the commitment of cluster members and the

availability of knowledge. Lastly, the proposed actions were introduced for enhancing the cluster's situation and noted the criteria required.

In summary, the cluster committee has a consensus to initiate the knowledge management project in the ceramic cluster by focusing on 2 points: supporting collaboration and enabling knowledge sharing among cluster members. The knowledge concerning accessing market opportunities will be selected as our case study. In the next model, characteristics of task and knowledge assets will be analyzed in detail.

IV.2.3. Task Model

This part of the methodology focuses on two issues which are tasks and knowledge assets. The TM-1 (task analysis worksheet) mainly focuses on the analysis of the knowledge-intensive tasks which are selected in OM-3 worksheet. Then, TM-2 (knowledge items worksheet) focuses on the knowledge assets which are used for achieving the task. In this study, we have made use of task model worksheets as the outline for interviewing with the experts in each task. The result from the analysis will be presented in the following part.

IV.2.3.1. Task analysis worksheet (TM-1)

This worksheet concentrates on the selected tasks in OM-3. Thus, the interviews have been done with the experts of each specific task. The first part of the worksheet aims at acquiring the overview of the task. Then, it decomposes the focused task into subtasks for analyzing the activities. The final part, the agents, knowledge, and resource are examined as additional factors. In this worksheet, the knowledge-intensive task about "accessing market opportunity" is analyzed in details. Results from the analysis are presented in the following table.

Task Model: TM–1-P3	**Task Analysis Worksheet**
Task	[P-3] Finding Market Opportunity
Organization	[A-1] Core Cluster [A-2] Government Agency [A-3] Association [A-4] Financial Institute [A-6] Supporting Industry [A-8] CDA

Goal and Value	*Goal:* Accessing new markets via trade fairs and exhibitions *Values:* Create opportunities for enterprises to sell their product in the global market. Decrease the pricing war in the domestic market. Motivate enterprises to develop their own competency.
Dependency and Flow	*Input Tasks:* None *Output Tasks:* None
Objects Handled	*Input objects:* New opportunities such as information about the trade fair Lessons learned from experienced enterprises Information and support from the government Financial support from financial institute *Output objects:* Decision support for enterprises to achieve at trade fair
Timing and Control	*Frequency:* About 3-4 times a year.
Agents	See **Organization** above
Knowledge and Competence	[K-1] Accessing global trends [K-2] Product development [K-3] Accessing new market opportunities [K-7] Acquiring support from the government [K-10] Ceramic Branding
Resources	1. Ceramic cluster website and e-commerce system 2. Mail, E-mail, Fax, Telephone 3. Cluster development agent (CDA) 4. Facilities at Ceramic Center
Quality and Performance	Purchase order from new clients after the trade fair.

Table IV.8: Task analysis worksheet (TM-1)

The expert claimed that supporting accessing new market will bring many advantages to the cluster e.g. create opportunity for enterprise to sales their product in the global market, decrease pricing war in the domestic market, and also motivate enterprise to develop their own competency. We classified the composition of task into particular groups rather than decomposing this task into structured subtasks. The details of this task will be illustrated in the knowledge model section. In the next worksheet, knowledge which is involved with this task will be inspected.

IV.2.3.2. Knowledge item worksheet (TM-2)

This part of the analysis mainly focuses on knowledge items and competence of the task. It constitutes a refinement of the result from OM-4 on the knowledge asset. This worksheet aims at analyzing the bottleneck and improvement relating to specific areas of knowledge which comprises three main parts. These are: nature of knowledge, form of knowledge, and availability of knowledge. It also allows knowledge engineer to assess the present situation of each knowledge asset and

considers if the knowledge asset need to be improved in specific point. In this study, six knowledge assets involved with the specified task were analyzed in table IV.9. The displayed result was combined from both the knowledge provider and user point of view.

The results in the table are considered as a benchmark for designing the knowledge system for improving these knowledge assets. It also implied that the nature of the knowledge asset varies the domain of knowledge. For example, knowledge asset in manufacturing domain (e.g. product development) trend more to be in an explicit form than business domains (e.g. accessing global trends or ceramic branding). In contrast, completeness and accessibility of the knowledge in business domain are better. In terms of availability of the knowledge, cluster members claimed that even though knowledge is in the right form and right quality, accessing the knowledge when and where they need to do so is still limited. This may be affected by two causes, level of trust, and the communication approach. The level of trust in the cluster level is still lower than CoP level. Moreover, the characteristics of the relationships between the members also have a great influence upon the level of trust. Thus, knowledge users experienced that accessing knowledge from another domain or from the experts who were competitors was limited. Another factor that affects knowledge sharing is the communication approach. Cluster members revealed that sometimes they could not access to the required knowledge wherever and whenever they want because of competitor-like relationship. It makes cluster members feel uneasy to acquire/share the knowledge in a direct way. Instead of acquiring the knowledge from the expert directly, they preferred to inquire the knowledge through the CDA who is the cluster facilitator.

Task Model: TM-2	**Knowledge Item Worksheet**											
ID **Name** **Possessed by** **Used In** **Domain**	[K-1] **Access global trend** Refer. OM-4 P: 1,2,3,5 and 6 Design		[K-2] **Products develop**. Refer. OM-4 P: 2,3,5 and 6 Manufacturing		[K-3] **New Market** Refer. OM-4 P: 3 Marketing		[K-6] **Logistic/Export** Refer. O~M-4 P:7 Sales		[K-7] **Govern. Support** Refer. OM-4 P: 1,3 and 9 Management		[K-10] **Ceramic Branding** Refer. OM-4 P: 3 and 8 Marketing	
Nature of the knowledge		To be Improved		To be Improved		To be Improved		To be Improved		To be Improved		To be Improved
Formal, rigorous	X				X		X			X		
Empirical, quantitative					X		X					
Heuristic, rule of thumb							X					
Highly specialized, domain-specific	X		X				X		X		X	
Experience-based	X		X				X		X		X	
Action-based	X		X				X		X		X	
Incomplete			X	X					X			
Uncertain, may be incorrect	X								X		X	
Quickly changing	X								X		X	
Hard to verify	X		X						X		X	
Tacit, hard to transfer	X										X	
Form of the knowledge												
Mind	X		X				X		X			
Paper			X		X		X		X		X	
Electronic	X		X		X		X		X		X	
Action skill			X				X		X			
Other	X		X									
Availability of the knowledge												
Limitation in time		X		X		X		X		X		X
Limitation in space		X		X		X		X		X		X
Limitation in access		X								X		
Limitation in quality		X										
Limitation in form			X			X				X		X

Table IV.9: Knowledge item worksheet (TM-2)

In summary, the results from the models in this level provide a great opportunity to understand the industry cluster context. The analysis has been done from the broadest view and drilled down to the specific views. The investigation was separated into three models.

- The first model (called cluster model) is aimed at identifying the stakeholders (knowledge providers, knowledge users, and decision-makers) in the ceramic cluster context. Besides, it provides a macro view (external and internal force) of the cluster.
- The second analysis aimed at examining the organization model of the cluster. The empirical result from this model composed of cluster's organizational context, list of knowledge-intensive task, list of required knowledge, and feasibility study report. If the project is feasible, then the next analysis will be initiated.
- The last analysis in this level aimed at examining the task model of the cluster. It focuses on the scope of knowledge-intensive tasks and knowledge assets which are derived from the organization model.

The outcome of these models provided us with a clear idea about the required knowledge assets for achieving the task and improvement points of the knowledge. In the next level, the knowledge model and collaboration model of the cluster will be investigated in order to extract the body of knowledge from expert and also the characteristic of knowledge sharing in the cluster.

