From Skills and Competences to outcome-based Collaborative Work: Tracking a decade's development of Personal Knowledge Management (PKM) Models

Ricky K.F. Cheong
UBS AG, Hong Kong
rcheong852@gmail.com

Eric Tsui
The Hong Kong Polytechnic University, Hong Kong SAR, China
eric.tsui@polyu.edu.hk

1. Introduction

PKM is still an under-explored or under-researched area (Pauleen 2009; Tsui 2002; Zhang 2009). The competency and proficiency of Individual Knowledge Workers, among other factors, underpin the success of an organisation's knowledge management journey. Individual learning is closely linked with organisational learning in knowledge management. Ahmed et al. (2002) mentioned that knowledge management involves individuals combining and sharing their experience, skills, intuition, ideas, judgments, context, motivations and interpretations. One of the knowledge management strategies proposed by Wiig (1997) is personal knowledge responsibility. It means to focus on individual responsibility for knowledge-related investments, innovations and also on the competitive side, renewal, effective use and availability to others of the knowledge assets within each employee's area of accountability. It also entails being able to apply the most competitive knowledge to the enterprise's work.

In the past decade, several scholars (e.g. Frand and Hixon (1999), Avery et al. (2001) Berman and Annexstein (2003) , Efimova (2005), Wright (2005), Zuber-Skerritt (2005), Agnihotri and Troutt (2009), and Jarche (2010)) have developed their model to describe PKM. Their model shared the same assumption that PKM is playing important role in knowledge management and has benefits to individuals, organisations and social communities.

2. What is Personal Knowledge Management?

Although there were not many researches in this area, several scholars have articulated what is personal knowledge management e.g. Frand and Hixon (1999), Avery et al. (2001), Higgison (2004), Jefferson (2006), Volkel and Abecker (2008), Martin (2008) and Harold Jarche (2010). The followings are the extracts of the related literature by different scholars which provides insight of the definition and nature of personal knowledge management.

(1) Frand and Hixon (1999)
Personal Knowledge Management is a system designed by individuals for their own personal use (Frand & Hixon 1999) and *"it is a conceptual framework to organise and integrate information that we, as individuals, feel is important so that it becomes part of our personal knowledge base. It provides a strategy for transforming what might be random pieces of information into something that can be systematically applied and that expands our personal knowledge."*

(2) Avery et al. (2001)
Avery et al. (2001) argued that *"PKM assumes that individuals have developed a self-awareness of their limits and abilities, i.e. what they know and what they can do. This personal self-awareness is an understanding of how much they know, how to access the things they know, strategies for acquiring new knowledge and strategies for accessing new information as needed. In the vast amount of information available and many means for acquiring new information, individuals have each mapped out their own areas of expertise and their own methods for additional learning."*

(3) Higgsion (2004)
Higgison (2004) defined personal knowledge management as *"managing and supporting personal knowledge and information so that it is accessible, meaningful and valuable to the individual; maintaining networks, contacts and communities; making life easier and more enjoyable, and exploiting personal capital"*

(4) Jefferson (2006)
Jefferson (2006) argued that *"PKM is focused on bottom up approach, with an individual perspective to KM. The goal is to allow individuals to choose what information to collect, how to structure it, and who to share it with. Individuals need to be able to manage their own information so that is meaningful, accessible when it needed, can be easily exploited. PKM allows workers to organise both digital and paper content in such a way to allow them to make sense of the deluge they are continually exposed to."*

(5) Volkel and Abecker (2008)
Volkel and Abecker (2008) termed *"Personal Knowledge Management to denote the process of the individuals to manage knowledge"* and *"PKM deals with embrained, embodied and encoded knowledge i.e. mostly with personal, self-authored artefacts."*

(6) Jerome Martin (2008)
Martin (2008) argued that *"PKM is knowing what knowledge we have and how we can organise it, mobilise it and use it to accomplish our goal, and how we can continue to create knowledge."*

(7) Harold Jarche (2010)

Jarche (2010) mentioned that *"PKM is an individual, disciplined process by which we make sense of information, observations and ideas. In the past it may have been keeping a journal, writing letters or having conversations. These are still valid, but with digital media we can add context by categorising, commenting or even remixing it. We can also store digital media for easy retrieval"*

Irrespective of how personal knowledge management is defined by different scholars, Cheong and Tsui (2010 Forthcoming) argued that the key purpose of personal knowledge management is to provide a framework for individuals to manage new information, integrate it and enrich each individual knowledge database in an effective manner; doing this successfully will empower each individual to easily apply their own personal knowledge to deal with new and old problems, to learn from new experience and to create new knowledge; and it is a continuous and interactive process which is not independent of other knowledge management.

3. Development of Personal Knowledge Management
Pauleen (2009) mentioned that the history of personal knowledge management begins with the idea of the knowledge worker by Drucker (1968) but Volkel and Abecker (2008) argued that the term of personal knowledge management has already been used since Polanyi (1958). In this section, the development of personal knowledge management was discussed since Frand and Hixon (1999), their work has impacted and drawn the focus of many scholars in this areas in the past decade.

Frand and Hixon (1999) mentioned that we are living in a sea of data, our challenge is knowledge and its management that everyone must listen to a great deal of noise in order to retrieve the few bits of information that are of value to them. Some problems appear to be intrinsic knowledge management, whether it is being performed using a word processor, a formal language-based tool or pencil and paper. These problems include (1) Categorising or classifying; (2) Naming things and making distinctions between them; and (3) Evaluating and assessing The PKM framework proposed by Frand and Hixon (1995) focused on personal information management and failed to address the importance of inter-personal knowledge activities.

Avery et al (2001) based on the idea created by Paul Dorsey and developed another PKM framework which addressed this gap to include collaborating around, securing and presenting information. Avery et al (2001) believed that PKM requires to clarify the distinction between data, information and knowledge and believed that information could become knowledge which entails activities such as comparing, exploring consequences, making connection to other information and knowledge and conversing with others. Their proposed PKM framework focused on the information skills which consisted of seven PKM skills namely (1) Retrieving information; (2) Evaluating information; (3) Organising information; (4) Collaborating around information; (5) Analysing information; (6) Presenting information, and (7) Securing Information.

Tsui (2002) provided a technology-centric view on PKM and also explored the issues when using the PKM tools available at that time. In the view of Tsui (2002), PKM is a

collection of processes that individuals need to carry out in their daily activities in order to manage their own knowledge management work including gather, classify, store, search and retrieve knowledge, it is not limited to work-related activities but also the social activities. Tsui (2002) suggested that the knowledge workers need constantly to (1) locate the right information quickly, (2) stay abreast with business and technology trend, (3) switching between learning and practising, (4) create new knowledge and be innovative, and (5) maintain communications and build trust among peers. These five suggestions are actually in line with the Avery et al (2001) PKM framework and communications and working with peers are a key element in PKM. In addition, PKM should enable innovation and put PKM in practise.

Berman and Annexstein (2003) based on the Avery et al. (2001) proposed PKM Skills and developed a personal knowledge book, "PK-Book", model to actualise the PKM. Berman and Annexstein (2003) argued that the ability to actualise context for PKM is facilitated by a design combination consisted of (a) a structured and secured container for the organisation of information, (b) algorithms for the generation of associated contextual metadata, and (c) utilisation of a contextual engine driven by applications. It is the natural processes associated with the organisation of focused information which leads to an ability to actualise context in information applications, and conversely, through the usage of context in applications, the focused information unit can be augmented and improved over time. The PK-Book model seeks to provide users with a natural organisational structure and methodology, along with a set of associated tools and applications that together to capture and reflect the structure of information as understood by the individual (Berman & Annexstein 2003).

Pollard (2004) worked out his model of personal knowledge management which focused on the information acquisition, information processing and social activities. The information acquisition includes looking up data, finding / retrieving information & answers, compiling/ researching / reading/ studying / learning, and subscribing to information source. The information processing activities include writing / analysing / narrating / interpreting, editing /reviewing / annotating, and sharing and publishing knowledge work. The social activities include finding people / experts, connecting to people, collaborating, and interacting. Pollard (2004) argued that this "system" has no pre-defined sequence, no flow and it is just an undifferentiated set of knowledge activities that underpin human intellectual activities.

Efimova (2005) argued that PKM is an interactive process between individuals, other people and ideas. This is an approach which focuses on supporting knowledge worker productivity by taking an active perspective in studying their work. Efimova (2005) defined PKM as managing a one-person enterprise, the knowledge product, e.g. the processes, tools, relations with partners, customers and suppliers, are connected with literature on personal effectiveness and time management or personal branding and networking. Efimova (2005) used Weblog as an example to illustrate the PKM works.

Wright (2005) defined PKM as the capacity to access and apply information and knowledge resources and process to enhance the effectiveness, productivity and

innovation of individual workers. Wright (2005) mentioned that while PKM was primarily an unconscious process and occurred naturally, it was more than personal. Wright (2005) based on an exploratory study of the work and learning processes of highly skilled experienced knowledge workers and proposed an alternative personal knowledge management framework which linked the problem solving activities with specific cognitive, information, social and learning competencies.

Zuber-Skerritt (2005) developed a "soft methodology" model of PKM based on the seven commonly shared values and principles of an action learning and action research (ALAR) culture which generated seven kinds of personal knowledge can be used for knowledge management in management education and the workplace. Zuber-Skerritt (2005) described this model as the values and actions for PKM and argued that which can serve as a practical guide for application in situations where personal knowledge can contribute to problem solving and effective organisational management for organisation and all individuals.

