Development and Application of a General Knowledge Management Maturity Model

Huan Ying Teah
Cisco Systems
huanying@gmail.com

Loo Geok Pee
National University of Singapore
peelooge@comp.nus.edu.sg

Atreyi Kankanhalli
National University of Singapore
atreyi@comp.nus.edu.sg

Abstract

This paper reviews, compares, and integrates existing Knowledge Management Maturity Models (KMMM) to propose a General KMMM (G-KMMM), which focuses on assessing the maturity of people, process and technology aspects of KM development in organizations. An accompanying assessment tool is also developed to facilitate practical application. The utility of G-KMMM is explored in a case study of a large public university's KM efforts. Findings indicate that KM maturity modeling can serve as a useful tool that describes and guides KM implementation effort by providing a clear description of the current status and indications of the way forward. Avenues for further research and practice are discussed.

Keywords: Knowledge Management Maturity, KM Assessment, Case Study

1. Introduction

In today's volatile competitive environment, Knowledge Management (KM) has become one of the most sought-after capabilities by many forward-looking organizations. As investments in various KM initiatives inflate, the call for coherent and comprehensible principles and practices to guide KM implementation efforts has increased. To address these needs, researchers and practitioners have proposed maturity modeling as a way of formally describing the KM development process by assessing the extent to which KM is explicitly defined, managed, controlled, and effective (e.g. Klimko 2001; Kulkarni and Freeze 2004; Kulkarni and St. Louis 2003; Paulzen and Perc 2002). While several KM maturity models have been proposed, a consistent view on how an organization's KM maturity can be assessed and determined remains elusive. Recognizing this gap, we attempt to address the following research question: *How can an organization's level of KM maturity be assessed?*

Also, the proliferation of many different KM Maturity Models (KMMM) adopting different definitions and assumptions has made their selection and application difficult. In addition, many of them have been criticized as ad-hoc in their development (Kulkarni and St. Louis 2003). Hence, an objective of this paper is to review and compare existing KMMMs. They are then integrated to develop a General KMMM (G-KMMM) that will provide clear definitions for important concepts as well as provide an assessment instrument for evaluating organizations' KM maturity level. To demonstrate the utility of the proposed G-KMMM, we apply the model to assess the KM maturity level of a large educational organization.

The expected contribution of this study is three-fold. First, as KM implementation involves significant organizational change in process, infrastructure and culture, it is unlikely to be achieved in one giant leap. The complexity of change involved in KM can be especially inhibiting to organizations new to KM. In this respect, the staged G-KMMM provides a general understanding and appreciation of gradual and holistic development of KM. It can serve as a roadmap that steers the implementation effort by providing a clear description and indications of the way forward. Second, for organizations that have implemented some form of KM, G-KMMM can support the ongoing development of KM by systematically analyzing their current level of KM maturity. The assessment instrument provided along with G-KMMM can also serve as a diagnostic instrument pinpointing aspects that necessitate improvement. Third, by integrating existing KMMMs and clearly defining important concepts, G-KMMM can potentially serve as a common model facilitating communication and improving understanding among researchers and practitioners.

2. Review of Knowledge Management Maturity Models (KMMM)

Maturity models describe the development of an entity over time, with the entity being anything that is of interest. In general, maturity models have the following properties (Klimko 2001): i) The development of a single entity is simplified and described with a limited number of maturity levels; ii) Levels are characterized by certain requirements, which the entity has to achieve on that level; iii) Levels are ordered sequentially, from an initial level up to an ending level (the latter is the level of perfection); iv) During development, the entity progresses forward from one level to the next. No levels can be skipped.

In this paper, the entity of interest is KM. KM refers to the process of identifying and leveraging the collective knowledge in an organization to help the organization compete (Alavi and Leidner 2001). Adapting Paulk et al.'s (1993) definition of process maturity to the KM context, we define KM maturity as the extent to which KM is explicitly defined, managed, controlled, and effective. The KM maturity model of an organization thus describes the stages of growth that the organization can be expected to pass through in developing KM.

In building an ideal KMMM, researchers have specified several requirements that need to be fulfilled: First, the model should be applicable to different objects of analysis, e.g. organizations as a whole, organizational unit, or KM systems (Ehms and Langen 2002). Paulzen and Perc (2002) suggest that one way to achieve this is to focus on processes rather than specific object of analysis. Second, the model should consider the views of different participants (Ehms and Langen 2002). Specifically, Paulzen and Perc (2002) suggest that employees need to be involved in the assessment of KM maturity. Third, the model should provide a systematic and structured approach which ensures transparency and reliable handling of the assessment procedure (Ehms and Langen 2002). Similarly, Paulzen and Perc (2002) have also emphasized the importance of measurement and standardization. Fourth, the model should provide qualitative and quantitative results (Ehms and Langen 2002). Fifth, the underlying structure of the model should be comprehensible and allow cross references to proven management concepts or models (Ehms and Langen 2002). Last, the model should support continuous learning and improvement (Paulzen and Perc 2002).

