# A Conceptual Review on Technological Intergenerational Knowledge Transfer

Sabiroh Md Sabri

Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, MALAYSIA
Email: sabir707@tganu.uitm.edu.my

Haryani Haron, Nursuriati Jamil and Emma Nuraihan Mior Ibrahim

Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA, 40450 Shah Alam, Selangor, MALAYSIA
Email: {haryani, liza, emma}@tmsk.uitm.edu.my

*Abstract*— **By the year 2030, Malaysian population is expected to reach aged population with 3.4 million being senior citizens. The retirement of the aging people is a concern to most organisations as it also means lost of an organisation knowledge. Lack of appreciation of the value of tacit knowledge and lack of planning to capture retirees' knowledge before they leave put many organisations in a position to suffer a loss of intellectual knowledge that may prove fatal. Therefore this research attempts to review issues that are considered essential in strategizing intergenerational knowledge transfer. In this paper, we reviewed 52 and examined various issues related to intergenerational knowledge transfer. Since transferring knowledge from older people involves a lot of challenges due to cognitive decline experience by themselves, we also studied research done in the area of social psychology and explore their applicability in knowledge transfer practice. We consider social psychology to be a discipline from which theories, models, and research results can be harnessed for knowledge management. Our review reveals important issues in the literature to be considered for successful intergenerational knowledge transfer.**

*Index Terms*—**knowledge transfer, intergenerational, knowledge recall, elderly, reminiscence, transactive memory system**

## I. INTRODUCTION

The world recently has been reported experiencing dramatic demographic shifts known as the 'age-quake' or the 'demographic time bomb'. This phenomenon has been reported to have a profound implication on the economy and society of nations tomorrow. The United Nations has described the world trends for aging population as unprecedented, pervasive, and enduring. According to the World Population Organisation (WPO) of the UN, when the total population of a country aged 60 or above reaches at least 15% of the total population, it can be concluded that the whole population is aging, and therefore this country becomes aged [1]. Research has shown that many countries are experiencing an increasing number of elderly. In Malaysia, by 2035, the country is

estimated to reach the ageing population status which means those above the age of 60 will constitute 15% of the population [1]. The retirement of the ageing people is a concern to most organisations as it also means loss of an organisation knowledge. According to International Data Corp., Fortune 500 companies relinquish over $31.5 billion a year because they fail to distribute knowledge [2]. U.S. organisations fail to capture critical knowledge and experience from older employees nearing retirement, and only a few organisations transfer the knowledge to younger employees [3]. Reference [4] also cautioned that, as the workforce shrinks in comparison to demand, only organisations that prepare in advanced for the demographic shift will be prepared to address it. Lack of appreciation of the value of tacit knowledge and lack of planning to capture retirees' knowledge before they leave put many organisations in a position to suffer a loss of intellectual knowledge that may prove fatal [4]. Furthermore, the great number of retired older workers is inevitably accompanied by a significant loss of knowledge [5–7]. The problem will not just be a lack of bodies but also skills, knowledge, experience and relationships walk out the door every time somebody retires and they take time and money to replace [8]. Many researches therefore agreed that organisations must critically manage their knowledge and they need to be transferred from the seniors to the younger generations to preserve the organisations' knowledge [7], [9], [10]. To combat the dangers of corporate amnesia, intergenerational transfer of knowledge is a matter of survival [11]. However, [12] emphasized that tacit knowledge is highly personal because it resides in the people's mind. Tacit knowledge is difficult to formalize, hence it is difficult to be communicated or shared with others. This type of knowledge is deeply rooted in someone's action and experience and also in the ideals, values and emotions he embraces and known to be very sticky and difficult to be transferred.

Transferring knowledge from one generation to another also involves a lot of issues and challenges. Therefore it is essential to have knowledge transfer

strategies and mechanisms that could work for both generations. The challenges of transferring knowledge are even greater when involving transferring knowledge from older people, since this segment of the population is subject to physical and cognitive impairment at higher rates than younger people. Cognitive decline which has been identified as the third area of concern in an aging population affects older people's ability to remember, focus, formulate ideas as well as reasoning capabilities. The declining of cognitive function in older people would hinder the recalling process and eventually make the transfer of knowledge hard to be achieved. However, many literatures suggested theories in knowledge recalling that could be explored to assist older people in recalling the knowledge. Furthermore, with the introduction of the remarkable variety of technology today, older people with cognitive impairment could be assisted and would be able to benefit from it.

Consequently, the paper outlines the theory and concept from various literatures on intergenerational knowledge transfer. This paper also explores the possibilities of harnessing reminiscence and transactive memory theories to address the issues that occur in the intergenerational knowledge transfer. Based on these theories, we draw our conceptual framework that proposes the issues to be considered in intergenerational knowledge transfer.

## II. METHODOLOGY

This study adopted a systematic review method in order to investigate the intergenerational knowledge transfer. A systematic review is a literature review following a rigorous, transparent and reproducible process, which aims to identify, select, appraise, analyse and synthesize, in a systematic and comprehensive way, research evidence on a specific research topic [13]. This method is chosen because it is widely considered as the least biased and the most rational way to synthesize research evidence. It is also known as a powerful tool to provide the best available knowledge for decision making. For this purpose, we followed the basic steps suggested by [13] which include: 1) formulate research questions, 2) determine criteria for literature inclusion and exclusion, 3) search for relevant studies, 4) select the research based on the inclusion and exclusion criteria, 5) assess the selected studies, 6) synthesize and summarize study results, and 7) interpret the review results.

This study sets out to answer the two following research questions: 1) what are the issues that occur in the intergenerational knowledge transfer? 2) how can reminiscence and transactive memory system theory be used to facilitate intergenerational knowledge transfer? To answer these questions, we conducted a literature search on online databases in the field of knowledge management and social psychology using keywords that we have defined earlier. We retrieved peer-reviewed papers as well as research reports, book sections and dissertations that could provide us insights on the research topic.

A total of 1752 papers appeared as a result of our keyword search. We skimmed through the title and abstract and downloaded 243 papers that looks relevant to our study. After a thorough evaluation, 52 papers that are related to our research were retained for further review and synthesis. Figure 1 shows the flow diagram of the systematic review methods that was carried out in this study.
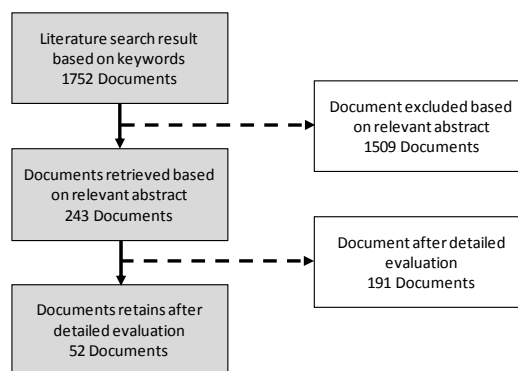


Figure 1: Systematic Review Flow Diagram

The results of our review are written in subsequent sections as issues that need to be considered in intergenerational knowledge transfer.

