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# Enhancing University Research Activities with Knowledge Management

T. Chandarasupsang*, N. Harnpornchai, N. Chakpitak, K. Dahal

*Abstract*— In the new economy, innovation is regarded as one of the solutions for almost every organisation to survive in the new business era. Universities, especially in terms of research activities, are no difference since they strive for novelties which potentially lead to innovation. An experienced researcher in the university has continually created tacit knowledge in a specific domain, but typically found it difficult to share this tacit knowledge among other researchers for the problem solving purpose. To overcome this problem and to better stimulate knowledge sharing activities among university researchers, Knowledge Management and Knowledge Engineering, particularly KADS, are utilised in this paper to assist a group of different domain researchers in putting their experiences together. In this way, each researcher can make explicit his or her tacit knowledge into KADS task, inference and domain knowledge models. The structured knowledge models captured from different researchers can then be merged together. In this paper, the research in Knowledge Management is selected as a case study, and the results show that the relevant tacit knowledge has been made explicit from a researcher and allow other researchers to share the knowledge as well as to add their own knowledge. Hence, their common research theme is effectively created, and also maintained by a group of researchers.

*Index Terms*—**Knowledge, Knowledge Engineering, Knowledge Management, Research**

## I. INTRODUCTION

From 1990 onward, the word "New Economy" has been recognised and widely discussed [1]. Although no universally accepted definition of this new economy has been agreed, the general assumption of the new economy refers to the economy that no longer depends solely on demand and supply. There are two major factors which leads to the development of the new economy and distinguishes its from the existing one. The first factor is the increasing influence of the globalisation and the liberalisation. This can be seen in the global scale where most of the industries are faced with the global competitive situations. The second factor is reflected from the rapid development and the use of Information Technology (IT). IT including internet becomes essential for business, education and government. This can be seen from the implementation of E-commerce, E-learning and E-government to enhance the conventional trading, learning and government services.

With regard to knowledge and learning, the term and the definition of the knowledge economy have been well defined by Peter Drucker [2]. This knowledge economy relies significantly on knowledge workers and IT for modern management. Nowaday, the term 'Knowledge-Based Economy' is used instead of the knowledge economy, but it still represents the similar meaning. Specifically, the Knowledge-Based Economy [3] is the economy which depends on generation, distribution and the use of information and knowledge. Under this economy, organisations must manage to harvest the knowledge in order to support their core businesses as well as to create business and technology innovation. This indicates the increasing importance of the knowledge workers within the organisations, especially in the knowledge-based operations. As a consequence, knowledge and learning activities of workers are regarded as the key success factors to drive the organisation forward and to arrive at the new innovation. This general conclusion of the knowledge worker is no difference to the academic research context and can be used to explain the university researchers as the innovative knowledge workers.

To better understand the concept and rationale behind the Knowledge Based Economy, it is better to understand the associated 'terms' as given in the following sub sections.

### A. Knowledge

By definition, knowledge is the whole body of data and information that people bring to practical use in action in order to carry out tasks and create new information [4],[5]. Knowledge means 'specialised' because a knowledge worker develops his/her own speciality and become specialist in particular areas. Everyone has individual knowledge, skills and experiences related to his/her action, problem solving and decision making opportunities. As a consequence, an organisation needs to develop common best practices, knowledge workers and eventually communities of practice to support their core businesses. In the academic research context, experience in research gained by the researchers during their problem solving is one of the key knowledge for

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universities. The researchers develop their own 'know-how', particularly in the new methods, techniques and tools for carrying out their research works.

### B. Learning

Generally, learning is the process of acquiring knowledge and skill [6]. Learning, teaching and training activities are directly linked to the development of both individual and organisational knowledge. The knowledge workers and their communities of practices should learn and learn to learn. Moreover, they must keep learning together. It has been indicated that capability of learning is a requirement for development of individual and organisational competitiveness [7]. Moreover, life-long learning is necessary for both knowledge workers and their organisations. To encourage learning in action, Knowledge Management (KM) effectively supports problem-based learning and learning by doing. For knowledge workers in the universities, KM provides them a learning environment supporting their academic research tasks. Hence, in this way, they are able to share with others their research experiences.

### C. Community of Practice

A team of experts and knowledge workers in a specific domain is called "Community of Practice" (CoP) [5]. In public service context, the CoPs for a specific task have been naturally built up within an organisation. Sometimes, CoPs can come across many different divisions within the same organisations. In a CoP, team learning and problem solving are very necessary in helping each other at work. Other knowledge workers within the same CoP can share experiences as well as exchange some ideas with the experts. KM directly facilitates sharing and dissemination of domain knowledge. In a university, communities of researchers assist each other in research problem solving. They practice research together in similar, interesting domains. Multiple disciplinary is promoted in order to create variety of research ideas. Multi-disciplines research is very essential for creating innovation within universities.