Agnihotri and Troutt (2009) argued that technology is a critical part of PKM to enhances individual efficiency and effectiveness such that it will help users to classify ideas and information, or to archive interactions emails and other items of they are easy to locate. Agnihotri and Troutt (2009) referenced to the PKM tools classification by Tsui (2002) and addressed the importance of fit between PKM skills and the tools.

In recent years, the development of PKM started to focus on technologies, e.g. online tools, Web 2.0 technology and semantic web, which enabled the development of PKM tools to support the workers to practise PKM in online and virtual environment. Pettenati et al. (2007) studied the relationship between social networking software and PKM skills; Diao, Zuo & Liu (2009) investigated the artificial intelligence in PKM; Kim, Breslin and Decker (2009) proposed a wiki-based semantic tagging system for PKM and Volkel and Haller (2009) proposed a conceptual data structures for PKM..

Pettenati et al. (2007) concluded that social networking tools and methods provide a tremendous opportunity and context to lead individual into the leaning and knowledge landscape and PKM skills are the enabling condition and final outcome of social network-based learning experience.

Diao, Zuo & Liu (2009) argued that although the application of artificial intelligence in personal knowledge was still at the initial stage, the requirement of artificial intelligence were increasing. The artificial intelligence can be applied to PKM for (1) intelligent search of knowledge, (2) automatic classification of knowledge, and (3) conversion of tacit knowledge. The use of artificial intelligence technology to assist in PKM illustrates the usefulness of artificial intelligence.

Kim, Breslin and Decker (2009) argued that typical personal management systems do not provide effective ways for representing knowledge worker's unstructured knowledge or idea. Based on this, a Wiki-based semantic tagging system (Wiki-based social Network Thin Client – WANT) was proposed to facilitate the collaboration and communication of

the knowledge creation and maintenance and also the social semantic cloud of tags (SCOT) was suggested to represent tag data at a semantic level and combine this ontology in WANT. Kim, Breslin and Decker (2009) mentioned that the PKM system is not only focused on managing data, but also on connecting people and enabling them to share data between them.

Volkel and Haller (2009) developed a unified data model called Conceptual Data Structure (CDS) to bridge the gap between unstructured content (e.g. informal notes) and formal semantics (e.g. ontologies) by allowing the use of vague semantics and by subsuming arbitrary relation types under more general ones. The purpose of the CDS serves as a guideline for future PKM tools, providing a set of crucial structural primitives as well as provides a knowledge exchange format.

Up to now, the development of PKM is divided into two clusters: skills/activities-centric and technology-centric. The skills/activities centric mainly focused on the skills for individual to manage their knowledge activities e.g. retrieving, analysing and collaborating information …etc. The technology centric mainly focused on classification / selection and development of tools, e.g. data structure and framework for tools development. The scope of the PKM also expanded from individual to more collaborative focused. Individual focus mainly concerned the self development/reflection and collaborative focus concerned knowledge sharing and interactive with people, community and society. The timeline of the PKM development and their focuses are illustrated in figure 4.1.
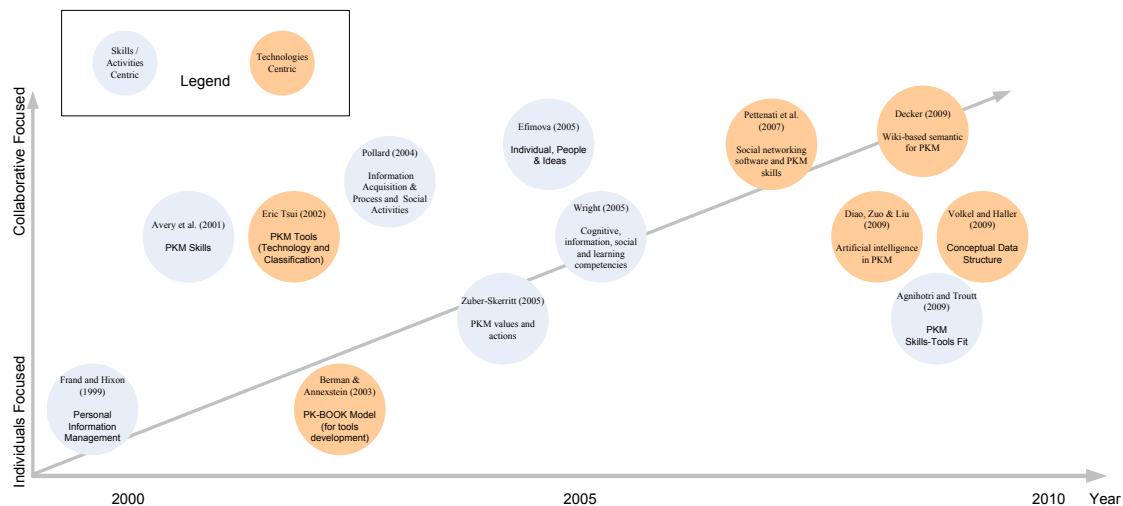

Figure 4. 1 PKM Development in Past Decade

4. Evaluation of Personal Knowledge Management Models
Many scholars have tried to put different aspects, e.g. skills, tools, connection, communities …etc, of PKM together to form the PKM model and explain the interactions. This section evaluates the PKM models by different scholars which including Frand and Hixon's (1999) PKM Model (PIM Model), Avery et al's (2001) PKM Model (PKM Skills Model), Berman and Annexstein's (2003) PKM Model (PK-Book Model) , Efimova's (2005) PKM Model (Individuals, Ideas and Communities Model), Wright 's (2005) PKM Model (Competences Model), Zuber-Skerritt's (2005) PKM Model (Values and Actions Model), Agnihotri and Troutt's (2009) PKM Model (PKM Skill-Tools Fit model), and Jarche's (2010) PKM Model (Aggregate, Understand and Connect Model) . The models will also be assessed their roles in the four generic knowledge management process (capture / locate, create, transfer / share and apply) as proposed by Seufert, Back & Krogh (2003).

4.1 Frand and Hixon (1999) PKM Model (PIM Model)
Frand & Hixon (1999) outlined five PKM techniques as (1) Searching / Finding; (2) Categorising / Classifying; (3) Naming Things / Making Distinctions; (4) Evaluating / Assessing; and (5) Integrating / Relating. Individual would attempt to utilise the computer to help an individual to manage the information explosion in an effective way.

(1) Searching / Finding
Searching / Finding focuses on using tools e.g. database selection tools and search engines. Individuals need to select appropriate staring points based on the characteristic of the data and understanding the different value and attributes of different search engines.

(2) Categorising / Classifying
Categorising / classifying is based on the principles used by library scientists e.g. Ranganthan, Deway, Cutter and others. It includes the classification schemes, organising information from general to become more specific, putting items into the most specific category, subdividing when new category is required.

(3) Naming Things / Making Distinctions
Naming things / making distinctions focuses how to select or use the name that are meaningful to people. It also requires using unique terms in consistent manner for distinct concepts e.g. names, abbreviation, file extensions ...etc. The challenge is how to select the name which is as complete as necessary and as short as possible to be able to identify the content and minimise confusion.

(4) Evaluating / Assessing
Evaluating / assessing focuses on the tasks related to determine if the information is complete and accurate, if any evidence of bias by evaluating the purpose of the information is provided, if there are any sources that confirm or validate the information provided, if the information is up to date, if the information is provided by the authority or expertise of the related topic.

(5) Integrating / Relating
Integrating / relating represents the work by individuals to apply the obtained information in problem solving and reflection.

The roles of Frand and Hixon's (1999) PKM model in the four generic knowledge management processes are summarised in table 4.1. Except for the fifth component, integrating / relating, which is related to applying knowledge, the other components in the model were on locating/capturing knowledge. As such, the model lacks the role of sharing/ transferring and creating knowledge.

Model's Components	KM Processes (Seufert, Back & Krogh 2003)			
	Locate / Capture	Share / Transfer	Create	Apply
(1) Searching / Finding	X			
(2) Categorising / Classifying;	X			
(3) Naming Things / Making Distinctions	X			
(4) Evaluating / Assessing	X			
(5) Integrating / Relating				X

Table 4. 1: The Role of Frand and Hixon's (1999) PKM Model

The framework proposed by Frand and Hixon (1999) focused on personal information management by individuals and missed the element of inter-personal knowledge work i.e. information and knowledge collaborating. However, this model has provided the ground work for scholars to build other PKM frameworks. The approach proposed by Frand and Lippincott (2002) addressed an important area in putting PKM in practise, especially in handling information overload.

Frand and Lippincott (Frand & Lippincott 2002) followed the idea of "knowledge spiral" by Nonaka and Takeuchi (1995) to articulate PKM as a strategy to deal with information (and information overload) and at the same time enables us to build upon or learn from the information we use resulting in the growth of our personal knowledge. It is related to the ideas of transforming information into knowledge which required to take a brief look at some concepts from leaning theory and to build our personal knowledge entrails learning.

The followings are the PKM tactics suggested by Frand and Lippincott (2002).

(1) Clarify your information needs for each situation.
(2) Plan your information acquisition strategy.
(3) Develop a sourcing strategy for your ongoing information needs.
(4) Identify "push" vs "pull" information.
(5) Adopt naming conventions and stick to them.
(6) File single copies of information
(7) Set criteria for what you want to save or delete.
(8) Work out how and when to process information.