IV.3. Concept Level

The concept level is comparable to the core of the proposed methodology. The objective of this level is to extract the knowledge from the experts in the industry cluster and modeled characteristic of information sharing of the cluster members. Therefore, two models (knowledge model and collaboration model) are adopted for supporting the objective. The knowledge model is set for capturing the experts' knowledge from tacit into explicit form. The captured knowledge will be organized and stored in the knowledge base in order to be used in the future. In contrast, collaboration model focuses on the flow of information and knowledge within the ceramic cluster. The details of both models will be presented as follows.

IV.3.1. Knowledge Model

The goal of the knowledge model is to extract knowledge from the experts in the ceramic cluster. In order to achieve this, the knowledge elicitation templates which are proposed in the CommonKADS model, were adopted to deal with different type of knowledge intensive tasks in the cluster. In our study, the knowledge modeling was divided into 3 main processes i.e. eliciting, transcribing, and modeling. An example of these processed were illustrated in figure III.11. In order to depict the knowledge modeling process, we have extracted the knowledge of the task "*Finding market opportunity*" [P-03] from the ceramic cluster. Hence, eight knowledge elicitation meetings were organized for interviewing different participants involved in this task. The details of each meeting are displayed in table IV.10. The table described the ID of the meeting, experts who attended the meeting, domain knowledge involed, focused topic, and the obtained knowledge model which is the result of the knowledge modeling process.

Meeting ID	Experts	Knowledge Domain	Knowledge Topic	Obtained Knowledge Model
M1-T-P03	CeraCluster Committee [*Core Cluster*]	[K-3] Accessing new market	Method	T-P03 I-P03-014 I-P03-007 I-P03-010
M2-T-P03	CeraCluster Committee [*Core Cluster*]	[K-3] Accessing new market	Lesson learned	I-P03-004 I-P03-020
M3-T-P03	Department of Export Promotion [*Government Agency*]	[K-7] Acquiring support from government	Acquiring Support from DEP	I-P03-015
M4-T-P03	Office of Product Value Development [*Government Agency*]	[K-2] Product development	Global trend	I-P03-021
M5-T-P03	Lampang Ceramic Association [*Association*]	[K-3] Assessing new market	Booth decoration and management	I-P03-016 I-P03-017
M6-T-P03	Export and Import (EXIM) Bank [*Financial Institute*]	[K-3] Accessing new market	Acquiring financial support	I-P03-019
M7-T-P03	Market Intelligence [*Supporting Industry*]	[K-3] Accessing new market [K-10] Ceramic branding	Online marketing and ceramic branding	I-P03-011 I-P03-012
M8-T-P03	Cera Cluster CDA [*Cluster Development Agent*]	[K-3] Accessing new market	Repository and Contacts	I-P03-005 I-P03-006

Table IV.10: Summary of the knowledge elicitation meetings

From the table above, the outcomes of these knowledge elicitation meetings are a set of knowledge maps required for completing the specific task. The first meeting has been done with the ceramic cluster committee in order to acquire an overview of the task: "Accessing to

new market opportunity". The knowledge model of this task is presented in the map ID: T-P03. This map contains task, sub-tasks and inferences which involved with the focused task. Task and sub-task elements are represented by hexagon shape, while the inference elements are represented with the rectangle shape. The knowledge map about "accessing to new market opportunity" (T-P03) is illustrated in the figure below.

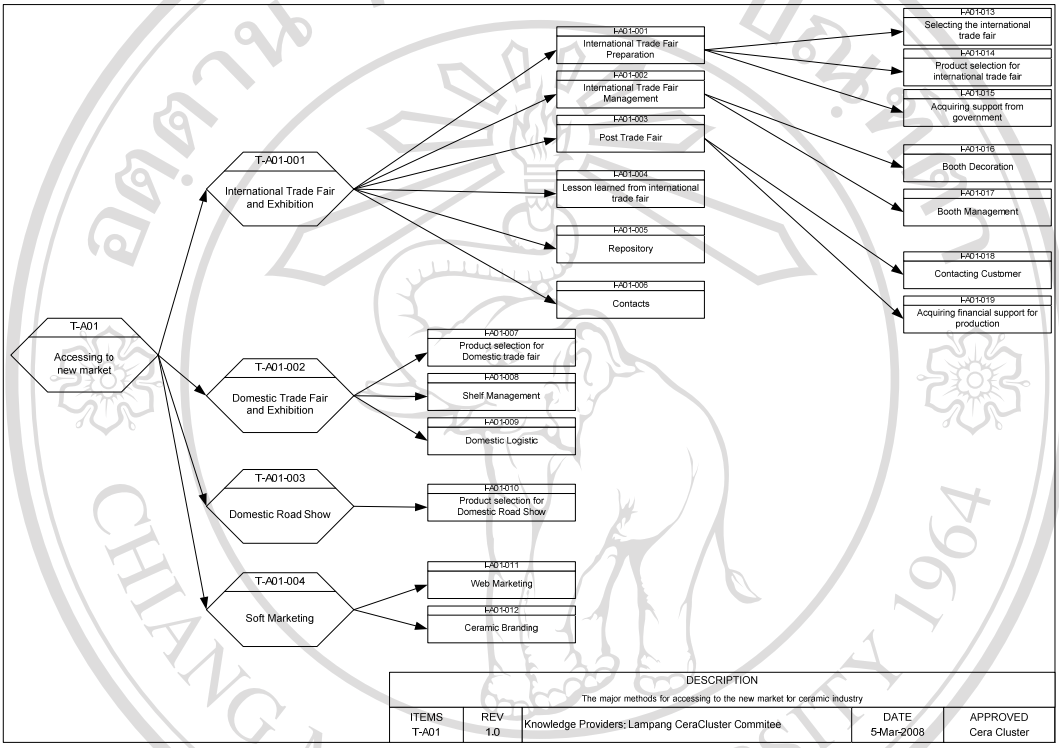


Figure IV.5: Knowledge model of accessing to new market task.

This knowledge model is the first model which is obtained from the experts in the cluster committee. The content of the knowledge is about the overview concept of the task (i.e. accessing to new market). The process of the knowledge modeling was explained in the chapter 3. The parent node of the knowledge model is the name of the task. Then, the child nodes in this model imply that the task assessing to new market should concern at least four sub-tasks: international trade fair, domestic trade fair, road show, and soft marketing. Then, the inference elements are connected with these nodes in order to describe the inference concept of each node. The knowledge map in the inference level is displayed in the same concept. The inference element is set as the parent node of the map. Then, the domain knowledge is represented with oval shape and connected to the inference element in order to describe the knowledge about specific concept. An example of the knowledge model of the

“product selection for international trade fair” (I-P03-014) is displayed in the following figure.