## III. KNOWLEDGE AND KNOWLEDGE MANAGEMENT

Knowledge is a mixture of someone's experience, values, information, insights, and grounded intuition that provides an environment and framework for evaluating and incorporating new experiences and information. It originated and is functional in the mind of the originators. In organizations it is often stored in documents or repositories as well as in organizational routines, practices and norms [14]. According to [15], knowledge can be classified into two different forms that are tacit and explicit knowledge based on their nature. Reference [16] refers tacit knowledge as the knowledge that rooted in actions experience, and involvement in specific context. Tacit knowledge is difficult to be communicated and formalized [12], [17], can be only expressed in words [15] and transferred through interactions with other people, sharing experiences, mental models and also technical skills [12]. [16], [18] define explicit knowledge as articulated (spoken) and generalized knowledge which could be expressed in formal language, mathematical equations or symbols. This type of knowledge can be easily and effectively share with others [12].

In understanding knowledge, it is quite useful to be able to distinguish between declarative and procedural knowledge. According to [19], cognitive psychologists believe declarative memory is responsible for storing facts and events, which is known as knowledge. Declarative memory gives an individual the capacity to store associations, and to do so in a single trial by storing information in proposing the truth or falsity of which can

be verbalized instantly. The system contains knowledge that can be thought and spoken about explicitly. However, in the case of memory for faces; these are very difficult to describe verbally [20]. Declarative knowledge can be altered under the influence of new memories. The retrieval process of declarative knowledge is not conscious and usually triggered by cues. However, sometimes a given cue will lead to the retrieval of only a very small amount of information that is potentially available. In expressing declarative knowledge, it requires directed attention, as compared to the expression of skills, which usually happen automatically [20].

On the other hand, procedural memory is proposed as the system containing knowledge of how to do things which guides both physical activities like cycling or swimming, and (partially) cognitive skills like playing chess or speaking in public. Usually, many attempts are needed to acquire procedural knowledge, although one-trial learning could also occur. These skills are difficult to express verbally. However, one possible way to show their presence is though performance. It can be argued that procedural memory is relatively autonomous in relation to declarative memory in a number of ways. [21] on the other hand classified knowledge based on its contents and divided knowledge into six types:

- **Know-what** - course of action is the right one
- **Know-how** - to get things done
- **Know-why** - something is
- **Know-when** - to do something, and when not to
- **Know-where** - to find what is needed
- **Know-who** - to ask

Regardless of which type or category knowledge is, it is important for knowledge to be transferred to avoid the loss. However, understanding the nature, type and category of knowledge may assist us in understanding how the knowledge could be managed. To manage knowledge effectively, many researchers have proposed various important aspects about knowledge management process to guide the way for effective knowledge management [12], [16], [22], [23]. Knowledge management as a whole involves four main processes as suggested by [24] which include knowledge creation, knowledge organization, knowledge transfer and knowledge application. The first process of knowledge management i.e. knowledge creation involves activities associated with entry of new knowledge into a system, and includes knowledge development, discovery and capture which most of the time involves tacit knowledge. The second process i.e. knowledge organization includes activities that preserve knowledge and allow it to remain in the system once introduced. It also includes those activities which retain the viability of knowledge within the system. The third process i.e. knowledge transfer refers to activities associated with the flow of knowledge from one party to another through the means of communication, translation, conversion, filtering and rendering. Lastly, the fourth process i.e. knowledge application includes the activities and events connected with the application of knowledge to business processes.
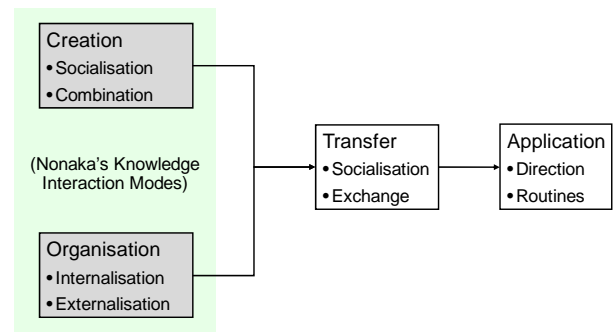


Figure 2: KM Processes and KM Sub-Processes
[24]

Figure 2 above shows the relationship between knowledge management processes and subprocesses as proposed by [15] that the four main knowledge management processes are related to knowledge conversion subprocesses such as Socialisation, Externalisation, Combination and Internalisation. The idea behind these knowledge management processes and subprocesses is for the organisation to create and build up its knowledge sources and resources and make them accessible and/or available wherever and whenever they are needed through a variety of knowledge management mechanisms [25]. However, since this study only focus on knowledge transfer, other processes will not be discussed further.

## IV. KNOWLEDGE TRANSFER

As one of important processes in knowledge management, many researchers have researched on various aspects of knowledge transfer and defined knowledge transfer according to their own context. Reference [26] defined knowledge transfer as a process of knowledge passing from one person to another person or from a group of people or organisations to another group of people or organisations. It is the act of conveying knowledge of one source to another, one group to another or one unit to another. In an organisation, knowledge transfer is often associated with the application of knowledge or skills to solve a particular problem. This knowledge or these skills are generally acquired through training which is considered as the first mechanism of knowledge transfer [27]. In our private lives, we often transfer knowledge to another person so easily and efficiently without noticing that we are doing it, for example when we are giving directions to a stranger or sharing our secret recipes with our friends. However, in organisations, effective and sustainable knowledge transfer is more complex because knowledge resides in organizational members, tools, tasks and their sub networks which are more complicated compared to personal knowledge. Moreover, people do not take ownership of the knowledge and make it more difficult to identify from whom the knowledge should be transferred from. Most organisation knowledge which exists in the mind of employees is tacit and sticky therefore hard to be

articulated. Knowledge transfer is not about transferring knowledge alone, it also involves the willingness of the other party or recipient to absorb the knowledge to his/her own benefits [28]. Many organisations voiced their concern about transferring knowledge from older to younger workers, yet research indicates few are doing anything about it. Organisations do not realize the value of the loss of employees' deep smarts until the workers leave their jobs [4]. Many organisations assign high priority to documentation, however not all important knowledge is stored in documents [29]. The experience of the organisation members, their ideas and decisions are also part of the organisational knowledge which is usually stored in a form of tacit knowledge. In an organisation, knowledge transfer would mean knowledge retention and help the organisation sustain. In a social context, knowledge transfer enables elderly to transfer their livelong experience and knowledge amongst themselves and to younger generations. It gives value to the elderly's accumulated experience and knowledge and enables the creation of special contexts for generational exchange. With the world's increasing number of retirees, many started to realize the importance of transferring knowledge from older generation to the younger generation before it is lost. We therefore need to provide a platform for elderly to enable them to transfer their knowledge effectively and efficiently.

