CHAPTER 2

LITERATURE REVIEW

This chapter reviews previous researches on five aspects: SMEs and industrial cluster, knowledge management and social network, knowledge creation theory, software development process and WEB 2.0 concept and technology. The first section begins with the prosperity of SMEs after the financial crisis period in Thailand. The concept of industrial cluster with respect to SMEs development is also discussed. The Lampang ceramic cluster in Thailand is the research case analysis. The second section reviews knowledge management that relates to the development of SMEs cluster. Social network is also discussed as it is an essential tool to improve knowledge sharing. The third section concentrates on knowledge creation process among members within clustering network. The spiral of knowledge that characterizes four processes (socialization, externalization, combination and internalization) is considered as new knowledge can be developed and expanded. The fourth section examines various concerns and techniques of social networking WEB 2.0. The main feature of WEB 2.0 is its efficient capability to promote community building as users can share, organize, discover and find people with common interest provided by the "pull" and "push" technologies. The final section focuses on the software development process in which the iterative process of spiral model is emphasized. Joint Application Development (JAD) as requirement elicitation technique is also reviewed.

2.1 SMEs and Industrial Cluster

The Small and Medium Enterprises (SMEs) has played a crucial role in the economic development of many countries (Beck, et al., 2005). In the recent years, with the global and fierce competition, in response to customer satisfaction requires firms to be more productive and competitive. The strength of new economies generally depends on the dynamism of enterprises that can response to market opportunities. However, due to the lack of both skilled workers and resources, SMEs are hardly innovated. The challenges to increase innovative capacity and create partnerships and networks are hence required. This means that the collective results from sharing resources (i.e. information, technology, and skills) among independent SMEs who specialize in each specific niche give more chances of productiveness and innovativeness. The concept of "industrial cluster" which is widely used in different industrial sectors in many countries gives successful evidences of improving organizational competitiveness (Meyer-Stamer et al., 2001). This section begins with the purpose of increasing better understandings of the Thai government's policy in promoting the SMEs sector. Especially after financial crash in 1997, SMEs are capable of adapting themselves to remain survive. SMEs are also one of the major sources that help recovering Thailand financial deficits. SMEs cluster in Thailand and are then discussed and analyzed. Industrial cluster concept and Lampang ceramic cluster are also discussed.

2.1.1 Contextualization of SMEs

SMEs cluster has been of considerable interest over the last decade as it associates with countries development. It is well-understood that the factor of globalization and free trade nowadays requires industrial firms to be competitive or otherwise to die. Burgelman et al. (2003) insisted that SMEs require innovative capacity of skills, expertise and knowledge to remain competitive. One of the problem issues that SMEs face is the competition against large-sized national and international companies. SMEs has been defined based on the number of several categories such as the employed workers, the output or sales amount, the annual turnover, etc. and differed in one country to another. Table 2.1 compares various definitions of SMEs based on the given agencies.

Table 2.1 Definition of SMEs based on the given agencies

Category	Agencies					
	European Union		OECD		DIP, Thailand	
	No. of workers	Annual turnover (M€)	No. of workers	Annual turnover (M€)	No. of workers	Annual turnover (MB)
Large	>250	>50	>500	>50	>250	>200
Medium	50-249	>10- 50	100-499	>10- 50	50-250	51-200
Small	10-49	>2 - 10	20-99	>2 - 10	10-49	0-50
Very Small	0-9	<=2	0-19	<=2	0-9	-

The studies showed that SMEs comprise over 95 percent of the economy with the average total employed workers of 65 percent labor forces in Asia-Pacific region (Kotelnikov, 2009; Mephokee, 2004). In the globalized economy where consumers from all over the world are becoming more quality-conscious, many manufacturers in the developed countries are capable of providing high-quality products at reasonable prices. However, in considering the nature of SMEs, there are a number of limitations of SMEs to satisfy consumer needs; for example, the difficulties in financial fund raising and the lack of skilled workers. To remain competitive in the market, therefore, SMEs must move away from its traditional low-cost-based strategy to customer-based focus.

Based on the cluster approach, SMEs are able to quickly obtain knowledge about marketing, technology, and business operations and compete in the global market through the combination of small-scale of competencies. Therefore, SMEs tend to transform into networking to assist them reaching their customers and partners. Morgan and Hunt (1994) suggested that to be an effective competitor in the global economy requires more cooperation and networking between firms, which will lead to establishing and maintaining competitive advantage in the market.

2.1.2 SMEs in Thailand

Started in the year of 1985, Thailand economy has expanded by the economic boom due to the Japanese Yen Plaza agreement invested in Southeast Asia. The internal factor of political conditions in Thailand is also more stable in compare with

surrounding countries such as Philippines, Indonesia, and China. This attractiveness of Thailand increased the rapid inflows of capital from Japan, Taiwan, Hong Kong, and Singapore in the late 80s and 90s (Daniere, 1991). However, the problem arose in 1996 from the imbalance payments of imported capital goods such as machinery and technology but decreased earnings from exports caused by the fluctuation of foreign exchange to Thai baht (Bell, 1996). It is precisely that these large imports of machinery and intermediate products are the root cause of such account deficit. This situation is perceived by many investors as the devalued of Peso of Mexico in 1994.

In order to quickly recover and improve country's trade balance, there are needs to increase domestic value added. As supporting industries, specialized SMEs that supply raw materials, parts and services needed for the productive activities of final goods will serve as a means to strengthen the industrial structure as a whole (Mukoyama, 1993). Since then, SMEs are recognized important and play a vital role to Thailand's national economy. Since that, Thai government promotes SMEs, by facilitating in technology and business management particularly clustering them with supporting industries, government agencies and educations. In 2004, the total number of enterprises in Thailand was 2,166,621 enterprises, of which 2,161,577 or 99.8 percent were SMEs. The total employed workers was 11,604,332 persons, of which 9,330,667 or 80.4 percent of worked for Small and Medium Enterprises (Office of Small and Medium Enterprises Promotion, 2005). SMEs are classified into industrial sector of 19%, service sector of 26%, wholesaler of 3%, retailer of 30% and others of 22%. However, the Thai industrial sector contributed the national GDP of 35.2 percent of THB 2,312.4 billion.

2.1.3 Industrial Cluster

Recent research on industrial cluster has made a contribution to the growth and competitiveness of the SMEs (Schmitz and Nadvi, 1999; OECD, 1999; Das et al., 2007). Cooperation and inter-firm linkage are among the interesting issues of many researchers. Nakizito and Darkoh (2002) reported that relationships among clustering firms in most developing countries are limited as compared to the industrialized countries. The attempts to develop proper KMS that promote communication and knowledge sharing among members are discussed (Sureephong et al., 2007). However, to guarantee the high efficiency and effectiveness of KMS is still a debate. Social network and virtual communities are among of interesting issues in cluster (Jeong and Lee, 2006). The next sub-sections review the concept of industrial cluster. The SMEs cluster in Thailand and Lampang ceramic cluster is then summarized and discussed.

2.1.3.1 Cluster Concept

The concept of regional cluster was popularized after a well-known book "The Competitiveness Advantage of Nations" by Michael Porter has been published since 1990. Porter defined cluster as "proximate groups of inter-linked core firms, suppliers, services providers, related company sectors, training institutions and other supporting agencies of particular industry within a local region" (Porter, 1990). These inter-links generate what so-called external economies such as an emergence of specialized suppliers, a pool of skilled employees, and a shared value of information

and knowledge (Rosenfeld, 1996; 1997). Different perspective of the cluster approach focuses on the linkage and interdependencies among members along the value chain process so that horizontal cluster and vertical cluster are defined (Bell and Albu, 1999). Horizontal clusters or downstream are typically defined by the similarity of the firms' products. Examples are industries that share a pool of resources such as technology, labor skills and a common market. Vertical clusters or upstream are linked industries in the supply chain or the flows of materials and goods through buyer-seller relationships. A cluster's boundary is identified by the linkages and complementarities across industries and institutions that are accounted to competitive issues. Therefore, a number of companies in cluster are varied to the degree of competitive linkages.

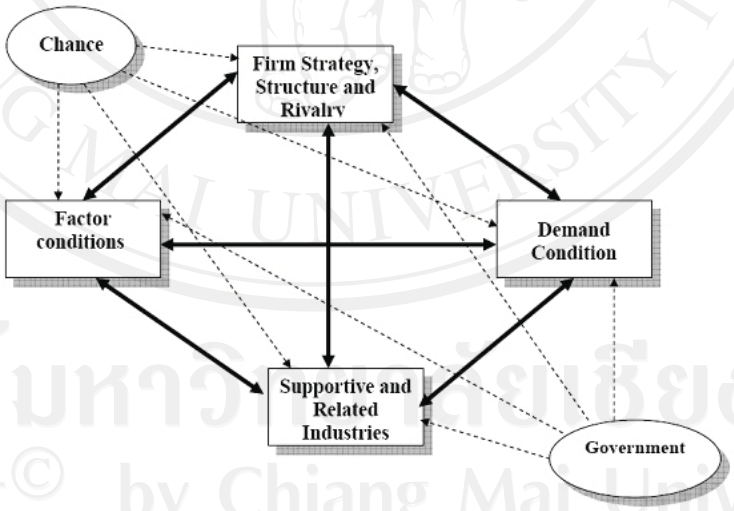


Figure 2.1 Porter's diamond model (Porter, 1998)

The key concept of cluster is related to Porter's analysis model of competitive advantages. He proposed that company competitive advantages are impacted by the four mutually key factors as depicted by Porter's Diamond Model in Figure 2.1.

These include "Factor Conditions", "Demand Conditions", "Supportive and Related Industries" and "firm strategy, structure and rivalry". The other two variables that affect all four components are "Chance" and "Government".

Factor conditions refer to the inputs used for production such as labor, land, natural resources, capital and infrastructure and skilled labor is one of the most important factors. For the demand condition, Porter argues that high quality and innovative products are demanded to be competitive. This can be supported by the closed proximity of upstream and downstream of related supporting industries so that information and ideas can be exchanged which in turn promotes innovations. Finally, the strategy, structure and rivalry are the dynamic conditions of firms. For example, a country will be more competitive in an industry whose key personnel hold positions that are considered prestigious. Management structure and styles are also affect competitiveness. Strong competition like Japan also stimulates innovation. Therefore, direct competition drives firms to work for increases in productivity and innovation. The role of government is to act as an accelerator or challenger by encouraging or pushing companies to raise their eagerness and move to higher competitive performance. This can be done through a number of supportive actions that will influence all four factors such as training the skilled workers, developing infrastructures and providing sources of funds. To sustain industry growth, therefore, the cluster approach is a practical way to maintain linkages of all 4 inter-linked factors.