Frand and Lippincott (2002) mentioned that PKM comes into play wherever and whenever working with information and knowledge, whether it is with paper or electronic documents, no matter it is email or snail mail, whether it is in our office, home or on the road. PKM should not focus on the tools used for personal task management e.g. "to do" lists, calendars, address books, appointment books, and some of the very primitive personal digital assistants, instead PKM should focus on the content of the tasks specifically with the information and knowledge management associated with that content (Frand & Lippincott 2002).

4.2 Avery et al.'s (2001) PKM Model (PKM Skills Model)
Avery et al.(2001) proposed a PKM framework with seven skills. The skills are, in one sense, problem solving, rather than problem definition, skills. The skills are focusing on (1) Retrieving information; (2) Evaluating information; (3) Organising information; (4) Collaborating around information; (5) Analysing information; (6) Presenting information and (7) Securing Information. The details of the proposed skill by Avery et al (2001) are as follows:

> (1) Retrieving information.
> Avery et al (2001) mentioned that retrieving information *" involves gathering information not just from print and electronic sources, but through experimentation and oral inquiry, as well as a broad range of more discipline-specific techniques. Capabilities required range from the low-tech skills of asking questions, listening, and following up to skills in using search tools, reading and note-taking. Concepts of widening and narrowing one's search, Boolean logic, and iterative search practices are an important part of the effective exercise of this PKM skill as are social skills required for more effective oral inquiry. Also, as the literature on information literacy emphasises, considerable effort should be placed on framing inquiry even before information retrieval commences. The effective use of Internet search engines and electronic databases in the inquiry process requires technology skills as part of the repertoire of PKM skills."*
>
> The challenge here is to identify those nuggets of information, from the large information environment, which can help to create new knowledge (Avery et al. 2001).
>
> (2) Evaluating information.
> Evaluating information skill is *"closely related to the skill of retrieving information. Strategies of information retrieval should be based on practices that select data and information that pass some evaluative tests. However, evaluation also takes place after retrieval as the quality and relevance of various pieces of information are judged as they relate to the problem at hand. We recognise that difference disciplines tend to emphasise disparate evaluative criteria as they determine quality and relevance. The greater availability of information in the current information-rich environments makes this skill of far greater importance in the electronic age. The intelligent use of some crude electronic tools, such as*

"relevance raters," can be relevant to the effective evaluation of information." (Avery et al. 2001).

The challenge here is to be effective in evaluating the quality and relevance of information from a large amount of information (Dorsey 2001). This skill requires full understanding of the subject matter and sensitivity to the value of the available information.

(3) Organising information.
Organising information skill is the core personal knowledge management skill identified by Frand and Hixon (1999). It is *"a central part of the inquiry process focused on making the connections necessary to link pieces of information. Techniques for organising information help the inquirer to overcome some of the limitations of the human information processing system. In some ways the key challenge in organising information is for the inquirer to make the information his or her own through the use of ordering and connecting principles that relate new information to old information. Elementary skills of synthesis and analysis are central to this process. Technological skills in organising information have become ever more important as electronic tools such as directories and folders, databases, web pages, and web portals provide the inquirer with ever more powerful tools to make connections."* (Avery et al. 2001).

The challenge here is to develop approaches that enable individual knowledge workers to develop strategies that are consistent with the nature of their work, with their learning styles, and with the nature of the collaborative relationships they may have (Dorsey 2001).

(4) Collaborating around information.
Avery et al. (2001) argued that *"the interdisciplinary literature on effective teams and groups is replete with principles for effective collaborative work. Listening, showing respect for the understanding of others' ideas, developing and following through on shared practices, building win/win relationships, and resolving conflicts are among those underlying principles. Within collaborative inquiry, partners in inquiry need to learn to have their voice heard and to hear other voices. Both cultural and more nuts-and-bolts practical issues need to be attended to. The availability of new electronic tools for collaboration to support both synchronous and asynchronous communication requires a whole new set of procedures for efficient information exchange.".*

The challenge here, as it relates to technology, is to identify how information technology can support the process of working smarter, rather than merely harder, and to overcome obstacles in the absence of social cues for appropriate behaviour (Dorsey 2001).

(5) Analysing information.

The analysis of information is *"fundamental to the process of converting information into knowledge. At the same time, this is the most discipline-specific information skill since the models, theories and frameworks that are central to analysis are frequently tied to the academic disciplines. Analysis builds on the organisation of information, but goes beyond it in its emphasis on the importance of respect for standards in public communities. This skill addresses the challenge of extracting meaning out of data. In some disciplines, electronic tools such as electronic spreadsheets and statistical software provide the means to analyse information, but the human element is central in framing the models that are embodied in that software."* (Avery et al. 2001).

The challenge is to extract meaningful information from data. This is the fundamental process of converting information into knowledge (Avery et al. 2001).

(6) Presenting information

Avery et al. (2001) argued that *"key to the presentation of information is audience; this means, as in the case of analysing information, that understanding disciplinary communities—often an important audience--and their norms and standards are of central importance. An effective presentation assumes not only an understanding of audience, but a clear understanding of the purpose of the presentation as it relates to audience. The history and theory of rhetoric provides an abundant literature for guidance in the exercise of this skill. The emergence of new electronic tools and venues for presentations, through computer-based presentation tools and web sites, makes attention to this information skill even more important."* (Avery et al. 2001).

It is important to have a clear understanding of the purpose of the presentation as it relates to the audience (Dorsey 2001). This is the art of composition and speaking. It is not enough just to prepare a professional looking PowerPoint slide or a colourful chart. The presenter has to understand the characteristics of the audience: who they are, what information they require, from what perspective they will interpret the information and how they will make use of the information presented. The challenge is to ensure the audience can pick up the information or knowledge in the context that the presenter has selected.

(7) Securing information

Securing information is frequently being neglected as an information skill (Dorsey 2001). In the view of Avery et al (2001), securing information is *"the centrality of intellectual property issues and the multiplicity of security issues arising from the explosion of electronically networked environments make security issues more and more salient. Securing information entails developing and implementing practices that help to assure the confidentiality, integrity and actual existence of information. An appreciation of intellectual property issues of copyrights and patents is very important. Such practices as password*

management, backup, archiving and use of encryption are other important elements for the effective practice of this skill in electronic environments."

The roles of Avery et al.'s (2001) PKM model in the four generic knowledge management processes are summarised in table 4.2. The retrieving information, evaluating information and organising information were taking the role in locate/capture knowledge, the collaborating around information was taking the role in share/transfer knowledge, the analysing information was involving create knowledge; and the presenting information and securing information were taking the role of share/transfer and apply knowledge.

Model's Components	KM Processes (Seufert, Back & Krogh 2003)			
	Locate / Capture	Share / Transfer	Create	Apply
(1) Retrieving information	X			
(2) Evaluating information	X			
(3) Organising information	X			
(4) Collaborating around information		X		
(5) Analysing information			X	X
(6) Presenting information		X		X
(7) Securing Information		X		X

Table 4. 2The role of Avery et al.'s (2001) PKM Model

Avery et al.'s (2001) PKM model is a more comprehensive model which not only include the information management skills but also the skills required for knowledge sharing .e.g collaborating, presenting and securing. This model has influenced a lot of PKM scholars in their work e.g. Berman and Annexstien (2003) in the PK-Book Model, Agnihotri and Troutt's (2009) PKM Skills-Tools Fit Model, and the recent PKM researches done by Wu (2007) for the Teacher at Taiwan and Cheng (2009) for the pre-service teacher at Hong Kong.

4.3 Berman and Annexstein's (2003) PKM Model (PK-Book Model)
Berman and Annexstien (2003) developed a Personal Knowledge Book Model "PK-Book Model", as shown in figure 4.2, based on the PKM Skills Model proposed by Avery et al (2001). The PK-Book model adapt the features of the traditional book which (1) provided to the user an understanding of the structure and topic set in the form of table of contents (TOC), (2) the pages of the book contain the raw information content in the forms of textual data, figures, and references; and (3) the index of a book provides means to quickly and easily search and locate information contained in the pages of the book. In addition, Berman and Annexstein (2003) applied new computing technologies to develop this PK-Book model and to make this PK-Book became a multi-dimensional object. The formal definition of a PK-Book object (Berman & Annexstein 2003) is a tuple B = (T,P,I,E), where T is the table of contents, P is the set of pages, I is the index, and E is the context engine which applies the contextual metadata in applications.
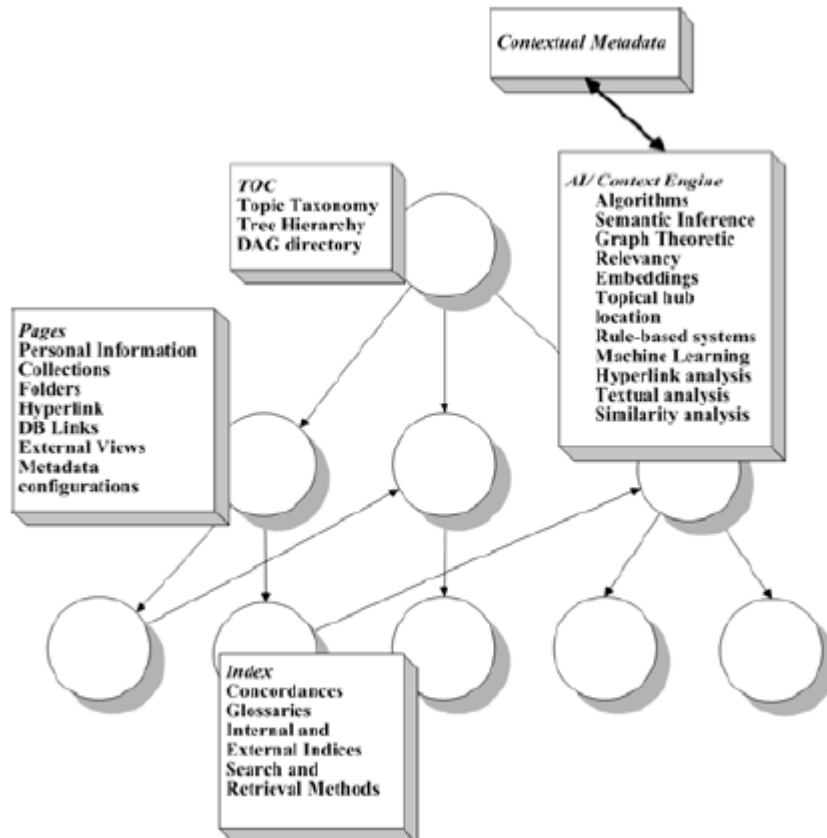
Figure 4. 2: Berman and Annexstien's PKM Model (PK-Book Model)
Source: Berman and Annexstien (2003, p. 5)

