UTILIZING E-LEARNING TOOLS TO FOSTER KNOWLEDGE MANAGEMENT PRACTICES IN MARITIME EDUCATION & TRAINING

Hieu, Pham Trong[1*]; Bolmsten, Johan[2]; Kitada, Momoko[2]

[1] Ho Chi Minh City University
of Transport
Vietnam

[2] World Maritime University
Sweden

Abstract. Knowledge management is widely considered as a key driver for an organization's innovations. Indeed, better utilizing intellectual property and promoting expertise exchange is a topic that has been discussed extensively within the MET discipline. With the fast advancement in information communication technology, there are opportunities for an organization in the maritime industry, includes MET institutions, to tackle some traditional barriers to knowledge management practices in an effective manner. However, depending on various situations, there are a number of factors that might affect the processes of managing knowledge within an organization. The causes of these failures range from lack of management support; improper planning, design, coordination and evaluation; inadequate skill of knowledge manager and worker; having problem with organizational cultural and structure; Disoriented implementation of supportive technology, budgeting and excessive cost.

This paper reviews, synthesises, and discusses some key factors that affect the knowledge management practices in relation to the maritime sector. Several challenges that can hinder the implementation process are identified and discussed. We suggest how a MET institution effectively can utilize modern technologies, including E-learning tools, other various existing web-based application and cloud-based application to foster knowledge management practices. We also introduce an knowledge management application framework that describe the possibilities of how these technologies can interact with each others and with the users of an organization.

Key words: knowledge management, knowledge management system, E-learning tool, organizational knowledge, MET training

*Corresponding author
e-mail:
tronghieu_hh@hcmutrans.edu.vn

1 INTRODUCTION

Knowledge management has become an increasingly popular notion since the late 90s (Frost, 2014). Studies show that the successful management of knowledge can improve organizational productivity, service quality, organizational innovation, and uniqueness (Nonaka, 1994; Grant, 1996). This is also true to organizations in the maritime sector. Specific issues of knowledge management in the maritime sector for example includes that knowledge resources are widely spread across various maritime-related organizations. The creation and retention of such knowledge are a challenge for the maritime sector.

This paper reviews, synthesises, and discusses some key factors of knowledge management in relation to the maritime sector. These factors will be positioned in contemporary Maritime Education and Training's (MET) challenges and how a MET institution effectively can utilize modern technologies, including E-learning tools to foster knowledge management practices both internally and externally. In this context, the expertise and capacity of MET institutions are also positioned as a knowledge provider. It is possible that MET institutions take the lead to create a supportive knowledge management environment to nurture knowledge sharing in the industry.

Of interest to this paper are developments in Information Communication Technology (ICT), which open up opportunities for MET as well as other maritime related industries to foster knowledge management practices in an effective manner in terms of cost, scalability, and shareability. It is however important to keep in mind that although knowledge management can be enhanced by technology, it is not itself a technology discipline, and too much reliance on an IT tool can lead to the expectation of a "silver bullet" solution. Knowledge management strategies should focus on determining the socio-technical function of the IT systems that are necessary for the specific activities and initiatives within an organization (Robertson, 2007).

This paper is structured as follows: (1) introduces a theoretical framework to knowledge management and knowledge management systems; (2) is about contemporary issues in the maritime sector in relation to knowledge management; and (3) discusses how several contemporary ICT development can improve knowledge management practices within MET and the Maritime industry.

2 BACKGROUND

2.1 Data, Information, and Knowledge

Knowledge is not information and information is not data, before heading into discussing knowledge and knowledge management, it is important to clarify what constitutes knowledge and what falls under the category of information or data

Data can be considered as facts or figures which describe something specific, but they are not organized in any way and basically do not provide any further information regarding patterns, context, inferring, or descriptions (Frost, 2014)

