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The Role of Information Technology for Knowledge Management Paradigm in Higher Education

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Abstract — The recognition of knowledge as a critical organizational resource that provides competitive advantage has led to the increasing practice of knowledge management in business organizations as well as higher education institutions. Since the main asset of higher institutions is knowledge of individuals, knowledge management activities should be formally recognized as a new paradigm that can contribute to knowledge creation. The role of information technology (IT) in knowledge management is an essential consideration for higher education institutions wishing to exploit information technologies to manage their knowledge assets. Considering that there are various types of information technology solutions for knowledge management, there is a need for higher education institutions to understand the role of information technology for various KM solutions. This paper presents some concepts of knowledge management applicable to higher education institutions, identify the current information technologies or infrastructure that can contribute to knowledge management, and describe the role of information technologies for knowledge management in higher education institutions using Nonaka and Takeuchi's SECI model. Some challenges in implementing KMS are also discussed. This paper aims to shedlight on the roles of information technologies for knowledge management for higher education institutions, and their challenges and thus, can assist stakeholders towards KM initiatives in higher education.

Keywords – Higher education; information technology; knowledge management; challenges

1. INTRODUCTION

The recognition of knowledge as a critical organizational resource that provides competitive advantage has led to the increasing practice of knowledge management in business organizations. The term "knowledge is power" has been used in organizations to reflect employees' knowledge as the critical assets in organizations. KM has become the major driving forces of organizational change and wealth creation and the company that utilizes knowledge of their employees and recognizes it as an intellectual capital has competitive advantage. KM, defined as the systematic way of managing knowledge that includes processes of creation, storage, use, dissemination, and application of knowledge has been adopted by business organizations as a new management paradigm, and is considered the main competitive tool [1]. Universities and other higher education institutions, whose core activities are associated with knowledge creation and dissemination and learning, can be categorised as knowledge-based organizations. It is reasonable to see higher education to be in this global knowledge-based society, and therefore, consider KM as their new management paradigm.

The attention to KM by most of the organizations has also been attributed to the emergence of new information technologies (IT) thathave improved the efficiency and effectiveness of KM processes.The importance of IT in facilitating knowledge management processes in organizations has gained attention in previous studies [1][2][3][4]. Edwards, Shaw, and Collier [2] conducted studies on the role of information technology in knowledge management to computer-supported groups and found that general information technology tools such as email, video-conferencing, and electronic discussion forum do play effective role in knowledge creation. Based on the literature study and previous studies of IT in KM, the present study defines information technology for knowledge management includes any tools, applications, hardware and software that are used for KM solutions [4]. Based on authors' experience who are currently employees in one of the universities in Malaysia, most Malaysian universities have infrastructure, such as Internet that enable sharing of knowledge among employees and have potential contribution towards efficient and effective knowledge management. This paper intends to shed lighton the role of information technologyto enable free flowing of knowledge in higher education institutions that may contribute to efficient and effective use of KMS among their employees in particular, researchers, lecturers, and students. This study adopts Nonaka and Takeuchi's model [3] as a guideline to discuss types of information technologies that can be used for knowledge creation or transformation.

2. KNOWLEDGE MANAGEMENT IN HIGHER EDUCATION

Davenport et al. [4] defined knowledge management as the exploitation and development of the knowledge as assets of an organization to achieve organizational goals. Like any other resource, knowledge is viewed as a resource that is vital to organization's survival and success especially in the 21st century. The knowledge-based view of the firm suggests that intellectual resources are key organisational assets that enable sustainable competitive advantage [5]. The recognition of knowledge as assets that need to be properly managed, has led many organizations to be involved in a new management concept called knowledge management (KM). KM has been a discipline that brings together people, processes and technologies, which enable the creation, capturing, transfer and application of knowledge-based assets [1]

Knowledge can be divided into explicit and tacit knowledge. Tacit knowledge is know-how, skills and experience embedded in the minds of individuals, and it is difficult to put into words, thus making it difficult to communicate or share with others [6][3]. Tacit knowledge can only be transmitted through direct interaction between transmitters and receivers of knowledge, for example, through training, meeting or personal experience. Knowledge and expertise of lecturers and students learning are examples of tacit knowledge. Since tacit knowledge has high value, Nonaka and Takeuchi [3] believe that in order for an organization to leverage its knowledge, tacit knowledge should become explicit. Thus, the goal of KM is to convert tacit knowledge to explicit knowledge [1][3][4]. Explicit knowledge is tacit knowledge that is formalized, well-documented, archived, codified and easily accessed by others [7][3]. It is a 'know what' knowledge that is objective in nature.