## II. KNOWLEDGE MANAGEMENT IN UNIVERSITY

Knowledge Management is a framework or tool set for improving the organisation's knowledge infrastructure, aimed at getting the right knowledge to the right people in the right form and at the right time [8]. Today, IT is regarded as 'the must' for a Knowledge Management System (KMS) in the new economy. To realise an IT-based KMS, Knowledge Engineering (KE) commits some effective techniques and tools for capturing, analysing and structuring both the tacit and explicit knowledge within an organisation. This includes also the design and the implementation of the system.

The KM within an organisation can be alternatively described as a concept: 'teaching the smart people how to learn' [7]. The modern organisations need to maintain and strengthen their core businesses. Human resource, new technologies and IT are major keys for learning and growth of an organisation. An organisation (including universities) should focus on developing CoPs, academic best practices and IT infrastructure to support the core of the university operation, especially research activities. Not only do the staff members do day-to-day works, but they also need to practice to learn and learn-to-learn. This should include how-to-learn-together. Learning activities should be encouraged at all levels, and these are individual, team and system levels in a university. The continuing improvement of communication, sharing and dissemination of data, information and knowledge among academic staffs could create synergy and harmonisation. In this way, the university develops some potential to be able to create new products and innovation. In this context, KM can be recognised as a learning system for the researchers to learn, learn-to-learn both individually and together by sharing and disseminating their working data, information and knowledge. To synergise the research, recognising the existing of the knowledge workers is a new requirement for universities. KMS directly assists a university in setting up socialisation process among its researchers for creating innovation.

## III. KNOWLEDGE ENGINEERING

KE provides method and methodology to design and construct knowledge systems [8]. The designed knowledge systems include for example, Expert System, Decision Support System, KMS and knowledge archive. The KE covers the processes of capturing, analysing, validating and modelling a domain of knowledge. To implement the structured knowledge base, IT-based KMS [5] requires some effective design techniques and tools provided by KE methodologies. One of the widely used methodologies is CommonKADS which is the EU de facto standard methodology for supporting the design and the implementation of knowledge systems. CommonKADS [2] or KADS (previous version of CommonKADS) has been broadly applied in power business. These include for examples, KM for planning, operation, maintenance, pricing negotiation, asset management and regulatory issues.

### A. KADS

KADS: Knowledge Analysis and Data Structuring is a KE methodology supporting the development of knowledge systems. In principle, a KADS knowledge model divides knowledge into three sub-areas: Task Knowledge, Inference Knowledge and Domain Knowledge. Task Knowledge contains knowledge about how elementary inference can be combined to achieve a certain goal. Moreover, Task knowledge itself can commit to achieve a particular goal, and represent fixed strategies for achieving problem-solving goals [6]. The Inference Knowledge is the control knowledge we abstract from the domain theory and describe the inference that we wish to make in this theory [6]. The domain knowledge embodies the conceptualisation of a domain for a particular application in the form of a domain

theory [6]. Domain knowledge can be viewed as a declarative theory of the domain. In fact, adding a simple deductive capability would enable a system in theory to solve all problems solvable by the theory [6].

### B. IT-Based Knowledge Management

Today, web-based technology becomes the default platform for development and services of a KMS. It enables KMS to deliver knowledge services to knowledge workers over the internet, the intranet and the extranet. The basic functions of the IT-based KMS [9] are Document Management System, Forum Discussion System, Capability Management System and Lesson Learned Knowledge Base. These required functions provide useful working document, discussion, expert's details and case studies respectively. In addition to the KMS features mentioned above, knowledge maps and knowledge models are also included and usually provide some guidelines to knowledge workers in sharing and dissemination of tacit knowledge at work. This effectively facilitates members of the CoP to understand the problems and learn together as well as helping each other in problem solving. Note here that knowledge model supports both team decision making and training. New member can learn from his/her CoP in action.

## IV. RESEARCH THEME

In order to share research knowledge, members of the research team are usually required to make endless forum discussion on their domain knowledge. These endless discussions typically focus on problems, literatures, methods and methodologies related to the problem solving tasks. Then, a common research theme can collectively be developed among the researchers. To overcome this problem and to better stimulate the interaction among researchers, KMS can effectively be utilised to facilitate the group of researchers to build up their synergy for team problem solving. Within a specific research domain, the researchers are normally sharing, exchanging and reasoning their domain knowledge as the following academic issues:

- Problems, Ideas and Strategies
- Literature and Critical Reviews
- Methods and Methodologies
- Technologies, Techniques and Tools

This can be elaborated by an example within the College of Arts, Media and Technology (CAMT), Chiang Mai University, Thailand. Within CAMT, researchers and PhD students communicate and discuss research topics through issues mentions above. The guideline for the discussion is developed and called 'the Research Theme Self Assessment'. The key words (4C) for this self assessment are given as follows:

- Concrete: clear and certain.
- Concise: short and clear without unnecessary words.
- Convince: provide sufficient justification.
- Complete: cover all important aspects and finish

them with high quality.