Information: For data to become information, it must be contextualized, categorized, calculated and
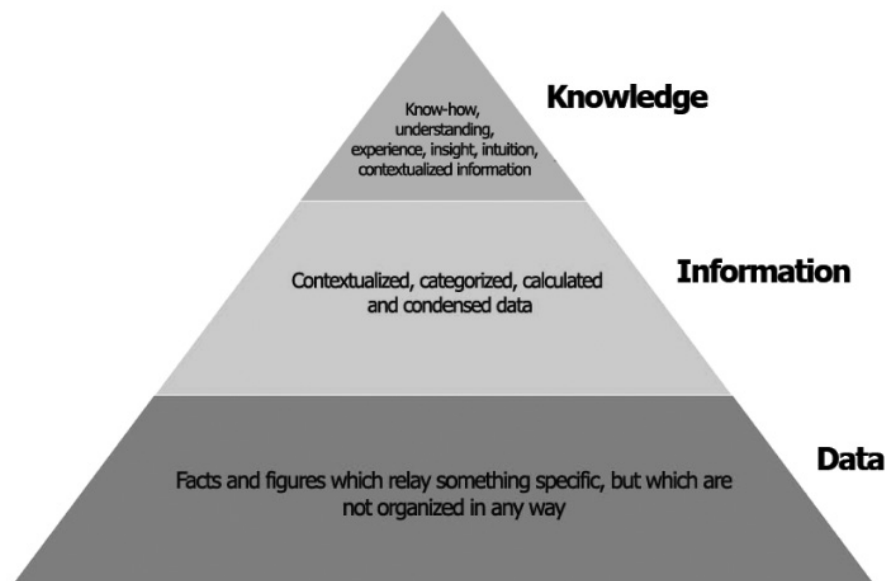

Figure 1 Knowledge pyramid

Source: Frost, 2014 (http://www.knowledge-management-tools.net)

condensed (Davenport & Prusak 2000). In other words, information paints a bigger picture from available data and makes it more relevant and purposeful (Bali, Wickramasinghe, & Lehaney, 2009).

Knowledge is "a fluid mix of framed experiences, values, contextual information, expert insight, and grounded intuition that provides an environment and framework for evaluating and incorporating new experiences and information. Knowledge originates and is applied in the mind of the knowers. In organizations it often becomes embedded not only in documents or repositories, but also in organizational routines, practices and norms." (Davenport & Prusak 2000). Knowledge implies know-how, understanding and experience of individual. Two types of knowledge can be distinguished, explicit and tacit knowledge.

2.2 Explicit knowledge and Tacit Knowledge.

Explicit knowledge can be transmitted to others. It is knowledge that is possible to codify and transmit in formal systematic language (Nonaka & Takeuchi, 1995) and can be readily articulated, accessed, and verbalized. Most forms of explicit knowledge can be stored in certain media (Wikipedia), It is sometimes referred to as know-what (Brown & Duguid 1998). Explicit knowledge is found in: databases, memos, notes, documents, etc. (Botha et al. 2008)

Tacit Knowledge, on the other hand, is harder to define knowledge and can be related to as for example experience and intuition. Tacit knowledge is personal and context-specific, and therefore hard to fully formalize and communicate. This type of knowledge is deeply rooted in action, commitment, and involvement

(Nonaka & Takeuchi, 1995). Sometimes it is referred to as know-how (Brown & Duguid 1998) and it includes cultural beliefs, values, attitudes, mental models, etc. as well as skills, capabilities and expertise (Botha et al 2008).

2.3 Knowledge Management

Knowledge management can be defined as *"the systematic management of an organization's knowledge assets for the purpose of creating value and meeting tactical & strategic requirements. It consists of the initiatives, processes, strategies, and systems that sustain and enhance the storage, assessment, sharing, refinement, and creation of knowledge"* (Frost, 2014)*.

The view of knowledge as an actual asset rather than some something intangible enables an organization to better manage and utilize its intellectual resources. For an organization to successfully manage its knowledge assets, there must be the right tools, at the right time, for the right people to create, store, share and reuse the knowledge. From that point of view, knowledge management can be seen as continuous processes and comprise of (1) Knowledge Discovery & Detection, (2) Knowledge Organization, Assessment and Storing, (3) Knowledge Sharing, (4) Knowledge Reuse, (5) Knowledge Creation, (6) Knowledge Acquisition (Botha et al, 2008).