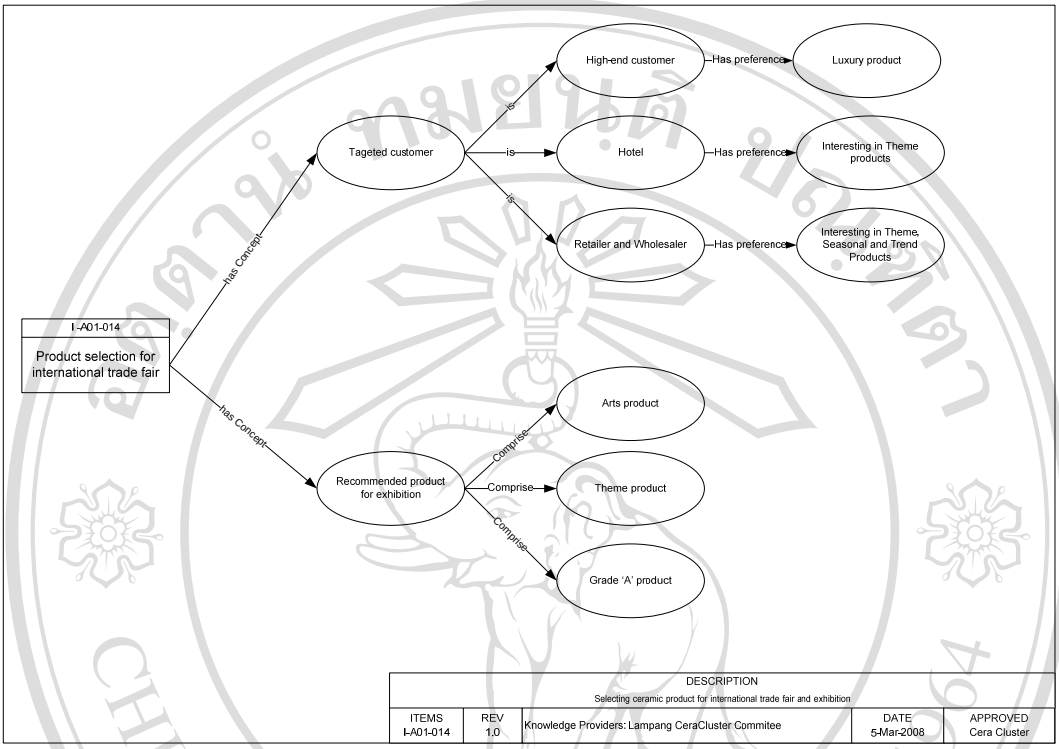


Figure IV.6: Knowledge model of the product selection concept.

The knowledge models above show the first group of the knowledge models which is extracted from the experts in the ceramic cluster committee by using the planning template. It implies the methods for accessing to the new market of this cluster. The complete knowledge models about this task are displayed in Annex D.

In this part, the knowledge assets which involve with the focused knowledge-intensive tasks are modeled into an appropriate format. Actually, there are many possible methods for representing the knowledge (e.g. rule base, semantic map, etc.). Thus, it is a judgment of the knowledge engineer to decide on knowledge representation method that best fit with the context. However, In this study, we represent the knowledge model in form of the semantic map due to it provides many advantages to our knowledge system e.g. readable by human and machine, give better search result, makes it easy to manipulate the knowledge, compatibility with the inference engine, etc. The application of these semantic knowledge maps will be described in chapter 5. The next section will concentrate on the knowledge exchange model of the ceramic cluster. Moreover, the characteristics of collaboration of the

cluster members will be analyzed in order to investigate the circumstances of the "*co-opetition*" relationship.

IV.3.2. Collaboration Model

The collaboration model of the industry cluster will be analyzed by both qualitative and quantitative methods. The interviews and questionnaires have been applied to members of the industry cluster in order to examine the characteristic and environment of the collaboration. Moreover, the results of analysis will be used to confirm the hypotheses and statements that obtained from experts in the context level. The analysis was separated into 4 parts i.e. expectation and satisfaction of member, activities in the cluster, information and knowledge exchange, and characteristic of collaboration. The outline of the questionnaire can be found in Annex C. We have analyzed questionnaire from 50 enterprises (45 SMEs and 5 large enterprises) in the ceramic cluster, which is about 25% of total registered ceramic company in Lampang province [Untong 05]. The presented information in this part was acquired and analyzed in March 2008. The interviews already taken place with the entrepreneurs or mangers of the enterprises. The results of the analysis are illustrated and described as follow.

IV.3.2.1. Expectation and satisfaction of cluster members

This part of the questionnaire refers to the proposed solutions by the cluster committee which are described in OM-1. The defined solutions are considered as the main activities of the ceramic cluster in order to improve the competitiveness of the ceramic cluster. The analysis aims at evaluating the expectation of the member for participating in the ceramic cluster. Besides, it also focuses on the satisfaction that they gained from being a member of the cluster. The result of the analysis will help us to understand the objective of the collaboration and also indicate the strength and weakness points of collaboration in the cluster, as showed in the following table.

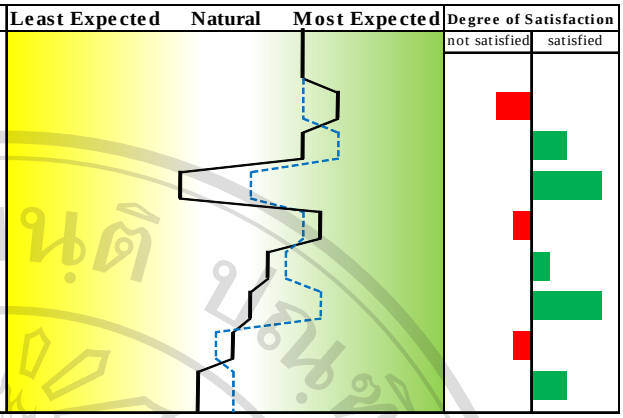
	Activities in the cluster	Least Expected Natural Most Expected	Degree of Satisfaction
			not satisfied / satisfied
1	Improving business network		
2	Consulting and solving problems together		
3	Increasing opportunity to acquire support from government		
4	Reducing production costs		
5	Reducing marketing costs		
6	Reducing research and development costs		
7	Reducing human resource development costs		
8	Reducing cost of investment in the infrastructure		
9	Improving the innovation of products and services		

Table IV.11: Expectation and satisfaction of SMEs

The graph above represents the expectations (solid line) and satisfaction (dash line) of the SMEs members in the ceramic cluster. The expectations line shows the degree of benefit that they expected to acquire from being cluster members. The satisfaction line shows the degree of benefit that they are obtaining from the cluster at the present. Then, the degree of satisfaction is the difference between expectation and satisfaction of the members. This graph implies that the SME members of the cluster expected to obtain these benefits from the cluster: improving business network, consulting and solving problems together, increasing opportunities to acquire support from the government, and reducing marketing costs. The results from the graph imply many interesting issues:

- Firstly, the SMEs have high expectation to exchange the information and knowledge between each others in order to solve their problems. However, they feel that the benefits that obtained from the cluster are unable to fulfill their expectation. This disappointment could be explained by referring to the OM-2 worksheet in the organization model. The direct sharing of knowledge and information in the cluster is still at a low level due to the special relationship as collaborator and competitor in the same time. This makes the members feel uneasy to inquire and share knowledge when they are face-to-face.
- Secondly, these enterprises gain the most satisfaction in reducing production cost, because at the beginning, they did not expect to be able to reduce costs by being cluster members. However, they gained many benefits from the collaboration within the cluster, such as aggregating demand to purchase common raw materials, sharing the orders between partners, and learning new techniques to reduce production costs.

- Lastly, reducing marketing costs is the second objective of SMEs participating in the ceramic cluster. They expected to gain opportunities to access new markets such as foreign markets, international trade fairs and ceramic road shows. However, many enterprises claimed that they did not receive such information from the cluster, nor from government agencies. The structure of the organization which explained in OM-2 worksheet that the cluster organization structure is flat. Thus, sometimes the information may not throughout the cluster members.

In the global view, the benefits from the ceramic cluster seem to satisfy the SME members. However, if we focus on the heights expectations from the cluster, we find that members still require better information sharing in order to solve their problems, and also better collaboration to access to the opportunities available from their membership, which are the potential success factors of the cluster. In contrast, if we analyze the expectation and satisfaction levels of the large enterprises in the ceramic cluster, we find that these enterprises are focusing on different benefits from the SMEs in some aspects. The expectation and satisfaction lines are presented in table IV.12.