(1) PK-Book Table of Content (TOC)
The PK-Book TOC is to facilitate the structural definition of the personal knowledge which accomplished by facilitating processes of outlining, cataloguing, and categorisation. The formal definition of PK-Book TOC is the hierarchy of topics and allows cross reference edges that respect the refinement or subset relation on topics. Hence, PK-Book TOC = (D,T) where D is the directed acyclic graph (dag) and T is the named topics identified with the nodes.

(2) PK-Book Pages
The PK-Book Pages are designed as an interface to the raw information data, accessible database, local data, and its visualisation (layout and style configurations). The Pages are blocked into a vector of frames f1, f2,….,fk…etc., where each frame represents a collection of semantically related elements.

(3) PK-Book Index
The PK-Book index is designed to facilitate information search and retrieval methods. These methods are applied to the book and its contents as well as to the related resources available through the network. The index allows for the

disambiguating and relevancy determination of terms, and allows integrating with the peer-to-peer sharing.

(4) PK-Book Context Engine
The PK-Book context engine is designed to utilise the contextual metadata (e.g. time stamping, history, and usage pattern and user profile) stored in the PK-Book pages. The goal of the context engine is to help augment and improve the functionality and information content of the PK-Book object over time. The contextual metadata can also include the external resources e.g. ranking topic specific information hubs, to determine the authority ranking of content and to determine the relevancy of information elements with respect to the context of the PK-Book.

Berman and Annexstein (2003) argued that the PK-Book Model draws the inspiration from potential synergy between the processes of information organisation and information contextualisation, and these two processes as "manus manum lavat" i.e. one hand washing the other. The process associated with information organisation include capturing, converting, cataloguing, categorising, outlining, manual filtering, and indexing, and the processes associated with information contextualisation include searching, crawling, browsing, focusing, semantic, evaluation, automatic filtering, analysing and confirming.

The roles of Berman and Annexstein's (2003) PKM model in the four generic knowledge management processes are summarised in table 4.3. All there model's components were actually involved to deal with locate/capture knowledge only and it was lacking the roles of sharing/transferring, creating and applying knowledge.

Model's Components	KM Processes (Seufert, Back & Krogh 2003)			
	Locate / Capture	Share / Transfer	Create	Apply
(1)PK-Book Table of Content (TOC)	X			
(2) PK-Book Pages	X			
(3) PK-Book Index	X			
(4) PK-Book Context Engine	X			

Table 4. 3: The roles of Berman and Annexstein's (2003) PKM Model

Berman and Annexstein (2003) mentioned that their PK-Book Model was only a conceptual model for computing design. It was too abstract that individuals are hardly to follow to build their own PK-Book. Besides, it is just focusing on the individual information management and lacking the elements for knowledge sharing. However, this model provided the insight of using computing technology to facilitate the PKM work.

4.4 Efimova's (2005) PKM Model (Individuals, Ideas and Communities Model)
Efimova (2005) suggested that a knowledge worker's activities could be mapped as interactions of an individual, other people and with ideas. The proposed PKM framework is illustrated in figure 4.3 which consists of (1) Individuals, (2) Ideas, and (3) Communities and Networks.

Efimova (2005) based on the views of Lave & Wenger (1991) and Brown & Duguid (1991) that new ideas and insights are often developed in the social context, and to defined that conversations and collaboration should be in the middle of the PKM framework. Making sense of information, organising ideas and creativity are the key elements for individuals to deal with ideas. Individuals should establish and maintenance relationship with the communities participants and awareness, exposure and lurking are the key processes to interact with ideas within the communities.

Efimova (2005) also argued that conversations require the unique personal contributions, enabling relations between participants, and awareness of a specific domain, its players and social norms. The participation in conversation requires learning to move from being an outsider to become a more active position through the participation at the periphery. Trust and shared understanding between people would enable the effective knowledge development and it is required to establish and maintain a personal network to keep track of contacts and conversation and to make choices about which communities to join and which can be ignore. In addition, knowledge workers are faced with a need for personal information management in order to organise their information which may be in the form of paper, digital archives, emails and bookmark collections.
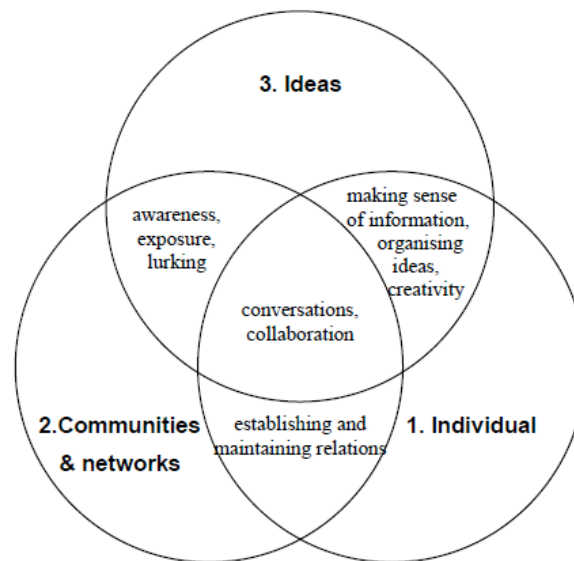

Figure 4. 3: Efimova's (2005) PKM Model
Source (Efimova 2005, p. 8)

The roles of Efimova's (2005) PKM model in the four generic knowledge management processes are summarised in table 4.4. The first component "ideas" was taking the roles in both create and apply knowledge, the "individual" was mainly focusing on locate/capture knowledge and "communities & networks' was taking the role in share/transfer knowledge.

Model's Components	KM Processes (Seufert, Back & Krogh 2003)			
	Locate / Capture	Share / Transfer	Create	Apply
(1) ideas			X	
(2) individuals	X			
(3) communities & networks		X		

Table 4. 4: The Role of Efimova's (2005) PKM Model

Efimova's (2005) PKM model provided the linkage between ideas, individuals and communities. It provided some important key concept of practising PKM e.g. the relationship between individual and communities not just need to be established but also need to be maintained; sense making of information and creativity are important for individual to generate ideas; and awareness, exposure and lurking are important for ideas sharing within the communities. The element of "Ideas" was introduced to PKM model which was not found in previous PKM models. However, this model is less focussed on the application of knowledge and how to better organise information for future use.

4.5 Wright 's (2005) Personal Knowledge Management Framework (Competences Model)
Wright (2005) proposed a PKM framework, as shown in figure 4.4, to link the problem solving activities with specific cognitive, information, social and learning and development competencies. It is based on the Tissen et al., (1998) proposed model of knowledge worker competencies and added a fourth competency namely learning and development. The capacity to apply the competencies is required to have support by the individuals, social and organisational enablers.

(1) Cognitive Competences
The knowledge workers develop and refine their problem solving capabilities through ongoing learning which including formal training and informal learning, observations and discussions, as well as work experience. The knowledge workers apply complex thinking skills e.g. problem identification and definition, pattern recognition, sense-making, analysis, implementation and monitoring. Varity of heuristic processes and analytical models are used to solve problems. The workers are not limited to single approach to problem solving and will continuously adapt, modify and refine their problem-solving techniques. As a result, the workers will acquire advance cognitive skills which include experimentation, prototyping and modelling. Communication, negotiation and conflict resolution skills are developed to apply in developing new knowledge and finally the process of reflection, including individual reflection and double loop learning and collaborative reflection within communities of practise, will be occurred around particular problem-solving practices.

(2) Information Competences
The core information competences involve sensing and sourcing information skills i.e. the ability to locate and capture the information in a short time, and questioning skills which enable to know what information resources to seek. It is the ability to asses, organise, structure, present and discard information resources

which are vital element for efficiently access and apply information. It involve to have strong search skills to enable quickly assess the quality and value of information resources.

(3) Social Competences

Knowledge work is a social interaction. It is a challenge to the knowledge workers that problem solving in today's complex environment involves teams, projects, collaboration and interaction. The problem solving involve working in a collaborative environment and effective problem solving require team building and maintenance activities e.g. communication and conflict resolution skills. How individual workers utilise their social competencies can be understood by the concept of social capital (Adler & Kwon 2000; Nahapiet & Ghoshal 1998). The social capital consists of three inter-related dimensions which are structural, cognitive and common understandings and relational. Structural defines the ties and configurations of the social networks which identify the patterns of connections among workers. Cognitive include the elements of shared language. Common understandings focus on the essential role of trust, shared norms and common identification.

