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Effective Personal Knowledge Management: A Proposed Online Framework

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***Abstract*—**This paper presents an analytical framework for an effective online personal knowledge management (PKM) of knowledge workers. The development of this framework is prompted by our qualitative research on the PKM processes and cognitive enablers of knowledge workers in eight organisations selected from three main industries in Malaysia. This multiple-case research identifies the relationships between the effectiveness of four online PKM processes: get/retrieve, understand/analyse, share, and connect. It also establishes the importance of cognitive enablers that mediate this relationship, namely, method, identify, decide and drive. Qualitative analysis is presented as the findings, supported by the preceded quantitative analysis on an exploratory questionnaire survey.

***Keywords*—**Bottom-up approach, knowledge organisation, organisational knowledge management, personal knowledge management, software agent technology.

I. Introduction

YEARS after the emergence of personal knowledge management (PKM), there is still a question on whether we are ready for this trend despite the widely used Web 2.0 in managing personal knowledge among technology savvy individuals. The latest study by McFarlane [1] prompted the question of readiness of research community in embracing the PKM concept as part of knowledge management theory.

There is no denying that PKM can be defined differently between individuals and across a community, which leads to the importance of knowing what a knowledge worker perceives and understands with the word "personal knowledge". In general, PKM is a "value management philosophy or approach since the idea is to add value to performance, well-being, and outcome through understanding and applying knowledge which has been effectively treated and efficiently applied systematically to achieve personal and non-personal goals" [1]. Based on this definition, this paper presents the relationship and congruence between PKM (which is enacted by a human and/or technology) and the renowned SECI model (which presents the overall knowledge creation and transformation processes among humans), and how this congruence manifests the emergence of effective PKM that is subconsciously practiced online.

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II. Related Works

A. PKM and Knowledge Organisation

A recent study on personal knowledge management (PKM) processes in the Malaysian context presents an analysis of how a knowledge worker (i.e. a common employee in general, a researcher specifically) manages personal knowledge. There are four main processes that generalise the way knowledge workers manages knowledge, regardless whether it is for official or personal task, as long as it involves knowledge retrieval, understanding, sharing, and communication. Focusing on the PKM processes across computer and internet tools and technologies, Ismail and Ahmad [2] suggested four main processes: get/retrieve, understand/analyse, share/ publish, and connect (GUSC), which are based on numerous reviews by Grundspenkis [3], Jarche [4], [5], Martin [6], Avery et al. [7], Pettenati et al. [8], and Razmerita et al. [9]. The summary of these reviews are shown in the form of PKM processes flow as shown in Fig. 1.

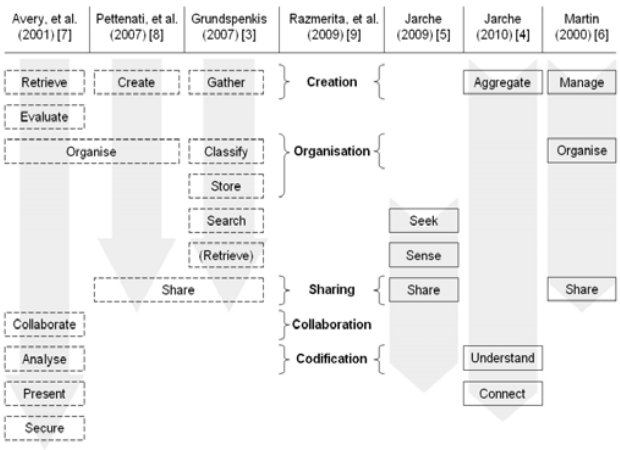

Fig. 1 Comparison of PKM Processes Flow among Authors

The PKM processes consist of tasks performed to get/retrieve knowledge (e.g. online search, RSS feed, aggregation, 'follow' shared updates), understand/analyse knowledge (e.g. summarise, write research papers), share knowledge (e.g. blog, RSS to blog, share link with reviews, tag people when sharing link, wiki), and connect to other knowledge sources and/or knowledge experts (e.g. from comments by others, from votes by others, from 'following' other's work or profile, email, online messages). Fig. 2 below shows a knowledge worker's cycle of processes involved in 'creating knowledge' by relating each process with the

renowned SECI model [10]. In general, get/retrieve knowledge is an externalisation process, understand/analyse knowledge is an internalisation process, share knowledge is a combination process, and connect to other knowledge is a socialisation process.