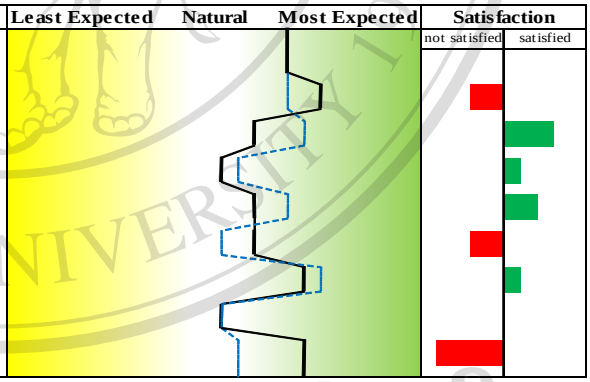
	Activities in the cluster	Least Expected Natural Most Expected	Satisfaction
			not satisfied / satisfied
1	Improving business network		
2	Consulting and solving problems together		
3	Increasing opportunity to acquire supporting from government		
4	Reducing production cost		
5	Reducing marketing cost		
6	Reducing research and development cost		
7	Reducing human resource development cost		
8	Reducing cost of investment in the infrastructure		
9	Improving the innovation of products and services		

Table IV.12: Expectation and satisfaction of large enterprises

Although large enterprises are in the minority in the Lampang ceramic cluster in term of quantity, they are the pillars of the cluster. The graph above implies that some objectives of the large enterprises have commonalities with those of SMEs, but some objectives are different. Compared with the SMEs' expectation, these enterprises focus less on marketing but more on Human Resource Development (HRD) and improving the innovation of products and services. In the next part, these objectives will be divided into the activity level in order to analyze the degree of collaboration and the impact of each activity on the collaboration of the cluster.

IV.3.2.2. Activities in the cluster

This part focuses on the activities already carried out by the members of the cluster. The main objective of this part is to validate the information from the cluster committee about the joint activities carried out to improve Lampang's ceramic cluster. Moreover, the questionnaire aims to evaluate the percentage of participation and the impact of each activity on the ceramic cluster. The questionnaire is composed of 14 main activities of the ceramic cluster that were declared in the OM-1 worksheet, as shown in table IV.13.

	Activities	Participation	Impact
1	Find more alliance/member for the cluster	48 %	
2	Meeting or exchanging information/knowledge between members of the cluster	100 %	
3	Meeting or exchanging information/knowledge with support cluster	100 %	
4	Plan and solve problems together	70 %	
5	Aggregate demand to negotiate with suppliers, buyers and government agencies	45 %	
6	Share orders with the companies in the cluster	40 %	
7	Joint research and development programs in products and services	30 %	
8	Joint investment among the member of cluster	30 %	
9	Joint participation in exhibitions at domestic and international levels	80 %	
10	Invest in public relations together	100 %	
11	Find new market channels together	49.5 %	
12	Organize training courses or seminars for workers	80 %	
13	Visiting domestic and international markets	70 %	
14	Setup a company to sell products of the members	40 %	

Table IV.13: Degree of participation and impact of activities on the cluster

The table above presents the percentage of participation of the members in each activity which implies the degree of collaboration of the activity. It also represents the impact of the activity to the cluster development from the members' point of view. From the result in the table above, we can classify these activities into 4 categories as shown in table IV.14.

Degree \ Impact	Low Impact	High Impact
High degree of collaboration	- Find more alliance - Co-invest in public relation - Visiting the markets	- Share information with core cluster - Share information with support cluster - Join exhibitions - Organize seminars for workers
Low degree of collaboration	- Share orders with core cluster - Joint investment - Setup a company	- Solve problems together - Aggregate demand - Joint research - Find new marketing channels

Table IV.14: Four groups of activities in the ceramic cluster

The first group is the activity which has high impact and a high degree of collaboration in the ceramic cluster. The activities in this group are used as the main actions to develop the ceramic cluster. These activities confirmed the results from expectations and satisfaction of the SMEs in part II of the questionnaire. Thus, this study will consider these types of activities as the core activities of the industry cluster.

The second group is the activity which has a high impact on cluster development but still has a low degree of collaboration from the members. These activities required improvements by the cluster committee or CDA. Comparing with the results in the part IV.3.2.1, improving the collaboration in these activities will increase the satisfaction of cluster members. We will also take these activities into account as a part of the requirements for the knowledge system.

The third group is the activity which has low impact but a high degree of collaboration. These activities have usually been done in order to improve the collaboration of the cluster. They may not give direct impact to the core business of the factory, but may help to sustain the collaboration of the cluster and will indirectly impact other activities.

The forth group is the activity which has low impact and a low degree of collaboration. These activities have been done by the small group of companies in the cluster. Although some activities will give direct impact on companies, there are many specific constraints in order to achieve the goal of collaboration. Thus, these activities are not considered as important activities for developing the ceramic cluster.

Hence, the proposed knowledge system for SMEs cluster will adopt the activities in the first and second groups as hard requirements and the activities in the third group as the soft requirements of the system. The analysis in parts I and II of the questionnaire implied the characteristic of collaboration in the Lampang ceramic cluster in terms of activity. This information will support the knowledge engineer in the design level of the proposed methodology, which will be explained at the end of this chapter.

IV.3.2.3. Willingness to share information

The objective of this part is to comprehend the information and knowledge sharing model of the cluster, which will help us in the designing the collaboration service of the KMS. This part attempts to answer the questions about *what kinds of knowledge are companies are willing to share in the cluster and what are the conditions of sharing*, which is one of our research questions. This part of the questionnaire will help us to examine the

willingness to share information and knowledge within the cluster. From the in-depth interviews, we realized that the cluster tends to share more complex knowledge within the cluster than outside. Thus, we designed the questionnaire by using the taxonomy of knowledge which is defined in chapter 2 (see more detail in table II.3). The level of networking is also concerns as the conditions of sharing i.e. anonymous level (sharing to outside the cluster), cluster level (sharing to support cluster) and core cluster level (sharing to core cluster member). The results of analysis are represented in the following table.

Knowledge Taxonomy	Examples	% of the willingness to share		
		Anonymous Level	Cluster Level	Core Cluster Level
Know-Who	Contact information e.g. address, e-mail	100	100	100
Know-When	When will the seminar take place?	84	100	100
Know-Where	Where is the international ceramic fair?	84	100	100
Know-What	What is the ceramic trend this year?	76	90	100
Know-How	How to solve ceramic problems?	30	82	92
Know-With	How this problem relates to another problem?	30	78	92
Know-Why	Why does this problem occur?	30	86	92

Table IV.15: Willingness to share information among cluster members

The results from analysis confirm our hypothesis that cluster members are willing to share their different types of knowledge in the different levels of the networking. The condition of knowledge sharing in this cluster is the "*level of trust*" which is mentioned in OM-2 worksheet. The level of trust in the network tends to have an effect on the complexity of shared knowledge. From the table, we can see that all members are willing to share know-who knowledge (which is the least complex knowledge) to anyone inside and outside the cluster. However, about one-fourth of members seem to be unwilling to share more complex knowledge (know-when, know-where and know-what) to anonymous outside the cluster. These types of knowledge concerned the opportunities in the ceramic industry such as where to get them, when to access them and the repository of the ceramic industry. The last groups of knowledge i.e. know-how, know-with and know-why tend to be shared primarily in the core cluster level and some in the cluster level. This group of knowledge concerns problem solving knowledge in the ceramic cluster.

In addition, members of the cluster claimed that some of these types of knowledge which involved proprietary knowledge (which may be called 'business secrets') may not be able to be shared even in the core cluster level, because they could affect the core competency of the enterprise. One example given was a list of clients of the enterprise.

Although the list of clients is know-who knowledge which is claimed can be shared to anonymous parties, this knowledge creates competitiveness in the enterprise. However, they can be shared under very specific conditions, such as exchanging proprietary knowledge between the strategic partners in the same supply chain, or sharing business secrets such as financial data to banks or government agencies. Thus, this study will consider that this level of knowledge can be shared under specific conditions, and the topic will not be taken into account in the KMS.

From the results of the analysis, we proposed the structure of knowledge sharing in the ceramic cluster called “info-structure”. The info-structure comprise four levels of information: contact information (global level), opportunity (cluster level), problem solving (CoP level) and business secrets (company level). These levels involved with different types of knowledge can be represented in figure IV.7.