(4) Learning and Development Competences

Learning is a continuous process and it is indistinguishable from ongoing work practices. Learning is contingent and contextual. For routine problems, workers refine their ability to quickly recognise problem types and act. The novel problems allow workers to develop stronger pattern recognition and sense-making capacities and more robust analytical and problem-solving techniques. The new knowledge is created through experimentation, innovation and prototyping. Problem outside the expertise of workers can enable the workers to apply reflection skills. The cognitive, information, social and learning competencies are continuously improved across the spectrum of problem types workers.

Figure 4.4 illustrates the PKM framework proposed by Wright (2005). This model also in line with previous PKM models that information and social are the key elements in PKM. In addition, this model provided a new angle of PKM in term of competencies for problem solving. However, as mentioned by Wright (2005) that this model needs further research to understand how knowledge workers tackle complex problems and also to examine the types of problems faced by different workers. Besides, it also required to study how experts can be developed and nurtured.

Problem type	Routine	Novel	Discovery	Outside of expertise
Cognitive problem-solving competencies	Apply rapid problem-solving process including: -problem-scoping -pattern recognition -sense-making -problem analysis -heuristics -risk assessment -identification of solution options	*In addition*: Careful, systematic definition, diagnosis and analysis of problem Reflection and double loop learning Improviztion skills	*In addition*: Create prototypes of complex ideas to make tacit knowledge explicit Structured discussion and collaboration process to explore ideas	Cautious problem solving featuring slower pace of problem definition and pattern recognition
Information competencies	Access personal notes and relevant information Ability to access, search, store and organize key information resources	*In addition*: Access and assess quality of external information (sensing and sourcing) Consultations with community of practice and external networks	Knowledge (information, assumptions, values) embedded in prototypes and models	Seek additional insights by seeking discussions with new networks (dynamic information sources)
Social Competencies	Primarily a Solitary activity	Collaborative activity requiring communication and collaboration skills Extensive internal and external discussions. Team work processes	*In addition*: Use of shared space for collaborative discussions of prototypes Supported by use of 'shared space' technologies	Engage in wider search for ideas and insight Develop more extensive external networks Internal community used to vette external information
Learning competencies	Stronger problem definition capacity	Increased pattern recognition and sense-making. Stronger analytical skills	Creation of new knowledge through experiments and prototyping	Capacity for reflection
Individual, social and organizational context	Individual motivation to excel, learn, risk taking and innovation, collaboration and strong interpersonal skills Strong social capital, high trust, strong bonding networks, strong bridging networks, support of community of practice and strong collaborative abilities Organizational enablers including flexibility, high trust, tolerance for risk and innovation, autonomy, supportive leadership and challenging work			

Figure 4. 4: Wright's (2005) PKM Framework
Source: Wright (2005, p. 163)

The roles of Wright's (2005) PKM model in the four generic knowledge management processes are summarised in table 4.5. The cognitive competencies and information competencies were taking the role in locate/capture knowledge, social competencies were mainly involving in share/transfer knowledge, and learning and development competencies were taking the role to deal with create and apply knowledge.

Model's Components	KM Processes (Seufert, Back & Krogh 2003)			
	Locate / Capture	Share / Transfer	Create	Apply
(1) cognitive competencies	X			
(2) information competencies	X			
(3) social competencies		X		
(4) learning and development competencies			X	X

Table 4. 5: The Role of Wright's (2005) PKM model

This model introduced an important concept in PKM which is the competences. The knowledge workers need to develop their competences in order to benefit to both individuals and organisations. The important argument/assuming here was that with good competences, it will increase the ability to create knowledge and as a result to improve the capability to deal with problems. This hypothesis is required further research to support its argument.

4.6 Zuber-Skerritt's (2005) PKM Model (Values and Actions Model)

Zuber-Skerritt's (2005) PKM model offered a system of seven values and principles and seven matching actions. The seven values and principles are, in the view of Zuber-Skerritt, the most important values and principles in action learning and action research (ALAR) which are (1) Advancement of knowledge and learning, (2) Collaboration, (3) Trust, respect and honesty, (4) Imagination and a vision of excellence, (5) Openness, (6) Non-positivist beliefs, and (7) Success.

(1) Advancement of learning and knowledge
Advancement of learning and knowledge is achieved by experience and reflection in iterative cycles of reflection and action. It is the essence of action learning.

(2) Collaboration
Collaboration leads to systemic development and synergy of results. Collaboration, team spirit and "symmetrical communication" accept that everyone is equal and unique and accept difference positively, and has capacity to contribute as best they can to solve a problem.

(3) Trust, respect and honesty
Trust, respect and honesty are the preconditions for the search for truth(s). It is the heart of action learning and action research.

(4) Imagination and a vision of excellence
Imagination, intuition, and vision of excellence can enrich the pursuit of ideas, possibilities and ultimately the knowledge and appreciation. It can lead to high level of performance.

(5) Openness
Openness is to criticism and self-criticism fosters the exploration of multiple possibilities, rather than single-minded or black and white solutions.

(6) Non-positivist beliefs
Non-positivist beliefs allow the development of grounded theory and reject the positivist belief that only valid and legitimate knowledge is scientific in nature. It recognise that knowledge is produced from various sources including people's subjective insight, intuitions and hunches as mentioned by Nonaka and Takeuchi (1995) that it must be practical and integrate both the explicit and tactic knowledge.

(7) Success
Success means shared success, accountability, recognition and reward, manifest in learning and productivity outcomes.

The seven actions are (1) Reflection on and in action, (2) Effective use of processes and methods, (3) Feedback from "Critical friends", (4) Leadership development, (5) Exploration of new opportunities, (6) Coaching, and (7) Team results. The model

integrated with these seven actions and the seven values are illustrated in figure 4.5. Zuber-Skerritt (2005) argued that this model is for developing, accessing and making explicit one type of knowledge in KM: the experiential, tacit and implicit knowledge that called as personal knowledge. This model can help to identity the personal knowledge as:

> (1) Knowledge through reflection on action / experience and through developing concepts and personal theories,
>
> (2) Knowledge through collaboration and effective use of group processes.
>
> (3) Knowledge of oneself (strengths and weakness) and of significant others through feedback, team building, respecting personal differences, and understanding what constitutes a winning team.
>
> (4) Knowledge of future goals and envisaged high achievement through vision building, creative thinking, right-brain activities and developing energy and motivation for success.
>
> (5) Knowledge of how to explore new opportunities through self-assessment, self-criticism, and through openness to criticism from others,
>
> (6) Knowledge of our basic beliefs and of the assumptions underpinning our research and development activities through learning from mentors, coaches and from the literature about paradigms and epistemology.
>
> (7) Knowledge of our team achievement and success through recognition, reward and celebration.

The roles of Zuber-Skerritt's (2005) PKM model in the four generic knowledge management processes are summarised in table 4.6. The "advancement and reflection" and "success and team result" were taking the role in apply knowledge; the "collaboration and effective use of process and methods" and "trust and feedback"; "openness and exploration of new opportunities", "non-positivist beliefs and coaching" were taking the roles in share/transfer knowledge; and "Imagination and leadership" were involving to deal with create knowledge. This model was lacking the role in locate/capture knowledge.

Model's Components	KM Processes (Seufert, Back & Krogh 2003)			
	Locate / Capture	Share / Transfer	Create	Apply
(1) Advancement and Reflection				X
(2) Collaboration and Effective use of process and methods		X		
(3) Trust and Feedback		X		
(4) Imagination and Leadership development			X	

(5) Openness and Exploration of new opportunities			X	
(6) Non-positivist beliefs and Coaching			X	
(7) Success and Team results				X

Table 4. 6: The Role of Zuber-Skerritt's (2005) PKM model
Source: Developed for this research

Zuber-Skerritt's (2005) PKM model is a conceptual model to put the PKM in actions and suggested seven actions match to the seven values / principles of PKM. This model covered both individual and collaborating with people. The underlying principle is action learning which addressed another important view to PKM that outcome of learning through Reflection. Another contribution of this model is the identified seven types of personal knowledge which could be used for knowledge management in workplace.
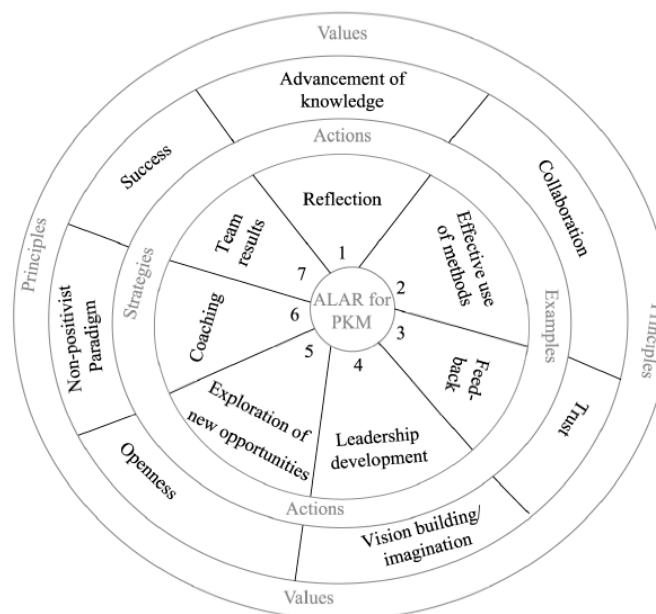

Figure 4. 5: Zuber-Skerritt's PKM Model (A values and actions model)
Source : Zuber-Skerritt (2005, p. 61)