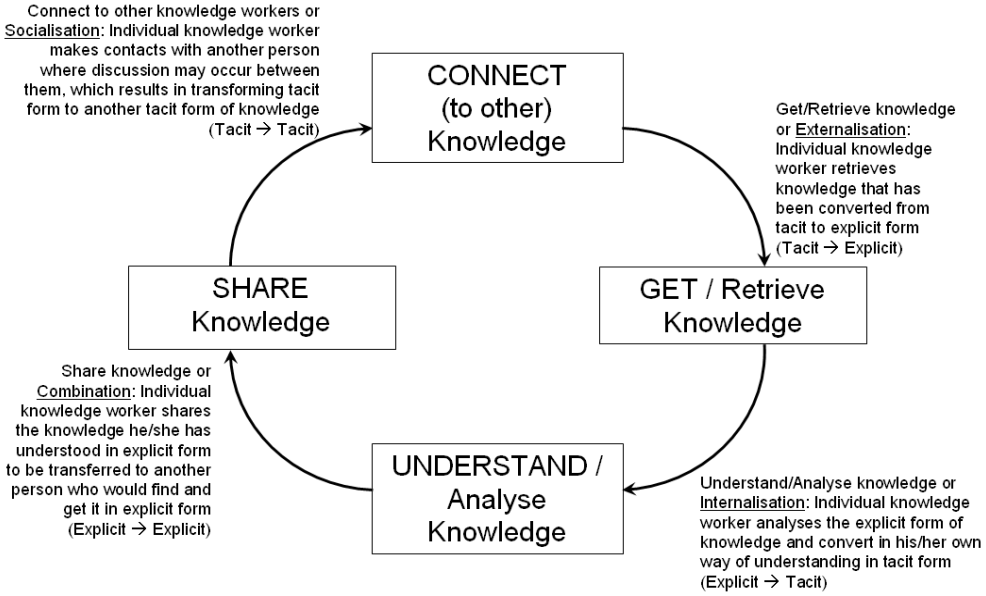

Fig. 2 GUSC PKM Processes Model (within Individuals)

Since there is a relationship between PKM processes and SECI model, a relationship emerges between PKM processes and knowledge management (KM) processes at organisational level. On a bigger perspective, PKM contributes to the success of KM in an organisation. If individual knowledge workers manage their personal knowledge effectively, there is no doubt that the objective of achieving the knowledge organisation status by top management can be realised. From this aspect, a knowledge organisation model by Awad and Ghaziri [11] exposes the KM processes and KM drivers required to realise the success of KM implementation in an organisation. According to this model, the KM processes include create, collect, organise, refine, disseminate and maintain knowledge at orgnisational level, whereas the KM drivers consist of technology, culture, competition, intelligence and leadership. Awad and Ghaziri [11] also mentioned that knowledge organisation derives knowledge from several sources, including personnel practices knowledge, such as the available expertise, the quality service they provide, and how to about find experts.

Knowledge workers practice knowledge depends on their capability in managing their personal knowledge. For example, a knowledge worker is expected to know 'how to go about finding experts' [11], an important process in PKM, with which knowledge workers 'connect to other knowledge and/or knowledge experts' [2]. With this link, there is a relationship between PKM processes and KM processes.

B. Cognitive Enablers in PKM

In reasoning the failure of knowledge management systems, Malhotra [12] put forth the topic of enablers and constraints of KM, by pointing out that the "active, affective and dynamic representation of knowledge makes better sense from a pragmatic perspective and is better aligned with theoretical representations of this construct beyond the domain of information technology management". Knowledge is active (i.e. best understood in action – it is not the theory but the practice of theory that makes the difference), affective (i.e. takes into consideration not only the cognitive and rational dimensions but also emotional dimensions of human decision-making), and dynamic (i.e. based upon ongoing reinterpretation of data, information, and assumptions while proactively sensing how decision-making process should adjust to future possibilities). The representation of knowledge provides a more realistic construct with "human and social interactions while situating this construct more proximal to performance outcomes" [12]. This previous work provides significant support to the recent proposal of PKM processes framework [2], especially in the domain of software agents. It is seen that the elements of active, affective, and dynamic, are required even by a 'mediator' (e.g. a software agent), to ensure that knowledge can be transferred, decision can be made, analysis can be done, and some form of socialisation can be deployed in an environment where the PKM processes are expected to happen. These elements form an understanding of the variables or factors mediating the PKM processes, which determine the success of the PKM implementation at individual (and/or agent) level. In the PKM

processes framework by [2], these elements are coined as 'cognitive enablers'.

Cognitive enablers are commonly covered under the domain of personality in psychology. In relation to this study, it is quite important to look into this aspect of cognitive enablers to understand how the BDI (belief, desire, and intention) and other strong notions of the agenthood can be modeled to enable the software agents to assist their human counterparts more efficiently and intelligently. Across the literature compiled by Mayer [13], the following personality components (i.e. what are considered under the behaviours expected of a software agent) are classified under cognitive enablers, sorted by the year they appeared in the literature (as shown in Table I). This list is selected from the 22 components [13], and tabulated according to its close relationship to the possibility of being deployed under agent's strong notions, identified as cognitive enablers under PKM processes framework [2]. The historical classification of personality components is considered relevant in the current research, as it outlines the fundamental theory of human personality, which this research considers to better understand the PKM processes at agent level.