*A. Intergenerational Knowledge Transfer*

Intergenerational transfer refers to the passing of information and knowledge from older to younger members of a kinship group or members of an extended family [30]. Reference [31] defined intergenerational knowledge transfer as any interaction whether one-on-one, within a group, or through written communication in print or online that conveys facts, context, connections, processes, or other insights between two generations. Two ways of passing the knowledge are through oral or multimedia means. Traditionally, transfer occurs through oral, where knowledge is verbally passed during learning activities, be it formal or not. The successful of passing the information could sometimes occur without any inscription of information. Nowadays, using multimedia means of transfer usually involve written or inscribed means which include image, audio, hypertext, and video means.

The literature has shown that a few research carried out in the intergenerational knowledge transfer has identified a few barriers. One of it is generation gap [27], [32]. A generation gap is a popular term used to describe a broad difference in values and attitudes between two generations or between elderly and younger generation [27]. The generation gap is a situation which occurs when the older and younger people do not understand each other due to differences in their opinions, habits and behaviours. The term becomes popular in Western countries during the 1960s when it was used to describe the differences in the culture of Baby Boomers and their parents. Even though there are some generational differences that have been reported throughout history, the differences between these two generations became

prominent compared to the previous one. Some of the areas that show a gap between these two generations are in fashion, music, culture and also politics. The literature has shown that each generation was shaped by the events that happened during their lifetime for example, the World War II, the Civil Rights Movements, the introduction of computers and Internet and etc. These events give a great deal of how they live their life and influence their mindset and the will power they have inside them.

Due to the differences in their expectations and mindset, there are more problems identified between these generations. One of them is communication problem. [33] in her research mentioned that research shows intergenerational communication creates more problems than opportunities. The issue begins with a difference in expectations, as Boomers are claimed to believe Gen Y should "'pay their dues,'" while Millennials want to advance quickly and bypass the grunt work. Potential problems continue to arise as Millennials "may not share Boomers' beliefs and values," since work-life balance and flexible career paths seem to be more of a priority than building a career. This same research explains another issue saying Gen Y may be "marginalized by their older and more senior coworkers," which makes "it more difficult for Millennials to earn workplace respect and credibility". Researchers also claim that this situation has caused problems due to lack of socialization and low level of communicative support from supervisors and affect the job turnover [34]. Therefore, intergenerational communication can be considered as a problem to organizational development and sustainability.

Working with elderly also involves challenges with their physical and cognitive decline. Even though there has been a debate on at what age cognitive decline begins, a cross-sectional age comparisons study through relevant neurobiological variables and measures of cognitive performance has revealed that cognitive decline appear to begin when adults are in their 20s or early 30s. On the other hand, some research shows that cognitive decline begins shortly after individuals reach maturity. On average we can conclude that cognitive decline usually begins at the age of 60 [35–37]. Cognitive decline in the elderly also contributes to memory decline. Memory is the explicit or implicit recall of information encoded in the recent or distant past. Current conceptualizations of memory, however, do not treat memory as a unitary system but rather divide it into hierarchical taxonomic modules based on duration of retention and the type of information that is being retrieved [38]. Reference [39] in their research argue that stories about a person's experience, and the experiences of others, especially people in relationship are the fundamental constituents of human memory, knowledge, and social communication. It includes three propositions: 1) Virtually all human knowledge is based on stories constructed around past experiences; 2) New experiences are interpreted in terms of old stories; 3) The content of story memories depends on whether and how they are told to others, and these

reconstituted memories form the basis of the individual's 'remembered self'. Furthermore, shared story memories within social groups define particular social selves, which may strengthen or compete with individual remembered selves. Cognitive decline faced by the elderly could be one of the barriers in the intergenerational knowledge transfer as the elderly will face difficulties in recalling their knowledge.

*B.  Knowledge Recall*

Knowledge resides in people's mind and defined as tacit knowledge. It consists of technical abilities, mental models, faith and ingrained perspectives not subjected to the easy manifestation [12]. Due to its nature, transferring tacit knowledge is a challenge as it depends on a positive and collaborative attitude from the knowledge holders [40]. One of the processes involved in transferring tacit knowledge is knowledge recall [40–42].

For tacit knowledge to be communicated it must be first converted into elements that anyone can understand [29]. One possible approach is the transformation of tacit into explicit knowledge. During the transformation, people and organisations frequently need to recall past episodes that, for some reasons, were not adequately documented when they occurred. Before a story can serve as knowledge transfer, it must be constructed or assembled. The assembly of a real story is the process of recalling knowledge of past events that have occurred. However, this is not a straightforward task. Incomplete information caused by lapses in memory and the lack of key facts are common issue in the recalling process. People and organisations frequently need to recall past events that somehow were not documented during its occurrence. The successful reconstitution of past events depends on several variables, such as how long ago the event occurred, and whether key people are still available to tell what they know. Although it is sometimes difficult to restore all known events, an adequate recall process can get it closer [40].

According to [43], recall is the act of retrieving information or events from the past while lacking a specific cue to help in retrieving the information. A person recalls when reminiscing about something he has experienced or learned. When we want to recall an episode that has occurred in the past and which has been witnessed by a group of people, we should count on their testimony to try to reconstitute the episode. It usually happens, however, that a participant alone is unable to tell the full story because he has only a partial knowledge of the full event. Only when grouped together the set of events can start to make sense [40]. The literature has shown that the two main theories of the process of recalling are the Two-Stage Theory, also known as Austin Simonson theory and the theory of Encoding Specificity. The Austin Simonson theory states that "*the process of recall begins with a search and retrieval process, and then a decision or recognition process where the correct information is chosen from what has been retrieved*". In this theory, recognition only involves the latter of these two stages, or processes, and this is thought to account for the superiority of the recognition

process over recall. Recognition only involves one process in which error or failure may occur, while recall involves two [44]. However, in certain situation, recall has been found to be superior as such as a failure to recognize words that can later be recalled [45].