4.7 Agnihotri and Troutt's (2009) PKM Model (PKM Skill-Tools Fit model)
Agnihotri and Troutt's (2009) proposed a PKM Skill-tools fit model based on the previous work done by Avery etal (2001), Frand and Hixon (1999), Jefferson (2006), Davenport (1997) and Barth (2004). The proposed model is as shown in figure 4.6. There are six compontents in the model namely (1) PKM Skills, (2) Technology Tools, (3) PKM Skills-Tools Fit, (4) Utilisation, (5) User's Context, and (6) Knowledge impact. The "PKM Skills-tools fit" and "Utilisation" are the mediators, and the "User's context" is a moderator.
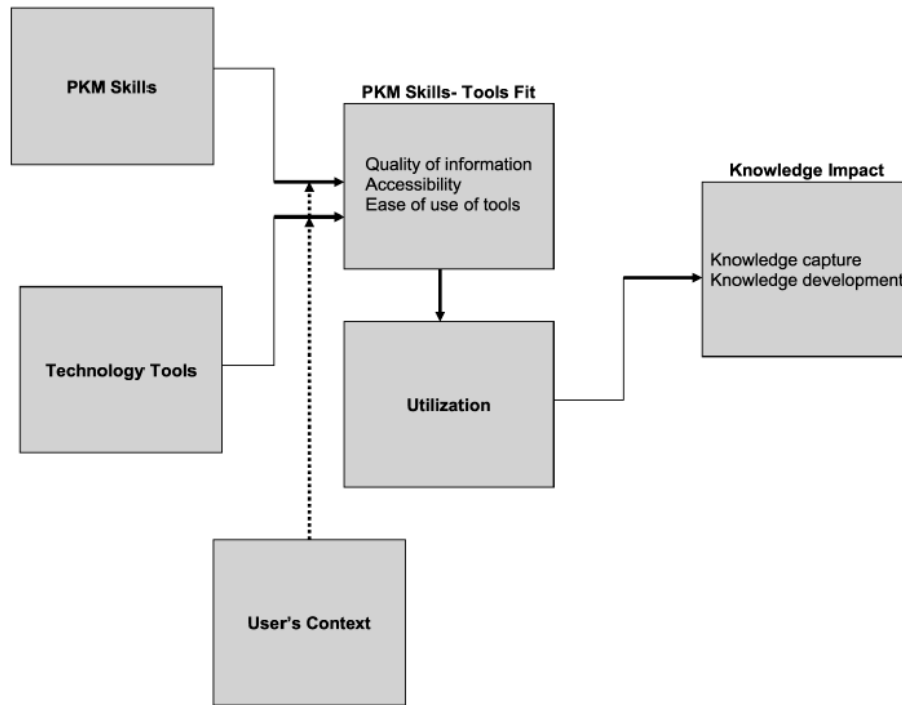
Figure 4. 6: Agnihotri & Troutt's (2009) PKM Model (PKM Skills Tools Fit Model)
Source: (Agnihotri & Troutt 2009, p. 333)

(1) PKM Skills
The PKM Skills is a set of skills for information management which including the seven PKM skills proposed by Avery et al (2001): retrieving, evaluating, organising, analysing, collaborating around, presenting and securing; and the PKM skills proposed by Hyams (2000): time control, workplace wellness, speedy reading, notation and research, document structuring, information design, target writing, processing infrastructure, and filtering techniques. In addition, Agnihotri and Troutt's (2009) argued that the workers also need to perform labelling, tagging and indexing in order the secured knowledge and be found and reused in the future.

(2) Technology Tools
Agnihotri and Troutt's (2009) mentioned that several technology tools are available for PKM. Based on the categories classified by Barth (2004) and Tsui (2002), the PKM tools can be classified as:

1. Index / Search Tools
2. Meta-Search Tools
3. Associative Links
4. Concept / Mind Mapping
5. Email management, analysis and unified messaging
6. Voice recognition tools
7. Collaboration and synchronisation tools
8. Learning Tools

This classification is actually obsolete due to the technical advancement in recent years. Update to this model is the subject of further research by the authors and definitely collaborative and social software play a key role in the revision of this outdated model. Nevertheless, Agnihotri and Troutt (2009) argued that these tools should not be the focal point, instead it is important to understand how these tools and techniques can facilitate the process of finding the solutions for knowledge worker's needs. It should involve aligning and studying the PKM skills and tools simultaneously.

(3) PKM Skills-Tools Fit
It is the core of Agnihotri and Troutt's (2009) PKM model and it is based on the Task-Technology Fit (TTF) theory of Goodhue and Thompson (1995). The TTF theory stated that there is a positive relationship between the available technology tools and the individual's performance; the technology must be utilised and good fit with the tasks. In the context of PKM, there are three dimensions of PKM skills-tools fit, it is believed that individual who try to find meaning in retrieved information and to integrate this information into their decision-making process, as such the following three dimensions were proposed to measure the fit.

1. Quality of information – to assess the proper interpretation of information and transformation of this into knowledge.
2. Accessibility of information – to access if it is easy accessible of new information as well as the saved knowledge.
3. Ease of use of tools – to access if the simplicity or complexity of the technology used.

(4) User's Context
The user's context is referred to the *"collection of relevant conditions and surrounding influences that make a situation unique and comprehensible"* (Degler & Battle 2000). In PKM context, Schwarz (2006) outlined 8 user contexts as below.
1. Operational – active applications and services
2. Organisational – current role of users, projects, department…etc.
3. Environmental – location, present persons and used hardware,
4. Historical – previous tasks
5. Attentional – text scope.
6. Behavioural – native operations, user actions
7. Causal – task concepts(goals), tasks/workflow
8. Informational – touched documents, relevant documents

Agnihotri and Troutt's (2009) argued that the PKM skills-tools fit is moderated by the user's context.

(5) Utilisation & Knowledge Impact

Agnihotri and Troutt's (2009) argued that if the tools can address the concerns of the user in exercising the PKM skills, it is highly probable that the perceived utility will be positively affected and there will be great improvement in terms of utilisation of these PKM skills and tools. Therefore, this utilisation of PKM skills and tools will lead to positive knowledge impact.

The roles of Agnihotri and Troutt's (2009) PKM model in the four generic knowledge management processes are summarised in table 4.7. The "PKM skills" were referenced to the Avery et al.'s (2001) PKM model and therefore it was dealing with all four knowledge management processes. The "technology tools" were mainly to deal with locate/capture and share/transfer knowledge; the remaining model components were focusing on the apply knowledge.

Model's Components	KM Processes (Seufert, Back & Krogh 2003)			
	Locate / Capture	Share / Transfer	Create	Apply
(1) PKM Skills	X	X	X	X
(2) Technology Tools	X	X		
(3) PKM Skills-Tools Fit				X
(4) Utilisation				X
(5) User's Context				X
(6) Knowledge impact				X

Table 4. 7: The roles of Agnihotri and Troutt's (2009) PKM model
Source: Developed for this research

Agnihotri and Troutt (2009) mentioned that it was a conceptual model only and future research was required to empirical test the model. Besides, there were only three dimensions of fit but some additional dimensions could be worth investigating. However, this model provided an important concept in PKM research that the PKM tools should be good fit to its purposes and able to facilitate the individuals to practise the PKM skills effectively.

4.8 Jarche's (Jarche 2010) PKM Model (Aggregate, Understand and Connect Model)
Jarche (2010) argued that PKM is of little value unless the results of the knowledge work are shared by connecting to others and contributing to meaningful conversations. In this view, Jarche (2010) proposed a three activities PKM model, as shown in figure 4.7, namely Aggregate, Understand and Connect. It is enhanced by Jarche's previous seven activities model and focused on streamlining knowledge and sharing with others.
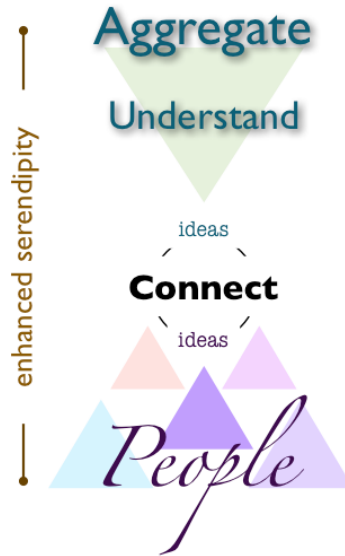
Figure 4. 7: Jarche's PKM Model
Source: Jarche (2010)

(1) Aggregate
It includes the observations and notes of information and knowledge and also looking for good sources of information (people), tagging and noting information from collaboration.

(2) Understand
It is to evaluate how the information may be useful in various contexts, find the right information at the right time and in right format, and making sense of it.

(3) Connect
It is on going conversations while learning and working, which is including connecting people to people, ideas to ideas and people to ideas.

The roles of Jarche's (2010) PKM model in the four generic knowledge management processes are summarised in table 4.8. The "aggregate" was dealing with locate/capture knowledge, "understand" was dealing with create knowledge, and "connect" was dealing with share/transfer and apply knowledge.

Model's Components	KM Processes (Seufert, Back & Krogh 2003)			
	Locate / Capture	Share / Transfer	Create	Apply
(1) Aggregate	X			
(2) Understand			X	
(3) Connect		X		X

Table 4. 8: The roles of Jarche's (2010) PKM model
Source: Developed for this research

Jarche (2010) argued that PKM increases the chances of serendipitous learning, it increase the likelihood of unexpected discoveries and connections when you contributing and sharing with others. One of the difficult aspects of PKM is triage, it is the ability to separate the important from the useless, and it is a time consuming process to develop good triage techniques. Jarche (2010) highlighted that the most important aspect of PKM is making our knowledge not only explicit but public, it is part of the connecting.