TABLE I
COGNITIVE ENABLERS ACROSS PSYCHOLOGICAL AND PKM STUDIES

Year	Personality component under Psychological Cognitive Enablers	Application in Cognitive Enablers under PKM Processes
1932	Schema	Decide
1958	Rehearsal	Decide
1959	Feature detectors	Identify
1964	Attention	Drive
1968	Short/long-term memory	Decide
1972	Episodic/semantic memory systems	Identify
1973	Encoding	Identify
1975	Prototype	Method
1977	Goals	Drive
	Scripts	Method
1981	Mood-congruent / mood-state-dependent memory process	Decide
	Spreading activation / mood activation	Drive
1983	Procedural knowledge	Method
1984	Mental models	Method
1986	Working memory	Identify
1991	Pattern recognition	Method
1955	Circumspection-preemption control cycle	Decide
1965	Primary/secondary processes	Method
1966	Transference	Identify
1976	Subliminal psychodynamic activation	Drive
1977	Imaginal/verbal representation processes	Method
	Modeling	Method

In the history of research under psychology, Mayer [13] identifies the most cited examples of cognitive theoretical perspective for each type of personality components. 'Memory network' is mostly cited under 'cognitive enablers', whereas 'expert knowledge' is mostly cited under 'cognitive establishments'. These two examples (i.e. memory network and expert knowledge) are found highly related to the work of PKM processes [2], where individual knowledge workers are bound to search for knowledge experts in their quest of getting, understanding, and sharing knowledge, and in doing so they 'reach' the informal network outside of organisational boundaries that, in many cases, happen to be the social network formed across the Semantic or World Wide Web. Social network, on the other hand, can be perceived as a form of metaphor that resembles 'memory network', where the connection among the nodes (i.e. constitute the connecting individuals in the virtual world) forms a worldwide network of memory on 'who are the experts of which topics at what levels supported and recommended by who else'. This 'memory' resides within the network itself, and despite the interpretation of 'memory network' in the domain of psychology, this terminology can be seen as a form of social intelligence across the current computers and the Internet technologies.

C. Agent-mediated PKM Processes

Current researches in knowledge management using software agent technology show a possibility of having intelligent agents to perform certain tasks on behalf of their human counterparts. In a recent study on agent-mediated PKM processes [3, 14], the PKM processes cycle shown in Fig. 2 is translated into an interaction between human and agent, where interactions are proven to be possible for human-agent and agent-agent, while easing the human-human interactions. Fig. 3 shows the transition of model from Fig. 2, but with more details on how human's and agents' knowledge are processed within the basic concept of PKM. This is based on the study conducted by Ismail and Ahmad [2], which tabulated the processes based on the social interactions within agent-based environment.

There are differences between this model and the GUSC model (Fig. 2) within individuals, especially in terms of the sequence in the process cycle, due to the mediation of tasks delegated to software agents. The order of processes in the Coshgean model (Fig. 3) starts with 'connect', and this is followed by 'share', 'get/retrieve' and 'understand/analyse'. The difference in sequence of processes is due to the different environments in which knowledge is being translated between tacit and explicit forms [2]. "The former represents the SECI interactions within a knowledge worker's mind in managing personal knowledge, whereas the latter explains the processes when software agents are used to mediate the task of finding knowledge experts" [2].

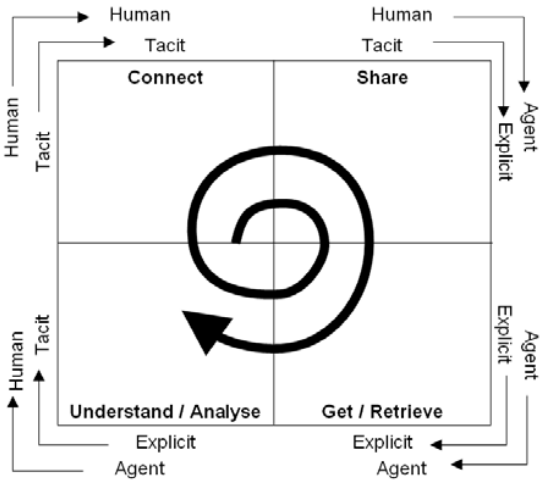

Fig. 3 Coshgean PKM Processes Model (between Human and Agent)

From a recent study [14], software agents are considered to have the capabilities that PKM processes would need. Comparing the SECI model [10] and Coshgean PKM processes model (Fig. 3), Table II summarises the "capabilities of software agents that allow further exploration of agent-mediated PKM processes, especially in defining the role of GUSC for the system based on the definitions given by authors in the past two decades" [14]. The intangible aspects of the agent-mediated system, such as cognitive enablers, are not discussed in terms of agent-mediation of this previous study. In fact, the perspective of socialisation between software agents and their human counterparts is emphasised as consistent with the concept of SECI model interactions by Nonaka and Takeuchi [10].