Through this guideline provided in the self assessment form, researchers at CAMT can effectively discuss the research issues and have the same understanding of what is expected.

## V. KADS FOR UNIVERSITY RESEARCH ACTIVITIES

In order to facilitate researchers, their conceptualisation must be made explicit for common understanding and sharing. Under KADS methodology, critical tasks and/or important goals of the research are firstly identified by the experienced researchers. Secondly the necessary inferences related to the specified task must then be classified. In academic research, the inferences usually cover their interesting problems, critical and relevant literatures, methods, techniques and tools which are useful for the research activities. Finally, the groups of domain concepts associated with each inference are captured from the community of research practice and then analysed. In addition, necessary supporting references including contacts, documents and information should be acquired from the research experts. These supporting documents/materials are usually called repository.

To demonstrate the approach above, the tacit knowledge about research in KM was captured and analysed. The knowledge model was depicted by using KADS notation. A case study has been given on research activities between CAMT, Chiang Mai University and School of Informatics, University of Bradford.

Regarding the knowledge modelling results, Figure 1 summarizes the inference knowledge supporting the development of the research theme (task). To specify the experts' conceptualisation, all domain knowledge was represented in semantic network. Figure 2 illustrates the domain concepts related to their interesting problems, ideas and strategies. In Figure 3, their literature and critical reviews already conducted is shown. Furthermore, some methods and methodologies are recommended in Figure 4. Then, a set of technologies, techniques and tools used by the community of researchers as is shown in Figure 5.
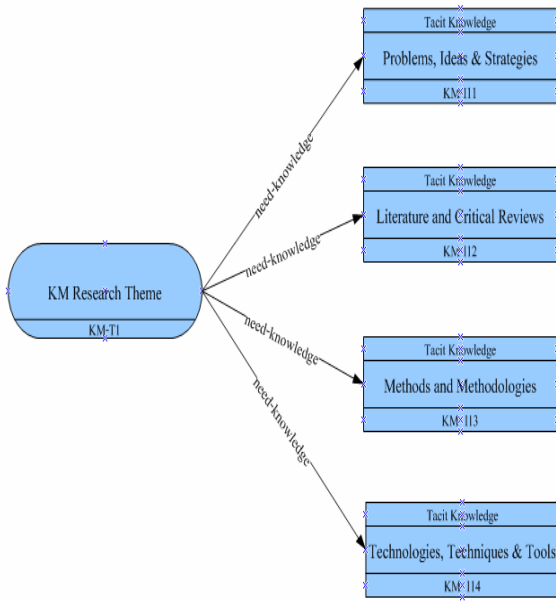
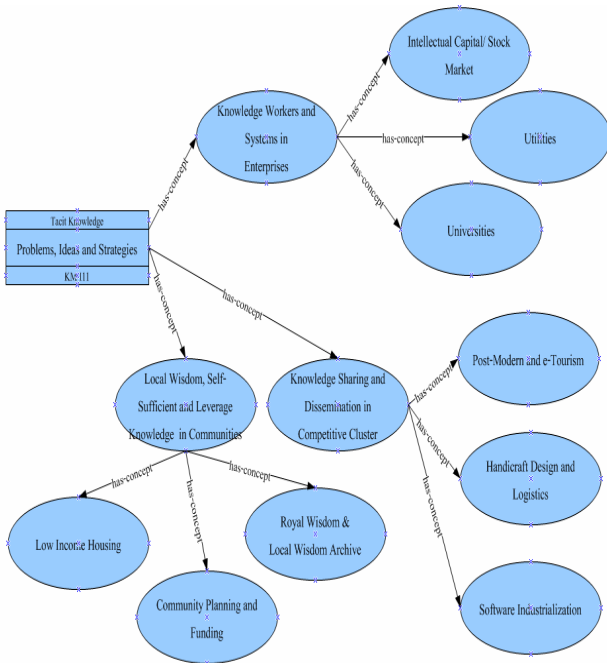Fig. 1  Task-Inference Knowledge Model