In reality, it is unlikely that a single KMMM can satisfy all these requirements. One reason is that some of the requirements may be in conflict with each other in implementation. For example, Ehms and Langen (2002) suggest that the model should ideally be applicable to different objects of analysis (requirement 1). This may call for higher level of flexibility in formulation of the model and consequently result in a less systematic and structured assessment approach (requirement 3). Another example is that the ideal model needs to consider the views of different participants (requirement 2). This is likely to increase the complexity of the model and reduce its comprehensibility (requirement 5). Hence, the next best alternative to an ideal model is one that strikes a balance between these requirements.

In the course of our research, we have identified nine existing KMMMs. These KMMMs can be further categorized into two groups, depending on whether or not they are developed based on Software Engineering Institute's (SEI) Capability Maturity Model (CMM).

2.1 Capability Maturity Model (CMM)

CMM is both a reference model for determining the software process maturity of an organization, as well as a normative model that helps software organizations in progressing along an evolutionary path from ad-hoc, chaotic software processes to matured, disciplined software processes (Herbsleb et al. 1997). The model has gained considerable acceptance worldwide and has been regarded by many as the industry standard for defining software quality process (Herbsleb et al. 1997; van der Pijl et al. 1997).

In CMMs, five levels of maturity are defined, namely initial, repeatable, defined, managed, and optimizing. Each maturity level is described by a unique set of characteristics. Apart from level 1, several different key process areas (KPA) are identified at every maturity level. Each KPA indicates the areas that the organization should focus on in order to improve its software process. Each KPA is further described by several key practices.

Although CMM is meant for describing software processes, researchers have suggested that it can be applied to KM maturity modeling. To the extent that software can be viewed as a knowledge medium, it is held that CMM can be adapted to the KM context (Armour 2000; Paulzen and Perc 2002). However, several differences between software management and KM need to be noted. Other than domain differences, KM is less structured compared to software management. Practices within KM are less standardized and outcomes are less easily measurable. As KM activities are spread throughout the organization among a large number of knowledge workers, its effectiveness needs to be judged by participants' perceptions, in addition to information such as the utility of KM systems. As a result, KPAs in KMMM are defined somewhat differently from the CMM (Kulkarni and St. Louis 2003).

2.2 CMM-Based KMMM

Four CMM-based KMMM were identified: Siemens' KMMM, Infosys' KMMM, Paulzen and Perc's Knowledge Process Quality Model (KPQM), and Kulkarni and Freeze's Knowledge Management Capability Assessment Model (KMCA). Like CMM,

all models except KMCA identified five levels of KM maturity which are usually named after the corresponding levels in the CMM (see Table 1). KMCA defines an additional level 0 to denote the complete lack of KM.

Table 1. Naming of Maturity Levels of CMM-Based KMMM

Level	CMM	CMM-based KM Maturity Models			
		Siemens' KMMM	**Infosys' KMMM**	**KPQM**	**KMCA**
0	Not Applicable				Difficult / Not Possible
1	Initial	Initial	Default	Initial	Possible
2	Repeatable	Repeatable	Reactive	Aware	Encouraged
3	Defined	Defined	Aware	Established	Enabled / Practiced
4	Managed	Managed	Convinced	Quantitatively Managed	Managed
5	Optimizing	Optimizing	Sharing	Optimizing	Continuously Improving

Similar to CMM, each level of KM maturity is described by a set of characteristics. However, it is observed that different sets of characteristics are specified in different KMMMs. Through careful analysis and consolidation, we identified a set of common characteristics. Each characteristic in this list is common to at least two KMMMs (see Table 2). Hence, this set of common characteristics represents the important aspects of each maturity level.

Corresponding to CMM, each KMMM identified KPAs that indicate the areas that an organization should focus on and issues that must be addressed to achieve a maturity level. Different KMMMs have specified different KPAs. Among them, people, organization, process and technology are the major KPAs common across all models.

Table 2. Common Characteristics and Maturity Levels of CMM-Based KMMM

Description	Siemens' KMMM	KPQM	Infosys' KMMM	KMCA
Lack of awareness of the need of KM	Level 1	Level 1	Level 1	Level 1
Aware of importance of KM to organization	Level 2	Level 2	Level 2	Level 2
Basic KM infrastructure in place	Level 3	Level 2	Level 3	Unspecified Probably Level 3
KM activities are stable and "practiced"	Level 3 (for individual parts of organization)	Unspecified Probably Level 3	Level 4	Level 3
Individual KM roles are defined	Level 3	Level 3	Level 2 (Knowledge Database administrator) Level 3 (dedicated KM Group)	Unspecified Probably Level 3
Management / leadership realizes their role in, and encourage KM	Unspecified Probably Level 3	Unspecified Probably Level 3	Level 3	Level 2
Training for KM	Unspecified Probably Level 3	Unspecified. Probably Level 3	Level 3 and 4	Level 4
Common organizational KM strategy	Level 4	Unspecified Probably Level 3	Level 4	Unspecified Probably Level 4
Use of metrics to govern KM	Level 4	Level 4	Level 3 (productivity gains) Level 4 (project/functional-level) Level 5 (organization-level)	Level 5
Continual improvement of KM practices and tools	Level 5	Level 5	Level 5	Level 5
Existing KM can be adapted flexibly to meet new challenges	Level 5	Unspecified Probably Level 5	Level 5	Unspecified Probably Level 5