4.9 Summary of Evaluation of PKM Models
Based on the evaluation of the PKM models, it is clear that PKM has evolved from mere individual activities to something that are more outcome/impact oriented; from information handling skills to personal competencies, sensemaking and self-reflection; from individually focused to a community and social collaborative focused. Increasingly the model also provides an alignment of the appropriate technologies. This evolution necessitates the definition of requirements for a comprehensive PKM model that comprehensively encapsulates the need for personal information management, knowledge internalisation, transferring of knowledge and knowledge creation, and learning.

5. A New Personal Knowledge Management Model
A conceptual model of PKM 2.0 was developed by the authors based on the literature review and also the results of a global survey about the roles and values of the PKM (Cheong & Tsui 2010b). There are four core components in this model, namely Personal Information Management (PIM), Personal Knowledge Internalisation (PKI), Personal Wisdom Creation (PCW) and Inter-Personal Knowledge Transferring (IKT). The interaction action of the components is illustrated in figure 5.1 and table 5.1 and provides more a detailed view of the model in terms of the required skill/competence, the belonging layer of the DIKW transformation, the inherent knowledge conversion and the involved KM process.
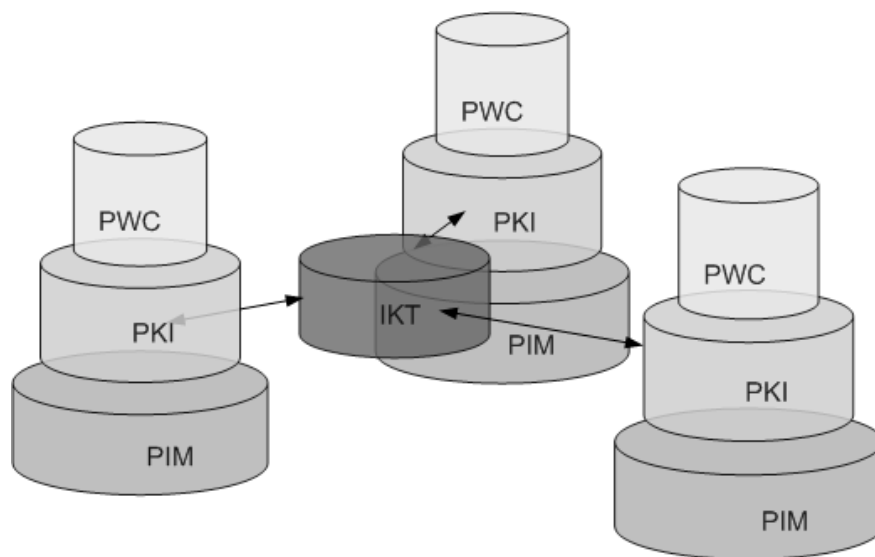
Figure 5. 1 : PKM 2.0 Conceptual Model
(Cheong & Tsui 2010b, p. 223)

PKM 2.0 Components	Personal Information Management (PIM)			Personal Knowledge Internalisation (PKI)			Personal Wisdom Creation (PWC)			Inter-Personal Knowledge Transferring (IKT)		
Skill / Competence	Retrieving	Evaluating	Organising	Analysis	Learning / Self Development	Reflection	Problem Solving	Creativity	Mental Agility	Securing	Presenting & Communication	Collaborating
DIKW Transformation Layer	Data ← → Information			Information ← → Knowledge			Knowledge ← → Wisdom			Information / Knowledge ← → Information / Knowledge		
Knowledge Conversion	Explicit ← → Explicit			Explicit → Tacit			Tacit ← → Tacit/Explicit			Explicit / Tacit ← → Explicit / Tacit		
KM Process	Capture / Locate			Create			Apply			Transfer / Share		

Table 5. 1 : PKM 2.0 Conceptual Model
(Cheong & Tsui 2010b, p. 223)

The underlying theories of this PKM 2.0 framework includes the DIKW hierarchy defined by Russell Ackoff (1989), the knowledge conversion framework suggested by Nonaka and Takeuchi (1995) and the KM process described by Seufert et al. (2003).

(1) Personal Information Management (PIM)
PIM is the focus of many scholars in the area of PKM and it is the process to capture or locate knowledge as defined by Seufert et al. (2003). The data is transformed to information and vice versa in this process and it is mainly deal with the past knowledge, as argued by Russell Ackoff (1989). Knowledge conversion is in the form of explicit knowledge (from one media, e.g. hard copy to another media, e.g. electronic copy), and is the combination process as suggested by Nonaka and Takeuchi (1995). The PIM is the foundation of PKM , where individuals are able to create their own knowledge database for immediate or future use in this process.

The required skills / competences in PIM are retrieving, evaluating and organising, which are the skills playing significant roles in capture / locate knowledge.

(2) Personal Knowledge Internalisation (PKI)

PKI is the process of creating knowledge in the KM cycles, suggested by Seufert et al. (2003). The information is transformed to knowledge and vice versa in this process. It requires understanding of the past knowledge and current information / knowledge available to an individual. It represents the understanding layer as mentioned by Russell Ackoff (1989) between knowledge and wisdom. The knowledge conversion is mainly in the form of explicit to tacit knowledge; it is the internalisation process in the SECI model (Nonaka & Takeuchi 1995). PKI is beyond PIM as it turns the past knowledge into new knowledge.

The required competences in PKI are analysis, learning / self development and reflection.

(3) Personal Wisdom Creation (PWC)

PWC is the process of applying knowledge in the KM cycles, suggested by Seufert et al. (2003). The knowledge is transformed to wisdom in this process, and putting the knowledge in practise to tackle the current challenges and prepare for the future, as argued by Russell Ackoff (1989) that wisdom is dealing with the future. The knowledge conversion in this process is between tacit to tacit/explicit; it involves the socialisation and externalisation process in the SECI model (Nonaka & Takeuchi 1995). PWC is beyond PKI as it puts knowledge in practise in tackling the daily challenges from personal life, social life and work.

The required skills / competences in PWC are problem solving, creativity and mental agility.

(4) Interpersonal Knowledge Transferring (IKT)

IKT plays an important role in PKM which maximises the knowledge work by others to form a knowledge collaborating environment for individuals. It is the process to share / transfer knowledge in the KM cycles suggested by Seufert et al. (2003). The information is transformed to knowledge in both explicit and tacit form in this process. It is a bidirectional transfer through different social activities in both face-to-face and virtual models. IKT is beyond PIM, PKI and PWC as it positions PKM 2.0 in an interactive and collaborating mode. It links the networked individuals together and gears the distributed process of socialisation, externalisation, combination and internalisation (Nonaka & Takeuchi 1995) in a meshed knowledge network to increase the knowledge flow and knowledge quality.

The required skills / competence in IKT are securing, presenting and communication, and collaborating.

The above PKM 2.0 framework focuses on the both individual and inter-personal interactions. IKT extends the knowledge works from individual centric to community and social centric. Communication, Sensemaking and Reflection are the key skills at IKT that enable individuals expending their knowledge work to the open knowledge space. Technologies become an important enabler and Web 2.0 technologies allow such collaboration work to be effectively carried out in a virtual environment.

5.1 Web 2.0 based PKM tools
The information technologies tools for PKM have been rapidly developed in the past decade and the authors believe that web 2.0 based tools are playing important roles to facilitate the practising of the PKM. Tsui (2002) argued that the IT based PKM tools are mainly divided into group-based and personal based KM tools. The group-based KM systems are generally for both intra (within group) and inter (between groups) collaboration, while personal KM systems are adopted by individual knowledge workers and operate within the permissible bounds of the enterprise IT framework and security network. The recently development of Web 2.0 enables a new model of PKM that involves formal and informal communication, collaboration and social networking tools (Razmerita, Kirchner & Sudzina 2009).

Setrag (2010) argued that Web 2.0 is about connecting people, inventing communities, and encouraging collaborative development on the Web; the greatest benefit of Web 2.0 will be realised through the context of collaboration within the enterprise, between trading partners, and across the Internet. Setrag (2010, p. 6) also mentioned that
"Business processes provide the context of collaboration, and social networking supports and augments the various phases of the BPM continuous improvement lifecycle."

In additional to the collaboration, Web 2.0 based PKM tools also plays a multifaceted role for communicating, sharing and managing knowledge; it enables a new model of PKM to facilitates interaction, collaboration and knowledge exchanges on the web and in organisations (Razmerita, Kirchner & Sudzina 2009). This new model of PKM enables instantaneous and ah hoc communication such that the internal knowledge can be dissimilated through out the business process effectively and values can be created from the external interaction and collaborations with business partners.

The authors published an innovative paper at Cutter IT Journal (Cheong & Tsui 2010a) to explore to put PKM in practise with business process management by leveraging the web 2.0 based tools, e.g. social networking tools, blogs and wikis, communication and collaboration platform e.g. Google Wave, and workflow groupware e.g. Microsoft SharePoint.

Given the present work at PKM is mainly at conceptual/preliminary stage and it is necessary to set a research direction to put PKM in practice in a more systematic approach. The research agenda should include the application of PKM in different individual (i.e. different professional and industry), organisation and social contexts (both industry and geographic difference), and also how the recent development of Web 2.0-

based and even the concept of cloud computing can enable PKM to maximise the contribution to competency improvement.