The benefit of cluster can be classified into two main types: cooperation and competition. Cooperation occurs mostly in vertical, involving companies and related institutions. Combining skills and resources through collaborative arrangements can improve organizational competitiveness (Porter, 1998: 149). Examples of what so-called passive advantages include: higher chance of receiving orders, a pool of skilled employees and specialized suppliers, and sharing of information and knowledge. Cluster allows companies to focus on what they know or can do best and releases other things that they can't do well. Among all of the advantages of cluster, access to knowledge and know-how is the most important. Competition is driven by the productivity of linkage firms, more chances of innovation, and an emergence of new business. Many authors also classify cluster benefits into two types: hard benefit and soft benefit. Hard benefits include productivity improvement, faster and easier access to specialized services, and joint ventures. Soft benefits include building trust from inter-firm collaboration and learning from knowledge sharing and exchange.

The formation of cluster may be natural such as the textile/ fashion clusters in northern Italy, the IT cluster in Silicon Valley, or intentional by the mutual projects from the clustering firms (Bazan and Schmitz, 1997). Clusters also originate in both industrialized and developing countries, although there are more chances of cluster development in advanced economies. In many successful clusters such as the Italian industrial districts, inter-firm networking primarily emerged spontaneously as the result of the particular historical and social environment surrounding the industries. However, networking in most developing countries appears to be uncertain or uncommon (Brusco, 1990; Nadvi and Schmitz, 1994). This corresponds to recent

studies stating that the stage of cluster development depends on 2 dimensions: external and internal environments (Rosenfeld, 2002; Porter et. al., 2003). For the internal factors, the progress of the cluster is encouraged by mobilizing the business environment through active cooperation and internal activities (Enright, 1996). The 2009 industrial survey of the UNIDO reported that among the top 10 dynamic industrial clusters in developing countries, strong cluster networks between firms and intermediary agencies is the key driver for cluster dynamics (UNIDO, 2009).

2.1.3.2 Industrial Cluster in Thailand

Since August 1999 after the financial crisis, the SMEs cluster in Thailand had been selected as the national agenda in the ninth national economic and social development plan. Under the project titled "Industrial Cluster", Department of Industrial Promotion (DIP) tried to stimulate SMEs to see the significance and benefits of industrial cluster. By linking core industries to upstream and downstream sectors, the competitiveness of industrial firms was therefore developed and prosperous. The study of cluster in Thailand was assigned and started by the National Economic and Social Development Board (NESDB) in the same year. Based on Porter's model, the final report of Thailand Cluster Mapping in the manufacturing and service sectors investigated has been proposed by Kenan Institute Asia (KIAsia, 2006). Three aspects of cluster including location, linkage, and commonality are considered in the survey methodology. The preliminary result of survey analysis revealed 60 interested clusters. Focus group interview and SWOT analysis are used in the second survey. Porter's diamond model factors are considered for the creation

of the cluster map. Final result has shown that there are 20 potential clusters and ceramic cluster in Lampang is ranked number 7 with the average total score of 53.33.

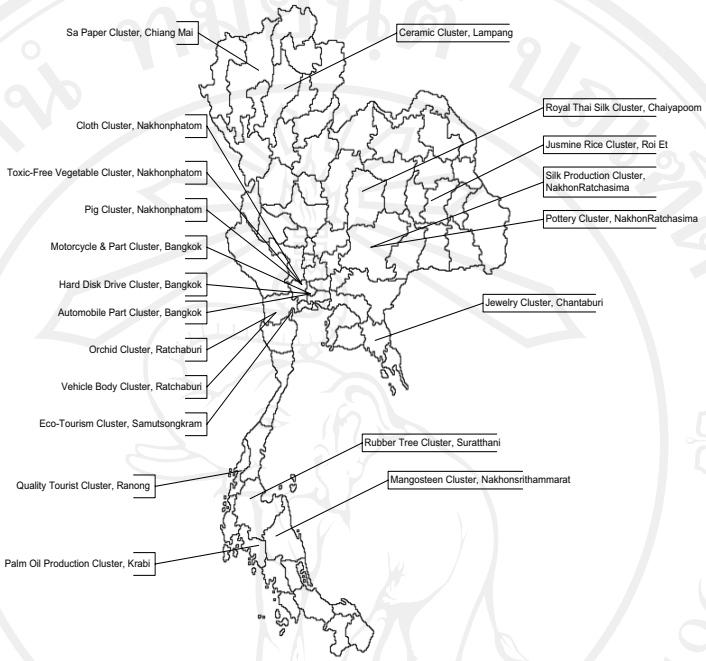


Figure 2.2 Twenty high potential clusters in Thailand

Table 2.2 Export amount of Thailand ceramic product during 2004-2008

(Customer Department, 2008)

Product Category	Export Amount (Million Baht)				
	2004	2005	2006	2007	2008 (Jan-Nov)
Floor Tile, Wall Tile and Mosaic	2902	3446.3	4243.3	3880.9	3103.3
Sanitary	4198	3818	4441.4	4621.1	4144.6
Insulator	781.7	705.8	700.2	888.1	659
Souvenir and Decorative items	1487.1	1273.3	1304.8	1077.5	1010.4
Tableware	7841.1	7492.6	7243.8	6557.4	5475
Total	17209.9	16736	17933.5	17025	14392.3

Figure 2.2 shows the geographical location of 20 potential clusters in Thailand while Table 2.2 shows the export amounts of Thailand ceramic product during 2004-2008.

2.1.3.3 Ceramic Cluster in Lampang

Ceramic industry is one of the most important industries in Thailand for its strong effects to the regional and national economic growth. Not only an increasing number in labor force but also a large amount of sales within and outside country it contributed. Most of the ceramic industries are located in the area closed to the sources of raw materials such as Ratchaburi, Saraburi, Lampang, and Chiang Mai provinces. For the whole industry, there are about 600 ceramic firms with more than 50,000 of labor forces around the country. The total export amount of ceramic products is more than 20,000 million baht each year. About 1/3 of the rough total 600 firms are located in the northern part of Thailand especially the Lampang province. As its location is closed to the sources of lignite and kaolin (white clay), the ceramics industry is mostly dynamic in terms of number of firms, job rotation and full range of supply chain services.

History of ceramic in Lampang has originated since 1947 by three Chinese immigrants then living in Bangkok became aware of the white clay source in the Jae Hom district in Lampang. At the beginning stage, raw material of white clay was used to produce sharpening stones. The first ceramic factory in Lampang was established in 1957 to produce the chicken painting bowls (called “chicken bowl”)

which became the trade mark of Lampang ceramic industry. Due to the low quality, the Thai government started to support the Lampang ceramic in 1967 by giving advice on knowledge on production and marketing to the manufacturers. In 1974, 18 small firms formed a group of network ("club") to produce chicken bowl and few decorative items such as vase and pottery. The objective of the club was to meet and exchange information about marketing, price and material costs. Later in 1970, the ceramic industries adopted technology in manufacturing which is the turning point for some firms beginning to export. This technology is so called "new kiln technology" which replaces the former wood firing to the latter gas firing. The third and fourth national policy plans, from 1972 to 1981, placed more emphasis on export promotion and less on import substitution, compared with the two previous plans. The first product generation made for export was the blue and white pattern of various styles which is demanded in international markets. The industry boomed from 1987 to 1997 where new production and new design with good marketing policy serve a greater variety of markets, domestic and international. The number of tableware manufacturers increased rapidly.

Competition in exporting market started around the year of 1990 from Japan and Taiwan. At this time, the Thai government's industrial development policy created an agenda to support regional industries. Lampang ceramic was targeted for assistance in both productivity improvement and exports. During this time, a number of new SMEs increased, and large firms extended their business and improved quality to concentrate on export markets. Moreover, as a member of the World Trade Organization (WTO) agreement and ASEAN Free Trade Agreement (AFTA),

Thailand has signed the agreement of trade tariffs on ceramic products. This era was a hard time for the industry from economy crisis during 1998 to 2000. The crisis hurt the railings and tiles manufacturers serving to domestic markets. Many of them went bankrupt, and others were reduced in size. The devaluation of money also caused many medium to large firms that mainly export products to improve their brand and quality to compete in the global market since then.

Major ceramic products can be classified into two main types: traditional ceramics and new ceramics. Traditional products are commercial products used in household and office building while new advanced ceramic products can be used in the heavy environments such as high temperature and specific function like electronic parts. The traditional products can also be classified into 5 types including floor tile, wall tile and mosaic, sanitary, tableware, souvenir and decorative items, and insulator. Based on their capital sizes, Lampang ceramic firms can be classified into 3 types: large, medium and small. The investment is generally more than 100 million baht for large firm while the investments for medium and small firm are between 3-60 million and less than 2 million baht respectively. From the survey report of Lampang ceramic firms by the Social Research Institute, Chiang Mai University in 2004, there are 2 large firms, 33 medium firms, and 162 small firms. From the Lampang Industrial Center (LIC) report in 2008, there are 240 registered manufacturers of ceramic products. Tableware factories are about 40 percent of the whole industry. Nearby the ceramic firms are groups of suppliers and input agents such as clay, machinery, mould, chemicals and color, and gas. The speeches from the interview of a couple leaders of medium ceramic firms which almost all products export are as follows:

- "Product design, innovation and brand image are the key success factors for global competitiveness".

- "Industrial standards and the environmental concerns during manufacturing process and the final products must be certified".

- "Skilled workers with advanced technology and quality of raw materials have to be put in the government and firms' policies".