Organizational knowledge exists in many different forms as tacit, explicit and embedded within individual, group, intra and inter-organization. Concerning organizational knowledge management, the work of Nonaka and Takeuchi (1995) around concept of tacit knowledge and explicit knowledge with their theory
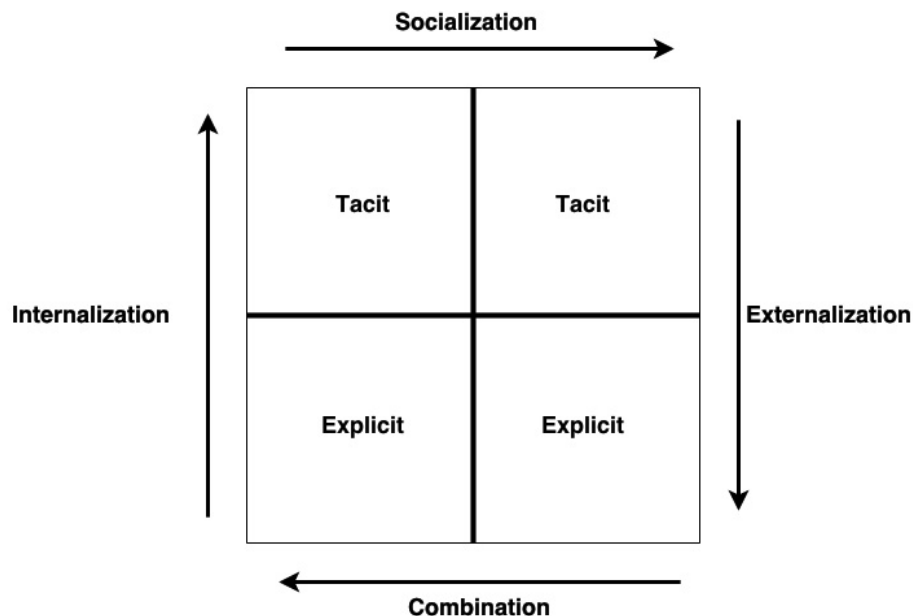

Figure 2 SECI Model (Nonaka & Takeuchi, 1995)

about knowledge creation process has established a cornerstone within knowledge management. These authors describe individual tacit knowledge as a source of the knowledge creation process within an organization. Knowledge is managed through four processes of knowledge conversion that includes socialization, externalization, combination and internalization. This knowledge management process amplifies from the individual to the group and the organization as described below:

"knowledge is created only by individuals. An organization cannot create knowledge without individuals. The organization supports creative individuals or provides contexts for them to create knowledge. Organizational knowledge creation, therefore, should be understood as a process that 'organizationally' amplifies the knowledge created by individuals and crystallizes it as part of the knowledge network of the organization." (Nonaka & Takeuchi, 1995, p. 59)

– **Socialization**: Tacit to tacit. Knowledge is passed on through practice, mentoring, imitation, and observation. The key to acquiring tacit knowledge is experience.

– **Externalization**: Tacit to explicit. This is quintessential to the knowledge creation process. Tacit knowledge is converted and codified into documents, manuals. Writing is an example of such transformation. Externalization holds the key to knowledge creation process as it create new explicit concepts from tacit knowledge.

– **Combination**: Explicit to explicit. This process involve combining different bodies of explicit knowledge (documents, meeting, database). Codified knowledge resources (e.g. documents) are combined to create new knowledge.

– **Internalization**: Explicit to tacit. As explicit knowledge are now mostly tangible asset, they are used and learned, then that knowledge is internalized, modifying the user's existing tacit knowledge. It is closely like "What you have learned from reading a document."

2.4 Knowledge management system

Knowledge management systems can be defined as "a class of information systems applied to manage individual and organizational knowledge processes and flows. They include ICT-based systems that are developed and used to support and enhance organizational processes of knowledge creation, storage/retrieval, transfer, and application" (Carlsson, 2003). However, there is still not an universal definition that falls into consensus between scholars. Robertson (2007) argued that although an IT system assists, facilitate and enhanced the knowledge management process, but

knowledge management is not an information technology discipline. It is suggested that an knowledge management system should be extended beyond the traditional information system. In this paper, we view the term knowledge management system as an abstract and generic system that includes IT-based information subsystems and non-IT-based subsystem. In other word, this referred generic system is composed of people, tools, technology, and knowledge asset that interact with each other to store, create new knowledge, and provide available knowledge to individuals in an organization who need it.