6. Conclusion

PKM is en emerging discipline and this paper evaluated the previous literatures and introduced a new PKM model. It is cleared that PKM is an important aspect in knowledge management but it is also an open question to the researchers that what is the roles and values of PKM in different individual, organisation and social context. The authors set a research direction to explore this research question and also to explore how technology can enable PKM to maximise the contribution to competency improvement. The authors believe that this future research would lead the scholars and researchers to continue or refocus to this important discipline.

References

Ackoff, RL 1989, 'From Data to Wisdom', *Journal of Applied Systems Analysis*, vol. 16, pp. 3-9.

Adler, P & Kwon, S 2000, 'Social Capital: The good, the bad and the ugly', in E Lesser (ed.), *Knowledge and Social Capital: Foundations and applications*, Butterworth-Heinemann, Boston.

Agnihotri, R & Troutt, MD 2009, 'The effective use of technology in personal knowledge management: A framework of skills, tools and user context', *Online Information Review*, vol. 33, no. 2, pp. 329-42.

Ahmed, PK, Kok, LK & Loh, AYE 2002, *Learning Through Knowledge Management*, Butterworth-Heinemann, Oxford.

Avery, S, Brooks, R, Brown, J, Dorsey, P & O'Conner, M 2001, 'Personal Knowledge Management: Framework for Integration and Partnerships', paper presented to Annual Conference of the Association of Small Computer Users in Education (ASCUE), Myrtle Beach, South Carolina, 10-14 June 2001.

Barth, S 2004, 'Self-organization taking a personal approach to KM', in M Rao (ed.), *Knowledge Management Tools and Techniques: Practitioners and Experts Evaluate KM Solutions*, Butterworth-Heinemann, Boston, MA.

Berman, KA & Annexstein, FS 2003, *Actualizing Context for Personal Knowledge Management*, Department of ECECS, University of Cincinnati, Cincinnati, OH.

Brown, JS & Duguid, P 1991, 'Organizational learning and communities of practice: toward a unified view of working, learning and innovation', *Organization Science*, vol. 2, no. 1, pp. 40-57.

Cheng, CK 2009, 'M.Sc. Thesis in KM: The Relationship Between Pre-service Teacher PKM Competency and Knowledge Acquisition', The Hong Kong Polytechnic University.

Cheong, KFR & Tsui, E 2010a, 'Exploring the Synergy Between Business Process Management and Personal Knowledge Management', *Cutter IT Journal*, vol. 23, no. 5, pp. 28-33.

---- 2010b, 'The Roles and Values of Personal Knowledge Management: An exploratory study', *VINE: The journal of information and knowledge management systems*, vol. 40, no. 2, pp. 204-27.

---- 2010 Forthcoming, 'Exploring linkage between Personal Knowledge Management and Organisational Learning', in D Pauleen & G Gorman (eds), *Personal Knowledge Management: Individual, Organisation and Social Perspectives* Gower.

Davenport, H 1997, 'Ten principles of knowledge management and four case studies', *Knowledge and Process Management*, vol. 4, no. 3, pp. 187-208.

Degler, D & Battle, L 2000, 'Knowledge management in pursuit of performacne: the challenge of context', *Performance Improvement, ISPI*, vol. 39, no. 6, pp. 25-31.

Diao, L, Zuo, M & Liu, Q 2009, 'The Artificial Intelligence in Personal Knowledge Management', paper presented to Proceedings of the 2009 Second International Symposium on Knowledge Acquisition and Modeling - Volume 03.

Dorsey, PA 2001, *Personal Knowledge Management: Educational Framework for Global Business*, Tabor School of Business, Millikin University, viewed 10 Aug 2008 <http://www.millikin.edu/pkm/pkm_istanbul.html%3E.

Drucker, PF 1968, *The age of Discontinuity*, Harper & Brothers, New York.

Efimova, L 2005, *Understanding Personal knowledge management: A Weblog case*, Enschede: Telematica Instituut, 12 March 2008, <https://doc.telin.nl/dsweb/Get/Document-44969/pkm_weblogs_final.pdf>.

Frand, J & Hixon, C 1999, *Personal Knowledge Management: Who, What, Why, When, Where, How?*, viewed January 18 2008 2008, <http://www.anderson.ucla.edu/faculty/jason.frand/researcher/speeches/PKM.htm%3E.

Frand, J & Lippincott, A 2002, *Personal Knowledge Management: A Strategy for Controlling Information Overload*, Anderson UCLA, viewed September 10 2009, <http://www.anderson.ucla.edu/faculty/jason.frand/researcher/articles/info_overload.html%3E.

Goodhue, DL & Thompson, RR 1995, 'Task-technology fit and individual performance', *MIS Quarterly*, vol. 19, no. 2, pp. 213-36.

Higgison, S 2004, *Your say: Personal Knowledge Management*, 7, 28 March 2010, <http://www.ikmagazine.com/xq/asp/sid.0/articleid.DDDD6EE3-47C6-49CD-9070-F1B1547FD29F/eTitle.Your_say_Personal_knowledge_management/qx/display.htm%3E.

Hyams, R 2000, *10 Skills of personal knowledge management*, viewed October 10 2008, <http://www.cgn.com/html/main.html?ContentFrame=http://www.cgn.com/html/services/knowledge/personal.html%3E>.

Jarche, H 2010, *Personal Knowledge Management*, Jarche Consulting, viewed March 26 2010 2010, <http://www.jarche.com/2010/01/pkm-in-2010/%3E>.

Jefferson, TL 2006, 'Taking it personally: personal knowledge management', *VINE: The journal of information and knowledge management systems*, vol. 36, no. 1, pp. 35-7.

Kim, H, Breslin, JG & Decker, S 2009, 'Personal knowledge management for knowledge workers using social semantic technologies', *International Journal Intelligent Information and Database Systems*, vol. 3, no. 1, pp. 28-43.

Lave, J & Wenger, E 1991, *Siturated learning: Legitimate peripheral participation*, Cambridge University Press, New York.

Martin, J 2008, *Personal Knowledge Management: The basis of Corporate and Institiutional Knowledge Management*, Spotted Cow, Alberta, September 18 2008, <http://www.spottedcowpress.ca/KnowledgeManagement/pdfs/06MartinJ.pdf%3E>.

Nahapiet, J & Ghoshal, S 1998, 'Social Capital, Intellectual Capital, and The Organizational Advantage', *Academy of Management Review*, vol. 23, no. 3, pp. 242-66.

Nonaka, I & Takeuchi, H 1995, *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*, Oxford University Press, Oxford.

Pauleen, D 2009, 'Personal knowledge management: Putting the "person" back into the knowledge equation', *Online Information Review*, vol. 33, no. 2, pp. 221-4.

Pettenati, MC, Cigognini, E, Mangione, J & Guerin, E 2007, 'Using Social Software for Personal Knowledge Manaegement in Formal Online Learning', *Turkish Online Journal of Distance Education*, vol. 8, no. 3, pp. 52 - 65.

Polanyi, M 1958, *Personal Knowledge: Towards a Post Critical Philosophy*, Routledge & Kegan Paul Ltd, London.

Pollard, D 2004, *Confessions of a CKO: What I should have done*, viewed 25 March 2010 <http://blogs.salon.com/0002007/categories/businessInnovation/2004/05/31.html%3E>.

Razmerita, L, Kirchner, K & Sudzina, F 2009, 'Personal Knowledge Management: The role of Web 2.0 tools for managing knowledge at individual and organisational levels', *Online Information Review*, vol. 33, no. 6, pp. 1468-4527.

Schwarz, S 2006, 'A context model for personal knoweldge management', *Modeling and Retrieval of Context, Lexture Notes in Computer Science*, vol. 3946, pp. 18-33.

Setrag, K 2010, *MyBPM: Social Networking for Business Process Management*, Pegasystems Inc, Feb 5 2010, <http://pegasystems.com/content/document.asp?ci=427%3E>.

Seufert, A, Back, A & Krogh, GV 2003, 'Unleashing the Power of Networks for Knowledge Management', in AJ Beerli, S Falk & D Diemers (eds), *Knowledge Management and Networked Enviornments*, Accenture LLP, New York, pp. 99-136.

Tissen, R, Anderiessen, D & Deprez, F 1998, *Value-based Knowledge Management: Creating the 21st Century Company: Knowledge Intensive, People Rich*, Addison-Wesley, Amsterdam.

Tsui, E 2002, *Technologies for Personal and Peer-to-peer (P2P) Knowledge Management*, Computer Sciences Corporation, Melbourne, <http://www2.csc.com/lef/programs/completed_02.html%3E>.

Volkel, M & Abecker, A 2008, *Cost-Benefit Analysis for the design of Personal Knowledge Management Systems*.

Volkel, M & Haller, H 2009, 'Conceptual data structures for personal knowledge management', *Online Information Review*, vol. 33, no. 2, pp. 298- 315.

Wiig, KM 1997, 'Knowledge Management: an introduction and perspective', *The Journal of Knowledge Management*, vol. 1, no. 1, pp. 6-14.

Wright, K 2005, 'Personal knowledge management: supporting individual knowledge worker performance', *Knowledge Management Research & Practice*, vol. 3, no. 3, pp. 156-65.

Wu, M 2007, 'Working Models For Teacher's Personal Knowledge Management', paper presented to Proceedings of Society for Information Technology & Teacher Education International Conference, Chesapeake, VA.

Zhang, Z 2009, 'Personalising organisational knowledge and organisationalising personal knowledge', *Online Information Review*, vol. 33, no. 2, pp. 237-56.

Zuber-Skerritt, O 2005, 'A model of values and actions for personal knowledge management', *THe Journal of Workplace Learning*, vol. 17, no. 1/2, pp. 49-64.