2.3 Non-CMM-Based KMMM

In the course of our research, the following five non-CMM-based KMMMs were identified, namely KPMG Consulting's Knowledge Journey (KPMG 2000), Klimko's KMMM (Klimko 2001), VISION KMMM (Weerdmeester et al. 2003), TATA Consultancy Services' 5iKM3 KMMM (Mohanty and Chand 2004), and WisdomSource's K3M (WisdomSource 2004). Among these models, the VISION KMMM (V-KMMM) defines 4 levels of maturity; the Knowledge Journey, 5iKM3, and Klimko's KMMM define 5 levels of maturity respectively; and WisdomSource's K3M defines 8 levels of maturity (see Table 3). Unlike other KMMMs, V-KMMM does not follow a progressive maturity pathway. Hence, it is considered to be incomparable to other KMMMs in terms of maturity levels and characteristics.

Table 3. Naming of Maturity Levels of Non-CMM-Based KMMM

Level	The Knowledge Journey	5iKM3	Klimko's KMMM	K3M
1	Knowledge chaotic	Initial	Initial	Standardized Infrastructure for Knowledge Sharing
2	Knowledge Aware	Intent	Knowledge Discoverer	Top-Down Quality-Assured Information Flow
3	Knowledge Focused	Initiative	Knowledge Creator	Top-Down Retention Measurement
4	Knowledge Managed	Intelligent	Knowledge Manager	Organizational Learning
5	Knowledge Centric	Innovative	Knowledge Renewer	Organizational Knowledge base / Intellectual Property Maintenance
6				Process-Driven Knowledge Sharing
7				Continual Process Improvement
8				Self-Actualized Organization

When comparing the characteristics of maturity levels of non-CMM-based KMMMs, we observed several common characteristics. This includes the lack of awareness of the need to manage knowledge at level 1, the awareness of the need to manage knowledge at level 2, and having continuous improvement at level 5. However, although most non-CMM-based KMMMs have five-staged structure similar to CMM-based KMMMs, the stages are named differently and characteristics defining each stage differ across non-CMM-based KMMMs. Hence, extracting common characteristics to summarize these KMMMs is less feasible and less likely to be accurate and representative.

Similar to CMM-based KMMMs, all non-CMM-based KMMMs except Klimko's KMMM identify KPAs that organizations should focus on in enhancing KM maturity. In general, common KPAs include people, process, and technology.

3. Proposed G-KMMM

The proposed model is a descriptive model in that it describes the essential attributes that characterize an organization at a particular KM maturity level. It is also a normative model in that the key practices characterize the types of ideal behavior that would be expected.

Similar to the majority of existing CMM-based and non-CMM-based KMMMs, the G-KMMM follows a staged-structure and has three main components, namely maturity levels, KPAs and common characteristics. Our literature review reveals that like the CMM, most existing KMMMs (both CMM-based and non-CMM-based) identify five levels of maturity. Accordingly, the proposed KMMM adapted the five maturity levels from CMM and named them initial, aware, defined, managed, and optimizing respectively (see Table 4). We renamed level 2 from "repeatable" to "aware" considering that level 2 is mainly characterized by awareness of the need to manage knowledge.

The G-KMMM dictates that organizations progress from one maturity level to the next without skipping any level. In practice, organizations may be able to employ key practices of a higher maturity level than they are. However, this can be counter-productive since each level forms a necessary foundation from which to achieve the next. Thus, the ability to implement practices from higher maturity levels does not imply that levels can be skipped.

Table 4. Proposed G-KMMM

Maturity Level		General Description	Key Process Areas		
			People / Organization	Process	Technology
1	Initial	Little or no intention to make use of organizational knowledge	Organization and its people are not aware of the need to manage its knowledge resources	No formal processes to capture, share and reuse organizational knowledge	No specific KM technology or infrastructure in place
2	Aware	Organization is aware of and has the intention to manage its organizational knowledge, but it might not know how to do so	Management is aware of the need for KM	Knowledge indispensable for performing routine task is documented	Pilot KM projects are initiated (not necessarily by management)
3	Defined	Organization has put in place a basic infrastructure to support KM	- Management is aware of its role in encouraging KM - Basic KM training provided - Basic KM strategy is put in place - KM roles are defined - Incentive systems available	- Processes for content and information management is formalized - Metrics are used to measure the increase in productivity	- Basic KM Infrastructure in place (e.g. single point of access) - Some enterprise-level KM projects are in place
4	Managed	KM initiatives are well established in the organization	- Common strategy and standardized approaches towards KM - KM is incorporated into the overall organizational strategy - More advanced KM training - Organizational standards	Quantitative measurement of KM processes (i.e. use of metrics)	- Enterprise-wide KM systems are fully in place - Usage of KM systems is at a reasonable level - Seamless integration of technology with content architecture
5	Optimizing	- KM is deeply integrated into the organization and is continually improved - It is an automatic component in any organizational processes	Culture of sharing is institutionalized	- KM processes are constantly reviewed and improved - Existing KM processes can easily be adapted to meet new requirements - KM procedures are an integral part of the organization	Existing KM infrastructure is continually improved upon