As previously mentioned, IT tools are only one important aspect of a knowledge management system. Human interaction and engagement is required to create a working solution for any knowledge management initiative and implementation. Botha, Kourie and Snyman (2008) suggest that functionalities of a complete knowledge management system should be capable of:

– **Supporting of Knowledge Detection, Sensing & discovery, organization:** Searching for existing knowledge. If knowledge exists within the organization, it must be properly recognized, externalized and categorized before it can be reused or shared within a system. With explicit knowledge, IT based systems can be used to search for knowledge by looking at the database, patterns and text.

– **Facilitating collaboration, socialization and communication:** Dealing with tacit knowledge is a lot more complex. It is perceived to include cultural beliefs, values, attitudes, mental models as well as skills, capabilities and expertise (Botha et al 2008). knowledge management processes that are related to tacit knowledge requires socialization, collaboration, communication, and such activities can take place under many different forms (Davenport & Prusak, 2000).

– **Enabling participants to create, distribute, share and reuse the knowledge easily:** Once the new knowledge has been detected or created, there should be an effective tool to store, organize, share, retrieve and reuse it. The user friendliness and the experience of the interaction with a system plays an important role to encourage users to participate in knowledge management processes.

However, depending on the situation, there are a number of factors that might affect the processes of managing knowledge within an organization. Some researchers indicate that the failures rate can be up to 50%, or even higher, if including all projects that did not live up to the expectations (Frost, 2014). The causes of these failures range from lack of management support; improper planning, design, coordina-

tion and evaluation; inadequate skill of knowledge manager and worker; having problem with organizational cultural and structure; Disoriented implementation of supportive technology, budgeting and excessive cost.

3   CHALLENGING IN KNOWLEDGE MANAGEMENT PRACTICES WITHIN MARITIME INDUSTRY

Common challenges that can be recognized in the maritime industry that implicates the management of knowledge includes a highly diversified workforce, remoteness of working environments, multicultural crew members or employees, and fatigue phenomena. While onshore, MET institutions also encounter difficulties to manage knowledge due to lacking incentives of engaging in a knowledge management initiative, inadequate ICT technical skills, and monetarily budget allocation.

The maritime industry by its nature is international and employs a high level of workforce diversity across nations and cultures (Fei, Chen & Chen, 2011). In some researches, it is estimated that two thirds of the workforce is working in multicultural environment (Kahveci & Sampson, 2001). Not only that, people from different countries speaks different languages. Even though english is now a common working language onboard the ship, the ability to communicate in english can significantly vary amongst seafarers (Fei, Chen & Chen, 2011). Apart from linguistic factor, a tight working schedule and fatigue phenomenon discourage seafarers from communication and their contribution to the knowledge management related activities. Whenever the ship is at sea, it becomes an isolated world spatially and socially. Most seafarers carry out their watch duty alone, where one group has a different schedule from the others. The manning trend is also to reduce the number of personnel on modern vessels, which makes the working environment even more isolated. Even with the help of modern ICT applications, the social connection with the rest of the world and with the onshore organization is still limited. It can be recognized that such working environment reduce the likelihood of encouraging the seafarer to be an active part of a professional network either for socialization or learning purposes (Goel 2003, Mazieres et al. 2002).

The above factors work in combination to make the daily communication difficult and consequently hinder the socialization and the sharing process of tacit knowledge. From a knowledge management perspective, the knowledge creation mechanism as described through the SECI model can be compromised and the effectiveness of learning and training efforts are reduced. The socialization plays an important role for

transformation of tacit knowledge to happen. However, in order for new knowledge to be created and transferred, there should be interactions and conversions between tacit and explicit knowledge via the four processes of socialization, externalization, combination and internalization. Consequently, if a company invests in a knowledge management initiative, there is a challenge to get the active engagement of onboard participants, who are key for a successful implementation effort.