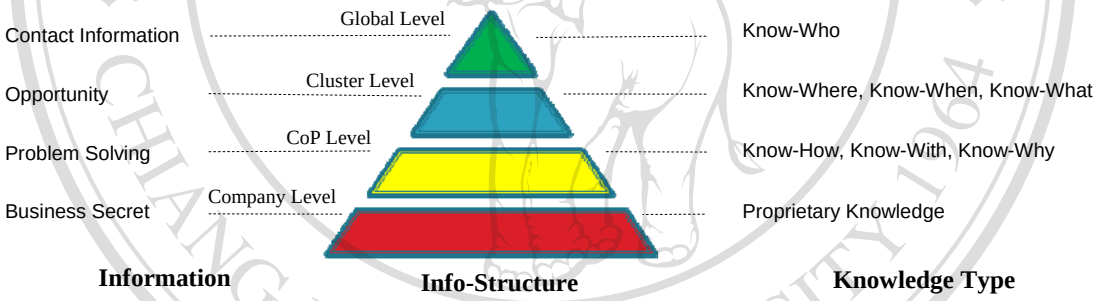


Figure IV.7: Info-structure of knowledge sharing in the industry cluster

This info-structure will be considered in our KMS in terms of characteristics of shared information in the cluster. Moreover, this could be used for designing authentication level of users for accessing knowledge/information in each level of the system. This will assure the experts that their knowledge will be stored in the right place for the right user. In the next part, we will analyze present situation of collaboration of the ceramic cluster.

IV.3.2.4. Characteristics of collaboration in the industry cluster

This part aims at analyzing the present situation of collaboration of the ceramic cluster. The criteria for analyzing are adapted from 20 success factors of collaboration [Bruce 07]. These factors are separated into 6 groups: environment, membership characteristic, process and structure, communication, purpose, and resource. It also indicates whether the

characteristic of collaboration in the cluster is suitable and sustainable or not. The results of the analysis imply the present situation of collaboration in Lampang ceramic cluster which are showed as follows.

20 Key Success Factors for Collaboration		Disagree	Natural	Agree
Factors Related to the Environment				
1. A history of collaboration or cooperation in the community.	69.17 %			
2. The collaborative group is seen as a legitimate leader in the community.	86.67 %			
3. A favorable political and social climate.	85.83 %			
Factors Related to Membership Characteristics				
4. Mutual respect, understanding, and trust among members and their respective organizatio	89.17 %			
5. An appropriate cross section of members.	85.00 %			
6. Members see collaboration in their own interest.	96.67 %			
7. The ability to compromise.	91.67 %			
Factors Related to Process and Structure				
8. Members share a stake in process and outcome	90.00 %			
9. Multiple layers of participation.	95.00 %			
10. Flexibility in both structure and methods.	91.67 %			
11. Development of clear roles and policy guidelines.	72.50 %			
12. Adaptability of the collaborative group to sustain itself in the midst of changes.	91.67 %			
13. An appropriate pace of development.	88.33 %			
Factors Related to Communication				
14. Open and frequent communication.	78.20 %			
15. Established informal and formal communication links.	96.67 %			
Factors Related to Purpose				
16. Clear attainable and realistic goals and objectives that are communicated to the partners.	96.67 %			
17. Shared vision.	93.33 %			
18. Unique purpose.	96.67 %			
Factors Related to Resources				
19. Sufficient funds, staff, materials, and time.	62.00 %			
20. Skilled leadership.	85.83 %			

Table IV.16: Characteristic of collaboration in the ceramic cluster

The result from the table above implies that the members of this cluster agreed that the collaboration of the cluster is in good condition. However, we could see some weak points which will be described as follows:

- The members agree that this collaboration is quite new to this industry. The average duration of membership in this cluster is only 3.23 years. This might affect some activities of the cluster in terms of experience. However, they do not feel that this factor will affect their collaboration in the long term.
- Another weak point is the lack of clear roles and policy guidelines of the cluster. Most members are still confused about the future roles and guidelines of the cluster. Most activities within the cluster are initiated by local or central government. In addition,

this cluster is in the newly developing stage. The sharing of vision and information from the cluster committee to members is absolutely vital.

- The weak point in terms of communication within the cluster is the lack of open and frequent communication. This disadvantage has a consensus of opinion among members that the collaboration needs to be more open and more frequent. At current situation, the Lampang ceramic cluster organizes official monthly meetings with the cluster committee. However, only 15-20 members participate in the meeting. The members who did not attend the cluster meeting would receive information from the cluster committee from time to time. Improving this flaw may also amend the weak point about the lack of clear vision mentioned earlier.
- The last disadvantage shown by the analysis is the lack of sufficient funds, staff, material, and time to collaborate in the cluster. The benefits from collaboration in the cluster may not be promptly financial, but are actually opportunities to develop the businesses. Also, it should be noted that there is no permanent support from any government agency for the collaboration. Government support was given to the project; however, cluster members agree that the unstable nature of the support from government may be the cause of unsustainable collaboration.

In conclusion, we could see that the environmental factors are suitable for the collaboration. Most of the members agreed to develop the collaboration of the cluster. The process and structure of the cluster are flexible and support the development. Also, the members have a consensus on the vision and purpose of the collaboration. However, there are two main points that require enhancement to create sustainable collaboration in the cluster: communication in the cluster and support in terms of resources from the government agencies and enterprises. Thus, this study will address the problem of communication among the members by proposing KMS to assist the cluster to have a better quality of communications among the member.

IV.4. Design Level

This level is a transition phase between the knowledge engineer who performed context and concept level, and the knowledge system developer who performs the implementation level. The main objective of this part is to convey the exact information from

previous levels to the implementation level in format of system requirements and specifications to the knowledge system developer. Moreover, these requirements and specifications are comparable to the protocol between the knowledge engineer and system developer. Thus, we have enlarged the CommonKADS design model by adopting the theory of software engineering in order to clarify the design model. Software engineering is always be used for transforming organizational requirements into software specifications and managing the software development project. For this reason, the design level in our model was composed of three parts: system architecture, scenario and specification. Each part aims at explicating the requirements of the ceramic cluster from different point of views which will be described in this section. Although the order of the processes is not significant, we recommend starting from the global view of the system (i.e. system architecture) to more specific view (i.e. system specification).

IV.4.1. System Architecture

From the review of the KMS architectures in chapter 2, the proposed KMS architecture for the industry cluster was adapted from three-tier KMS architecture [Chua 04] which identified three distinct services supported by knowledge management technologies: *knowledge*, *collaboration* and *presentation*. Each service is designed for solving particular problems in the industry cluster. In this part, we will specify the system architecture in the functional point of view. The consensus among the cluster members and knowledge engineer is essential in this model. Lack of agreement over the system architecture may leads to incorrect system specification. In our case study, the consensus of the ceramic cluster committee, CDA and the knowledge engineer is achieved. The proposed KMS architecture for the ceramic cluster was illustrated in the following figure.