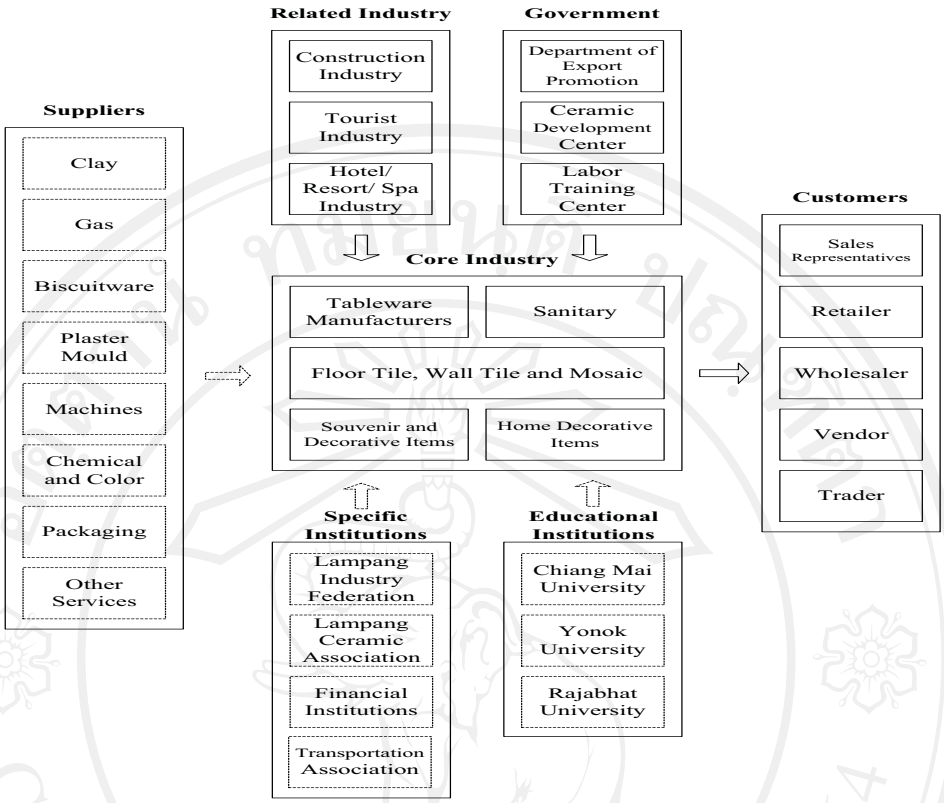
Table 2.3 Commercial value of Lampang ceramic products (in million baht)

(Office of Commercial Affair, Lampang, 2008)

Year	Commercial Value	Expansion Rate	Export Amount	Domestic Sales	
				Non-Vat	Vat
2001	1604.04	-	1044.29	47.30	512.45
2002	1745.88	8.84	1134.64	48.59	562.64
2003	2400.46	37.49	1299.35	84.67	1016.44
2004	2633.07	9.69	1469.63	94.01	1069.44
2005	2805.41	6.54	1161.84	1161.84	
2006	2675	-4.63	1103	1571	
2007	2629	-1.72	1161	1468	
2008	2777	5.63	1432	1344	

The total commercial value of Lampang ceramic products from 2001 to 2008 is shown in Table 2.3. The rate of market growth seems to be increased every year except in the year of 2006 and 2007 crisis. In an average, approximate value was about 2,000 million baht, of which 50 percent was export.

Lampang cluster development program was initiated in 2002 by the Industrial Finance Corporation of Thailand (IFCT). With the assistance from the United Nations Industrial Development Organization (UNIDO) to promote cluster in developing countries, ceramic industries in Lampang was selected as one of the promoting cluster project. Also in 2003 after Porter gave his speech on how to improve the country's international competitiveness, the government took an interest in supporting Lampang ceramic cluster project operated by IFCT. There are also public and private institutions supporting the ceramic cluster. These include government sectors, specific institutions, educational institutions, and related supporting industries. Examples are the Department of Industrial Promotion (DIP), the Ceramic Industries Development Center (CIDC), Lampang Ceramic Association (LCA), etc. A common goal was committed to improve industry's productivity, increase export amount and make Lampang ceramic to become the ceramic hub of Southeast Asia by 2012.



Note: Dashed Line Arrow - Loosely Collaborated

Solid Line Arrow - Tight Collaborated

Figure 2.3 The Lampang ceramic cluster map

Figure 2.3 depicts the Lampang ceramic cluster map. For its most significance role to the provincial GDP growth, a word of "ceramic" was put into the Lampang vision in 2003 of what so-called "Green, Clean, and Ceramic". Cluster activities are initiated through meetings, seminar workshops, and field trip to see the best practices of cluster in Thailand and abroad. The 5 groups of ceramic cluster are formed in 2004 namely Trust, Active, Believe, Harmonize, and Sira-Lampang. The goals within and among groups include joint purchase of raw materials, joint development of new products, sharing orders, and attendance at Bangkok International Gift and Bangkok International Household (BIG & BIH) Fair. However, the interviews with 3 leaders

of the 5 groups indicate that there are few changes of firms' performance. Attending trade fairs and sharing of basic information are most of the common benefits. Furthermore, some of the members have withdrawn from the group because they were not reluctant and successful in the cluster project. Only a little cooperation among clustering members still exists. In 2006, CeraCluster is initiated seemed to be the most active ceramic cluster. Becoming a limited company in 2007, CeraCluster sets its goal in product quality, standards, and trademark.

2.2 Knowledge Management

The current economy has forced organization to increase competitiveness by adding value to products and services with an enhanced use of technology. Such dynamic environments create risks and uncertainties so that companies have to react quickly by managing organizational knowledge (Paiva et al., 2002). Knowledge has become a vital role in business management (Toffler, 1990; Drucker, 1993). To deal with this, well-organized knowledge management is recognized as key source for the enterprises (Liebowitz, 1999). Moreover, competitive organizational knowledge is more concern with human experience or tacit knowledge than codify knowledge. Knowledge management process is important for new organizational knowledge creation. To support KM process for the enterprises, IT-based knowledge management systems is also discussed.

2.2.1 Knowledge and Knowledge Management Process

The growing interest in knowledge management has been affected by a number of factors and organizations need to react. Globalization and virtualization increase competition due to the transformation to knowledge-based economy which requires changes in organizational structures and processes (Hall, 2003). As organizations moves towards the knowledge-based business, their success will increasingly depend on how successful knowledge workers are capable of applying and managing knowledge productively and efficiently. The ability to identify and use key knowledge is a crucial factor for organizations to survive. Therefore, the organizations are facing the need to improve the management of their knowledge. Knowledge can be defined as "actionable information" (Schreiber, 1999) or justified belief (i.e. information) (Nonaka, 1995). What makes knowledge differ from information is that knowledge focuses on increasing firms' capacity by effective action while information is the flow of messages or meaning which may add to knowledge. In more details, knowledge can be classified into two types: tacit and explicit knowledge. Tacit knowledge is difficult to express since it is subjective and skill-based while explicit knowledge is easily exchanged and understandable (Nonaka, 1991). Nonaka and Takeuchi (1995) also suggested that continuous innovation is the product of new knowledge created from the conversion of tacit knowledge to explicit knowledge. Therefore, the basic assumption of KM is that organizations that can manage individual and organizational knowledge better than competitors will have more chances of gaining company competitiveness.

More specifically, knowledge management can be viewed as the systematic management of knowledge resources and processes in order to create value for an organization such as achieving process and product improvement, executive decision making and organizational adaptation and renewal (Earl, 2001; Wong and Aspinwall, 2004). Wan and Zhao (2007) gives the term of knowledge management as the management of process that govern the creation, dissemination, and utilization of knowledge by merging technologies, organizational structures and people to create the most effective learning, problem solving, and decision-making in an organization through communities of practice. This research focuses KM process by classifying its activities into 4 stages: creating, representing, sharing and utilizing knowledge.

Knowledge creation involves developing new content or replacing existing content within the organization's tacit and explicit knowledge (Pentland, 1995). Nonaka proposed the knowledge creation model to describe how the knowledge is transferred and created in the organization (Nonaka, 1995). Knowledge representation sometimes called knowledge codification is the transformation of knowledge into a form that is suitable for selection such as sound, picture, video, database, etc. Nonaka's knowledge conversion process is a good example. Knowledge sharing (known as knowledge transferring) is the process of disseminating individual knowledge throughout the organization via a specific medium. This is the most important stage since new knowledge which is the competitive knowledge will not be created without knowledge sharing process. Finally, knowledge utilization is the stage that provides the right knowledge to the right people at the right time. This

requires technology of storage and retrieval so that knowledge workers can access knowledge to complete their tasks.

For SMEs cluster, knowledge management is perceived as a practical tool in sustaining organizational success for improved efficiency and innovation. Handzic (1985) who addressed the issues of KM in SMEs concluded that KM needs to be integrated into strategic management of the organization. To achieve this, managers have to build KM awareness, determine its outcomes, audit and value knowledge resources, and develop and implement KM solutions. However, there is no exact KM solution that fits all SMEs. The early KM solution encouraged individuals to learn each other through verbal communication and social interactions (Senge, 1990). In practical, however, it is not quite successful for this softer KM approach. Sanchez (2004) suggested that technologies should be combined as IT-based knowledge management systems to support individuals beyond their limited boundaries. The process of KM in capturing, creating, using and transferring knowledge can then be enhanced intra and across organization which in turn, continuous improvement and knowledge creation can be promoted.

In the revolution of internet and web-based technologies, people can access information easily and globally, store them personally, and share them interactively. Networking and collaborative work is increasingly supported by internet and web applications, where organizational functions become more decentralized and globalize. In the last few years, the new concept of Web 2.0 which consists of social networking tools creates new features for networking and collaboration;

decentralization, openness, dynamic and user orientation (Tapiador, et al., 2006). As a result, Web 2.0 is recommended as an appropriate tool contributing to the development of efficient web-based applications for the storing, disseminating, and sharing of existing knowledge as well as the creation of new knowledge. One of the purposes of this research work is to support KM process in the industry cluster. The required KMS which is described in the next section is very important tools as it provide mechanism for knowledge workers to participate in the KM process efficiently.

2.2.2 Knowledge-Creating Company

The theory of knowledge-creating company was originated and developed based on the study of successful Japanese companies in 1986 by Nonaka and his colleague Takeuchi. Seven-Eleven Japan, Honda, and Canon companies are examples of their studies. Adding the human dimension into the western meaning of knowledge, they define knowledge as "a dynamic human process of justifying a personal belief toward the truth and/or embodying a technical skill through practice (Nonaka, 1994)". Two types of knowledge are classified: tacit knowledge (e.g. intuitions, individual's experience, or embodied technical kills) and explicit knowledge (i.e. a meaningful set of information expressed in words, numbers or diagrams). Tacit knowledge is hard to explain or communicate while explicit knowledge is easy to express and write down. Most organizations tend to focus their business management on the explicit knowledge and ignore people skills and experiences which are the most important knowledge for company's competitiveness.

2.2.2.1 Knowledge Conversion Process

There are two dimensions of knowledge creation process: one of which focuses on the transformation between tacit and explicit knowledge and another which aims at the levels of knowledge creating entities (individual, group, organizational, and inter-organizational). Four modes of knowledge conversion process is proposed and known as SECI model: socialization, externalization, combination, and internalization which is shown in Figure 2.4.

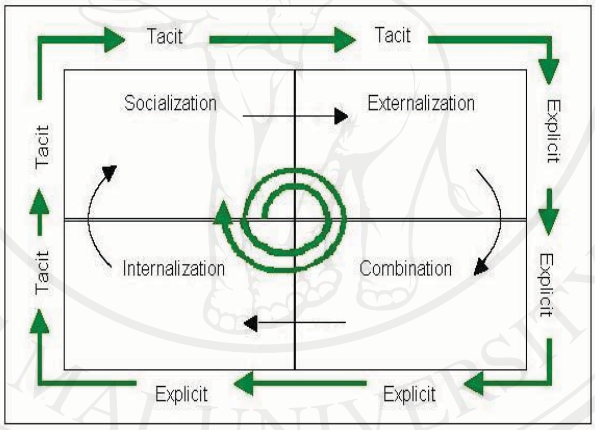


Figure 2.4 The SECI model of knowledge creation (Nonaka and Toyama, 2003)

Socialization

Socialization is a process of creating mutual tacit knowledge through shared experiences or social interaction. To make it successful, a "field" or "place" of interaction is required. The term socialization is used to emphasize that tacit knowledge is exchanged through joint activities such as being together, spending

time, joining in the same environment in both formal and informal rather than through written or verbal instructions (Nonaka and Konno, 1998). For example, new workers who work with old experienced workers may acquire skills through observation, imitation and practices. Discussion, criticism, and creative dialogue are also medium of sharing experience. Japanese companies often set up informal meetings outside the workplace where participants have discussion while drinking sake and having meals, thereby creating common tacit knowledge as well as increasing trust, care and commitment. This certain kind of environment is termed as "Ba" which can be virtual or physical spaces in Japanese context. In cluster, socialization may occur among product developers, customers, suppliers and cluster development agent (CDA) to share tacit knowledge for product improvement.