At shore, MET institutions also encounter challenges that can hinder knowledge management initiatives. Even though the importance of knowledge management has been acknowledged as a high level of priority, the implementation process is not always straightforward. Technically, some ICT skills and knowledge are often required in order for an instructor to successfully use a knowledge management system to codify, store, extract and share their knowledge. A MET institution itself is a non IT discipline, so when going beyond non-IT-based approaches (e.g. meeting, conference, socialization, etc.), most of the instructors and teachers need to be trained to use the IT-based tools properly. Difficulties in interaction with the technology discourage them to engage in any IT-based knowledge sharing activities.

Not only that, tight teaching schedules of teachers/instructors can also be seen as a barrier factor. The implementation of knowledge management involves many inter-related processes; creation, acceptance, adoption of values and procedures. It also requires strong guidance, support and cooperation across departments. Sometime teachers and instructors do not have time to participate actively in a knowledge management system or simply do not have time to manage the implementation of knowledge management or an effort of that kind in an institution.

Additionally, investing in a knowledge management solution is often expensive and there are limited effective assessment tools and mechanisms to evaluate the successfulness of knowledge management initiatives. The effectiveness of knowledge management has been recognized as notoriously difficult to evaluate, especially in monetary terms (Ahn & Change, 2004). The benefit that a well-working knowledge management implementation brings about is not something that is tangible. For some institutions, knowledge management must be linked to economics, and its value is expected to be readily apparent (Botha, et al 2008). In many cases, MET are from public sector with limited budget allocation which prevent them to invest excessively into such an fancy investment.

The factors mentioned above can weaken the knowledge management effectiveness. The activities of knowledge storage, sharing, and reuse can be hindered if the teacher and instructor have to deal with inappro-

priate tools or sophisticated technology. The process of externalization to convert what an instructor/teacher knows into a sharable system turn out to be a time consuming process. Weber (2007) warns that a knowledge management initiative risk failure when it is designed without input from stakeholders of an organization. Related work shows the correlation of employee contribution with the success knowledge management implementation (Frost, 2014). Having said that, providing a familiar application for knowledge management play critical role as it helps to encourage the user to participate in knowledge storing, organizing, retrieving, sharing and reusing activities.

4   SHOULD MET INSTITUTION START TO PLACE MORE EMPHASIS ON KNOWLEDGE MANAGEMENT?

Better utilizing intellectual property and promoting expertise exchange is a topic that has been discussed extensively within the MET discipline. Maritime industry has a very mobilized workforce, working in remote workplaces all over the world. In MET there is a shortage of experienced experts who have been involved extensively in real-world practice. Some experts work as instructors in an institution for a short period of time, then they leave for seagoing job. Such movement introduces challenges for knowledge management when it comes to manage the waste of intellectual property.

As previously mentioned, the importance of implementing ICT into educational activities has been widely recognized. There are also efforts in the knowledge management domain to encourage the contribution and facilitation of knowledge exchange within maritime knowledge community. There is a need to spark knowledge management initiatives by promoting collaboration, and expertise exchange between institutions, teachers and students. It is possible that MET institutions take the lead to create knowledge management supportive environment and nurturing knowledge sharing culture in the industry. A positive culture helps to encourage organizational member to share their knowledge as it strengthen trust (Davenport & Prusak, 2003), increase the willingness to accept knowledge and the ability to learn from their peers and group (Chua & Lam, 2005; Wu et al, 2010). A knowledge sharing culture also contributes to nurture informal communication, informal learning, openness to business process changes, and better reaction to external changes (Weber, 2007; Wu, Du, Li & Li, 2010). As a result, better knowledge management practices not just only benefit the METs themselves, it also helps to facilitate and nurture the knowledge sharing culture and knowledge sharing skills for a future workforce.