The theory of encoding specificity finds similarities between the process of recognition and that of recall. The encoding specificity principle states that "*memory utilizes information from the memory trace, or the situation in which it was learned, and from the environment in which it is retrieved*". Encoding specificity helps to take into account context cues because of its focus on the retrieval environment, and it also accounts for the fact recognition may not always be superior to recall [45]. To understand recall further, [46] divided recall into subcategories namely free recall, cued recall and serial recall. Free recall is the process in which a person is given a list of items to remember and then is asked to recall them in any order. This type of recall often displays evidence of either the primacy effect (when the person recalls items presented at the beginning of the list earlier and more often) or the recency effect (when the person recalls items presented at the end of the list earlier and more often), and also of the contiguity effect (the marked tendency for items from neighbouring positions in the list to be recalled successively). Cued recall is the process in which a person is given a list of items to remember and is then tested with the use of cues or guides. When cues are provided to a person, they tend to remember items on the list that they did not originally recall without a cue, and which were thought to be lost from memory. This can also take the form of stimulus-response recall, as when words, pictures and numbers are presented together in a pair, and the resulting associations between the two items cues the recall of the second item in the pair. Serial recall refers to our ability to recall items or events in the order in which they occurred, whether chronological events in our autobiographical memories, or the order of the different parts of a sentence (or phonemes in a word) in order to make sense of them. Serial recall in long-term memory appears to differ from serial recall in short-term memory, in that a sequence in long-term memory is represented in memory as a whole, rather than as a series of discrete items. In the earlier section, we have mentioned knowledge recall as part of important process in knowledge transfer. Figure 3 below shows conceptual framework how recalling process from individual memory process [47] act as a feed in the knowledge transfer process [24]. Even though knowledge recall has never been mentioned explicitly by any researcher, [48] agrees that recalling activities occurred during his experiment to determine knowledge mechanisms in knowledge transfer. For the purpose of transferring knowledge, no literature shows which type of recall is more effective than any other. It all depend on what knowledge we want to recall. Therefore, we suggest that any type of recall could be used depending on the person and the environment where the person is in. Since recall involve psychological part of human being, we review the reminiscence theory and transactive memory theory to

further comprehend recall and analyze how these theories could be harnessed in supporting knowledge transfer.
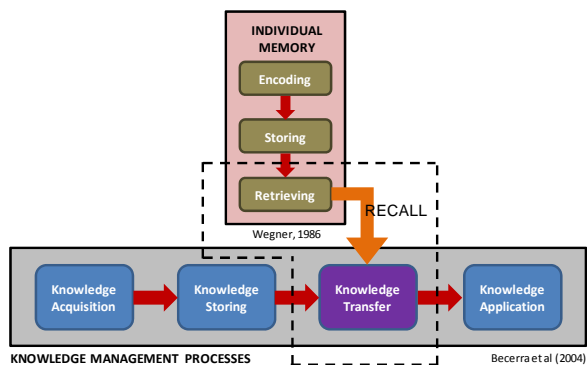


Figure 3: Conceptual framework of memory recall and its relationship to knowledge transfer

### C. Reminiscence Theory

Reminiscence refers to the process of recalling personal events or experiences from one's past that are memorable to a person [49]. The theory of reminiscence has become a debate since [50] classic paper on life review in the elderly. The debate started negatively with Butler's critics of reminiscence as non-purposive, escapist and impulsive behavior. Later, the concept of life review as a therapeutic intervention was introduced [51] where he suggested that taking an extensive autobiography could help older adults with the developmental task "to clarify, deepen and find use of what one has already obtained in a lifetime of learning and adapting". Reference [52] in her research stated that reminiscing is a technique employed to help patients think and talk about their lives. This technique can be implemented in a structured group, in an unstructured group, or on an individual basis. However, implementation and evaluation of this intervention have been difficult to attain and documented. Reminiscence has been studied for various purposes among all is to determine its effect on cognitive functioning [53–55]. The sharing of personal reminiscence in a group can be seen as a process of turning intrapersonal reminiscence into interpersonal memory exchanges. Group members begin to explore, to gradually confront and to reconsider specific memories that over time form the thematic and interactional content of their experience together [56]. However, many reviews of reminiscence research and practice agree on the main limitations. Lack of conceptual clarity and evidence are some of the limitations pointed out by [57]. On the basis of these serious limitations, [57] outlined some future reminiscence research which will be used as the basis of our research. Reference [57] in their research suggest that humans have a capacity and need to retrieve, articulate, and disseminate self-narratives from memories which lay in a form of the building blocks of these narratives. This process must be initiated by some factors, which one of them a component that is called "triggers". Memories do not occur in a vacuum but rather are situated in various social contexts. These elicited and situated memories are filtered through a series of individual difference variables that have the power to moderate many important characteristics. Next, reminiscence serves a purpose beyond simple recall. They function to allow a person to achieve some psychosocial goal. In other words, reminiscence serves particular functions. Finally, remembering our pasts for a specific reason produces an outcome, such as strengthening a person's sense of mastery or self-esteem.

The concept of reminiscence has been studied by many researchers, especially for elderly where reviewing memories can be used to revive interest, self-esteem and improve quality of life. Literature has also shown some studies on group productivity which discussed group versus individual. For example, it is commonly believed that "two heads are better than one". Reference [58] reported that research indicates that when people collaborate to recall an event the group does remember more than individuals working alone. It is also possible that information recalled by others in the group may provide cues to help individuals remember items that they would not recall if working alone. From the literature, we believe that reminiscence concept can be applied not only in reviewing elderly's memories but also in recalling their experience and knowledge. Therefore, we intend to explore the "trigger" component in [57] model of reminiscence which also will be used to recall knowledge that resides in elderly's mind.