Higher education institutions are places where creation and transfer of knowledge occurs dynamically between students and lecturers as well as among other academicians. The role of universities and higher education institutions in providing knowledge and learning in various disciplines may put them as knowledge based organizations. They offer high quality programs to students who, after graduation are expected to be able to create new knowledge and be innovative in inventing solutions to problems.Universities' assets are mainly from knowledge of lecturers, students, and researchers, and thus, sharing of knowledgehas traditionally existed a long time ago. Since a formal KM was introduced and discussed in business organizations, its adoption and implementation in universities and higher education has recently been given wide attention in previous studies[8][9][10][11][12]. These previous studies were looking into how KM can fit into higher education institutions. In other studies,Basu and Sengupta [13] conductedan exploratory studyto investigatethe factors that influence the success of knowledge management initiatives in a business schoo in India. Ramakrishnan and Yasin [14] conducted a study on the uses of KMS among academic and non-academic in Malaysian universities using quantitative and qualitative study. They explored the perceptions of academic and non-academic staff on how KMS can benefit their institutions. Lundberg [15] conducted a literature study on the relevance of KM in higher education by looking at the properties and processes of KM that can make higher education as knowledge intensive organisations. These studies focused not only on academics but also non-academic such as administrators that include registrar, human resource, and finance departments. What makes these studies different from the present study is they did not discuss specific roles of the use of information technologies or their applications in higher education institutions. Their emphasis was on the foundation of KM, and the areas where KM can be applied. The present study fills this gap by exploringthe roles of information technology and its application for managing knowledge among researchers, academicians, and students.

Rowley [8] described four objectives of KM in higher education through the lens of Davenport et al.'s KM objectives [4], which are to create knowledge repositories, improve knowledge access, enhance knowledge environment, and view knowledge as an asset. Through these objectives, knowledge management activities can be created and disseminated in order to promote organizational learning, information sharing and knowledge empowerment to improve organizational performance. The implementation of KM may contribute to new knowledge creation and is able to preserve organizational assets for knowledge optimization and to use that knowledge for teaching and learning[10]. The concept of student-centred learning in universities where students' are expected to be more proactive in sharing their knowledge may take advantage ofcapabilities of KM. KM can also benefit higher education through effective mechanisms in better quality and effective knowledge delivery, and development of human capital in order to enhance knowledge investment in the organization [16]. Higher education organizations implementing knowledge management initiatives would be able to identify expertise amongst their resources, characterize information to be used as education strategies and learn from previous success stories and failures with regard to the education system [17]. A recent study conducted by Sonsangyos [18] states that knowledge management in the universities has to be developed and supported in various ways namely through organizational leadership. There is a need for a knowledge management champion in order to create a learning organization hence the benefits of knowledge management can be realized. In a global competition, the efficient and effective use of KM would need to be driven by information technology. It is intention of this study to propose the use of IT for effective and efficient KM by utilizing the Nonaka and Takeuchi's SECI model as a guide.

3. INFORMATION TECHNOLOGIES (IT) FOR KNOWLEDGE MANAGEMENT

Leveraging knowledge effectively requires the use of IT, and thus, universities and higher education institutions need to begin harnessing those technologies to realize the potential capabilities and value of KM. Although KM in organizations is more than just implementation of IT, it requires IT as enablers that can promote knowledge creation, store, distribute, and retrieve knowledge for reuse. These activities of KM cannot be achieved without IT as enablers in this 21st century where the need for rapid access for relevant knowledge is rising tremendously. It has been found in the literature that organizations use various IT such as collaborative information and communication systems [19] , electronic knowledge repository (EKR) [20], and electronic networks of practice using technologies such as websites, electronic bulletin boards and e-mail [21] that have functions to enable communication between employees for knowledge exchange. Some organizations use intranet, data warehouse, knowledge repository, decision support tool and groupware for implementing KM which enable knowledge to be communicated and stored for reuse. The goals of these technologies are to support and enhance the organisational processes of knowledge creation, codification, and utilization [1][22].With the capabilities of IT in managing knowledge, they are no longer used as only database; they provide the capabilities of exchanging documents, and allowing interactions by connecting individuals in the organizations in a faster way, which increase knowledge sharing. IT enable organizations to convert tacit knowledge to explicit knowledge so that knowledge is accessible to other organizational members. The term used for IT-based systems that is used to support KM processes is knowledge management systems (KMS). While some companies feel that KMS systems are classes of information systems, others described KMS as any information technologies that enable sharing, and exchanging of knowledge such as email, discussion forums, and video conferencing [23].