The majority of the KMMMs reviewed identify people-related, process-related, and technology-related KPAs. The remaining KMMMs also refer to these aspects even if they do not explicitly mention these KPAs. Together, it is expected that these KPAs can provide a comprehensive assessment. The proposed framework thus defines three KPAs, namely people, process and technology (see Table 4). These KPAs concur with researchers' suggestion that KM needs to consider organizational, human (psychological and sociological) and technological aspects in order to deliver thorough and successful business support (Quintas et al. 1997). The people KPA includes aspects related to culture and organization's strategies and policies; the process KPA refers to aspects concerning KM processes; and the technology KPA relates to aspects about KM technology and infrastructure.

Our comparison revealed that non-CMM-based KMMMs share less common characteristics among themselves than CMM-based KMMMs. In addition, their common characteristics are similar to those identified among CMM-based KMMMs. Hence, the

characteristics describing each KPA at each maturity level in the proposed model correspond largely to those identified among CMM-based KMMMs as presented in Table 2 (see Table 4).

The proposed G-KMMM fulfills many requirements of an ideal KMMM. First, it can be applied to several different objects of analysis, including organization as whole and traditional or virtual organizational units. Second, it takes into account the views of different participants on organization's KM tasks as the proposed assessment instrument explicitly specifies the need to interview different participants and consult different data sources. Third, by explicating the assessment instrument, we attempt to provide a systematic and structured approach which ensures transparency and reliable handling of the assessment procedure (see Section 3.1). We also defined and detailed the important concepts, maturity levels, their characteristics, and key practices in an endeavor to encourage comparison and standardization of definitions and measurement. Fourth, the results provided by the proposed KMMM are mainly qualitative. However, quantitative results may be generated in surveys of users' perception on KM's effectiveness. Fifth, the proposed G-KMMM is comprehensible in that it adopts a staged structure and clearly defines each maturity level and KPAs as well as corresponding characteristics. It also allows cross references to proven management concepts or models like change management and strategy planning. Finally, the proposed KMMM supports continuous learning and improvement as evident in level 5's characteristics which state that "KM is deeply integrated into the organization and is continually improved upon".

3.1 Assessment of KM Maturity

Although most existing KMMMs are developed to address practical needs and thus can be expected to have formal assessment procedures, most of them are proprietary and rarely available in public sources. Among the KMMMs reviewed, only the instruments of Knowledge Journey, KPQM, and KMCA are available. To facilitate practical application of the G-KMMM, we developed an accompanying assessment instrument (see Table 5). For the organization to attain a certain level of maturity, its response to all items characterizing that maturity level must be positive. That is, it must carry out all key practices of that level.

A majority of the items in the proposed assessment instrument were adapted from existing instrument as appropriate. These include the Knowledge Journey's KM Framework Assessment Exercise, KPQM, KMCA and the KM Assessment Tool (de Jager 1999). The KM Assessment Tool (KMAT) is a diagnostic survey that helps an organization in determining the effectiveness of its KM practices. New items were constructed to assess aspects identified in Table 4 but where suitable existing items were not available. For example, a new item (TEC4b) was developed to assess whether there is seamless integration of technology with content architecture.

Table 5. Proposed G-KMMM Assessment Instrument

Level	Item	Source
KPA: People		
2	***PEO2a*** Is organizational knowledge recognized as essential for the long term success?	Knowledge Journey
	PEO2b Is KM recognized as a key organizational competence?	KMAT
	PEO2c Employees are ready and willing to give advice or help on request from anyone else within the company	Knowledge Journey, KMCA
3	***PEO3a*** Is there any incentive system in place to encourage the knowledge sharing?	Knowledge Journey