TABLE II
SOCIAL INTERACTIONS WITHIN AGENT ENVIRONMENT

SECI Interactions	Social Interactions within Agent Environment
Externalisation Tacit → Explicit	Human → Agent The task of finding the knowledge expert is mediated by an agent, when the knowledge seekers SHARES by passing the messages and documents to the agent in explicit form.
Combination Explicit → Explicit	Agent → Agent Agent GETS the messages and documents from other agents, in explicit form.
Internalisation Explicit → Tacit	Agent → Human The knowledge seeker UNDERSTANDS the messages and documents found by the agents.
Socialisation Tacit → Tacit	Human → Human The knowledge seeker and the knowledge expert (the agents' human counterparts) CONNECT to each other.

In fulfilling the need of delegating tasks to software agents, the understanding of agents' characteristics and capabilities are investigated from the clear definitions suggested by earlier authors. These definitions are tabulated against the concept of Coshgean PKM processes model [14] and GUSC model [2], as shown in Table III. It also shows how "the forms of knowledge (i.e. explicit and tacit knowledge) are interchanged within the interactions that occur between humans, between human and agent, and between agents" [14].

TABLE III
SOFTWARE AGENTS CHARACTERISTICS AND CAPABILITIES

Authors	Definition of Software Agents	Application in GUSC
Coen (1991) [15]	Programs that ***engage in dialogs and negotiate and coordinate the transfer*** of information	Get, Share, Connect
Russel and Norvig (1995) [16]	Anything that can be viewed as perceiving its environment ***through sensors and acting*** upon that environment through effectors	Connect
Gilbert, et al. (1995) [17]	Software entities that ***carry out some set of operations*** on behalf of a user or another program with some degree of independence or autonomy, and in so doing, ***employ some knowledge or representation*** of the user's goals or desires	Understand
Maes (1995) [18]	Autonomous agents are computational systems that inhabit some complex dynamic environment, ***sense and act*** autonomously in this environment, and by doing so ***realise a set of goals or tasks*** for which they are designed	Understand, Connect
Jennings, et al. (2000) [19]	An encapsulated computer system that is situated in some environment and that is capable of ***flexible action*** in that environment in order to meet its design objectives	Get, Understand, Connect, Share
Ali, Shaikh and Shaikh (2010) [20]	Computational systems that inhabit some complex dynamic environment; ***sense and act*** autonomously in this environment and by doing so ***realise set of goals or task*** for which they are designed	Understand, Connect

III. METHODOLOGY

A questionnaire survey was conducted across three main industries in Malaysia: manufacturing, service, and education. This exploratory study was conducted to understand the processes and cognitive enablers of PKM over computer and internet tools and technologies among knowledge workers. The results of this survey were presented in [2]. A total of 118 responses were received and quantitatively analysed to support the results from the next interview survey. Since the questionnaire survey is only an exploratory study to understand the PKM situation in general, the small number of 118 answered and returned questionnaires out of 696 questionnaires distributed, is considered ample.

The questionnaire survey was followed by a theme-based interview survey on experts who were randomly selected from eight organisations, to further refine the understanding of the PKM processes and cognitive enablers. Eight interviews were conducted from July 2011 to January 2012 and the recorded interviews were transcribed and analysed to derive the contents and comparable themes. The interview focused on analysing the PKM processes and cognitive enablers that exist over computer and internet tools and technologies.

IV. RESULTS AND FINDINGS

All interview respondents agree with the processes

identified for PKM, with high agreements on get/retrieve, share, and connect. Little feedback is elaborated on the understand/analyse process since the issues are quite subjective whether it is done over tools and technologies or manually offline. For example, not many people consider that commenting or reviewing others' share of knowledge is a process of analysing, especially when the commenting is done on purely personal topics that do not seem relevant to official knowledge. This is regardless of their own definition of 'personal knowledge', which is knowledge possessed by a person that may or may not be for official work.

Fig. 4 summarises the results gathered for each PKM process, with estimated average on levels of requirement for each process. The level of requirements is based on a scale from 0 to 5, according to the following definitions:

0 – No requirement: Not mentioned
1 – Very low requirement: Only for certain updates
2 – Low requirement: Usually governed by regulatory body
3 – Neutral: Only when needed, e.g. for every specific new knowledge
4 – High requirement: Constantly and often required for updates
5 – Very high requirement: Frequently required, more than once a week, frequently referring to others for almost all tasks

There are differences between the levels of requirement for PKM processes performed within organisation compared to those outside the organisation. Some organisations are very strict in controlling the protocols of PKM processes (e.g. in telecommunication, banking), which restricts knowledge workers to work within the allowed perimeters, despite the need to look for external sources. Even the external sources are predetermined by the people within the organisation, due to the restricted knowledge to be used according to regulatory bodies.