Alavi [24] described the functions of KMS correspond to two models: the repository model and network model. The repository model views knowledge as an object and emphasizes the codification and storage of explicit knowledge such as memos, reports, presentations, organisational routines or discussion databases where contributors record their experiences and react to others' comments, which later are accessible to others [24]. With regards to this model, creating repository is one of the objectives of KM projects [4]. Knowledge repositories are used to store (1) external knowledge, for example, competitive intelligence; (2) structured internal knowledge, such as manuals, and reports; and (3) informal internal knowledge like discussion databases that contains lessons learned, and the best practice. The repository model keeps tacit knowledge such as experience and expertise that has been codified or explicit knowledge such as organisational routines, processes, practices, and norms [25][26]. In this model, knowledge is transferred from person to repository and repository to person. Conversely, the network model enables direct exchange of tacit knowledge, which sometimes inaccessible via explicit knowledge. The network model is to connect person-to-person for knowledge exchange [24] and to point to a person possessing knowledge. The network model is useful when explicit knowledge is not understood by the user of knowledge, and therefore requires social interactions and direct communication among individuals. Yellow pages, corporate directories, or knowledge maps are examples of network model[2][27]. These examples of network model provide the database on experts profiles and their expertise for use by those who need to get direct feedback from those experts. The function of this network model in the organization is to improve knowledge access, where knowledge can be accessed by locating the experts and seeking for their expertise to solve problems. For example, at Teltech Resource Network Corporation, the expert network provides a technical expert referral service by maintaining a comprehensive database of external technical experts [4]. Any knowledge on technical domains can be acquired by contacting the experts in this network. To encourage their employees to use the expert network, Techtech pays its employees to participate in the network. At the Chevron Corporation, an intranet was used to provide a pointer database that would allow users to identify potentially helpful individuals named on the system and encourage follow-up off-line [28]]. Both repository and network model enable both tacit and explicit knowledge to be shared. Table 1 presents the list of IT that can be categorized into these KMS models.

TABLE 1: List of information technologies for knowledge management

KMS Types	KM-related Technologies and Tools	A&L[1]	Bhatt[2]	Bowman[3]	Duffy[4]	Earl[5]	Gallupe[6]
Network Model	Email						
	Yellow pages of experts, corporate directories, knowledge map					√	
	Groupware;Electronic discussion forums		√	√	√	√	√
	Electronic Bulletin Board	√	√		√	√	
	Videoconferencing	√	√		√		
Repository Model	Knowledge portal, blogs			√	√	√	
	Database; data warehousing				√		√
	Document/knowledge repository	√		√	√	√	√

Notes: [1]Alavi and Leidner [1], [2]Bhatt et al. [16], [3]Bowman[17], [4]Duffy[7], [5]Earl[18], [6]Gallupe[23]

4. ROLES OF IT FOR KM IN HIGHER EDUCATION— APPLICATION OF NONAKA AND TAKEUCHI'S MODEL

The role of IT in higher education institutions should be expanded to enable more opportunities for lecturers, researchers, and students to have global collaboration with other institutions. In general, universities have been using a lot of data and information that are accessible in information systems. The universities mostly have implemented network technologiesto enhance ease of access of documents such as policies, and reports by making them available on corporate intranet. Communications between lecturers and students are through electronic mails. Although these technologies are now common in universities, they are not formally recognized as KMS. KMS requires not only IT as enablers but also organizational processes, procedures and people who create and use knowledge. For higher education moving towards KM initiatives, it is important to recognize the potential of currently available technologies and maximize use of them so that organizations can minimize the capital costs and at the same time enhance organizational performance.