### D. Transactive Memory Theory

The concept of transactive memory was first proposed by [47] based on the "group mind" idea which was disfavoured among the group behaviour theorist. [47] then studied the transactive memory theory which proposed the prediction of group and individual behaviour through the understanding of how they process and structure information they acquired. Wegner explained transactive memory by starting to focus on the study of the thinking processes of an individual. He then defined transactive memory system as a set of individual memory systems in combination with the communication that takes place between individuals [59]. Transactive memory systems, as a concept of social cognition, also refer to the idea that people in a continuing close relationship tend to develop a shared system for encoding, storing and retrieving information from different substantive domains. Reference [60] in their study suggested that tacit knowledge could be individually-owned or collectively-owned. By exploring transactive memory and knowing what other people know, individuals in groups can have access to external memory as well as their own individual memory. As a result, a group information-processing system is formed. Three relevant key processes of transactive memory systems are identified using the metaphor of a directory-shared computer network: directory updating, information allocation, and retrieval coordination [61]. To have a better understanding about this process, it is essential to first understand the components involved during the process.

*Individual memory*

We start by looking at the basic individual memory processes which is commonly understood to occur in three stages which are encoding, storage and retrieval. Figure 4 below illustrates the processes in individual memory. The three stages involve the information being entered into memory, information resides in the memory and information being brought back from memory respectively.
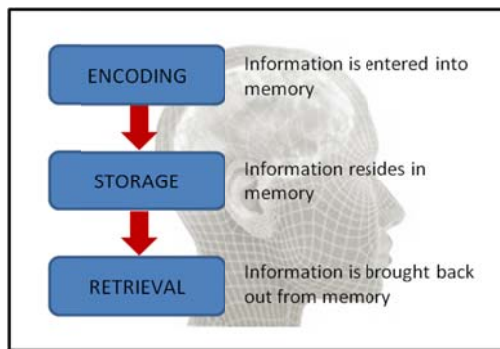


Figure 4: Conceptual Individual Memory Processes [47]

The successful operation of our memory depending on the success of these three stages. However, there are situations when we fail to execute all three successfully. We often have encoded something in our memory but fail to retrieve them. When this happens, memory failure occurred. Three possible situations when memory failure occurred are (i) information gets into memory but somehow falls out (ii) the information gets into memory, stays in but we could not find it, and lastly (iii) the information never gets into the memory at all. Another issue to consider when dealing with human memory is how the stored information is organized? Memory theorists have proposed a variety of organisational processes whereby items of information are not merely stored one by one but are stored as connected sets. This means that the information for example, in a form of a sentence may be stored as connected sets of items. Processes that make or break such connections can occur during encoding to create organisations. Complementary processes that operate at retrieval can locate the item by taking advantage of the organised storage that has been produced. Subsequent retrieval of either one is often accompanied by retrieval of the other. At the same time, retrieval of one of these items very seldom yields the memory which allow us to recognize that disconnections can also be stored (perhaps as absent connections) for later retrieval.

To ensure that the connection between information can exist and one way to hinder memory failure, [47] proposed the incorporation of "metamemory" idea in transactive memory discussion. Metamemory refers to memory about memory which includes knowledge about encoding, storage and retrieval processes. Metamemory is important in determining how well we use our memory skills as if we know what, where and how we have

encoded the information, we can retrieve the information better.

*External Memory*

As much as we rely on our own memory, we often underestimate the use of external memories in our life. The literature has shown that when remembering something that do not need to be remembered forever, people tend to store them in external memory such as book, papers, floppy disks etc. [47]. When remembering something that do not need to be remembered forever especially everyday memory tasks, people tend to store them in external memory [62]. External memory often used as an aid that provides some startling reminders. It also acts as the central storage area for a larger body of information. On certain condition, information that we have never encoded may become available for us to retrieve because we are able to access some external storage. Externally stored items of information are retrievable, however, only when we know something about what they are and where they are. The successful retrieval from an external memory item thus requires the prior encoding of at least two additional pieces of information (i) a retrieval cue or label for the item and (ii) a notion of the location of the item. This seems to be a general requirement for the use of external storage. The concept of memory items, i.e. label and location are similar in individual memory. We should be able to retrieve information successfully from both individual and external memory if we are able to identify the memory items. However, both individual and external memory faces some issues during the processes of encoding, storing and retrieving. By encoding the information, we can retrieve the information better.

*Individual Vs Group Memory*

People cannot guarantee that the information that they have encoded can be retrieved in the same form as the information sometimes damaged, lost or changed. These changes could take place due to individual memory effects or could also due to a result of transactive phenomena. Individuals may talk about some items of information as they are encoding them. When such transactive encoding occurs, labels are linked to the item by the conversant as a group. Although this has the benefit of allowing each group member subsequent access to details of this item unknown to self but known to others, it also tends to colour what is perceived by the group. It is also possible that information recalled by others in the group may provide cues to help individuals remember items that they would not recall if working alone. The benefits of group recalling compared to individual recalling has been widely discussed in the literature [40], [58], [63], [64].

*Issues in Current Transactive Memory*

The current transactive memory introduced by [47] proposed that human memory is transacted over to another human memory; being individual or group and stored in memory of others. From our analyses, we found

some limitations with regards to the current transactive memory system.

- **Limitations on human memory capacity** – human memory has a limit in terms of its storage capacity. Even though although we can store a lot in our memory we hardly can retrieve all the memory we stored.
- **Poor metamemory** – unsystematic label and location structure. In the **absence of person holding metamemory,** information cannot be retrieved when metamemory is lost.
- **Circumstantial** – people chosen as an expert is being forced into the situation therefore may not be the real expert.
- **Information is vulnerable to modification** – during the transactive processes, information could be damaged, lost or changed.
- **Must have a long standing group not impromptu group** – impromptu groups may have poor memory systems because their impromptu action is based on inferences and stereotypes and prone to exaggeration and error.
- **Non mobility** – people can only transact their memory when they are physically together and they must be stationary.

As we analysed the issues faced in the current transactive memory system, we realized that, transactive memory could help the reminiscence process in knowledge transfer especially when it is supported by the use of current technology. Figure 3 shown in the earlier section depict the individual and group memory process in transactive memory as suggested by [47] and its relationship with knowledge management processes by [24]. This clearly shown that in the knowledge management process, before the knowledge could be transferred, it first need to be retrieved from an individual or group memory. Therefore, with the implementation of transactive memory theory, it would help people in reminiscing and subsequently support knowledge transfer.