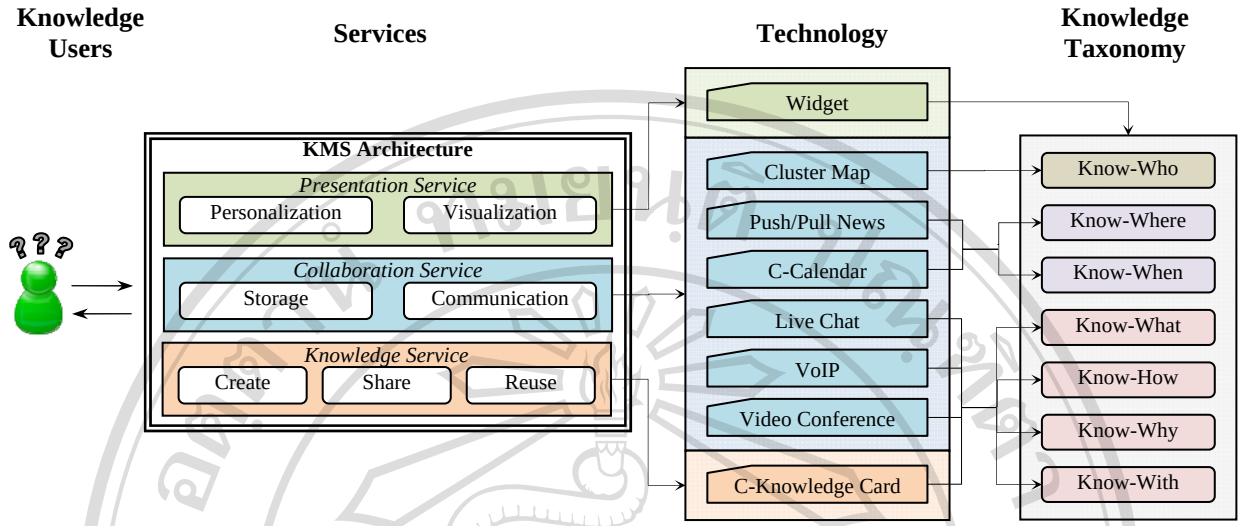


Figure IV.8: The functional view of the KMS architecture

In the KMS architecture, the *knowledge service* aims at supporting knowledge creation, sharing and reusing. These activities were facilitated by the concept of Collaborative Knowledge Card (CK-Card) which will be discussed in detail in the next chapter. This technology is proposed and developed in this research so members could mutually manage the knowledge of the cluster.

- The *collaboration service* aims at assisting the communication and information storing of the cluster. The collaborative technologies which support this service are a kind of information and communication technology over the internet. The simplest examples of the collaborative technologies are live chat and discussion board. However, selecting the appropriate technology should cover many issues:
  - the type of knowledge to be supported,
  - cluster's activities to be supported,
  - organizational context,
  - IT infrastructure,
  - basic knowledge of the members on particular technology, etc.

  Neglecting these issues could lead to failure in integrating the knowledge system with the cluster [Malhotra 04]. From the proposed architecture, various types of collaborative technologies are selected for supporting the sharing of different types of knowledge. For examples, the cluster map which is a kind of 'cluster's address book',

is proposed for sharing the knowledge about *know-who*. The Push/Pull News and collaborative calendar (c-calendar) are considered as tools for sharing the knowledge about *know-where* and *know-when*. Whereas live chat, Voice over Internet Protocol (VoIP) and video conference are integrated to support the communication among the cluster for exchanging more complex types of knowledge.

- Finally, the *presentation service* aims at personalizing and visualizing the amount of information and knowledge on the knowledge system to suit each knowledge user. In this study, we proposed the widget - which is a small client-side application - as a tool for customizing the user's view. This widget also allows knowledge users to acquiring the collaboration and knowledge services directly from their desktop.

In practice, the architecture model is very important to the KMS development project because it provides a common-view among the members of the cluster who are not IT professionals, and the knowledge engineer. The functional view of system architecture shows the available services which are the benefits that they would obtain from the system. Moreover, the services and technologies provided could be considered as the outline for defining the system specification. In this part, we gave a general idea about the KMS architecture and their functions. However, the details of each function will be described in detail in the next chapter.

IV.4.2. System Scenario

In order to create a scenario model for the knowledge system, the 4+1 model [Kruchten 95] is adopted for describing the scenario model of the system. The system scenario aims at illustrating the interaction between objects and processes in the ceramic cluster. As we depicted about the 4+1 model in chapter 3, four views (i.e. logical, development, process, and physical view) are required for designing the fifth view which is scenario view. These views were acquired from the system architecture and cluster interviews in the previous levels. In this chapter, we will present an example of scenario model with the UML use case diagram and sequence diagram. The complete system scenario model of the ceramic cluster can be found in Annex E.

The UML use case diagram was generated from the requirement of the system architecture. It presents a graphical overview of the functionality provided by the system in

terms of the actors, their goals (represented as *use cases*) and dependencies between those use cases. The use case diagram illustrated the actors (e.g. CDA, core cluster, support cluster, etc.) and their roles in the KMS.

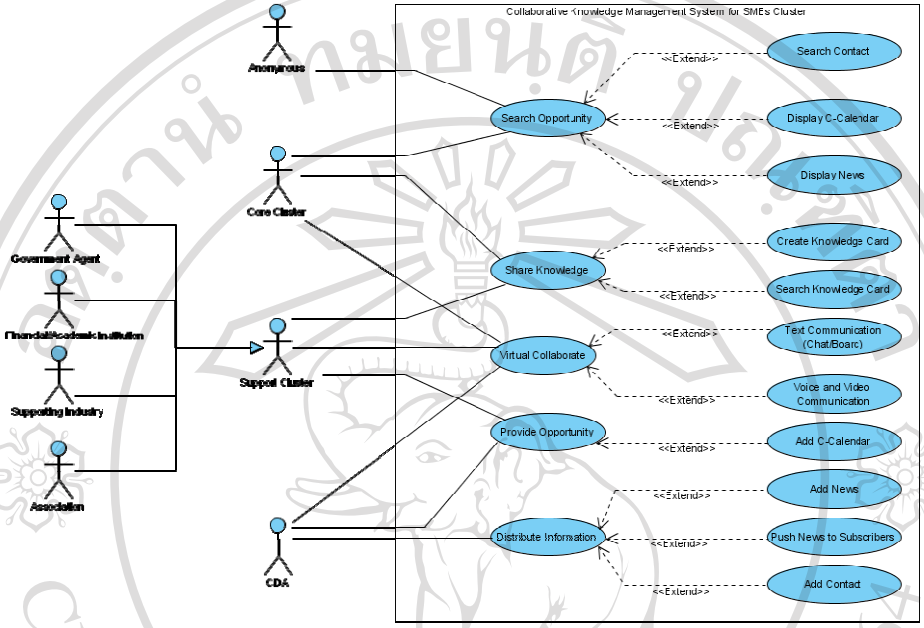


Figure IV.9: Use case diagram of the KMS and cluster members

The use case diagram above implies that there are four types of participants in the knowledge management system, the CDA, support cluster, core cluster and anonymous user. The goal of each type of user is different.

- The CDA acts as the administrator of the system. The roles of the CDA to the system are facilitating the virtual collaboration of the system, providing opportunities to members, and distributing information to all users.
- The core cluster is composed of the experts and knowledge users. This group of users is the primary actor of the KMS. It is allowed to access most of services on the system except the administration module.
- The support cluster is the knowledge provider, a representative of a government agency, financial and academic institution, supporting industry and/or association. The relationship among these participants is *generalization.* Thus, they have the same roles in the system i.e. sharing their knowledge, collaborating with the core cluster, and providing opportunities from their part to the ceramic cluster.

- The anonymous user is the participant who is not a stakeholder of the ceramic cluster, but is interested in the information from the cluster. Regarding the security of the system, an anonymous user could acquire some types of knowledge from system (i.e. know-who, know-where and know-when), but the domain knowledge may be prohibited. The extended use cases represent the function of the knowledge system that the participants could perform.

The sequence diagram extends the requirement of the system in terms of interaction among the actors. It shows how the processes operate with one another and in what order. This diagram was used to model the message, information or knowledge that exchanged from one actor to another in the system. In this part, we will demonstrate the sequence diagram for knowledge sharing in the ceramic cluster by using a case study of a *ceramic trade fair*, as shown in figure IV.10.

From our initial investigation into the knowledge sharing in the ceramic cluster, we found that there is no explicit system for sharing the knowledge in the cluster. Moreover, the procedure of knowledge acquisition is also vague. There is only a meeting of cluster members before the ceramic trade fair in order to prepare for the trading. Knowledge about the trade fair from the experienced members was shared to define the strategy of the exposition. However, the shared knowledge came from the memories of the experts and was mostly incomplete. Moreover, the members of the cluster admitted that the meeting after the trade fair was frequently neglected. Thus, this sequence diagram shows the scenario of the knowledge sharing in the cluster via the KMS.