Nonaka and Takeuchi's SECI model [3] is the most widely discussed theories in KM literature. Based on empirical evidence in case studies of Japanese firms (Honda, Canon, Matsushita, NEC, Sharp, and Kao) and with the intention to develop a new theory of KM, the model, namely SECI was constructed. SECI is a model from the combination of the words socialization (S), externalization (E), combination (C), and internalization (I) and it focuses on the distinction between tacit and explicit knowledge. Based on SECI model, four different modes of knowledge conversion are introduced (Figure 1): 1) socialization (from tacit knowledge to tacit knowledge); 2) externalization (from tacit knowledge to explicit knowledge); 3) combination (from explicit knowledge to explicit knowledge); and 4) internalization (explicit knowledge to tacit knowledge)

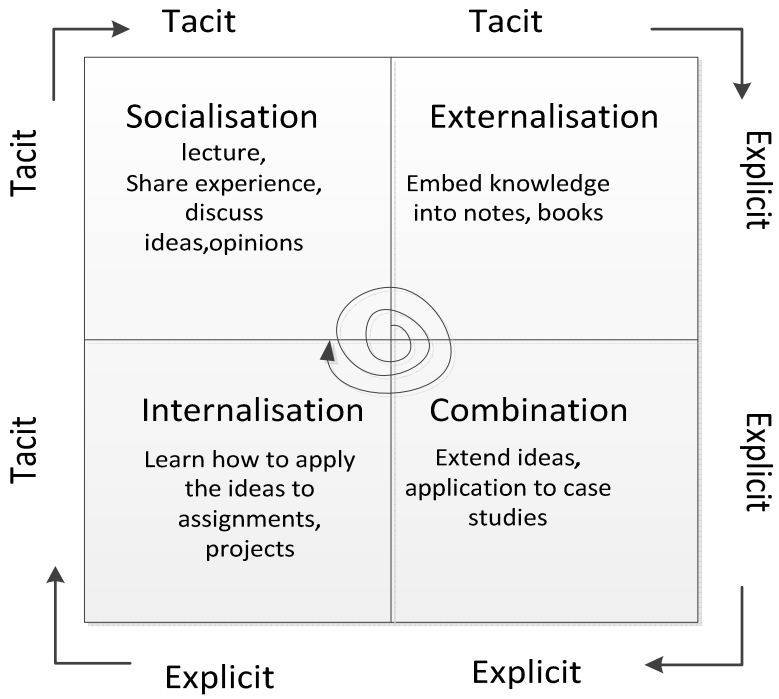

FIGURE 1: Nonaka and Takeuchi's SECI Model [3]

Nonaka and Takeuchi's SECI model is helpful in providing insight into a wide range of issues related to knowledge creation process. It is a generic model that can be modified and used to fit into various industries including higher education institutions. As Nonaka and Takeuchi's SECI model describes processes in knowledge transformation or conversion from tacit knowledge to explicit knowledge, this model is applicable to be used for identifying types of IT to fit each KM conversion process because for each process, different types of IT are needed. Furthermore, each of them may have different functions for use with different types of knowledge. In this paper, we aim to shed some light on various uses of IT for different mode of knowledge conversion based on Nonaka and Takeuchi's SECI model [3].

A. Socialization (tacit to tacit)

Nonaka and Takeuchi described that socialization is when individual shares tacit knowledge directly with another or face to face interaction such as through observation, imitation and practice. Socialization enables the capture of what everybody knows and to connect people who know. Through this activity, good practices and experiences can be captured and a team of knowledge assets can be built. In higher education institutions, among the key stakeholders are: 1) researchers, who discover new ideas; 2) lecturers; and 3) students. There are other stakeholders such as universities administrators.

Among the activities involve during socialization between lecturers and students are lecturers give lecture in a class, and students participate by asking questions, and have some discussions on the subject matter. During this process, knowledge is mainly transferred via direct interactions between the lecturer and the students. A network model of KMS is suitable for socialization mode or tacit-to-tacit knowledge transfer. For example, video conferencing can be used for transfer of knowledge between lecturers and students for long distance communication such as distance learning or virtual postgraduate supervision. Lecturers can benefit the use of video conferencing to conduct external examination with other universities without being physically present and thus, save cost of travelling. Any questions related to the course can be further discussed in electronic discussion forum, and any announcement can utilize electronic bulletin boards. For researchers, knowledge map or experts' profiles enable the experts and their expertise to be available online and accessible by postgraduate students looking for supervisors or external collaborators.Another is to construct a network of experts,that is called Community of Practice (CoP) using Internet. CoP can link academicians across sites, divisions, countries and functions. For example, lecturers teaching programming languages can have their own CoP worldwide to discuss the best way to improve programming among students. The CoP enables academicians to construct and access to accumulated knowledge of experts directly.