## V. KNOWLEDGE TRANSFER THEORY

There were very few literature that could be found which discuss about knowledge transfer theory. Even if there were, the focus of each study was totally different from each other hence, it makes it difficult for us to compare them. Reference [65] in his research discussed three theories to predict human performance in distinctive and identifiable ways on a variety of transfer tasks. Each mechanism has been associated with a particular kind of transfer scenario that specifies the conditions necessary for transfer (i.e., type of prior knowledge and application context). The first mechanism of reference [65] interest is analogical transfer [42]. Analogical transfer is composed of three subprocesses: i) retrieving a prior knowledge structure, ii) creating a mapping between it and the current problem or situation, and iii) using that mapping to generate new knowledge structures relevant to the application context. The knowledge transferred usually believed to be in declarative form but sometimes can also be procedural. Numbers of evidence for analogical mapping shows that although people are capable of mapping deep relational structures, the retrieval of an analogue is heavily dependent upon matches between the surface features of the current problem and prior problem solving experiences. Therefore, analogy is perhaps a better explanation for near transfer than for far transfer.

The second transfer mechanism of interest is knowledge compilation proposed by [66], [67]. Knowledge compilation was specifically proposed to explain how declarative knowledge is brought to bear on problem solving in the context of the ACT-R theory - a theory which talks about how human cognition works. This computational mechanism operates through the deliberate and explicit, step-by-step interpretation of a declarative statement that generates new production rules as a side effect. Those rules are then optimized via rule composition and the result is a procedural representation of the content of the declarative knowledge given a specific goal. The knowledge compilation mechanism can be viewed as a translation device that translates or interprets declarative knowledge into a set of procedures and actions that can be used to solve problems. Since knowledge compilation operates on declarative knowledge, it can be used in a wide variety of application contexts because the knowledge has yet to be proceduralized, or tied to the goals of a particular problem solving context. This mechanism embodies a tradeoff between applicability and efficiency in that it has wide applicability across many contexts but requires a complicated and lengthy application process to translate the declarative knowledge into a set of actions. There is some empirical support for knowledge compilation but the evidence is not extensive [67], [68].

The third transfer mechanism of interest is the error correction mechanism which proposed that the role of declarative knowledge is primarily to help a learner identify and correct his or her own errors. The constraint violation theory has both declarative and procedural components that operate in parallel, and the function of declarative knowledge is to constrain possible problem solutions. When incomplete or faulty procedural knowledge generates undesirable outcomes, these are recognized as violations of those constraints and the responsible rules are revised accordingly. The power of declarative knowledge is that it can help the learner pinpoint the cause of an error, and transfer is the process by which errors are identified and remedied. This mechanism has wide applicability in that the constraints can be applied to a variety of problems that may require different strategies or sequences of actions to produce the correct solution. The constraint violation theory has been shown to generate power law learning curve [69] and to support the design of successful tutoring systems [70].

In addition to each transfer mechanism using different cognitive processes, each mechanism has also been hypothesized to operate on specific types of prior knowledge structures. Analogy uses exemplar knowledge that consists of a declarative representation that may also

have procedural attachments [71]. Knowledge compilation uses declarative knowledge such as instructions, advice, or tactical knowledge. Error correction uses declarative knowledge of the constraints for a particular problem domain [69]. Reference [65] study was able to test the predictions of each transfer theory, and predict what transfer mechanism will be triggered for a given set of transfer scenarios.

However, the three theories discussed by [65] who highlighted alternatives for knowledge transfer does not share any similarities with the sender-receiver framework proposed by [72]. The theory proposed by [65] are to be used when the type of knowledge is known while [72] proposed a knowledge transfer framework where the knowledge is incomplete to the sender and receiver. In developing the sender-receiver framework, they first introduce the market view of knowledge transfer and treat knowledge as a good that moves in a knowledge market where parties may have incomplete and asymmetric information about other participants and the knowledge itself. Reference [72] highlighted the two groups of participants in a knowledge transfer: senders, the person who is giving the knowledge; and receivers, the person who is receiving the knowledge. They also studied knowledge transfer in four types of information structures: symmetric complete information, sender-advantage asymmetric information, receiver-advantage asymmetric information, and symmetric incomplete information. Later, they proposed that knowledge transfers can be analyzed at nodal (focusing on the behavior of one party), dyadic (focusing on the joint behavior of a pair), and systemic (focusing on the behavior of a system consisting of providers and seekers) levels [73]. The research resulted on the impacts of information structures on knowledge. First, a firm involving in knowledge transfers must decide to which type of information structure a knowledge transfer belongs. However, determining the information structure of a knowledge transfer may not be straightforward. Second, the effectiveness of signals in knowledge markets depends critically on the information structure. Signals help a receiver select a knowledgeable sender under sender-advantage asymmetric information structure, while they only provide better estimates of the value of a sender's knowledge under the symmetric incomplete information structure. Third, one should also be aware that the information structure of a knowledge market changes dynamically and participants of the market must adjust their strategies accordingly.

From these literature we conclude that, for successful knowledge transfer, we need to have suitable mechanisms through the consideration of transfer scenario that specifies the conditions necessary for transfer [48]. Apart from that it is also important to consider which type of information structure a knowledge transfer belongs to and decide if the mechanisms work at nodal or dyadic level.

## VI. KNOWLEDGE TRANSFER STRATEGIES AND MECHANISMS

To understand human thinking and problem solving in complex and novel situations, [48] suggested the need to have a general theory for how people use and adapt their prior knowledge to solve new problems. [48] also added that, aspirations towards such a goal have traditionally been discussed in terms of transfer, or how knowledge acquired from one task or situation can be applied to a different one. In order to ensure the success of knowledge transfer, organization usually adopt certain mechanisms during the process of transferring the knowledge. These mechanisms are usually chosen depending on the organization's needs and requirement as well as the suitability of their environment and working culture. Knowledge transfer mechanisms are social and structural means to facilitate the knowledge activities involving the knowledge management processes and subprocesses as suggested by [24] and shown in Figure 2 earlier. It is used in order to get the most out of knowledge sources and resources [25]. On the other hand, many organisations proposed other mechanisms to transfer knowledge such as Job Aids, Mentoring, Process Documentation, Identification of Best Practices, Communities of Practice, Job Shadowing, Critical Incident Review, Storytelling, Document Repositories and Structured On the Job Training [13], [28], [74].