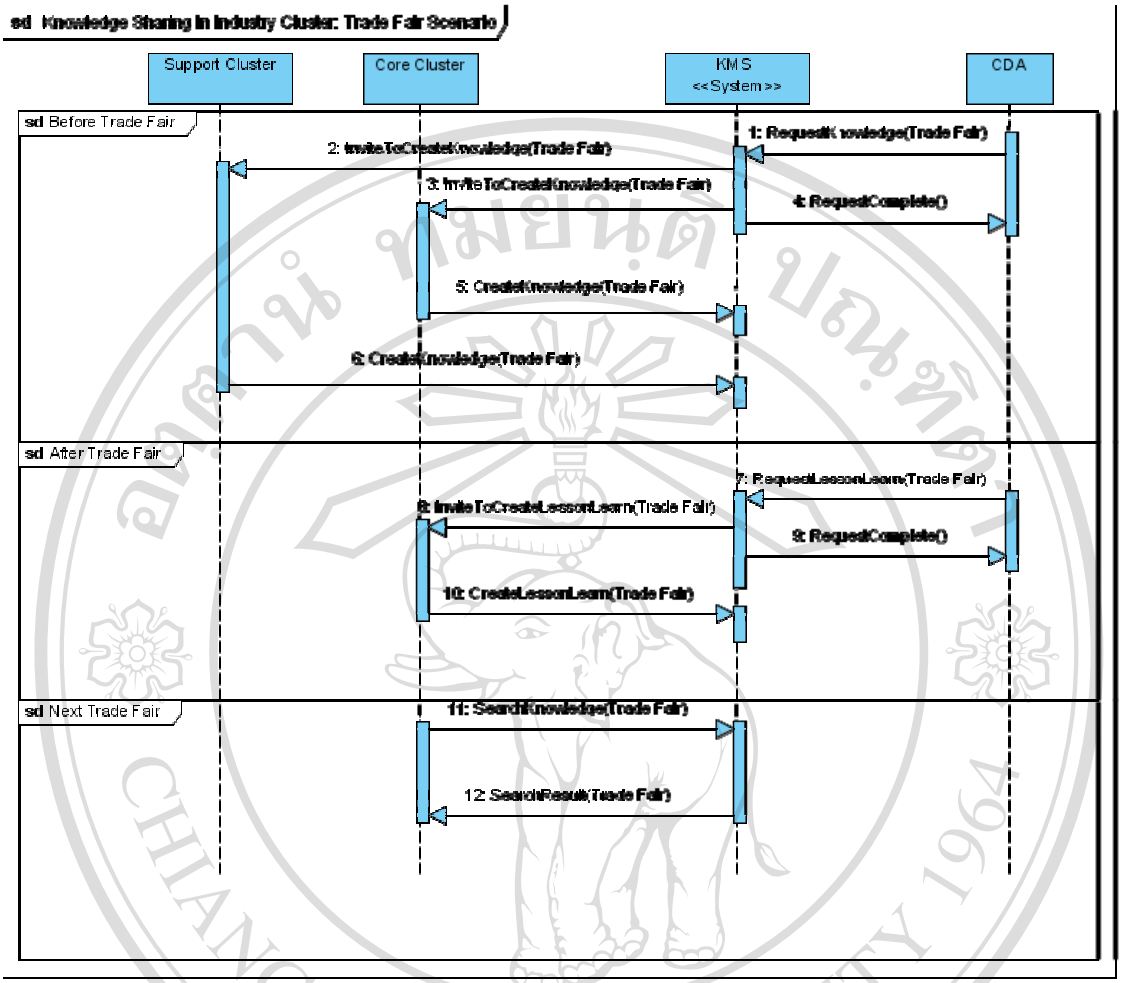


Figure IV.10: Sequence diagram of knowledge sharing activities

The sequence diagram above was divided into three periods: before the trade fair, after it, and next the trade fair. Assume that there is no knowledge about the ceramic trade fair in the knowledge system. The process was initiated by the CDA sending a request to the KMS for inviting members to share knowledge about "*trade fair*" via KMS. The invitation message will be sent to all members in the ceramic cluster by the system. Then, the CDA receives a message from the KMS to inform that the invitation is completed. As soon as the members have read the message from CDA, the experts or experienced members could access to the KMS via the link provided in the message. They can jointly create the knowledge card about the ceramic trade fair, similar to the wiki concept. Hence, a new knowledge card about the ceramic trade fair was created and ready to be acquired by the knowledge users interested in contributing to the ceramic trade fair in the future.

After the ceramic trade fair, the CDA sent another invitation to the cluster members who participated in the exhibition to share their experience and knowledge about it. On this occasion, the experienced members could share their knowledge, different points of view and lessons learned warnings, best practice, etc. This new knowledge will be appended in order to enlarge the knowledge of the ceramic trade fair. These knowledge maps will be stored in the KMS and await retrieval by the knowledge users in the next trade fair. At this point, we already have architecture and the views of the system which is a kind of system requirements from the ceramic cluster. However, these requirements are in the format of diagrams, which are not precise and unsuitable for the system development. Therefore, the next section will address the transformation of these diagrams into the explicit form to reduce ambiguity.

IV.4.2.1. System Specification

Creating the system specification is the fundamental of software engineering theory, known as System Requirement Specification (SRS). It is not only the medium communication between the system designer and system developer but also the guideline for software development project. In this chapter, we will present a these specification in brief. The full details of system specification could be found in Annex C. The SRS approach comprises five specification documents: requirement, function, design, system and test.

The *Requirement Specification* (RS) of our knowledge system is elicited from the analysis from the previous models and the proposed system architecture. The table below briefly presents a list of requirements for developing the KMS for a ceramic cluster.

RS-1	Support Knowledge Creation	
RS-1.1	Provide opportunity	*(Refer to FS-1.2 and FS-5.3)*
RS-1.2	Create knowledge card	*(Refer to FS-2.1)*
RS-1.3	Add contact	*(Refer to FS-1.1)*
RS-2	Support Knowledge Sharing	
RS-2.1	Push/Pull news system	*(Refer to FS-4)*
RS-2.2	Collaborative calendar system	*(Refer to FS-5.1 and FS-5.2)*
RS-2.3	Display collaborative knowledge card	*(Refer to FS-2.1 and FS-2.2)*
RS-2.4	Display cluster map	*(Refer to FS-3.1)*
RS-3	Support Knowledge Reuse	
RS-3.1	Search opportunity	*(Refer to FS-4, FS-5.1 and FS-5.2)*
RS-3.2	Search knowledge card	*(Refer to FS-2.2 and FS-10)*
RS-3.3	Search contact	*(Refer to FS-3.2)*
RS-4	Support information storage	*(Refer to FS-1)*
RS-5	Support Communication	
RS-5.1	Text communication	*(Refer to FS-6)*
RS-5.2	Voice and video communication	*(Refer to FS-7)*
RS-5.3	Support mobile device integration	*(Refer to FS-8)*
RS-6	Support Users' Personalization	*(Refer to FS-9.1, FS-9.2 and FS-9.3)*
RS-7	Support Users' Visualization	*(Refer to FS-9.4 and FS-9.5)*
PS-8	Support Knowledge System Management	*(Refer to FS-1)*

Table IV.17: Requirement specification

Functional Specification (FS) describes the needs by the system such as technique, material or service, which is referred by the requirement specification. This type of specification helps avoid duplication and inconsistencies, allow for accurate estimates of necessary work and resources. Moreover, it also helps for verifying that all the hard requirements of the organization are supported in the system. The verification can be done by linking the requirements from table IV.17 to the functional specification, as shown in table IV.18.