Externalization

Externalization is a process that relates to the expression and translation of tacit knowledge into explicit forms that can be easily understood by others. People are able to externalize their tacit knowledge through dialogue and sharing of perspectives, often via symbolic language. When tacit knowledge is made explicit, knowledge is crystallized and becomes the basis of new knowledge. Metaphor, analogies, concepts, or models are normally driving factors for externalization process. Metaphor is usually "deduced" from company's vision and slogan while the analogy and concept are "induced" from driving experiences and developed by team members. Example of metaphor is the "Automobile Evolution" of Honda City car, and later on the concept of "Tall Boy" emerges through an analogy (Nonaka, 1991). Information

from discussion and tacit knowledge sharing can bring to the concept of controlling firing temperature and clay quality specification control for the improvement of product development quality.

Combination

Combination is a process of assembling new and existing explicit knowledge into a systemic explicit knowledge. By linking several elements of explicit knowledge with newly-created explicit concept from externalization process makes new explicit more tangible. "Break down" concept, for example, is frequently used by middle manager to integrate company core concepts such as corporate vision, marketing concept and product concept into a new meaningful object. An archetype such as a set of specifications for a prototype of new product or a working model such as a new business procedure is example of the combination result. Combination activities include a wide range of procedures such as meetings, conversation, document exchange and analysis in both physical and virtual environments. Information technology plays a significant role in this process because it is quite beneficial using software to create, modify and even combine explicit knowledge among business functions and across organizational boundary. Groupware is one of the typical well-known software that is used in many businesses. A product prototype with its functionality comparing to the expected result such as percentage of product cracked is a good example of combination step in ceramic cluster.

Internalization

Internalization is a process of absorbing explicit knowledge into tacit knowledge through "learning by doing" or "practicing". Something that we repeatedly learn generally ends up with an insight. Experiences throughout the learning process are internalized into individuals' tacit knowledge and become shared mental models or technical know-how. For explicit to become tacit, conversion of verbal or diagram into documents, or oral stories and by reflecting upon them is helpful. Moreover, the technique of "re-experiencing" is also beneficial and supportive as one team experiences is useful for another team experience. Once tacit knowledge is accumulated at individual level, a new knowledge is created. For ceramic cluster, knowledge from testing product prototype in combination step may reveal that firing temperature control is less effect than controlling the clay material quality.

2.2.2.2 Spiral of Knowledge

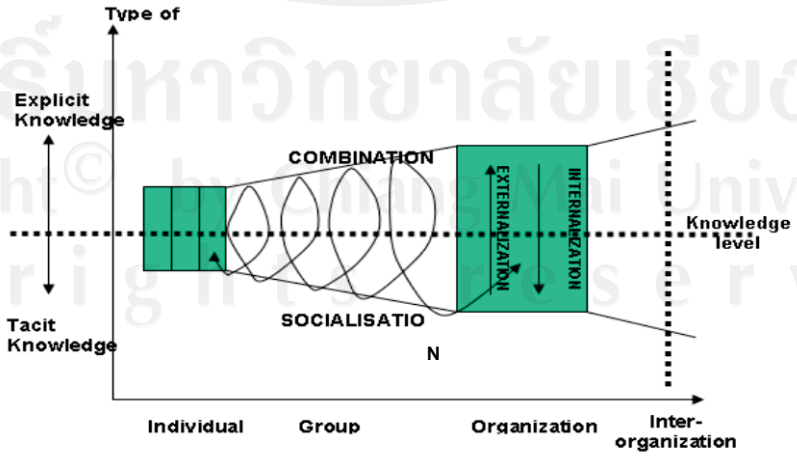


Figure 2.5 Spiral of organizational knowledge creation (Nonaka, 1994)

The spiral of knowledge as shown in Figure 2.5 is the movement through the four modes of knowledge conversion process and organizational knowledge is created. In general, the spiral starts from socialization and move along the SECI model. Different knowledge contents are generated along the four modes (sympathized, conceptual, systemic, and operational knowledge). The amplitude of knowledge contents becomes larger in scale as it moves up to the next loop of the SECI process or elevates the ontological levels (individual, group, organization, and inter-organization). In ceramic cluster, for example, sympathized knowledge about clay quality of cluster members' needs will become conceptual explicit knowledge about the ingredients' ratio of raw material through externalization process. In the combination stage, existing knowledge such as technologies are mixed with new conceptual knowledge creating a product prototype, known as systemic knowledge. The new product prototype is put into the operation process such as product burning to see the percentages of cracked items. The knowledge learned from the first spiral will be internalized to the cluster members so that the quality of clay for burning production will be improved in terms of give less percentage of cracked items in the next spiral.

Knowledge creation is one of the important factors which drive industry cluster development and growth. Without knowledge sharing among clustering members, SECI process will not complete its cycle. Through social interaction, technology and knowledge transfer occurs, therefore leading to the development and growth of clusters.

2.2.3 Knowledge Management and Cluster Dynamics

Current researches on industrial cluster in developing countries increasingly focus on the issues about the dynamism of clusters for its longer-term competitiveness (Bell and Albu, 1999). A number of common interests give emphasis on the "technological" aspects that are the drive force of dynamism. Many authors described cluster dynamics as an influencing mechanism of cluster development. Cluster dynamics depend on the ability of the members to manage interdependencies and to increase competitiveness by exchanging and creating new knowledge (Porter, 1998). This facilitates other players in the same cluster from accessing knowledge spillovers that contribute innovations (Cooke, 2002). In addition to formal interactions, social network plays an important role for the development of knowledge transfer. As it is connected by a group of informal relationships, there are better chances of information exchange and interactions from sharing of expertise, resources, and information. Traditional form of social network or community of practice (CoP) varies from friendships to face-to-face communities. As communication technology advances, a new form of online communities or vCoPs makes it possible to share and collaborate across time and space boundaries through the internet. The vCoPs has been recognized as a main tool of knowledge management (KM) to convert tacit knowledge into explicit knowledge.

The concept of KM on cluster dynamics is to bring participants together in the same place to share ideas and collaborate toward the desired outcome. By developing an effective knowledge management system (KMS), knowledge can be captured,

shared, and exchanged to promote new knowledge creation in cluster. This enables each player to optimize his/her efforts for the benefit of cluster. The KMS also support interactive communications between experts which are more concerned about tacit knowledge exchange in vCoPs. This paper emphasizes on vCoPs by providing virtual spaces of dynamic web to a group of people in cluster who share a concern, a set of problems and who deepen their knowledge and expertise to interact on a continuous basis. Static KMS is only effective at igniting new ideas or solving routine problems, however, dynamic KMS (DKMS) is continuously evolving system in which tacit knowledge can be accessed and built upon through interactions.

2.2.4 Knowledge Management System

Knowledge management system (KMS) is a set of Information Systems (IS) that are applied to manage organizational knowledge by supporting and enhancing the processes of knowledge creation, representation, sharing, and utilization (Alavi and Leidner, 2001). This requires the deployment of information and communication technologies (ICT) to support several activities concerning KM process such as virtual meeting, knowledge sharing via chat, blog or web board, etc. ICT is recognized as useful tools of KMS as it allows users to communicate and share anywhere and anytime. In addition to the ICT, people who involve in the specific KMS must be emphasized. Schreiber (1999) classified the KMS-related people into knowledge manager, knowledge engineer, knowledge provider, knowledge user and knowledge developer. All types of people can be grouped into three types: manager, user and developer which will be further used in the research methodology. Mangers

are people who address knowledge needs and make decision for development actions. Users are people who use knowledge and usually understand what knowledge they require from the KMS. Developers are people who develop the KMS. Current, the new trend of developers are teamwork. This means that all types of users must be involved in the analysis, design, and development of the KMS.

One of the key aspects concerning the KMS in this research is the design and development that shall meet the objective of individual clustering members. This will motivate them to use and share knowledge through the KMS in a sustainable way. In the industrial context especially in the developing countries, the dynamism of clusters which is the ability of members to manage linkages and relationships is the important key factor for organizational long-term competitiveness (Bell, 1999).

2.2.5 Knowledge Management Technology

Knowledge Management Technology (KMT) can be defined in several ways. However, most literatures focus on selection of technologies that contribute to KM solutions. To achieve this, selected technologies must be able to support all stages in the KM processes which vary from enterprises to enterprises. Depending on the policy and activities of KM process that members within the organizations and communities are committed. Table 2.4 shows few examples of the information technologies which are generally used to support the KM processes. The table shows the examples of common technologies that were used in many KM projects. However, for successful of KM solution, technologies is the only one part.

Organizational process and people in the organization are the two key enablers. Therefore, all the 3 components of KM must be worked together along the KM process and software development process.

Table 2.4 List of IT generally used in KM projects

Technology	Purpose	Create	Represent	Transfer	Utilize
Wiki Web [Nastase 08]	To make possible collaborative content management which allow user to create, share and modify the content collectively.			X	
Search Engine [Kim 07]	To store and to classify web pages according to their content and level of interest.				X
Electronic Document Management Systems [Dieng 00]	Providing facilities to support complete document management from the creation to the archiving.				X
Groupware [Coleman 99]	Supporting the efforts of teams and other paradigms which require people to work together, even though they may not actually be together, in either time or space. Groupware maximizes human interaction while minimizing technology interference.				X
Push/Pull Technology [Tiwana 03]	Push technology distribution and deliver knowledge to their audience after filtering it through highly customized filter. Requires a user to actively seek information when they need it. This system does not distract user by unwanted updates but requires user initiative.			X	X
Discussion Board [Yang 05]	Help users to request information and respond to the issue. It could be used as a tool for gathering solutions from different points of view.	X			

2.2.6 Social Network Theory

"The power of social network theory stems from its difference from traditional sociological studies, which assume that it is the attributes of individual actors -- whether they are friendly or unfriendly, smart or dumb, etc. -- that matter. Social network theory produces an alternate view, where the attributes of individuals are less important than their relationships and ties with other actors within the network. This approach has turned out to be useful for explaining many real-world phenomena, but

leaves less room for individual agency, the ability for individuals to influence their success". (Wikipedia)

Social network theory has been applied to the real business cases to examine how companies interact with each other, characterizing the many informal connections that link executives together, as well as associations and connections between individual employees at different companies. These networks provide ways for companies to gather information, increase competitiveness, and policies.