Fig. 4 (a) shows that the highest requirement to frequently get/retrieve knowledge within and outside of organisation is agreed by the respondent from service industry (R07), partly due to the nature of work of the respondent, which is managing events. Half of the total number of respondents agrees with a high average of 3.5 for get/retrieve knowledge, with most level of agreement weighing on getting/retrieving knowledge from outside of organisation. This proves that knowledge workers across the three industries rely on 'reaching' outside source for this get/retrieve knowledge process.

Fig. 4 (b), on the other hand, shows an overall low average compared with the other PKM processes, with highest average being at level 4, but similar to the get/retrieve process, half of the total number of respondents agree with a high average of 3.5 for understand/analyse process. Unlike get/retrieve process that has the lowest average of 2, understand/analyse process has the lowest average of 2.5. Overall, understand/analyse process does not portray extreme levels in requirements, but most requirements are to 'reach' outside sources. This means that knowledge workers depend on external knowledge sources or experts to verify their understanding of certain new knowledge.

Fig. 4 (c) shows a variety of requirement levels for share process, with most sharing is done with people outside of organisation, except for respondents from telecommunication and bank (R04 and R05) who are obliged to the rules and policy of their organisations not to share much knowledge with people outside their organisational boundaries. This results in low averages of 2 (for R04) and 2.5 (for R05). Requirement for share process is high for achieving the organisational goals of lifelong learning (average 4.5 for R01) and business project investment (average 4.5 for R03). This pattern shows that the process of sharing knowledge depends on the type of personal and/or organisational goals that the knowledge worker is trying to achieve. It also stamps the fact that regardless of knowledge sharing culture that may or may not exist in the organisation, the process of sharing is still required to manage personal knowledge.

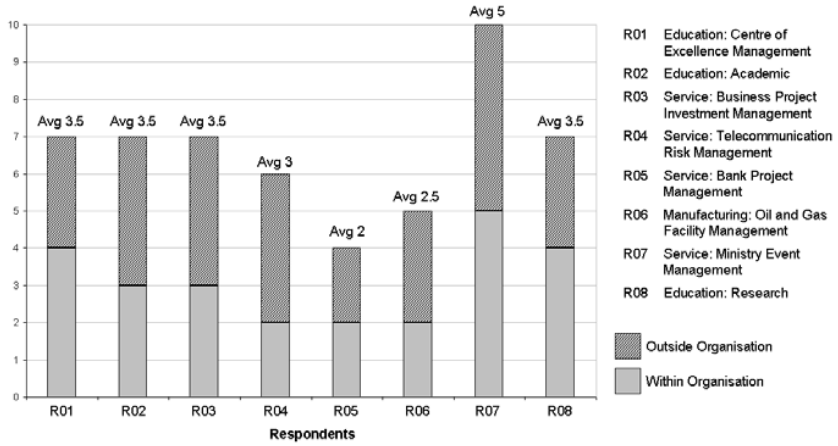

Fig. 4 (a) Summary of Findings for PKM Get/Retrieve Process (N = 8)

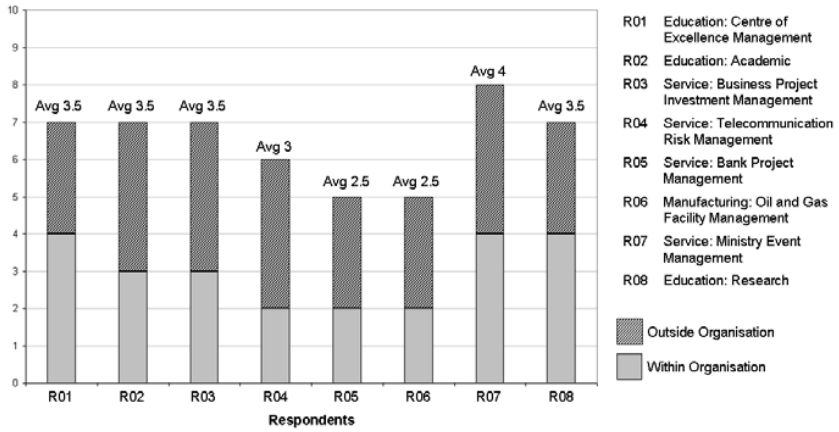

Fig. 4 (b) Summary of Findings for PKM Understand/Analyse Process (N = 8)

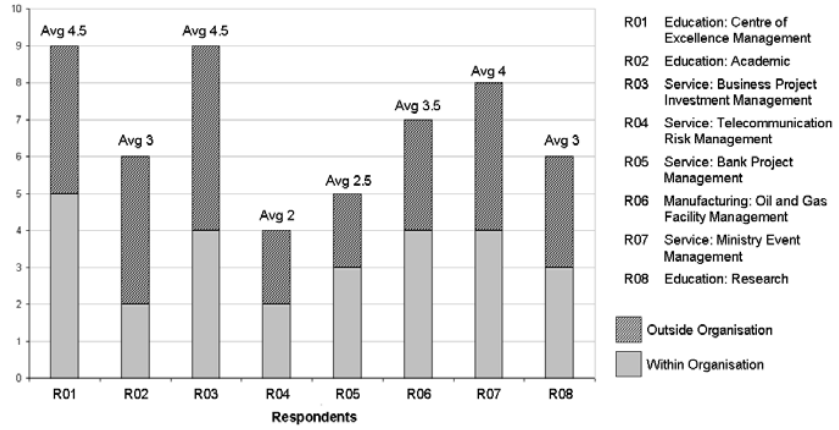

Fig. 4 (c) Summary of Findings for PKM Share Process (N = 8)