	- Employee's KM contribution are taken into consideration - Rewards for team work, knowledge sharing/re-use	
	PEO3b Are the incentive systems attractive enough to promote the use of KM?	Developed
	PEO3c Are the KM projects coordinated by the management?	Developed
	PEO3d Are there individual KM roles that are defined and given appropriate degree of authority? - Chief Knowledge Officer - Knowledge Officers / Workers	Developed based on Siemens' KMMM Level 3, Infosys KMMM Level 3 Knowledge Journey
	PEO3e Is there a formal KM strategy in place?	Developed based on Siemens' KMMM Level 4
	PEO3f Is there a clear vision for KM?	Developed
	PEO3g Are there any KM training programs or awareness campaigns? e.g. workshops for contributors, users, facilitators, champions	Developed based on Infosys' KMMM Level 3
4	***PEO4a*** Are there regular knowledge sharing sessions?	Developed based on Infosys' KMMM Level 4
	PEO4b Is KM incorporated into the overall organizational strategy?	Knowledge Journey
	PEO4c Is there a budget specially set aside for KM?	Knowledge Journey
	PEO4d Is there any form of benchmarking, measure, or assessment of the state of KM in the organization? - Balanced scorecard approach - Having key performance indicators in place - Knowledge Return on Investment	KMAT - Knowledge Journey - Knowledge Journey - Developed based on Infosys' KMMM Level 5
5	***PEO5a*** Has the KM initiatives resulted in a knowledge sharing culture?	Developed based on Infosys' KMMM Level 5
KPA: Process		
2	***PRO2a*** Is the knowledge that is indispensable for performing routine task documented?	Developed based on Infosys' KMMM Level 2
3	***PRO3a*** Does the KM system improve the quality and efficiency of work?	Developed
	PRO3b Is the process for collecting and sharing information formalized? - Best practices and lessons learnt are documented	KMAT (I-P4)
4	***PRO4a*** Are the existing KM systems actively and effectively utilized?	Knowledge Journey
	PRO4b Are the knowledge processes measured quantitatively?	Developed based on Infosys' KMMM Level 4
5	***PRO5a*** Can the existing KM processes be easily adapted to meet new business requirements?	Developed based on Siemens' KMMM Level 5
KPA: Technology		
2	***TEC2a*** Are there pilot projects that support KM?	Developed based on Siemens' KMMM Level
	TEC2b Is there any technology and infrastructure in place which supports KM? - E.g. Intranet portal - E.g. Environments supporting virtual teamwork	Developed based on Infosys' KMMM Level 3.
3	***TEC3a*** Does the system support only the business unit?	Developed based on Infosys' KMMM Level 3
4	***TEC4a*** Does the KMS support the entire organization?	Developed based on Infosys' KMMM Level 4
	TEC4b Is the KM system tightly integrated with the business processes?	Developed
5	***TEC5a*** Are the existing systems continually improved upon (e.g. continual investments)?	KPQM Level 5

4. Research Design

In applying the G-KMMM, we adopted a case study approach, which allowed us to understand the complex interactions among people, processes, and technologies (Dubé and Paré 2003). The research was conducted in a large public university in Asia. We focused on assessing the KM maturity of the Information System (IS) organization in the subject university. The IS organization, "Computer Hub", provided computing and infrastructure support for the entire university, which consisted of over 30,000 students and more than 4,000 faculty and administrative staff. The case was selected on the basis that it was critical – it satisfied the conditions for applying the proposed G-KMMM as IS management is knowledge-intensive work. In addition, the subject IS organization's work was of considerable complexity considering that it served a relatively large population of users across different domains. Furthermore, several units of the IS organization had

began implementing KM as pilot projects albeit not in-sync. Although studying a single organization may seem a narrow focus, the subject organization was large with many IT units operating separately. Hence, we considered the subject organization to be a suitable choice for demonstrating the application of the G-KMMM in a large organization with multiple units, which is typical of many large organizations.

There were about 130 employees in the Computer Hub, which was composed of 10 functional groups. In this study, we focused on four units, namely the Academic Information System (AIS), Corporate Information System (CIS), IT Call Centre (ITCC) and Faculty IS (FIS) units. These units were chosen because they were the technology centres and served a representatively large group of users, ranging from 150 to 6000 people. It was expected that this would allow us to obtain a representative overview of the Computer Hub.

The main role of AIS and the CIS units included application development and maintenance. AIS developed and maintained systems serving the student population while the CIS developed and maintained systems tailored to the corporate segment. ITCC was responsible for providing frontline call centre and walk-in technical support for the university community. Each major faculty in the university was supported by its own FIS unit, which catered to the specific IT needs of the faculty. The FIS units relied mainly on the infrastructure and services provided by Computer Hub, but also hosted their own servers and developed their own applications based on their needs.

Interviews were conducted with managers of all units over a three-month period. As managers held an overview of their unit and were collocated with employees, they were expected to be in appropriate positions to respond to questions related to their units' KM effort. An interview guide was developed based on the assessment instrument proposed in Table 5. Each interview lasted 30 to 90 minutes. All interviews were tape-recorded and transcribed. A detailed coding scheme was also developed to arrange data collected. As far as possible, we also requested for live demonstration of relevant systems and related documents.

5. Results and Analysis

In this section, results for individual IT units are first presented. These results are then consolidated for the Computer Hub as a whole. Results will be discussed for each of the KPAs, namely people, process and technology.

5.1 Academic IS Unit, Corporate IS Unit, and IT Call Centre

People – AIS, CIS and ITCC recognized the importance of KM to the organization and the staff members were generally aware of the benefits of knowledge sharing.

Process – Some processes for capturing, sharing, and reusing knowledge existed as evident in that formal KM technologies were used to document routine knowledge and support the work of developers. For example, Microsoft SharePoint® was used to set up team sites for new projects, which served as project portals where members could collaborate and share information. Apart from that, these IT units also stored and shared files on servers. These units also collectively published a monthly electronic newsletter on their websites to disseminate information about updates in IT development, resources and services.

Technology – Other than EDMS®, CMS®, Microsoft SharePoint® and Developer's Corner, an IS for tracking the inventory of software that was developed at various IT units and departments was also implemented in early 2005. This system served as a basis for encouraging component reuse across projects in different IT units. However, managers noted that it was difficult to control its usage at the IT unit level.