Reference [75] who researched on the university-industry interactions and knowledge transfer mechanisms discover that traditional knowledge transfer methods such as publications or collaborative research were perceived as the most significant ways of transferring knowledge in university. In a society, study shown that we often use storytelling to transfer knowledge. According to [39] people have been telling stories to each other for million of years. Stories are told from a mother to a child, from a friend to another. Stories travelled as people travel when they bring along the stories to be told at another place they go to. As technology evolves, people started telling stories transmitted by electronic means to passive audiences incapable of doing anything but listening and watching. No matter how or where stories are told, story telling is considered to play an important role in human interaction [39]. However, the role of storytelling and story understanding is far more significant in human memory than simply being an example of human interaction. The reason that humans constantly relate stories to each other is that stories are all they have to relate. When it comes to interaction in language, all of our knowledge is contained in the stories and the mechanisms to construct them and retrieve them. Apart from identifying the suitable mechanisms to be used to transfer their knowledge, organisations often strategize their knowledge transfer exercise to ensure its success. Reference [13] furthermore added that, the effectiveness of this process hinges on several factors that were broken down into three major categories: i) determinants related to transfer knowledge attributes, ii) those related to the actors involved in the process, and iii) determinants related to transfer mechanisms. Reference [48] on the other hand stated that work in cognitive science over the past 30 years has taken a "divide and conquer" approach to attaining knowledge transfer goal. Researchers have pursued separate lines of inquiry by investigating the

cognitive processes of transfer for particular learning and problem-solving scenarios. This work has led to the development of several specialized theories of transfer including analogical transfer, knowledge compilation, constraint violation and transfer-appropriate processing among others [48].

From these literature we can conclude that to ensure successful knowledge transfer, we need to identify the suitable knowledge transfer mechanisms. Apart from that, it is important to comprehend that knowledge transfer mechanisms also involve a person's cognitive ability and play an important role in ensuring the success of knowledge transfer.

## VII. DISCUSSIONS

As the retirement number increased, many organisations realized the importance of transferring knowledge from their senior employees to the younger generations in order to retain their organizational knowledge. Our societies need to retain knowledge from elderly to preserve our culture and heritage. In order to ensure the success of intergenerational knowledge transfer, we reviewed researches carried out and pointed out the issues that are considered essential in the intergenerational knowledge transfer. Our review showed that cognitive ability and knowledge recall are two of the main issues that need to be considered in intergenerational knowledge transfer. Many researchers have proposed knowledge transfer strategies and mechanisms that might be used to transfer knowledge from one generation to another [9; 76] but none has really consider the cognitive decline experienced by elderly which could lead to the difficulties in knowledge recall which is one of the essential process in knowledge transfer. Knowledge recall involves some psychological aspect of human being which is the main factor of why we believe it is important to consider psychology theory in our study. Reference [77] consider reminiscence as a process of recall and interaction which involves recalling or telling of early events or a memorable early experience which may occur with or without specific purposes. Reminiscence is an interaction between the person recalling the memory and one or more individuals. As cited by [78], transactive memory theory considers an extension of an individual's memory system to include the knowledge of others as a mode of an external memory system. The memories of collaborative individuals aggregate to form a combined, interdependent memory body, or system, which elicits a synergistic effect; the individuals involved in and contributing to the transactive memory system are more effective at information recall and their recollections are generally of higher quality [79]. Reference [78] also suggested that future research may investigate how information systems can enhance human abilities in the transactive memory system to relieve cognitive strain and enhance individual memory capacity. From the literature, we believe that these two theories could be explored more to support knowledge recall and knowledge transfer among elderly. With the development of technologies that was created to improve services and

enhance the independence and quality of life of older people, we intend to combine the psychology theory with technology advancement to support knowledge transfer. Realizing the importance of knowledge transfer from one generation to another, we intend to explore the reminiscence theory and transactive memory system to help us in providing a platform for elderly to transfer their knowledge.

Based on research carried out by [57] on reminiscence and [78] on transactive memory system, we have identified the research gap that need to be filled as shown in Figure 5 below:
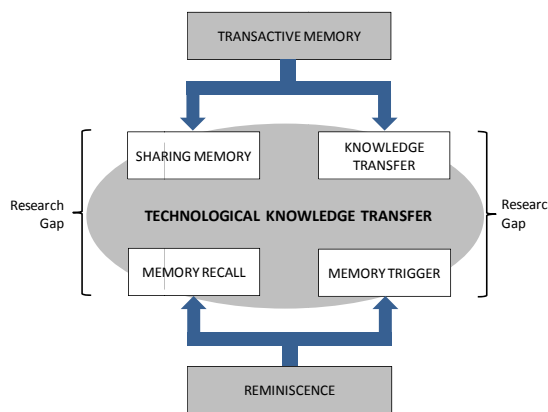


Figure 5: Research Gap

In order to overcome the issues in current transactive memory, we explore the use of technology as proposed by recent research published by [80] whom explore the use of the Internet as one of a member in transactive memory group. Figure 6 and 7 below show the idea of technology supported transactive memory in reminiscence for knowledge transfer. This idea could overcome the issues of storage limitation, poor metamemory and vulnerability of information. With the introduction of mobile technology and the use of smart device in the new transactive memory concept, we should be able to address the mobility issue as well.
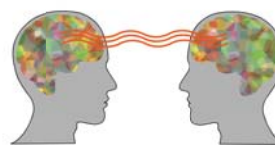