2.2.6.1 Social Network Concept

A social network is a social structure which connects several people. Each individual or organization usually ties to one another with various types of connections; (values, interests, habits, exchange of products etc.) (Barnes, 1954). Social network can be lose or tight. Social Network Theory (SNT) views social relationships in terms of nodes and ties. Nodes are the individual actors within the networks, and ties are the relationships between the actors. The term network refers to the set of all nodes, relationships and mapping of those relationships (Granovetter, 1973). A social network model includes five components (Wasserman and Faust, 1994):

(i) a set N of actors;

(ii) a collection L of links or ties that represent relationships between ordered pairs of actors;

(iii) a "sociograph" Gd consisting of nodes, which represent actors, and directed or undirected lines between the nodes, which represent the relations among actors;

(iv) a sociomatrix or adjacency matrix A, which has as many rows and columns as there are actors and where the elements xi,j record the relationships between actors i and j; and

(v) a characteristics matrix C, which has as many rows as there are actors and as many columns as there are attributes of interest. A social network then is defined by: S = { N, L Gd, A, C }.

The “actors” N in a social network can be anything that can be represented by nodes in a graph. In a supply chain network, for instance, the actors could be the producers, processors, assemblers, transporters, wholesalers, retailers, government agencies, or certified standards enterprises. The set L of “links or ties” in a social network represents the connections among pairs of actors. In a supply chain network this could be flows of material, flows of money, flows of product information or information required to carry out transactions. Beyond representing the flows in a supply chain network, links also reflect the relationships between core firms in the network, such as financial partnerships. “Relationships” between the actors in a network may be of many forms, but the graph theory is a common used model. Links may be simple and only indicate that a connection of a certain kind exists between actors. Directed links indicate the direction of a relationship, e.g. the direction of an information or product flow. Valued or weighted links also indicate the intensity or frequency of a relationship. Finally, actors may be connected by several relationships, each requiring a separate link.

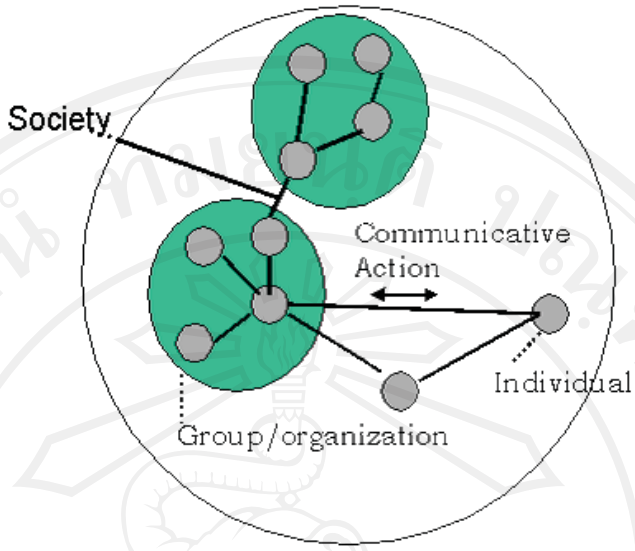


Figure 2.6 Conceptual model of a network society (Dijk, 2003)

Social network analysis (SNA) is the method used to examine how people or organizations interact with each other, characterizing the informal connections between people as well as connections between individual employees at different enterprises. These networks provide ways for actors to communicate, and share information and knowledge. Figure 2.6 shows the conceptual network model connecting individuals, groups, inter-organizations and societies. By visualizing and analyzing knowledge network, SNA can be applied to a wide range of business problems such as team building, human resource, sales and marketing and knowledge management and collaboration (Ehrlich and Carboni, 2005).

Social network is related to knowledge creation process. Social network facilitates the knowledge creation process because they define members' ''connectedness,'' which in turn directly affects the conditions of intellectual

collaboration and exchange process among members. For the dynamics of organization, Granovetter (1985) indicated that knowledge sharing often requires social processes and interactions because of the tacit nature of knowledge. This corresponds to knowledge conversion process proposed by Nonaka and his colleague where the exchange of tacit knowledge in the socialization depends on the social relation. Therefore, the study of social networks has become a major organizational focus on the development of communities where networked collaborations are the key to knowledge creation and sharing process.

2.2.6.2 Virtual Communities and Social Networks

Virtual communities are communities that adopt and integrate the advanced information and communication technologies into daily life at home, office or places to reach the connected economy via physical or wireless cable (Go¨tzl et al., 2002). It is a place where a group of people around the globe who have common interest to share and exchange. Virtual community is mostly topic-oriented. There is a wide range of practices in virtual communities varying from education, government, business and a number of online services including access to social environments, community services, business information, and e-commerce. Examples of large scale digital-governments are www.parliament.go.th for Thailand or www.whitehouse.gov for United States. “www.pantip.com” is also a good example of social virtual community. Commercial virtual communities are usually owned by profitable companies. Large scale commercial cities, such as eBay at www.ebay.com and United Parcel Service (UPS) at www.ups.com, are often referred to as commercial or

industrial portals. There are also non-profit organizations supporting virtual communities based on predefined goals and interests such as www.redcross.or.th of the Thai Red Cross Society or www.organdonate.in.th of the organ donation center. However, there are some disadvantages of virtual communities in term of decreasing the social or physical community. The community members thus might forget to learn about new interests.

Virtual communities commonly provide both profit and non-profit services and can enhance major social and economic advancements. Digital environments contribute to the increase of creativity and enable organizations, suppliers and customers to develop interaction and establish a variety of standards (Einemann and Paradiso, 2004). For example, the commercial banks provide many transactional services to customers and organizations such as inquiring account balance, depositing and transferring money and even bill payments. Virtual community and social network are quite used interchangeably. However, social network tends to be more "Open" than virtual community which is used in a common term. Social networks play an important role in business activities and economic development. We can search, add or remove any member from our social network. Pantip.com, YouTube, Myspace and Facebook, etc. are examples of social network. eBay is a good example of virtual community (virtual marketplace) and also represents social network web where millions of users worldwide buy and sell products, discuss the products, share common interests, get help and feedback from each other, and advertise the products. Figure 2.7 shows that a number of users access social network websites increase at a high percentage of growth.

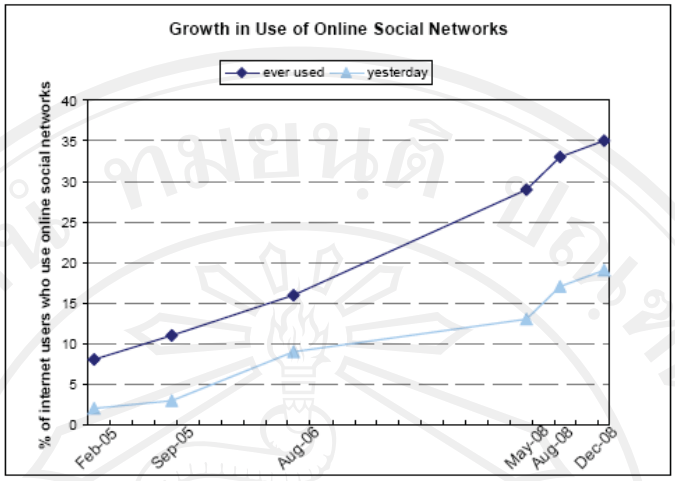


Figure 2.7 Growth in use of online social network

(http://www.taleo.com/blog/media/Online%20Social%20Networks.png: accessed: Oct 20, 2009)

Virtual communities and social network are fundamental conditions for industrial cluster development. Unless social interaction among members happens, collaborations and knowledge sharing will not succeed. As it is loosely connected diverse network, social communities create linkages between individuals and firms within and across organizational boundaries. Therefore, collaboration activities and knowledge sharing are disseminated through online applications.

2.2.6.3 Social Network Analysis

Social Network Analysis (SNA) is a sociological paradigm to analyze structural patterns of social relationships (Scott, 1991; Wasserman and Faust, 1994). It provides a set of methods and measures to identify, visualize, and analyze the informal personal networks within and between organizations. To model social networks, SNA employs ideas and methods from graph theory, algebra, and statistics. Thus, social network analysis provides a systematic method to identify, examine and support processes of knowledge sharing in social networks (Müller-Prothmann, 2006).

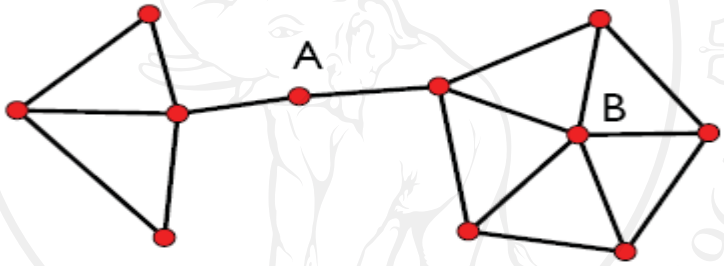


Figure 2.8 Example of social network relationship

Centrality is the common SNA measure which is the extent to which a person is in the center of a network. Central people have more influence in their network and tend to be more satisfied with their jobs than people who are less central. Measures of centrality include degree, betweenness and closeness. Degree centrality is a number of people attached to each person. Betweenness centrality indicates the extent to which a node lies on the shortest path between every other pair of nodes. Actor with high betweenness has great influence over what flows in the network indicating important links. Closeness centrality is the number of links that a person must go through in order to reach everyone else in the network. Figure 2.8 gives example of

social network relationship. B has high degree centrality while A has high betweenness centrality. The analysis of social network will be discussed in the next section using social network software.

SNA has become an important tool for organization to understand the connection between patterns of interactions and business outcomes such as job performance, job satisfaction, adoption of new ideas or technologies, likelihood of information getting shared, and creation of new ideas. SNA can also help support knowledge sharing such as identification of personal expertise and knowledge and investigate the transfer of tacit knowledge. From the perspective of KM, therefore social network analysis helps identify basic network properties, positions of network members, characteristics of relations, cohesive sub-groups, and bottlenecks of knowledge flows. The application of SNA for the examination of organizational knowledge sharing is divided into seven steps (Müller-Prothmann, 2007):

1. defining objectives and the scope of analysis (knowledge domain)
2. developing the survey methodology and designing the questionnaire
3. identifying the network members
4. collecting the survey data
5. analyzing the data through formal methods of social network analysis
6. interpreting the results of analysis
7. designing interventions and taking actions

2.2.6.4 Social Network and Knowledge Management

The purpose of knowledge management is to formalize, store and transfer knowledge among individuals or communities of practices. Therefore, by visualizing social network in an organization, there are more chances for finding who knows what. Traditionally, social networks grow by themselves in an informal way through collaborations which is the starting point of KM. Nowadays one of the broad KM tools is to support personal contacts and interactions in the use of social networks which is most likely facilitates the collaborative activities between people in the organization. Prusak (2002) mentioned that "Knowledge flows along existing pathways in organizations. If we want to understand how to improve the flow of knowledge, we need to understand those pathways". The effectiveness of an organization – innovation, productivity relies on the strength of the relationships of its people. The sum of the relationships among people, norms, values and shared meaning in an organization is often called social capital which is important to the success of an organization. In fact, all of these lie to some extent on the quality of the relationships among their stakeholders. SNA provides a view into the network of relationships that gives knowledge managers leverage to:

- Improve the flow of knowledge and information;
- Acknowledge the thought leaders and key information brokers (and bottlenecks);
- Target opportunities where increased knowledge flow will have the most impact on your bottom line.