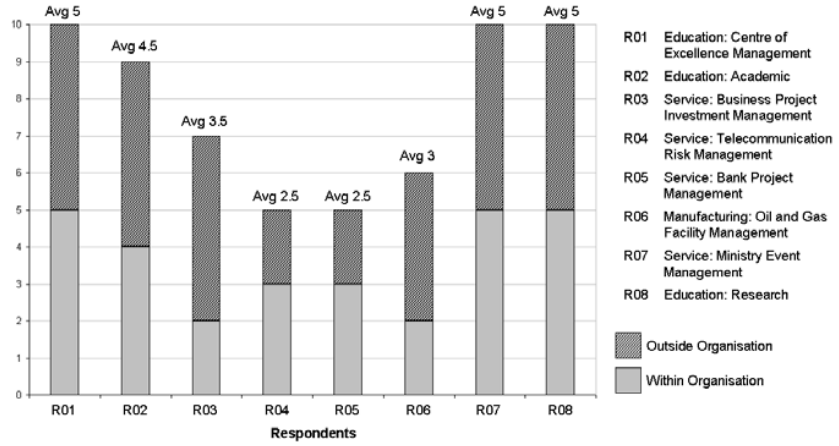

Fig. 4 (d) Summary of Findings for PKM Connect Process (N = 8)

Fig. 4 (d) is tabulated with highest number of maximum requirement level (average 5), which is agreed by 3 respondents: R01 and R08 from education industry; and R07 from service industry. This figure also shows that for organisations with strict rules and policy in sharing knowledge outside of organisational boundaries (R04, R05 and R06), they are required to connect within their organisations to seek knowledge experts. In other words, the organisations have already identified and allocated required expertise in-house, in order to retain the organisational knowledge within the boundaries. Five out of 8 respondents agreed that they highly require connections outside their organisations to manage their

personal knowledge effectively (R01, R02 and R08 from education industry; R03 and R07 from service industry), even though their needs and usage of these connections are different.

In terms of cognitive enablers, all interview respondents could describe their drive, method, identification and decision, in the PKM processes. At most times, the identification of what knowledge and who has the knowledge depend on third parties, such as recommended by friends, or redirected by supervisor, but these also depend on the type of organisation, since some of the identification of knowledge is embedded in the organisational structure and policy. In general, the cognitive enablers (i.e. drive, method, identify and decide) are the mediating variables for PKM processes to achieve effective PKM.

Fig. 5 summarises the results gathered for each cognitive enabler. The strength of the cognitive enablers being the factor for effective PKM is based on a scale from 0 to 5, according to the following definitions:

0 – Unable to answer: Not mentioned
1 – Very weak factor: Only for certain updates
2 – Weak factor: Usually governed by regulatory body
3 – Neutral: Only when needed, e.g. for every specific new knowledge
4 – Strong factor: Constantly and often required for updates
5 – Very strong factor: Frequently required as determinant to processes

The differences of the cognitive enablers are not distinct between internal and external organisational reach, but overall factors are taken into account in determining the importance of the enablers. Thus, Fig. 5 includes the gist of the interview findings across all enablers, gathered from each respondent, who stated other factors that determines the cognitive enablers as a whole (shown in the leftmost column in Fig. 5).

From Fig. 5, the strongest cognitive enabler in determining the effectiveness of PKM differs across industries. For example, respondent from faculty (R02) believes that method, identify and drive are the strongest factors, but the respondent from event management (R07) feels that method and decide are the strongest enablers in PKM. Overall, 'decide' and 'identify' receive the most number of strongest factor (factor = 5, frequently required as determinant to processes), with both being agreed with such level by three different respondents: R06, R07 and R08 for 'decide'; and R02, R05 and R06 for 'identify'.

Apart from the highest points, the weakest factor is 'method', which respondents R03 and R04 (factor = 2, usually governed by regulatory body) subscribe to. Even though respondent R05 is from an organisation that is governed and controlled by strict policy (i.e. banking organisation), R05 claimed that it still depends on the individual knowledge workers when it comes to 'method' of managing personal knowledge. In other words, regardless of the type of organisation and how strict the organisation is in their policy of PKM processes, it still depends on the individuals' ways that motivate and/or enable them to manage their knowledge effectively. Eventually, it is about meeting the deadline in order to achieve both their personal and organisational goals, as agreed by most respondents in their remarks on 'time' (R01, R04 and R05).