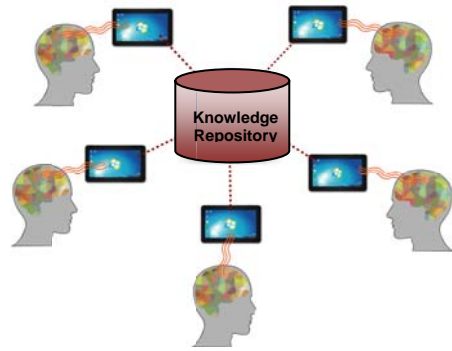Figure 6: Traditional Transactive Memory

Figure 7: Technology Supported Transactive Memory



Figure 8: Overview of Issues in the Research

## VIII. CONCLUSION

As the retirement number increased, many organisations realized the importance of transferring knowledge from the older generation to the younger generation. We analyzed paper written on issues related to intergenerational knowledge transfer and discussed the issues that need to be considered in intergenerational knowledge transfer. Reference [81] in her research emphasized how characteristics of the source of knowledge, the recipient, the context, and the knowledge itself affected knowledge transfer. As cited by [82], [81] found that the importance of these factors varied over stages of the transfer process. Factors that affected the perception of an opportunity to transfer knowledge, such as the reliability of the source, predicted difficulty of transfer during the early initiation stage, whereas factors that affected the execution of the transfer, such as the recipient's ability to absorb knowledge, affected difficulty during the implementation phases. The "causal ambiguity" of the knowledge or the extent to which it was not well understood predicted the difficulty of transfer throughout all phases of the transfer process. Other research has examined the factors affecting knowledge transfer in organisations [83]. Research has been done, for instance, on how characteristics of individual members, such as their ability and motivation, affect the transfer of knowledge from training to transfer contexts. This paper explores the reminiscence theory and transactive memory theory to be used for knowledge transfer. Since the knowledge transfer process involves knowledge recall which involves psychological aspect of people [84], we believe it is important to consider the psychological part of human in making the knowledge transfer success by harnessing the two theories together. We studied the current transactive memory system combined it with reminiscence. As we analyzed the current transactive memory, we proposed technology supported transactive memory to overcome the issues faced by the current transactive memory so it can be implemented in supporting the knowledge transfer. Figure 8 shows the overview of issues that we have discover in the research and how they are related. By understanding this issues, we hope to be able to provide a technological platform for intergenerational knowledge transfer.
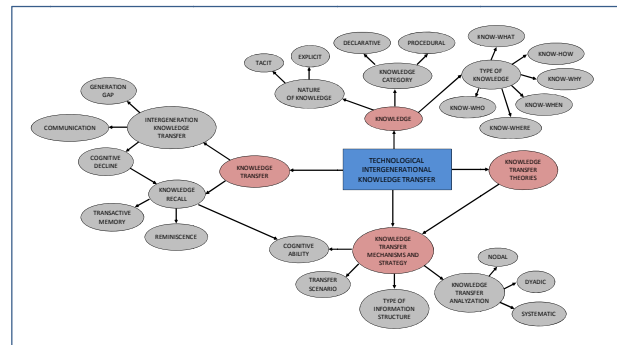
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**Sabiroh Md Sabri** is a Lecturer in the Department of Applied Management, Universiti Teknologi MARA, Terengganu, Malaysia. She obtained her M.Sc in Information Technology from Universiti Teknologi MARA, Malaysia in 2008 and her B.Sc in Information Technology from the same university in 2001. She is currently pursuing her PhD in knowledge management at the same university. Her research interests include knowledge management and information technology for quality of life. Among her publications are Knowledge Management Mechanisms for Attrition Control in Private Higher Learning Institutions, Knowledge Management International Conference (KMICE 2012) and Knowledge Management Practices (KMP) and Academic Performance in Universiti Teknologi Mara (UITM) Terengganu, Malaysia, World Applied Sciences Journal 12, 2011.

Sabiroh is currently a member of International Association of Computer Science and Information Technology (IACSIT) and The Society of Digital Information and Wireless Communications (SDIWC). Her paper has won the Best Paper Award in "KM in Education" category in the 6th Knowledge Management International Conference held in Johor Bharu, Malaysia.

**Haryani Haron** is an Associate Professor at Faculty of Computer and Mathematical Sciences, University Teknologi MARA, Selangor, Malaysia. She received her B.Sc in Computer Science from Arkansas State University, USA in 1986, her M.Sc in Computer Science from Universiti Teknologi Malaysia, Kuala Lumpur in 1996 and her PhD in Computer Science also from Universiti Teknologi Malaysia in 2009. She has held several administrative positions such as Head of Center for Information Technology Studies, Faculty of Computer and Matematical Sciences, UiTM and currently is the Director of Academic & Student Development at INTEC Education College.

Her current research interests are Knowledge Management, Knowledge Management Technology, Information Systems Methodology, Social Informatics, IT Management. Until date she has published more than 40 peer-reviewed papers and journals. Among her publications are Knowledge Taxonomy for Developing Organizational Memory System (OMS) for Public Institutions of Higher Learning (IHL) in Malaysia and Current Challenges and Future Perspective: The Influence of Organizational Intelligence on Libyan Oil and Gas Industry. She has been awarded numerous grants related to knowledge management research and actively involve in various consultation works with Government-Linked Corporations and other organisations.

Dr. Haryani Haron is a member of International Association of Computer Science and Information Technology and has served as external examiner for PhD in various universities. One of her paper has won the Best Paper Award in "Intelligent System in KM" category in the 6th Knowledge Management International Conference held in Johor Bharu, Malaysia.

**Nursuriati Jamil** is currently an Associate Professor at Faculty of Computer and Mathematical Sciences, University Teknologi MARA, Selangor, Malaysia. She received her B.Sc in Computer Science from California State University, USA in 1986, her M.Sc in Computer Science from Universiti Teknologi Malaysia, Kuala Lumpur in 1995 and her PhD in Information Sciences from Universiti Kebangsaan Malaysia, Selangor. She has held several administrative positions such as Head of Computer Science department, Head of Consultation Unit, Head of Research Interest Group (Information Retrieval) and Head of Communication and Information Center.

Her current research interests are multimedia information retrieval, signal and image processing. For her research activities, she has published more than 30 peer-reviewed papers and journals with h-index of 5. She has received numerous grants relating to image processing, speech recognition and information retrieval. She has also received a best paper award for one of her work entitled "Acoustical Analysis of Filled Pause in Malay Spontaneous Speech" in a conference presented at Kangwondo, Korea on December 2012. For her most recent work of "Ear Biometric Recognition", she was recently awarded two gold medals.

Dr. Nursuriati Jamil is an active member of the IEEE Computer Society, ACM Information Retrieval Group and International Society of Optical Engineering (SPIE). She currently serves as Executive Committee Member of IEEE Computer Society, Malaysia Chapter. Previously, she was appointed as Secretary, IEEE Computer Society, Malaysia Chapter for year 2011 and 2012. A member since 2002, she has been actively involved in organizing IEEE conferences, workshops and DVP programs for IEEE members in Malaysia. She was also invited by IEEE Victorian Section, Australia to give a talk in Swinburne University of Technology in Melbourne, Australia in December 2012.

**Emma Nuraihan Mior Ibrahim** is a Senior Lecturer at Faculty of Computer and Mathematical Sciences, University Teknologi MARA, Selangor, Malaysia. She obtained her Bachelor in Information Technology (BIT) from Charles Sturt University, Australia in 2002, her M.Sc in Information Technology from Universiti Teknologi MARA, Malaysia in 2004 and her PhD in Information Technology also from the same university in 2009.

Her current research interests are Human Computer Interaction (HCI), Non-Functional Requirements. She has published more than 10 peer-reviewed papers and journals. Among her publications are Exploring Informational Privacy Perceptions in the context of Online Social Networks: A Phenomenology Perspective and Trust or Distrust in the Web Mediated Information Environment: A Perspective of Online Muslim Users.

Dr. Emma Nuraihan is currently a member of Usability Professional Association and Qualitative Research Association of Malaysia and has been appointed as reviewer for various conferences.