2.2.6.5 Social Network Software

To analyze social network is not an easy task especially for the large network data. Data analysis of social networks needs coding of the collected data and application of formal methods. It consists of nodes, representing individual network members, and ties, representing the connections between the members (relations). Most social network software allows relational network data to be entered into a matrix. Some additional software tools are provided for converting data across file formats; for instance a Pajek add-on allows Excel or text files to be converted into a Pajek-readable format. Huisman and van Dujin (2005) compare and rank the score of selected SNA software as shown in Table 2.5 UCINET is selected for the research analysis due to its user-friendliness, shareware, and low requirement of hardware specification.

Table 2.5 Scores for selected SNA software

	Fuctionality					Support		
	Data	Visual-ization	Descript-ion	Proces-sing	Stat-istics	Manual	Help	User-friendliness
MultiNet	+ -	+	+ -	+	+ -	+ -	++	+
NetMiner	++	++	++	++	+ -	+	+	++
Pajek	+	++	+	++	0	-	0	+ -
StOCNET	+ -	0	+ -	0	++	+	+	+
STRUCTURE	-	0	+ -	++	+	++	0	+ -
UCINET	++	+(1)	++	++	+ -	+	+	+

(1) The programm NetDraw for network visualization is distributed with UCINET.

Source: Huisman and van Dujin 2005), p. 311.

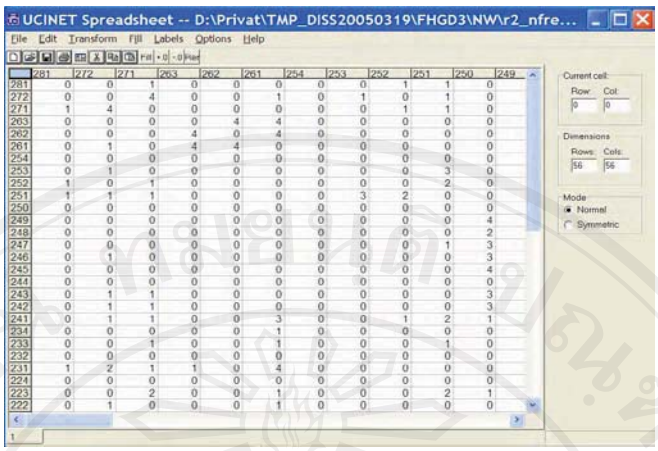


Figure 2.9 Adjacency matrix in the UCINET spreadsheet editor

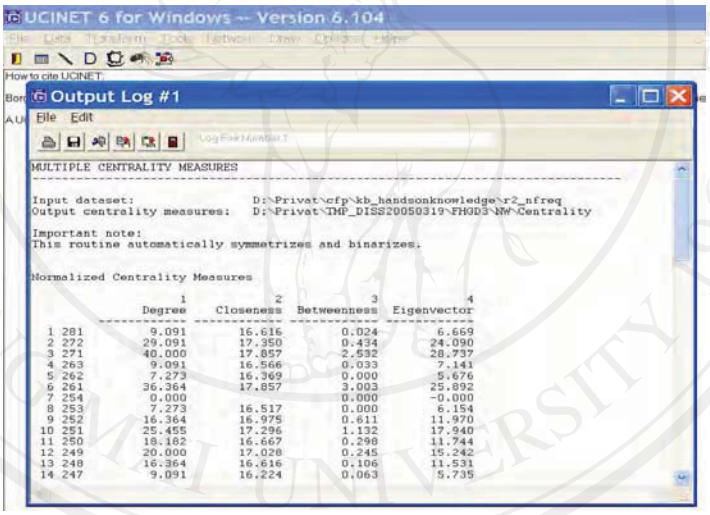


Figure 2.10 UCINET screenshot of centrality measures

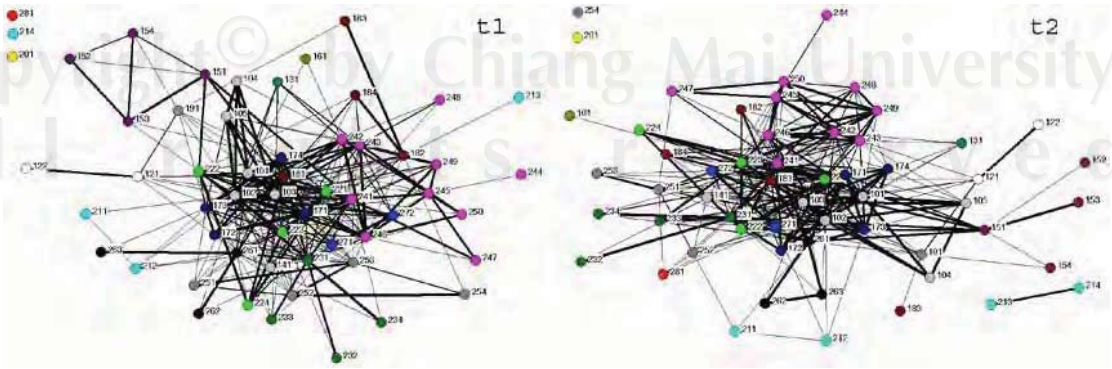


Figure 2.11 Visualization of networks in t1 and t2 using NetDraw

The SNA approach permits the relationships among the elements of a matrix to be quantitatively illustrated based upon a Boolean matrix. Figure 2.9 is example representing a social network in a form of Boolean matrix. Figure 2.10 gives example of network measurement. In addition, by using NetDraw, the pattern of networks can be visualized as shown in Figure 2.11.

Social network is therefore required for the communities in the network to communicate and share information and knowledge to create the dynamism of knowledge flow. Moreover, to enhance global network demand an online social network in which the internet seems to be one of the best solutions. Web 2.0 is a phenomenon of network society which creates a larger degree of contribution to users' participation. The details of Web 2.0 will be explained in the next section.

2.3 Software Development Process

A software development process or software process is a structural set of activities and associated results which lead to the production of a software product (Sommerville, 2001). These may involve the case of developing new software or upgrading the existing software. Although there are many different software processes, the fundamental phases of software life cycle process include 4 main stages: specification, design and implementation, validation, and evolution. A number of software process models are available. Each model has some advantages and disadvantages. To select the appropriate model depends on the nature of software project, experiences of users, time schedule, and etc.

2.3.1 Software Process Models

Software process model is an abstract representation of software process. Each process model has its own particular characteristics and process steps. A number of software models have been proposed and used for several years. There are 4 process models that are accepted worldwide as follows:

1. Waterfall Model
2. Evolutionary Development
3. Formal Systems Development
4. Reuse-based Development

Waterfall model is the earliest process model comprising multiple sequential stages. Its method begins with the target system requirements and progresses through analysis, design, development or coding, acceptance or verification, installation or operation, and maintenance. This approach seems to be high acceptable in terms of its structural methodology. However, there are at least two main problems dealing with this approach. Firstly, at the beginning of most system projects there are often difficulties for users to identify requirements and goals in a detailed level. Boehm's studies have also shown that the burden cost of a system increases due to changes in users' requirements (Boehm, 1976).

Evolutionary development uses an interleaved technique by repeating the activities of specification, development and validation. Rapid feedback across these

activities is required. Prototyping technique is one of the rapid development approaches that can be efficient used (Agresti, 1986). Instead of knowing all of the requirements at the beginning of a project, prototyping yields results without first requiring all information. The feedback from the users is therefore significant that provide additional information for the next version of prototype. However prototyping may lead to false expectation from users and poorly designed system. Secondly, developing a system using the Waterfall model generally consumes time and once it is implemented some business and functional environments sometimes change which may result in the system no longer meeting user requirements.

Formal systems development utilizes a development process that is based on formal mathematical transformation of system models to executable programs. Similar to the waterfall model, the formal approach has clearly defined (cascading) phase boundaries. However, the activities are more formal concern in terms of mathematical representation. Therefore, the formal systems development model is typically employed when developing systems that require strict safety, reliability and security requirements.

Reuse-based development is based on the existing project components that can be designed and coded by users and incorporate them into their system. The advantages of this model are the reduction of software burden at one time of development which in turn reduce cost and risks. However, there is a lack of control over system progression as the real need may not be cleared.

There are both advantages and disadvantages of each process model. In case of the KMS for industrial cluster, the requirements which are more concern with tacit knowledge are evolved. There is a need to adapt the process iteration where parts of the design and implement are repeated to meet the changed requirements. Spiral development is the development of the system from an initial outline/ requirement which is the inner loop of spiral throughout the outer loop to the final product. The spiral process requires a mix of evolutionary development using prototyping technique to develop the incremental versions of the system prototype. However, an iterative process is applied in the sequence of the analysis and design stage during system development. This corresponds to the cycle of cluster business process so that the consideration of risks will be taken place for the next loop of the spiral process. More details of spiral model will be reviewed in the next section.

2.3.2 Software Spiral Model

The Spiral Model is designed to include the best features from the Waterfall and Prototyping models. It is also one of the different approaches of reusable software process model where the software process can be adapted to the needs of the system project. The Spiral Model is a risk-driven process model originally developed by Boehm to address known problems with earlier process models of the software life cycle (Boehm, 1988). Similar to the Prototyping Model, an initial version of the system is developed, and then repetitively modified based on input received from users' evaluations. Unlike the Prototyping Model, however, the development of each version of the system is carefully designed using the steps involved in the Waterfall

Model. With each iteration around the spiral (beginning at the center and moving outward), the more complete versions of system are built (see Figure 2.12). Each cycle involves tasks through the four quadrants. The first quadrant is to determine objectives, alternatives, and constraints for the cycle. The second quadrant is a risk analysis and evaluation of alternatives for the cycle. The third quadrant is to develop and verify the next level product. The fourth quadrant involves planning for the next phases. Each cycle of the spiral model iterates through these four quadrants. The number of cycles depends on the size and complexity of the project. However, the assessment of risks and a new version of prototype that minimize risk are the key tasks of each cycle.