Result – According to the proposed G-KMMM, AIS, CIS and ITCC were at maturity level 2 for all KPAs, where organization was aware of and had intention to manage its organizational knowledge. Of the 3 KPAs, these IT units were most mature on the technology aspect.

5.2 Arts and Social Science's Faculty IS Unit

The FASS's FIS unit was in charge of providing frontline IT service and support to the faculty. It was responsible for customizing and supporting all IS used in the faculty's operation and the administration. It also assisted academic staff in exploring the use of IT in teaching, learning and research.

People – IT professionals in FASS's FIS unit were mainly system programmers (6 out of 8) who worked on both faculty and campus-wide projects. Around 30% of its employees were involved in campus-wide projects such as module registration system and time table system. This indicated that employees in this unit possessed more technical skills and had richer experience. The unit also practiced job rotation as a mechanism for knowledge sharing and redundancy. However, its frequency depended largely on availability of manpower.

Process – Formal knowledge sharing sessions were held as a formal process to facilitate knowledge-transfers between employees. However, it was reported that the need for such structured knowledge sharing sessions had diminished as employees' skill sets became more or less on par with each other over time.

Technology – The unit had an intranet and utilized EDMS® but their actual usage fell short of a formal knowledge repository. The intranet contained only procedures and policies that were useful to new and junior staff members but less necessary for senior staff members who were familiar with its content; while the unit was earmarked as the first faculty to utilize EDMS® for storing its corporate documents at the Dean's office, the impetus for the system was not so much the recognition that KM was needed, but rather that there was a need to reduce the backlog of paperwork which took up a lot of storage space in the faculty.

Result – In general, the KM maturity of FASS's FIS unit was at level 1, where there was a lack of formal processes to capture, share and reuse organizational knowledge. Although the unit's people were aware of the need for KM, its process and technology were still at level 1. This indicated that more effort was needed in these areas.

5.3 Architecture's Faculty IS Unit

The unit comprised of three sections, namely the IS, Education Development and Technical Support. The IS section was responsible for customizing and supporting the software used in FoA's operations and decision-making; the Education Development Section assisted the academic staff members in applying IT in their teaching; and the Technical Support Section provided infrastructural support (e.g. multimedia and audio

visual services).

People – On the whole, staff members at the unit were technologically savvy and were aware of the need for KM. However, as staff turnover rate was very low (on average one every two years), retaining employees' knowledge was not a critical concern.

Process – Although the unit had several processes for capturing and sharing knowledge, they were not formally considered as KM efforts. Other than maintaining the faculty website and intranet, the unit utilized common directory services provided by the Computer Hub to share its files and documentation. The unit also started using Documentum's EDMS® as its internal document repository for the past years. Documents stored included policies, guidelines and standard operating procedures that could support tasks such as application development and exam marks processing. However, the manager noted some performance issues with the system and observed that usage was still infrequent. In view of the difficulty faced in managing information request from users, the unit was also exploring the potential of implementing business intelligence application packages in supporting the task.

Technology – As with other FIS units, the unit utilized services provided by the Computer Hub, in addition to the EDMS® introduced. The unit also preferred customized software packages as it had limited manpower for developing software themselves.

Result – As the unit was at level 2 for all three KPAs where the organization was aware of and had the intention to manage its organizational knowledge, the unit was considered to be at the aware level in terms of overall KM maturity.

5.4 Business's FIS Unit

The unit managed a number of different applications such as the module registration and teaching feedback system. It also assisted business research students in developing systems for conducting experiments.

People – Employees in the unit were generally unaware of the need for KM.

Process – All staff members were collocated in the same office. As a result, informal face-to-face interaction was the most common mode of knowledge sharing. However, some formal processes for storing and sharing system documentation, user requirements and system code were accomplished through the use of Microsoft's SharePoint®.

Technology – Other than using services provided by the Computer Hub, the unit maintained 3 additional internal servers. However, these were mainly used more for storing documents. The unit made use of the application inventory system provided by Computer Hub to look for reusable components prior to developing new systems. They also regularly updated the system with new components they had developed on a quarterly basis.

Result – In general, the unit's KM maturity was at the initial level (level 1) as it lacked general awareness of the need for KM.

5.5 Computing's Faculty IS Unit

The unit had been described as a "mini Computer Hub" by other units. This was partly

due to the high level of autonomy the unit had compared to other units and the wide array of services offered. The unit consisted of back-end support team, front-end user helpdesk, workshop and lab technicians.

People – The IT professionals in the unit were generally more KM-savvy compared to helpdesk support staff members and technicians – 3 out of the 5 IT professionals interviewed at the unit had at least a basic understanding of KM, while none of the helpdesk support staff members and technicians interviewed had heard of KM.

Process – The unit had several formal processes for storing and sharing its information and knowledge using shared directories on the UNIX server, the Network Operations Portal (NOP), and the faculty's IT services website. Knowledge indispensable for routine tasks were also documented. For example, the NOP supported the work of helpdesk and workshop staff members, who used it as a knowledge base of lessons-learned in resolving problems.