FS-1	Administrative Functions
FS-1.1	Manage User: *Cluster map manipulation*
FS-1.2	Manage News: *Push/Pull information*
FS-1.3	Manage Opportunity: *Collaborative calendar*
FS-1.4	Manage Virtual Collaboration: *Collaborative platform*
FS-2	Collaborative Knowledge *Card Functions*:
FS-2.1	Collaborative *Knowledge Card*
FS-2.2	Knowledge *Map Search*
FS-3	Cluster Map Functions: *Collaborative platform*
FS-3.1	Cluster Map Visualization
FS-3.2	Cluster Map Visualization
FS-4	Push/Pull News Functions: *Display news and events from the news database*
FS-5	Collaborative Calendar Functions: *Display list of events from c-calendar*
FS-5.1	Display Week calendar
FS-5.2	Display Month Calendar: *display on the calendar page*
FS-5.3	Add New Event to Calendar
FS-6	Live Chat Functions: *Allow user to send text message to online users*
FS-7	Video Conference Functions: *Allow user to create virtual meeting room*
FS-7.1	Broadcast audio to online users
FS-7.2	Broadcast video to online users
FS-7.3	Display online users in the conference room
FS-8	Voice over Internet Protocol (VoIP) Functions: Allow us to communicate to mobile devices
FS-8.1	Web-based VoIP Phone
FS-8.2	VoIP Server
FS-9	Widget Functions: *Allow user to personalize information from the KMS*
FS-9.1	Customizable knowledge map search
FS-9.2	Customizable news view
FS-9.3	Customizable calendar view
FS-9.4	Customizable cluster map view
FS-9.5	Customizable collaborative system
FS-10	Advanced Search Functions: *Allow user to search over the collaborative knowledge card system*
FS-10.1	Knowledge card search
FS-10.2	Wiki content search
FS-10.3	Forward inference search
FS-10.4	Backward inference search

Table IV.18: Functional specification

Design Specification (DS) shows the characteristic of the KMS structure. It aims at describing the detailed design of the system architecture. This type of specification also implies the level of access and features of the system that each level of user can manipulate. Each feature of the system should be referred to the requirement and function specifications in order to justify the purpose and technique used behind the feature. Our design specification was separated into 4 levels regarding the info-structure that was proposed in the collaboration

model. The descriptions of features and screens of each level of user are shown in the table IV.19.

DS-1 Area Level 0: Global Level
- DS-1.1 Top Menu Frame
  - *Home, Cluster Map, Calendar*
- DS-1.2 Main Content Frame
  - Portal *(Refer to RS-2:FS-3)*
  - Cluster Map *(Refer to RS-2:FS-3)*
  - Calendar *(Refer to RS-2:FS-5)*

DS-2 Area Level 1: Cluster Level
- DS-2.1 Top Menu Frame
  - *Home, Cluster Map, Calendar, Knowledge Card, Advanced Search*
- DS-2.2 Main Content Frame *(Extended from DS-1.2)*
  - Knowledge Card *(Refer to RS-1.2:FS-2)*
  - Advance Search *(Refer to RS-3.2:FS-10)*

DS-3 Area Level 2: CoP Level
- DS-3.1 Top Menu Frame
  - *Home, Cluster Map, Calendar, Knowledge Card, Advanced Search*
- DS-3.2 Main Content Frame *(Extended from DS-2.2)*
  - CoP Knowledge Card *(Refer to RS-2.3:FS-2)*
- DS-3.3 Widget
  - Search *(Refer to RS-6 and RS-7:FS-9.1)*
  - News *(Refer to RS-6:FS-9.2)*
  - Events *(Refer to RS-6:FS-9.3)*
  - Knowledge Card *(Refer to RS-7:FS2)*
  - Collaborative System *(Refer to RS-5.1 and RS-5.2:FS-7 and FS-8)*
  - VoIP Phone *(Refer to RS-5.3:FS-8)*

DS-4 Area Level 3: Administrator Level
- DS-4.1 Top Menu Frame
  - *Home, Cluster Map, Calendar, Knowledge Card, Advanced Search, Administrator Control Panel*
- DS-4.2 Main Content Frame (Extended from DS-3.2)
  - News Management *(Refer to RS-1.1:FS-1.2)*
  - Subscriber Management *(Refer to RS-1.1:FS-1.2)*
  - Cluster Map Management *(Refer to RS-1.3:FS-1.1)*
  - Collaborative Platform Management *(Refer to RS-8:FS-1.4)*

Table IV.19: Design specification

System Specification (SS) is the software, hardware, or resource requirements for implementing the developing system. It defines two sets of system requirement: recommendation and minimum. For our KMS, the system specification concerns server and client specifications. The system specification is shown in table IV.20.

SS-1 Hardware Specification
- SS-1.1 Server Specification
  - Processor: Intel Pentium4 3.0 GHz minimum
  - Memory (RAM): 2048 MB recommended
  - Etc.
- SS-1.2 Client Specification
  - Processor: Intel Pentium4 1.0 GHz minimum
  - Memory (RAM): 512 MB recommended

SS-3 Software Specification
- SS-3.1 Server Specification
  - SS-3.1.1 KMS Server (Linux distribution Debian)
    - Apache Web Server
    - MySQL
    - Red5 flash server
  - SS-3.1.2 VoIP Server (Linux distribution Debian)
    - Asterisk 1.4.0 or compatible
    - Festival TTS
    - Mbrola TTS Voice Pack
- SS-3.2 Client Specification
  - Microsoft Internet Explorer 6.0 or Mozilla Firefox 3.0
  - Adobe Flash Player 9.0 plug-in
  - Adobe AIR Installer

Table IV.20: System specification

Test Specification (TS) provides the detailed summary of what scenarios will be tested and how they will be tested for a given feature. Actually, there are several ways for testing the system. In this study, we propose three types of test specifications which are Demonstration Test (DT), Function Test (FT) and Operational Test (OT). The demonstration test aims at testing the system in each view of users who manipulate the system. The functional test intends to verify the correction of each function. Lastly, operational test is about assessment the knowledge system in the scenario view. The table V.21 shows an outline of functional test specification. The complete version can be found in Annex E.

Issue	Proper	Fair	Poor	Comment
FT-1 Administrative Functions				
…				
FT-2 Collaborative Knowledge Card Functions:				
…				
FT-3 Cluster Map Functions:				
…				
FT-4 Push/Pull News Functions				
…				
FT-5 Collaborative Calendar Functions:				
…				
FT-6 Live Chat Functions:				
…				
FT-7 Video Conference Functions				
…				
FT-8 Voice over Internet Protocol (VoIP) Functions				
…				
FT-9 Widget Functions				
…				
FT-10 Advanced Search Functions				
…				

Table IV.21: Functional test specification

From this point, all the requirements from the ceramic cluster were explicated and transformed into the system software specification and made ready for the knowledge system development. The results from this level would be handed over to the system developer in order to continue the system development and implementation process. The KMS for the ceramic cluster which is an outcome of the implementation level will be discussed in the next chapter.

IV.5. Conclusion

In summary, this chapter shows the obtained results from applying the model suite to Lampang's ceramic cluster in Thailand. It concentrates mainly on the first three levels of the model. The results from the context level are composed of three models: cluster, organization, and task model. The cluster model implies the physical network of the ceramic cluster. The organization model reveals the present organizational context of the ceramic cluster e.g. level of trust, structure, and knowledge sharing approach. And, the task model focuses on selecting the knowledge-intensive tasks and knowledge assets for our case study. In this level, we selected the "*finding market opportunity*" and its knowledge required as the instance. Then, the concept level is composed of two models (i.e. knowledge and collaboration model). The knowledge model aims at extracting the expert's knowledge and represent in the semantic knowledge map. The collaboration model concentrates on the approach for exchanging the information within the cluster. Finally, the design level aims at interpreting the requirements from previous levels into system architecture, scenarios, and specifications. The outcome from this chapter is the specification documents for developing the KMS for the ceramic cluster. These documents are also considered as the medium between knowledge engineer and system developer.