B. Externalization (tacit to explicit)

To leverage knowledge to the whole organization, tacit knowledge has to be converted to explicit knowledge; this is called externalization. Externalization enable the "know-how" knowledge that is gained through socialization be documented. Tacit knowledge is converted to explicit knowledge and explicated, codified and stored in knowledge repository for easy access by others so that the knowledge can be reused. To have effective knowledge transfer, and to avoid loss of knowledge during tacit to tacit knowledge transfer, for example, lecture, it is possible to record knowledge. Lectures can be recorded, stored and uploaded in Youtube that is made accessible only for those students that are taking the course. For faculties, knowledge repository can store rules, policies, solutions, work flows, and processes that can be accessed anywhere anytime they are needed. Administrative rules, courses for undergraduates and postgraduates, and program requirements can be stored in knowledge repository. Every new semester, the knowledge repository can be accessed to retrieve program requirements for students' enrollment. Any addition or modification of the program can be updated in knowledge repository. Other internal knowledge such as research reports, and the result of discussion by academicians in workshops can be stored in knowledge repositories. Knowledge repository can act as a knowledge-base for keeping keynote speech, the universities conference publications, and any publications that were published in conferences and journals by academic staff as well as students' thesis and final year projects.

C. Combination (explicit to explicit)

At this stage, individuals exchange and combine knowledge through exchange mechanisms such as discussions on the existing explicit knowledge. As a result of discussions, the existing knowledge is modified, updated,improved and combines with other knowledge to create new knowledge. Blogs, electronic document management systems, and portals are examples of repository where knowledge can be stored. Every semester the lecturer teaches the course, and he or she may have different students. In class activities, the students discuss, and provide the solutions for every assignment given to them. The students may have to do research for their assignments. Through this process, new knowledge is discovered, and the combination of knowledge of different students may create new knowledge, which is later updated in the course for the following semesters. The old knowledge created previously and the existing knowledge may be kept in the repository for reference by other lecturers and students. New knowledge keeps on growing that can lead to more innovations. The readily available knowledge of lecturers in repository such as ebook, or youtube, will be updated based on feedback from students. A lecturer can create his or her portal to transform all his or her teaching documents that include notes, syllabi, assignments, grades, case studies, and references specifically for the courses. Any lecture notes can be transformed into ebook. Blogs can be used by lecturers toshare their experiences about students' common problems, and how they solve them. Sharing knowledge via blogs in a form of story telling may attract students and other lecturers to read and provide comments. Electronic document systems are useful for storing syllabus of all courses, thus the easy access of syllabus could improve speed of curriculum revision and updating. Students' performance analysis and historical records on students' performance can be stored electronically and reused for analysis to further improve their performance. Solutions for problems faced by students (lessons learned)can be documented so that any same problems occur can refer to the solutions, hence reducing efforts in reinventing new solutions.For researchers, having electronic document management systems may help them store and keep track their publications. When their expertise are made available online, it is easy for external collaborators, post graduate students and industries to contact them, which open doors for them to be recognized globally.

D. Internalization (explicit to tacit)

The internalization of newly created knowledge is the conversion of explicit knowledge into tacit knowledge. At this process, knowledge required from sources such as books, and publications is internalized and transformed into actions or practices in the organizations. The process of conversion from explicit to tacit is the opposite of conversion of knowledge from tacit to explicit but the technologies used are the same. Conversion of explicit knowledge to tacit knowledge in higher education is when lecturers incorporate lessons learned and students' evaluation and form into action such as more exchange of knowledge via electronic discussion forums. For researchers, the accumulation of knowledge acquired in publications help more new knowledge be created and new ideas produced. The sharing of tacit knowledge can be conducted in a form of presentation in virtual conferences.