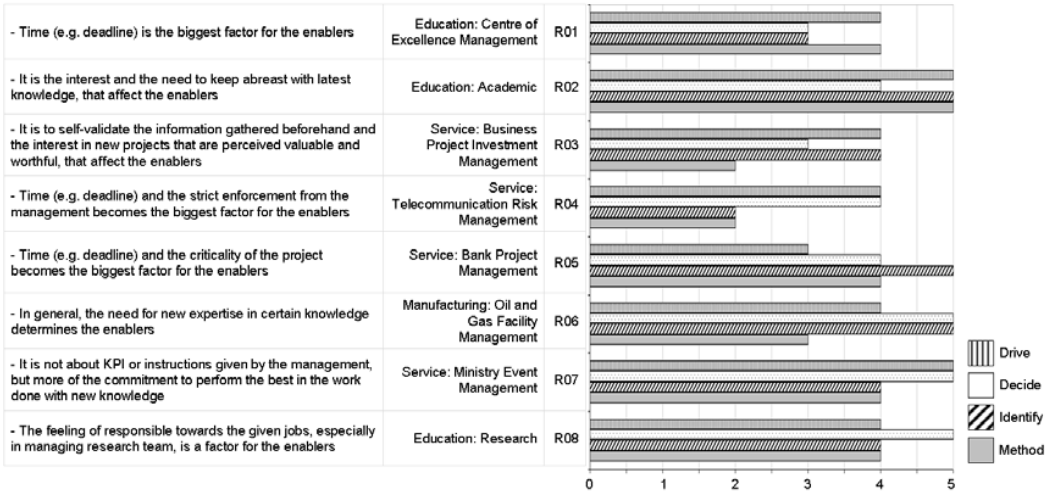

Fig. 5 Summary of Findings for PKM Cognitive Enablers (N = 8)

From the results shown in Fig. 5, time (e.g. deadline) is a factor that determines the cognitive enablers, even though the accreditation and rewards given after an achievement of job performance that meets the deadline do not contribute much to the ability of the knowledge workers in terms of method, identify, decide and drive. In this matter, time is a determinant for a person's key performance indicator (KPI), but how the KPI is met is not evaluated according to the cognitive enablers. In other words, cognitive enablers are the hidden but important elements that ascertain the efficiency of PKM processes, as agreed by the interview respondents.

V. Discussion

From the content analysis of the interview survey, the model for PKM processes can be expanded into an effective PKM framework, as shown in Fig. 6, which simplifies the mediating four cognitive enablers that relate the four independent variables of PKM processes to the dependent variable of effective PKM. In a nutshell, cognitive enablers are the determinants or control variables that ascertain the get-understand-share-connect processes exist and occur in PKM.

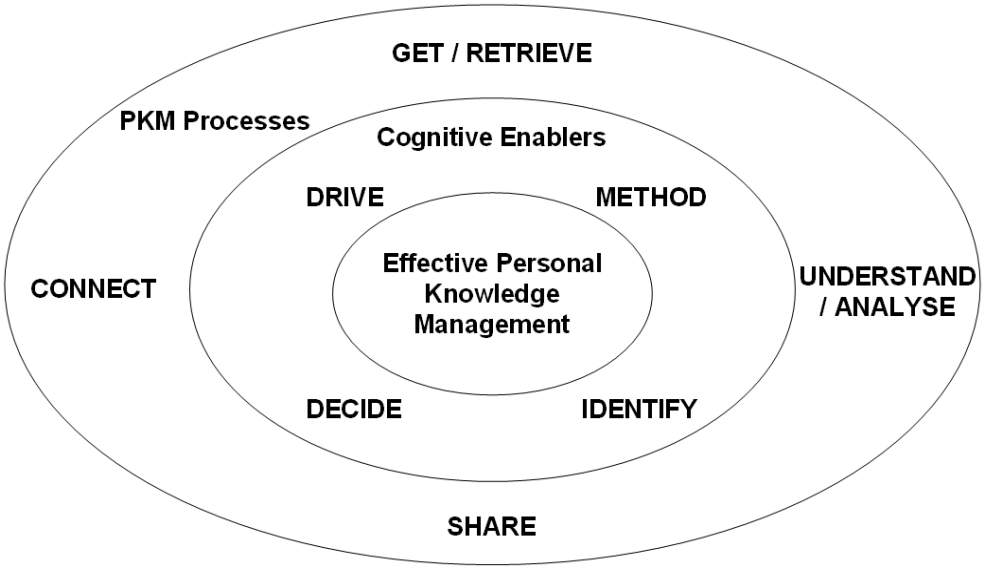

Fig. 6 Effective Personal Knowledge Management (Human Aspect)

This proposed model (as shown in Fig. 6), symbolises the interrelation among the PKM processes and cognitive enablers. It does not constitute that all cognitive enablers should exist in full form in order for each PKM process to work efficiently. In fact, there is a possibility of having the cognitive enablers carrying different percentages of weight in terms of importance and necessity, to support each PKM process. This may also varies across different background of individual knowledge workers, especially those from different industries. Yet, the whole concept of having these enablers and processes is valid across all individuals and industries. Hence the way the model is drawn is in a dynamic shape, to show fluidity of the existing elements within the concept.