Secondly, future seafarers need to be equipped with contemporary skills and knowledge to handle dynamic change and uncertainty of working reality. At the same time, the faculty member of MET institutions should always find ways of upgrading and exchanging the knowledge and expertise with their students and their peers. Indeed, expertise exchange is crucial in MET. For example, it is important for a maritime expert, who is a maritime vocational instructor moving from shipboard operations to an academy simulation laboratory. It is also important for another "practice" faculty - a linguistic teacher who is moving from other university settings into the maritime education and training setting. There are always challenges of understanding and embracing the pedagogical and scholarly demands associated with a dynamic balance of theoretical and experiential education. In this case, an effective knowledge management help to better utilize intellectual assets, improving competitive advantage of a MET, and perhaps most importantly to help MET to keep up with the real-world practice. Studies show that that the successful management of knowledge resources can improve organizational productivity, service quality, promoting organizational innovation and uniqueness (Nonaka 1994, Grant 1996, Teece, 1998). A study of 443 company with more than 50 employee in New Zealand to examine the relationship between knowledge management implementation with the firm innovation and performance indicated that firms with knowledge management capabilities use resources more efficiently, more innovative and perform better than companies without a better developed knowledge management implementation (Pirkkalainen, Pawlowski 2013). Knowledge management via education and training should be no longer seen as an extravagance profit but as a necessities in order to keep up with changes and competitors (Wild, Griggs & Downing, 2002).

5   KNOWLEDGE MANAGEMENT AND ICT

With the fast advancement in ICT, including for example faster internet speed, the maturity of Web 2.0 platforms, online social networking, cloud-based technology, and their ecosystem applications, there are opportunities to tackle some traditional barriers to knowledge management practices. Throughout the literature, IT tools are being used and they play an important role in facilitating or enabling management practices (Alavi & Leidner, 2001; Wild et al, 2002). This paper proposes a framework which takes advantage of existing IT-tools and technologies. Its focus is around a core e-learning platform and its capability can be extended with the support of many other IT-based applications. These applications can be considered as being

familiar with contemporary youth generation and with most of MET instructors and teachers.

5.1 Using E-learning platform to foster knowledge management practices.

Investing in a knowledge management can be expensive and take a lot of organizational effort. When it comes to knowledge management tools that are available on the market today, literally there are thousand of options to chose from (Frost 2014). We made an attempt to synthesize the capabilities of existing open-source e-learning platform to an MET/industry organization's operational procedures and processes in combination with the use of other available IT tools, e.g. Content Management System (CMS), WIKI, Cloud storage, etc. From that feasibility assessment, we propose a conceptual E-learning based knowledge management system model. The main goal is to utilize already established ICT facilities to improve and foster knowledge management practices in MET/industry organization in a cost-effective and scalable manner.

5.2 Why E-learning?

E-learning can be a way to empower a workforce with skills and knowledge (Wild et al, 2013). Taking advantage of E-learning systems in knowledge management is not a new occurrence. E-learning as a core platform of knowledge management systems has been used and deployed by many major corporations. CISCO System and McDonald's are just two examples of companies that promote and integrate E-learning as a core system for its knowledge management strategy (Cisco System, 2001; Wild et al, 2013). This coupling is due to the fact that E-learning and knowledge management processes have many attributes in common. Many basic knowledge management processes can be mapped onto an e-learning's basic courses, lesson units, and functions. The accessibility to internet and faster connection speed also make E-learning a viable solution that allow organizations to deploy learning and training to their workforce anytime, anywhere and enables an organization to share the knowledge across a distributed network. That also allows employees to take on learning activities in a flexible manner alongside with their daily work. This feature is important from a practical knowledge management perspective. When a real-world problem is successfully solved, its relevant know-whats and know-hows can be saved into a knowledge repository for later reference, sharing and reuse. At the same time, the processes of externalization and combination as described in SECI model occurs when one tries to convert knowledge from experience, skills and other relevant explicit knowledge (e.g. reference documents) into some tangible

things as a learning objects. During such interacting processes, new knowledge can be created too. The point is, there should be a learning system available in place and in time that is easy and familiar to interact with. As with most educational and training institution, E-learning can be considered an essential and a familiar system.