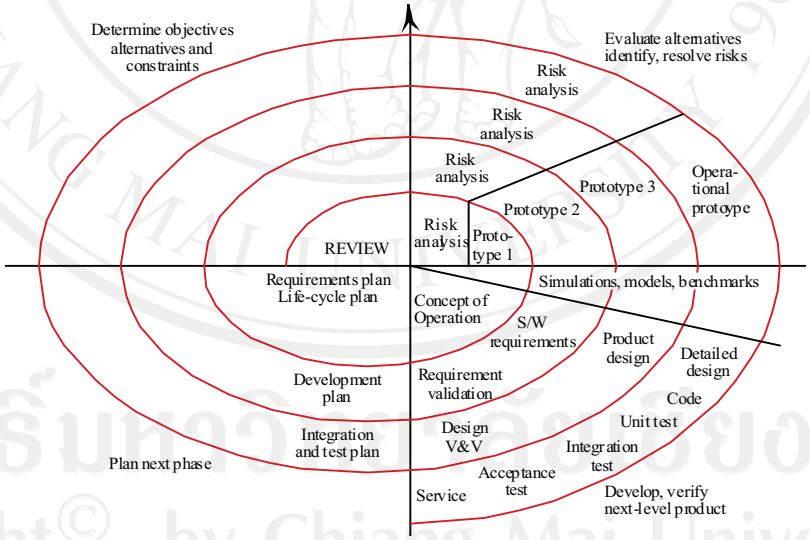


Figure 2.12 Boehm's spiral model of the software process (Boehm, 1988)

Advantage of software spiral process is that it promotes reuse of existing components of software in the early stages of development. This allows quality objectives to be formulated during development as users know what they want early.

It encourages prototyping to minimize unnecessary elaborate specification and eliminate any errors and unattractive alternatives early. As it focuses on risk management, any system rework can be done when needed (at the end of each cycle). However, this requires facilitators who have good risk-assessment skills and collaborations among development team are essential.

Risk assessment in both technical and management risks is used as a means of evaluating each version of the system to determine whether or not development should continue. If the customer decides that any identified risks are too great, the project may be stopped. For example, if a substantial increase in cost or project completion time is identified during one phase, the customer or the developer may decide that it does not make sense to continue with the project, since the increased cost or lengthened timeframe may make continuation of the project impractical or unfeasible. Prototyping is one of the beneficial techniques to manage risks. Moreover, joint application development which is discussed in the next section is also a useful tool that helps manage the risks especially the risk of unclear or poor requirements. Therefore, users' involvement during software development seems to be the most important issues for industrial cluster KMS.

2.3.3 Joint Application Development

An important aspect of the iterative development approach is the Joint Application Development (JAD) process. Proposed in the late 1970's by IBM, JAD is used as a technique for developing business system requirements. The purpose of

JAD is to bring together IT and key stakeholders in a structured workshop setting to extract consensus based system requirements. This is accomplished by using a trained JAD facilitator and customized, planned agendas to assist the participants in arriving at complete, high quality requirements. Experiences have shown that the JAD process substantially reduces development time, costs and errors. Many literatures in software engineering fields speak in the same direction that user involvement plays a vital role for software development success. JAD Environment is normally equipped with facilities, technology and tools such as visual aids, recorder, and useful software. JAD is designed to extract high-quality knowledge and information from participants within a compact timeframe; typically from 3 to 6 month. Key participants include end users, developers, mediators and experts. Users' roles include the explanation of business rules and requirements, reviews of designed prototypes, and making acceptance decisions. Developers and IS personnel generally listen and write down concerning issues and requirements offered by the users and decision makers. JAD allows faster development time by using informal meeting approach and reusable software development. Satisfactions of software product are also high due to the constant involvement from the participants. Keys to successful JAD session include the right people committed to the project, creating prototype for a quick decision, a detailed agenda, a scribe to document the proceedings and record the agreed upon requirements and good group dynamics.

Effective JAD session consists of 5 distinct stages: (1) the project definition, (2) research of user requirements, (3) preparation for the JAD session, (4) conducting the JAD session and (5) the writing the document that contains all decisions made during

the session (Wood, 1989). The project definition define the purpose, scope, and objectives of the JAD session, selecting the JAD team, invite and obtain commitment to attend sessions from the appropriate stakeholders, and schedule the session. The right people have to be involved, and the presence of a skilled facilitator can keep the session focused and can minimize unproductive emotional attacks and defenses. The research phases deal with fact-finding and information gathering. The work flow and preliminary specifications of data elements, screens, and reports are obtained by interviewing users. The JAD session phase is the heart of JAD approach that must follow the agenda to gather and document the project needs and requirements. It is important to ensure all participants are given equal treatment during the process. The work flow, data elements, screens, and reports steps are collected in the phase. Techniques and tools can improve the efficiency of the JAD session. The use of prototyping for screen design is a one of the communication mechanisms. Finally, the information captured from the JAD session is further refined through analysis efforts, open questions or issues discovered through the sessions are resolved, and the final document is returned to stakeholders for review and validation.

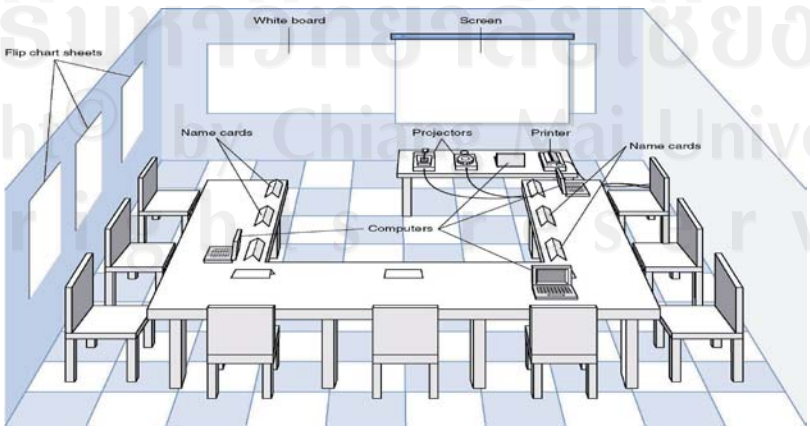


Figure 2.13 Typical JAD room (Dennis, et al., 2005)

As well, effective JAD session depends on the JAD session room. A typical JAD room is equipped with tools and equipments such as whiteboard, visual aids, computer, projector and flip chart. With today electronic meeting system, conducting JAD session is quite convenient and productive. Figure 2.13 displays a typical JAD room with many facilities provided. Moreover, before the JAD session is conducted, the JAD workbook consisting of information relevant to the project, risk and constraint, and statement of system scope and objective is prepared and send to the JAD members before each JAD session meeting.

JAD is an important technique for iterative development process. JAD is used as a technique for developing business system requirements. Iterative development methodology includes JAD techniques for determining user requirements. These requirements are reflected in a set of products that are produced using analysis and design stage. The iterative approach divides applications into smaller versions for incremental delivery. In the development of KMS for cluster, for example, the design objective is to provide 3 dynamic functions of web applications. Therefore, JAD session #1 aims at the major priorities of such 3 functions. The user log on, social networking, customizing background and font color and calendar management are examples of major components that are discussed and concerned during the first JAD session. To allow users see and use some parts of the system early will motivate them to come and join the rests of JAD sessions until the finishing JAD.

In conclusion, to be successful in JAD, the interaction between users who have the best understanding of that job and developers who have the best understanding of

how technology works must be harmonized. Moreover, the best solution of software depends mainly on the process that all groups in JAD session will work as one team with a shared goal. A proper planning of JAD especially the JAD session agenda and the moderator who carry out that plan are also significant. In the case of the industry cluster where the interaction among clustering members is quite low, a shared goal of the project must be committed. Therefore, a common goal must be based on the information and knowledge that all members are willing to share. The KMS using social networking tools such as web 2.0 to implement product prototype will also increase interaction among JAD participants.

2.4 Web 2.0 Concepts and Technologies

As the online social networks are becoming a new growth in the internet era, individuals constantly design to interact with each other in business and in personal contacts. There are also a number of excellent resources available to everyone to become a part of online social network. The new concept of web 2.0 announced by Tim O'Reilly in 2004 has initiated a strong impact to social networking in virtual communities for its dynamic concept of "web for participation" or "web for individual services since then.

2.4.1 Web 2.0 Concepts

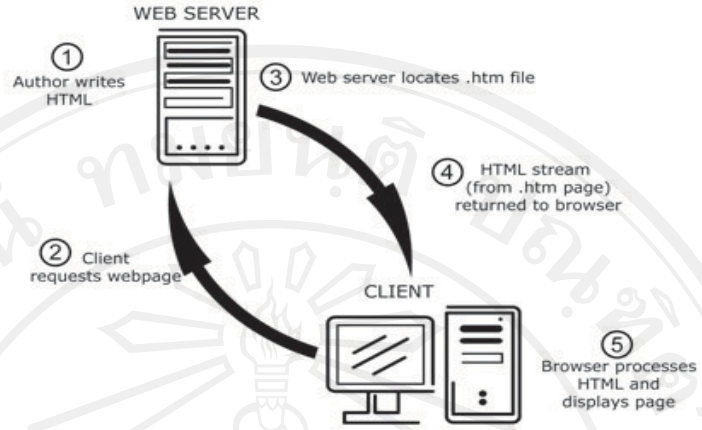


Figure 2.14 Static web 1.0

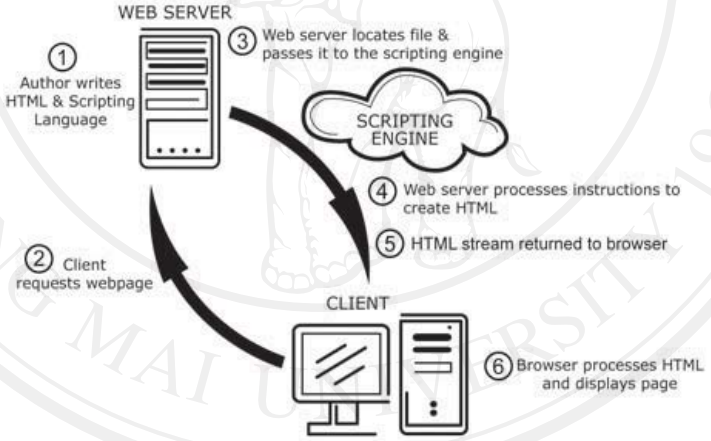


Figure 2.15 Dynamic web 2.0

O'Reilly (2005) defines Web 2.0 as "the network as platform, spanning all connected devices. Web 2.0 applications are those that make the most of the advantages of that platform: delivering software as a continually-updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an 'architecture

of participation' and going beyond the page metaphor of Web 1.0 to deliver rich user experiences". Hoegg et al. (2006) also defines Web 2.0 as "the philosophy of mutually maximizing collective intelligence and added values for each participant by formalized and dynamic information sharing and creation". Therefore, to develop Web 2.0 sites requires some technologies as tools for the development such as AJAX or mash-ups. Figure 2.14 and Figure 2.15 compare the difference between Web 1.0 and Web 2.0 in terms of the static and dynamic functions from client and server sides.