Tacit to Tacit Knowledge Via Socialization	**Tacit to Explicit Knowledge Via Externalization**
Lecturer shares tacit knowledge with students directly through face to face interaction such as through discussion, observation, imitation and practice ***Information Technology:*** *video conferencing* – distance learning ,virtual postgraduate supervision *Internet*- Community of Practice (CoP) *Knowledge directories*- consultation, advice *electronic discussion forum/ collaborative tools* - exchange of ideas and allow that ideas to be stored for later retrieval	Articulate tacit knowledge about academic, research and administration procedures into explicit form via policy, models, reports and etc. (e.g administrative rules, program structure for undergraduates and postgraduates, and program requirements) ***Information Technology:*** *Knowledge repository*- store rules, policies, solutions, work flows, processes, research reports, the result of discussion by academicians in workshops
Explicit to Tacit Knowledge Via Internalization	**Explicit to Explicit Knowledge Via Combination**
Consolidate knowledge gained and internalize the knowledge by embedding own's beliefs and values. Associated with the learning process and making use of that knowledge. ***Information Technology:*** *electronic discussion forum/ collaborative tools,* *Blog – story telling method of sharing experiences* *social media*- opinions, ideas and feedback	Knowledge are combined, analyzed, rearranged, added, categorized, and exchanged via students' performance analysis, end of semester report, assessments strategy (e.g assignment, final exam, lab exercises, class project) ***Information Technology:*** *Portal* *Blogs* *Electronic document management systems*- access information, store new knowledge

FIGURE 2: The roles of information technologies for each method of knowledge conversion in SECI model

Various types ofinformation technologies and their applications that are currently available in higher education institutions can be used to support implementation of KMS, hence supporting a dynamic process of knowledge creation. The implementation of KMS can complement the adoption of the learning management systems (LMSs) in higher education institutions to support teaching and learning processes. LMS is a comprehensive and integrated application of technology to manage the knowledge used in teaching and learning.In Malaysia, LMS has been widely used higher in universities for managing learning resources. In 2011, 26 higher education institutions in Malaysia already have an LMS, and most of them (57.7%) are using Open Source platforms while 34.6% purchased commercial LMS and 15.4% developed their own [29].However, in the current higher education scenario, the LMS, is still focused on the mechanical aspects of learning, such as content delivery and assessment [30], undermining the full potential that the system can bring to the community of practice in higher education. Hence, the challenge lies in the efforts to design systems that are focused on more important aspects of managing the knowledge assets of the institutions by providing the tools to support the knowledge processes in teaching and learning. Therefore, it is foreseen that the implementation of KMS will be able to support the effectiveness of LMS in contributing to improvement in teaching and learning.

5. CHALLENGES

The implementation of information technologies for KM in higher education will face challenges like other organizations on account of human nature, organizational hierarchy, and culture of organizations. Although information technologies play important roles for KM, effective knowledge management may require significant change in culture and values, organizational structures and reward systems for successful KM. Effective implementation of KMS requires commitment from researchers, lecturers, and students and other stakeholders to be willing to share and retrieve knowledge via information technologies recommended in this paper. Resistance to change, lack of commitment and lack of cooperation from members of faculties are traits of human nature that will pose a challenge to higher education to implement KMS. One of the reasons could be a nature of higher educations where knowledge represents the power of individuals, and therefore, losing tacit knowledge may threaten their positions. Thus creating knowledge sharing culture will be a challenge to higher education institutions.

Implementation of KMS is a challenging job whereby use of information technologies that allows access to knowledge anywhere, anytime requires changes in security policies to avoid misuse of knowledge. Certain procedures, and work flow may be affected that involves many people and processes, and thus creating pressures to the staff and hence low commitment to use of KMS.

For successful KMS implementation in higher education, motivating users (researchers, lecturer, and students) to contribute to KMS is a critical success factor. Commitment from leaders, provision of incentives and knowledge sharing culture from "my knowledge" to "our knowledge" and high quality of KMS may contribute to the successful implementation of KMS in higher education institutions [31].

6. CONCLUSIONS

The objective of this paper is to discuss the roles of information technology for knowledge management in higher education institutions based on Nonaka and Takeuchi's model [3]. For each conversion of knowledge, information technologies are proposed for use by higher education institutions. The roles of information technology discussed in this study are to fulfill four objectives of KM: to create repository, to improve knowledge access, to enhance knowledge environment and to recognize knowledge as intellectual capital. Some challenges may be faced by higher education institutions for successful implementation of KMS are discussed. This paper provides insights to higher education institutions on the roles of information technologies for knowledgement and thus, enables these organizations to maximize use of their current information technologies for managing their intellectual assets as well as to have proper planning on successful KMS. Future work will look into factors that may contribute to the success of KMS by collecting empirical data among academicians, and a new framework will be developed to support the effective use of recommended information technologies in this study.

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