The functionalities of an E-learning system permit the capture, storage and dissemination of learner's insight and expertise through rich media resources (audio, video, textual material, written guideline and documentation). Toward organizational knowledge creation, e-learning is a promising means to manage intellectual assets (Wild et al, 2002). For example, operational processes can be mapped into an e-learning course and lesson that help an organization to improve the skills of their workforce or creating a training portal for new workers as an internal training portal that store organizational knowledge (see Figure 4 and Figure 5).

If properly deployed, an e-learning system can become a growing-knowledge-repository that enables MET to continuously deliver the organizational knowledge to their employees with "what they need to know" at "when they need to know".

Additionally, there is a need for an MET institution to keep up with the industry with the ever changing real-world environment. An E-learning based knowledge management system that is accessible over the internet will enable an organization to train, educate and support their workforce, partners, customer and other stakeholder. In return, an institution can generate more knowledge through the use of that system as well as benefit from the information and knowledge gained from their knowledge partners.

Fortunately, the recent development of many web-based platforms and its applications, cloud technology, interoperability of databases, online social network have empowered an e-learning system with even more features. Figure 3 describes a framework of an e-learning based knowledge management system.

In the framework, the core is powered by an E-learning system which acts as intermediate interface that allows users to interact with the knowledge management process (knowledge discovery, detection, organization, assessment, and knowledge sharing reuse, creation, acquisition, sharing). For example, via its capability of creating an online training course, it can be used to support an effort from human resources of providing an internal training program to the employee. Surrounding that activities, existing explicit organizational knowledge (e.g procedures, policies, documents, etc.) can be made available and transferred to the people who need it. By interacting with the system (creating lessons, searching for available resources, etc.), the knowledge conversion processes (e.g. combination and
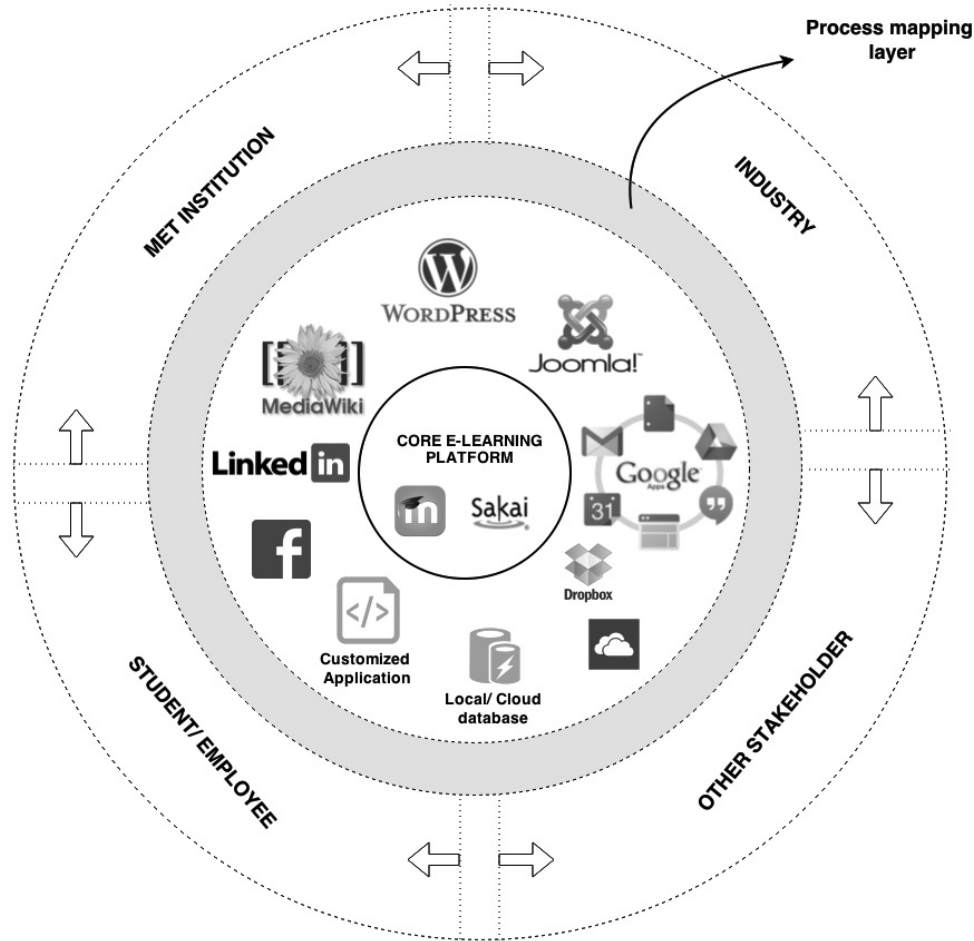
Figure 3 Framework of E-learning based knowledge management