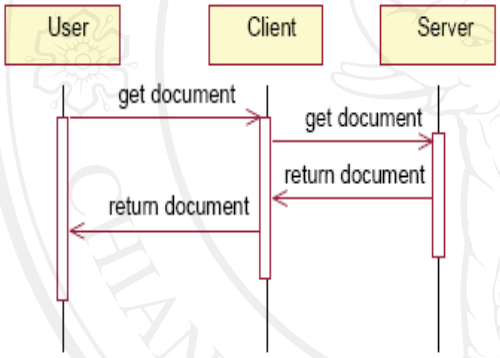


Figure 2.16 Pull technology

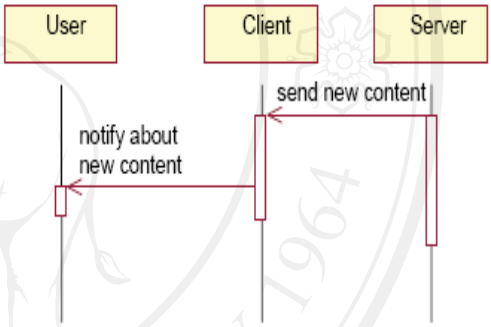


Figure 2.17 Push technology

There are some main differences between the old version of web or Web 1.0 and the new version of web or Web 2.0. Web 1.0 is web for publishing and personal use while Web 2.0 is a new generation of web which enhances social networking and community, and facilitates collaboration, interaction and sharing among users. One of the most important concepts of Web 2.0 is to make users who have less IT knowledge and habitually retrieve information to become the creators and editors of web contents. In the previous version of Web 1.0, information is created and disseminated to the users by the content providers and the webmasters. Users specifically ask for

something by performing a search or requesting existing information which is called the **"pull technology"**. This has to be repeated for each web site from which the user wants to get useful information. In contrary, people in Web 2.0 can create and share their contents. This means that all information in Web 2.0 sites do not originate from the people who design and put the website on the internet, but from the millions of users worldwide who share the information with one another. Web 2.0 also implements **"push technology"** which makes web applications more interesting. Selected (customized/ personalized) data is automatically delivered into the user's computer on a pre-arranged schedule or when certain events occur. Push technology is the essence of services oriented architecture (SOA) in which it allows developers to implement and reuse code in flexible ways. Push technology is useful for both social networking applications and enterprise applications because it provides an efficient way to implement several services. As a result, the acquisition of information is either initiated on the user/client side (pull) or on the provider/server side (push) (see Figure 2.16 and Figure 2.17).

The main concepts of dynamic social networking of Web 2.0 include rich internet applications (RIAs), software as a service (SaaS), mashups and collective intelligence (CI) (Minsk et al., 2007). RIAs generally split the computation processing to the client side and the data manipulation and operation has been done on the server side to reduce the server workload. This can be done by using scripting language such as the Asynchronous JavaScript and XML (AJAX). Not only the response time of the appeared result decreases, but the refresh rate is also minimized by AJAX. Traditional web application requires the whole web page to be retrieved

which consumes communication bandwidth. However, an AJAX engine of web 2.0 which is mostly found in the current browser provides a means of partial web page refresh which responsiveness can be improved. AJAX is the use of JavaScript to operate other technologies such as XML for HTML (XHTML), Cascading Style Sheets (CSS), XML Style sheet Transformation (XSLT). Developers and even users are able to generate interactive and rich user interfaces at the client's side. Really Simple Syndication (RSS) is another example of RIAs that deliver real time information by feeding to users automatically. SaaS is a new concept that views software as a service instead of packaged product. The benefit of SaaS is to reduce time and cost of software updates or maintenance at the client site as they are sent from the server side via the internet connection. To use the software, users only require access to the providers of SaaS through web browser which the cost is generally based on pay-per-use or subscription basis. This is why SaaS sometimes called "Software or application on Demand". The concept of Mashups allows users to extract, mix and reform the content over the web to suit their needs using application programming interfaces (APIs). Developers and users are, therefore, capable to pick and choose from a set of inter-related components in order to build an output that meets their needs. Multi sources applications or contents can be integrated into a single view or required format for mashup. The benefits of mashup include lower cost development and adjustable configuration of existing contents to fit new needs of end users. The CI concept lies on the assumption that knowledge is generated by the aggregation of users' wisdoms in the network. Wikipedia.com is a good example supporting CI concept. The research will focus on the most common Web 2.0 tools such as blogs, wikis, RSS, social bookmarking and newsgroup forums. The diagram

of Web 2.0 component offered by O'Reilly to explain above ideas is illustrated in Figure 2.18.

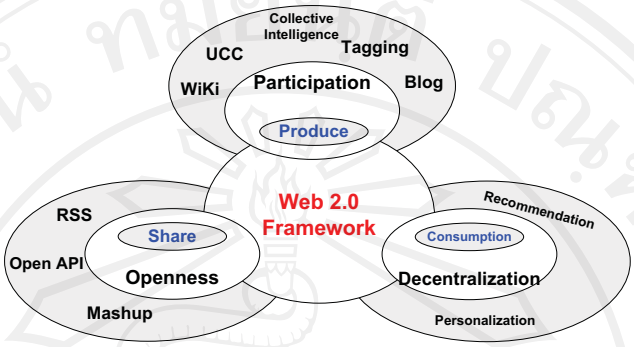


Figure 2.18 The components and ideas of web 2.0 (Wan and Zhao, 2007)

2.4.2 Web 2.0 Tools

The basic concept of the Web 2.0 is based on a number of web services and applications. These services and many of the application tools are relatively mature including blogs, wikis, multimedia sharing services, content syndication, podcasting and content tagging services. These services have been used and well-known for several years and new features continue to add on (Anderson, 2007). In this research, the most common Web 2.0 tools such as Blogs, Wikis, RSS, newsgroups and forums and social bookmarking are discussed.

2.4.2.1 Blogs

One of the most useful tools of the Web 2.0 era is blogging. Blogs are like online diaries where people can post their thoughts, information, links and interests.

A blog or weblog offers an ability to store content that is posted by date or links to other sites creating what is called blogosphere. The feature of blog also allows for immediate feedback or comment on a posting. The types of blog content vary from text, images, files, audio and video. Blogs are generally used for a personal form of publishing content. However, blogs are also widely adopted in the organizations by knowledge workers to spread their knowledge internally and externally or to communicate with their public (Kelleher and Miller, 2006).

2.4.2.2 Wikis

A wiki is a free online space that enables users to create, edit, tag, and link content in a collaborative manner. The basic idea behind the wiki concept is that anyone who can view the page can also contribute to knowledge construction (Reinhart, 2005). One of the remarkable benefits of wiki is the ability to offer a quick way to collaborate textually, while creating a dynamic content web site. Collaborative writing is inherently a social act which will increase the number of ideas and viewpoints in various subsections that are written by experts (Colen and Petelin 2004; Noel and Robert, 2003). This will increase motivation among participants, possibilities for less experienced writers to improve their skills, and higher levels of acceptance of the final product. Wikipedia is the best known wiki system, consisting of more than 4 million articles and around 10,000 users each day posting and updating contents (Voss, 2005).

2.4.2.3 RSS

RSS, the abbreviation of 'real simple syndication' or 'rich site summary' allows users to find out updates to the content of RSS enabled websites without actually having to visit and access the site. Instead, information from the website (regularly, new story title and synopsis, along with the originating website's name) is direct to the source where you can easily take part of the information you have selected. Based on RSS concept, it can enable the user by staying up-to-date with huge amount of new information without surfing numerous websites everyday (Ward, 2007). An RSS-feed can be obtained and deciphered with help of a feed reader which keeps a reader updated on new posts. Technically, RSS is an XML-based data format for websites to exchange files that contain publishing information and summaries of the site's contents.

2.4.2.4 Newsgroups and Forums

Newsgroups are public bulletin boards on the Internet where you can post comments and reply to other people comments. They are a useful place to find answers to questions or to talk to people who are interested in the same things as you. Newsgroup topics can be newsworthy, newsgroups have nothing to do with the daily news, and the term is somewhat misleading. Newsgroups are organized into categories and subcategories, with categories having the most diversity.

2.4.2.5 Tagging and Folksonomy

The key word “tag” is associated with or assigned to a piece of information (text, photo, video etc.) and describes such piece of information. Tagging will follow the associations of the collective since it does not follow any pre-determined categories. Folksonomy is collaborative tagging and method of collaboratively creating and managing tags to annotate and categorize content. Tagging is the adding of keywords to a digital object (e.g. a blog, website, picture, audio file or video clip) to categorize it. When they are public, the tags together can all be searched by all users, creating a “Folksonomy”.

In summary, the feature of Web 2.0 is to focus on people interaction. The question of how to make people interact with each other and share data through Web 2.0 technologies and tools is critical challenge. The performance of collaboration is basically depended on how to effectively convince or motivate proper participants to interact with each other. The contents created and posted via wikis and blogs can be either knowledge or garbage. For example, people sometimes intentionally destroy the content of the wiki to affect the quality and reliability. In case of blogs, lately responses to postings may cause the blog discussion bored and messy which could severely slow down interaction. The design of Web 2.0-based applications, therefore, should give priority to the process of users and information management so that people are more likely and willing to interact and share their information and knowledge deliberately.

2.5 Conclusion

The growth of economy depends on how successful countries can manage the SMEs. However, to compete in the global-scale economy, SMEs forms into cluster to collaborate and share knowledge. Social network among the clustering members and web-based KMS are required. For the sustained use of the system, the design and development of the system must be involved by all types of stakeholders including developers, clustering members, CDA and related supporters. Only key players in cluster are selected in the JAD team.

To catch up the rapid changes in high advanced information and communication technologies, software development must also be adapted. In the competitive environments like industrial cluster, web based strategies are the common approaches. Web technologies and tools change almost every year. Therefore, the development of new software/ KMS must be adapted or changed to be compatible with the change in technologies. At the same time, the speed of new knowledge creation must also correspond to the rapid changes in technology, web based application and the social networking environments which the rapid speed of knowledge access, use and share are crucial concerned.

To handle all the rapid changes in competitive situation, social networking WEB 2.0 is adopted. The development of KMS should combine software spiral process with the knowledge spiral process namely “double spiral” process based on the evolutionary development approach. Each cycle of double spiral ends up with the

dynamic KMS based on individual needs and the improvement of business process or new knowledge learned from collaboration and knowledge sharing through the use of KMS. The next cycle of double spiral will expand the quality and quantity of both software content and knowledge content for the ceramic cluster. More information and details of double spiral process will be discussed in the next chapter.