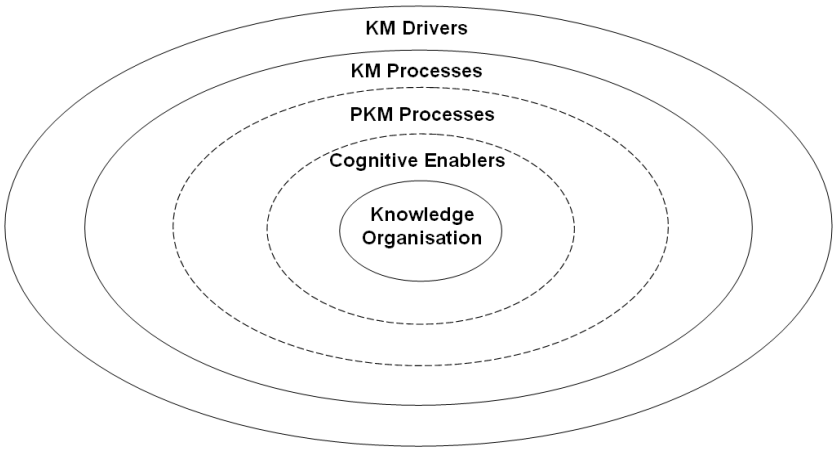

Fig. 7 Knowledge Organisation Theoretical Framework (PKM-OKM Approach)

The interpretation does not stop here. In fact, if this effective PKM framework is embedded in the knowledge organisation framework proposed by Awad and Ghaziri [11], and understanding that the knowledge organisation depends on the ability of individual knowledge workers to manage their personal knowledge, a framework of PKM-OKM approach of

knowledge organisation framework can be illustrated as in Fig. 7. The Effective PKM model (Fig. 6) is foreseen as the granular KM construed on an organisation, since the core player that makes the PKM effective is the 'people' or knowledge workers who exist and work within the organisation. With this fundamental concept in mind, we argue that KM processes suggested in Knowledge Organisation Model [11] can be further broken into PKM processes and their mediating cognitive enablers (Fig. 7).

In supporting this argument, the interview respondents agree that the final outcome of their knowledge gain and use during the PKM processes is the achievement of their organisational goals and key performance indicators. Most respondents also believe that if knowledge workers could not manage their personal knowledge well, then they may not be able to achieve their personal goal or KPI, and the organisational goal will be in jeopardy. In other words, there is a tight-coupling between the PKM processes and KM processes in achieving organisational goal and OKM.

Since the whole idea is determine how the granularity of PKM processes can finally produce an outcome of a knowledge organisation, the Knowledge Organisation Theoretical Framework (Fig. 7) is also supporting the bottom-up approach to PKM-OKM.

VI. Conclusion and Further Work

This paper outlined the results from surveys conducted, in proposing the frameworks of effective PKM and the bottom-up approach to KM in organisations. The effective PKM framework is yet to be tested on the strength of relationships between the variables involved, namely PKM processes with effective PKM, cognitive enablers with PKM processes, and cognitive enablers with effective PKM. Future work is expected to be implemented using a questionnaire survey to test these relationships and identifying the strength of each relationship that exists in the framework. Using the Likert scale on constructs for each variable and analysing correlation using the Pearson correlation coefficient, the strength of each relationship can be verified.

In technical terms, even though software agent can mediate some tasks of PKM on behalf of its human counterpart, the 'perceived simple' externalisation process (i.e. get/retrieve knowledge) is seen as hard to articulate even in agent environment. As pointed out by Nonaka and Takeuchi [10], "a more important kind of knowledge is tacit knowledge, which is hard to articulate with formal language. It is personal knowledge embedded in individual experience and involves intangible factors such as personal belief, perspective, and the value system".

As easy as it may seem to search for information online, it is not that easy to program a software agent to know what it is looking for, especially if the tacitness of the knowledge out there is too complicated to be understood by the agent. Yet, with the BDI (belief, desire, and intention) notions of agency, it is a challenge worth experimenting in future work. Thus, the future work on this study will validate the framework using quantitative survey and analysis, along with software agent simulation of the PKM processes. Quantitative validation will include the correlation coefficient measurements to understand the strengths of each relationship among the elements in effective PKM model, whereas the validation via simulation will prove that an individual knowledge worker's PKM will be more effective when the elements proposed in effective PKM model are embedded in the multi-agent systems.

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