Technology – The technologies used to support KM in the unit included shared directories on the UNIX server, the Network Operations Portal (NOP), and the faculty's IT services website. On the UNIX server, two common directories were designated to store system configuration documents and meeting minutes. The NOP contained a series of web applications that were used by the networking team to manage the FoC network. It could also be considered as part of their knowledge repository, housing documents such as networking guides, frequently asked questions and troubleshooting tips. The portal was developed out of a pilot initiative by the networking team and had since been used by other faculty staff members and students for purposes such as software and wireless card loans. The faculty's IT services website was another avenue for the unit to capture and share knowledge. However, it served more as a place for providing guides to users and disseminating information among unit staff members as only few staff members had permission to modify the website. The unit was also experimenting with an open source collaborative portal featuring forums, mailing lists, and source code management. If successful, it could support KM efforts in the unit.

Result – The unit was at the aware level (level 2) of the proposed KMMM. It was aware of the need to share its knowledge and had some systems in place to manage it. However, the initiatives had mostly been ad-hoc and there was a lack of a KM strategy to guide the effort.

5.6 Dentistry's Faculty IS Unit

People – Dentistry's FIS unit consisted of four IT professionals and two technical support staff. As all staff members worked in the same office, direct face-to-face communication was preferred to computerized collaboration tools. The manager also commented that since there was limited manpower, the unit needed to focus on its main responsibilities and hence did not have time to explore and experiment with applications related to KM.

Process – The unit did not have any formal KM process. As staff members were collocated, most interactions were face-to-face and informal.

Technology – The unit focused on supporting imaging technology and systems tailored towards medical usage. Although an intranet was in place, it was not used for knowledge

sharing and transfer purposes. There was also a plan to implement EDMS®. However, with the departure of the staff-in-charge, the plan was placed on hold indefinitely.

Result – The unit's KM maturity was at level 1 for all KPAs as there was a general lack of awareness of the need for KM.

5.7 Faculty of Engineering's FIS Unit

The unit was divided into two teams, namely the IT Applications Support Team and the Systems Support Team. The former was in charge of developing systems and providing administrative, academic and educational end-user support and consultation, while the latter supported and maintained the teaching clusters and the IT infrastructure

People – The unit had the most number of IT professionals compared to the other FIS units. In general, the staff members were aware of the need for KM.

Process – As a process for sharing knowledge among developers, Visual SourceSafe® was used to share code and maintain system versioning. Files were also shared among members on shared directories. As with other faculties, all staffs worked in the same office. As such, face-to-face interactions were preferred in project collaborations.

Technology – The unit attempted to introduce EDMS® to its dean's office. However, the plan was abandoned after pilot testing because the paper system was generally preferred.

Result – The KM maturity of the unit was at the initial level (level 1). Although there was a general awareness of the need for KM among staff members and some process existed for knowledge sharing (level 2 for people and process KPAs), it lacked specific KM technology or infrastructure for supporting KM.

5.8 Scholars Programme's IS Unit

People – Staff members in the unit were generally unaware of the need for KM.

Process – The unit used the Online Learning System (OLS) for sharing documents and information. OLS is a web-based learning management system specifically designed for students to support teaching and learning at the university and offers functionalities such as a file repository and forum. However, the OLS had several restrictions that limited employees' ability in exploiting the system. For example, each file upload was capped at a size of 40MB, this limited the type of files that could be shared among staff members. Recently, the unit had started using team site to store forms and other student information.

Technology – The unit used services provided by the Computer Hub for its mission-critical systems, but also maintained its own file servers, databases and applications servers. The unit was also in the process of setting up a faculty forum, which could potentially serve as a central source of knowledge resources in future.

Result – The unit was still at the initial level (level 1) of KM maturity as there was a general lack of awareness of the need for KM.

5.9 Computer Hub

To determine the KM maturity of the Computer Hub, the distribution of maturity ratings of all IT units in all KPAs was summarized (see Table 6). Considering that for an organization to attain a particular maturity level, the attributes of that level and lower

levels have to be fully achieved, the maturity level of the least mature IT unit will determine the maturity level for the whole IS organization.