Source: Authors

Figure 4 An internal training unit can be planed
as structural lessons

Source: Authors

Figure 5 Within each section, explicit knowledge such as documents,
reference material can be linked from various locations and sources

Source: Authors

externalization) are taking place within an individual, and therefore facilitate the creation of the new knowledge.

A part from the core layer, other supportive applications such as Web 2.0 Content management system (CMS), cloud-based applications and online social networking are positioned as useful tools to assist knowledge management practices of an organization (Sultan, 2012). In-house content management and database access are often difficult and complicated to maintain, deploy, administer and inflexible to the rapid changing real world practice. Such technical limitations translates into significant planning, design, implementation challenges and increase operational cost that discourage many knowledge management project (Sultan, 2012). When acting in combination, the two inner layers can complement each other and contribute to addressing traditional barriers of knowledge management practices. Online social networking tools make it easier for anyone to feed information from their professional network, contribute to knowledge creation, sharing and forming an informal learning environment. It is easier than ever before to share a content of any kind from a website or from any CMS system over an online social network (see Figure 6).

Being web-native, these systems can work together and facilitate sharable mechanisms that extend the capability of an E-learning system. For example, within a lesson of an E-learning course, any reference and learning resources can be linked to any webpage that is located in cloud storage. For example, in figure 5, a cloud-based google document can be embedded inside an E-learning lesson unit and allow its authorized users to directly access, edit and collaborate without relating to the actual original location within the file repository. Figure 6 describes an inter-link capability that an E-learning system can benefit from these technologies. The web-native characteristic of these systems provide

Figure 6 Information from a webpage or a CMS system can be easily embed in a social network (Facebook) post and shared across any interested group of people. Such post in a social network can also be linked back any other CMS or E-learning system.

any particular content an Uniform Resource Locator (URL) link that other systems easily can reach, reuse, and embedded. In other scenarios, the web-native social network feature enables an E-learning based knowledge management system to link directly to a social network page of an expert or an informal professional social network group. From there, the learners can contact, connect and seek support directly from that professional network. The created knowledge from that process can be updated back to the system for storage and reuse. In figure 6, any newly updated information from Facebook social network hosted by an institution or an informal professional network instantly are updated to author's personal feed. Each of these feeds, social page of an organization or group have an unique web-friendly URL that allow any web-based system to connect to and embedded in.

These sharable mechanisms allow any MET institution, industry, informal professional network and other stakeholder to share, contribute and collaborate on common knowledge artifacts and exchange expertise with ease. If it is successfully implemented, an organization from the industry can assist its project partners, workforce and contribute their applicable knowledge back to a MET by providing an access or a sharable training course. With other knowledge management scenarios, a MET community can take advantage of such technology leverage to promote and improve its internal and external knowledge management practices.

6 CONCLUSION

The importance of knowledge management for an organization to innovate and create a competitive advantages has been widely recognized. The capabilities of today's ICT and its potential applications provide MET opportunities to better cope with knowledge management practices internally and externally. E-learning is an important system to any educational and training institution, and can contribute to enhance the organizational knowledge management practices. In this paper, a framework has been proposed that positions an E-learning system at its core with the support of many other web 2.0 applications and cloud-based technology. It enables real-world processes to be mapped with E-learning courses and lesson units. The framework intends to lower the barrier of using an E-learning system for teachers and instructors and encourage them to engage into knowledge management initiatives. The successful of knowledge management solution require a systematic analysis and design, and the proposed framework needs to be taken into consideration and experiment in order to meet the complex need of particular setting.

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