Fig. 2  Domain Knowledge on Problems



Fig. 3  Domain Knowledge on Literature Reviews
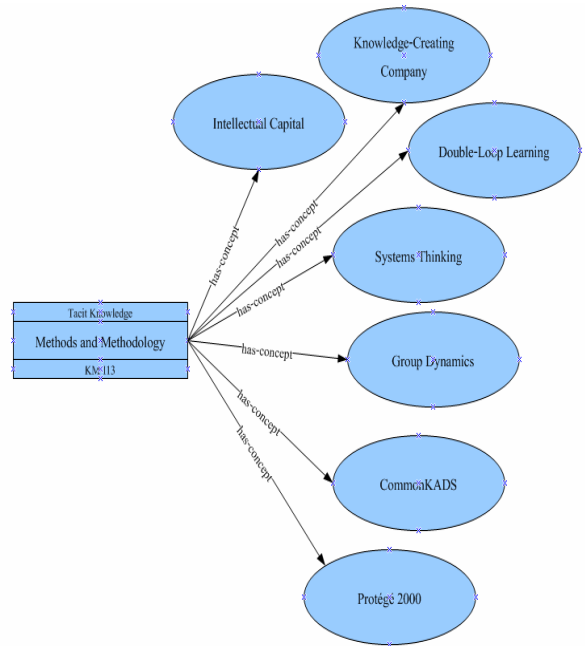


Fig. 4  Domain Knowledge on Methods and Methodologies

Fig. 5 Domain Knowledge on Technologies, Techniques and Tools



Fig. 6 IT-Based KMS

## VI. DEVELOPMENT OF AN IT-BASED KNOWLEDGE MANAGEMENT

To realise the IT-based KMS, the knowledge model was constructed in web artifacts by using Microsoft Visio software. Task, inference and domain knowledge maps were created respectively and posted into the portal software. In this paper, the Microsoft Shared Point was selected as a portal system and the support collaborative technology [10] to the community of researchers. The collaborative technology aims at providing repository document management and web-based forum discussion. The realised IT-based KMS should provide a complete knowledge pack for a particular action. The knowledge pack basically comprises of knowledge maps and attached repository, forum discussion and portal. An example of the knowledge packs is illustrated in Figure 6.
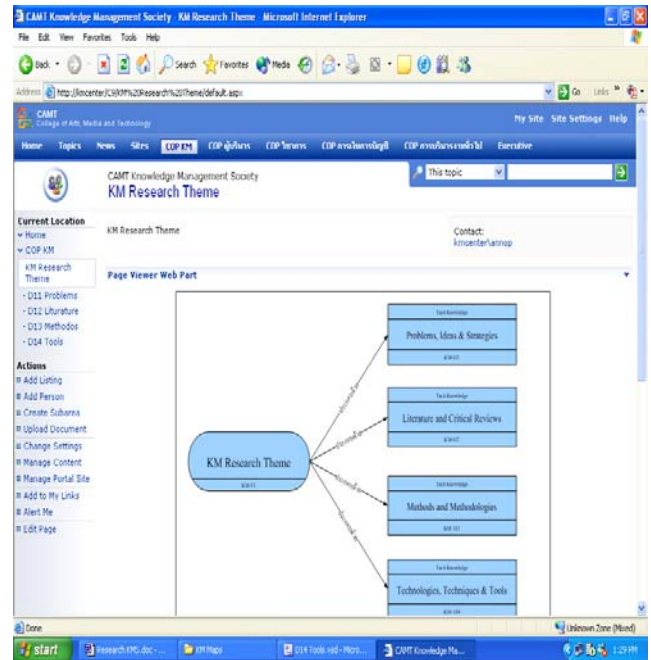
## VII. UTILISING THE KNOWLEDGE IN UNIVERSITY RESEARCH ACTIVITIES

To make use of the prepared knowledge model, the knowledge pack can be selected from the portal system menu. Prior to a research activity, research project manager has to propose some research tasks and issue it to the whole community. The members of the research community then try to create and synergise their ideas and assist each other in the community to complete the tasks as well as to resolve the issues. A concept may be populated from a domain knowledge map by the conductor in discussion. By using portal technology, each domain concept provides some necessary web links to the supporting references. As mentioned previously, the references include contacts, document and support information regarding the concept. During the discussion, some other useful concepts may be pointed out and can be picked up by the community for further reasoning until receiving a final conclusion. The conclusion is mainly on the classified problem areas, the required literatures, the designed methods and the selected technologies, techniques and tools for the research task. The new research theme is then created to meet the interesting research scenarios.

## VIII. CONCLUSION

Knowledge Management is useful and essential for the effective university research activities as shown in this paper. University researchers can be considered as knowledge workers. By using the KADS knowledge model, a research community is able to make explicit, share and disseminate their research tacit knowledge including classified problem

areas, required literatures, designed methods and selected technologies, techniques and tools in order to develop new research theme. In addition, Information Technology especially Internet enables the research community of practice to globally communicate and collaborate in a research task. Collaborative technology also provides asynchronous communication to get rid of researchers' time and location limitations. Therefore, university researchers from different countries are able to do academic research together via Internet.

Note that although the KADS approach for the universities research activities is focused in this paper, the approach can also be applied to other organisations (Bank, Industries, or Pharmacy).

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