Table 6. Maturity Levels of IT Units

Item	AIS, CIS, ITCC	FASS	FoA	FoB	FoC	FoD	FoE	SP	Item	AIS, CIS, ITCC	FASS	FoA	FoB	FoC	FoD	FoE	SP
KPA: People									**KPA: Process**								
PEO2a	Y	Y	Y	N	Y	N	Y	N	***PRO2a***	Y	Y	Y	N	Y	N	Y	N
PEO2b	Y	Y	Y	N	Y	Y	Y	N	***PRO3a***	Y	N	N	N	Y	N	N	N
PEO2c	Y	Y	Y	Y	Y	Y	Y	Y	***PRO3b***	Y	N	N	N	N	N	N	N
PEO3a	N	N	N	N	N	N	N	N	***PRO4a***	N	N	N	N	N	N	N	N
PEO3b	N	N	N	N	N	N	N	N	***PRO4b***	N	N	N	N	N	N	N	N
PEO3c	Y	N	Y	N	Y	N	N	N	***PRO5a***	N	N	N	N	N	N	N	N
PEO3d	N	N	N	N	N	N	N	N	**KPA: Technology**								
PEO3e	N	N	N	N	N	N	N	N	***TEC2a***	Y	N	Y	N	Y	N	N	N
PEO3f	Y	N	N	N	Y	N	N	N	***TEC2b***	Y	Y	Y	N	Y	Y	Y	Y
PEO3g	Y	N	N	N	N	N	N	N	***TEC3a***	Y	Y	Y	N	Y	Y	N	N
PEO4a	N	N	N	N	N	N	N	N	***TEC4a***	N	N	N	N	N	N	N	N
PEO4b	N	N	N	N	N	N	N	N	***TEC4b***	N	N	N	N	N	N	N	N
PEO4c	N	N	N	N	N	N	N	N	***TEC5a***	N	N	N	N	N	N	N	N
PEO4d	N	N	N	N	N	N	N	N									
PEO5a	N	N	N	N	N	N	N	N									

People – It was observed that managers in the AIS, CIS and ITCC units were more aware of KM-related issues compared to FIS unit managers. All the Computer Hub managers interviewed appreciated the need for proper management of organizational knowledge. In comparison, fewer FIS unit managers interviewed had heard of and appreciated KM. This suggests that more effort is needed to raise awareness of the need for KM.

It could also be observed that smaller IT units tended to be shorthanded and were more focused on operational issues. Two IT unit managers reported that given the small size of their units, they did not have the time and resources to experiment with KM. FASS's FIS manager also acknowledged that for knowledge sharing to be effective, the unit needed to have slack human resources to ensure that normal operations were not adversely affected.

Although informal incentives were offered in some IT units to encourage knowledge sharing, there was a lack of an organization-wide incentive scheme to promote knowledge sharing formally. For example, FoC's FIS unit managers admitted that they were likely to give staffs who shared their knowledge a better appraisal, but this practice was informal.

Process – While there had been plans by the Computer Hub to formalize KM processes across IT units through efforts such as organizing knowledge sharing sessions between IT managers and implementing the application inventory system, its effectiveness had been limited. One reason is that the needs of different faculties might be unique. A similar system developed for different faculties might require different components and existing components in the application inventory system might not FIS. Another reason is the lack of standardization for system development platform. Although the Computer Hub encouraged the use of J2EE, individual IT units had the autonomy to choose their preferred platform.

IT unit managers had acknowledged that the application inventory system could be

regarded as a stepping stone towards better management of knowledge in the Computer Hub. With better standardization of system development platform and clearer guidance from the Computer Hub, IT units would be able to share and reuse knowledge more effectively.

Technology – Overall, a network infrastructure was in place to support KM. While some KM-related systems such as SAP-KM®, Documentum's EDMS® and Microsoft SharePoint® had been implemented to support employees in their work, their potential functions had not been really exploited. Among the IT units interviewed, FoC's effort on developing a collaborative web portal was closest to a pilot KM project.

Results – For the people aspect, three of the units were at level 1 and five were at level 2; for the process aspect, three of the units were at level 1 and five were at level 2; for the technology aspect, five of the units were at level 1 and three were at level 2. Following the rule that for an organization to attain a particular maturity level, the attributes of that level and lower levels have to be fully achieved, we concluded that KM maturity for the university's Computer Hub was at the initial level (level 1). However, since many IT units were at level 2 for some KPAs, it appeared that the organization was closing in on level 2.

6. Discussion and Conclusion

The proposed KMMM can be a useful tool for assessing KM development and indicating possible improvements. Indeed, the subject organization had expressed interest in the model. However, the main concern of unit managers was that their units might be unfavorably rated. Hence, for the proposed G-KMMM to accurately reflect the reality, it is important that management do not use it as a tool for disciplining and penalizing units that under-performed. Rather, it should serve as an indication of areas needing more resources and guidance.

As observed in the case study, an organization can be at different stages of maturity for each of the KPAs. While this could be considered a complication within the model, we believe that this highlights the model's usefulness as a diagnostic tool for performing KM self-assessment in that it identifies the aspects that require improvement for the organization to progress to the next level of KM maturity. It should also be noted that although a single maturity rating for the organization can be obtained by aggregating ratings for the KPAs, the rating distribution should also be reported to avoid loss of constructive information.

Some may argue that defining the ultimate stage of KM maturity may be difficult and irrelevant as KM advances or as we move on to new concepts. Our contention is that the proposed G-KMMM serves more as a descriptive rather than prescriptive model. Hence, the conditions for attaining maturity may evolve and serve more like a moving target to encourage continuous learning and improvement rather than a definite end by themselves.

To assess its validity and improve generalizability, future research can apply the proposed KMMM to different contexts. Another interesting avenue for future research will be to investigate the relative importance of practices in each KPA at different stages of maturity. Identifying and understanding these dynamics may help organizations better chart their future KM development. Longitudinal studies may also be conducted where

KM development and maturity of organizations are tracked over time. This can provide both researchers and practitioners more in-depth understanding of the growth of a knowledge organization.

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