Knowledge Retention

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ABSTRACT

With ongoing globalisation, organisations are increasingly confronted with worldwide competition. In order to build and sustain their competitive advantage, the knowledge and expertise of an organisation's staff needs to be seen as a critical strategic resource (Bender & Fish, 2000). The problem is that whilst expertise cannot be transferred, people "walk out the door" and their knowledge and expertise goes with them. Hence, it is extremely important to ensure, that knowledge is retained within the organisation (Bender & Fish, 2000). This paper aims to conduct a research about how to retain the knowledge in organizations. The main objective of the research is developing a tool for assessing and applying knowledge retention system in organizations. In order to satisfy the aims and objectives, a thorough review for the relevant literature was conducted, and a new framework was developed to enable organisations to measure the status and to successfully implement a knowledge retention system. The new model was developed based on existing models and has several strength over them such as, dealing with knowledge retention as a whole process and gathering the concepts of knowledge sharing, codification, retrieval and renewal. The data was collected analyzed for three organisations by conducting a chi square test for the survey data results, which was supported by the data gathered from the interviews and the real observation. It was concluded that knowledge retention is not a simple IT system that can be applied and that most of the organisations are at a level where knowledge is shared and partially stored, but not yet completely retained. Therefore, it was recommended that the organisations build a suitable environment for knowledge sharing at individual level, to codify knowledge and to search for a suitable system where this knowledge can be documented, stored and easily retrieved. Using the developed model was recommended as well since it enables the organisations defining and hence filling the gaps, which may exist in their knowledge retention system.

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RESEARCH INTRODUCTION

1.0. INTRODUCTION

Once an employee is no longer working with the organization, his/her knowledge is also no longer available. Therefore, one of the crucial challenges facing organisations is losing the knowledge of their expertise, due to either retirement or resignation.

Many organisations are trying to develop their human resources system in a way that helps in keeping their employees; however, still retirement and even resignation sometimes cannot be prevented. For this reason, it is essential that organisations retain the knowledge of their employees.

Bender & Fish (2000) argue that whilst expertise cannot be transferred, people "walk out the door" and their knowledge and expertise goes with them. Hence, it is extremely important to ensure, that knowledge is retained within the organisation. The idea of knowledge retention should be developed in order to help the organisations to have their own knowledge based on the individuals' knowledge. Only when the organisation can have its own knowledge it can survive regardless who leaves or who joins.

1.1. AIMS OF THE RESEARCH

This paper aims to introduce method/system/process of retaining knowledge in organisations and to provide a tool for organisations to enable them assessing the level of knowledge retention and applying it. This will be based on examination of the current practices, identification of the gaps and the problems in those practices through literature review and through real case studies of three organisations.

A knowledge retention system shall enable organisations to retain their expertise knowledge by sharing, documenting and storing this knowledge, and hence, preventing it from "walking out the door" when expertise retire or leave the company.

1.2. RESEARCH OBJECTIVES

Developing a model for applying and assessing the status of the knowledge retention in organisations is the main objective of this research. In addition to, developing a list of requirement for organisations, which enables them to implement a new knowledge retention systems or enhance their existing system. Moreover, measuring the effectiveness of the existing knowledge retention process and the system(s) which are used to store knowledge (such as, databases, internet, intranet…) and examining the current and the best

practices. The effectiveness of such systems can be examined through people (employees) satisfaction with the system and specifically through figuring out to what extend this system is helping them in retrieving the information that they are looking for.

In order to identify a unified framework of knowledge retention (KR) various KM & KR models proposed by leading KM researchers and recent survey evidences are comprehensively reviewed in the next chapter.

Moreover, the research examines the current practices in the UAE. The study is done for three cases and the three of them are international- UK based organisations. The study was done in the UAE offices (Abu Dhabi/ Dubai) for each of them.

A literature review is conducted to search for existing tools or models for knowledge retention/ knowledge management in organisations, knowledge definitions, types of knowledge, importance of knowledge, current practices and barriers to knowledge sharing. In the next chapter the literature is reviewed, the models from the literature are explained and critically reviewed.

CHAPTER -2-

LITERATURE REVIEW

2.0. INTRODUCTION

In the previous chapter the aims and objectives of this research were discussed, this chapter presents a review of the relevant literature.

Literature review was conducted to find out about the concept of knowledge and its retention. This chapter will focus mainly on knowledge definitions, types of knowledge, the existing models of knowledge management and retention, roles of individual in retaining and sharing knowledge and the barriers to knowledge sharing. This chapter is divided in eight main section. The first section will be about knowledge; it will contain definitions of knowledge, description of and differentiation between the two types of knowledge. It talks as well about the importance of knowledge and its retention. The second section is about individuals, why we should focus on individuals and what do we mean by expertise. The third section will discuss success factors of knowledge management, while the forth section is about advantages and disadvantages of codifying knowledge. The fifth and the sixth sections will include description of some of the existing knowledge management and knowledge retrieval models, which will be used as basis for developing new knowledge retention model. The seventh chapter is about

existing practices and barriers to knowledge sharing, and the last section is a summary of the reviewed literature.

2.1. ABOUT KNOWLEDGE:

2.1.1. KNOWLEDGE DEFINITION:

Knowledge has always been an interesting subject for researches; numerous definitions exist for knowledge. Bender & Fish (2000) argues that "Knowledge originates in the head of an individual and builds on information transformed and enriched by personal experience, beliefs and values, with decision and action-relevant meaning. It is information interpreted by the individual and applied to the purpose for which it is needed". In order to manage something you must be able to recognize it. Knowledge does not exist in isolation though. It is something that can be picked up or locked in a company vault (Watson, 2003).

Patel et al. (2000) define Information as the "data interpreted in a given context, while knowledge is a body of information, coupled with the understanding and reasoning about why it is correct. Knowledge is the cognitive ability to generate insight based on information and data and it is typically gained through experience or study in some combination." One dominant assumption can be described as the 'knowledge as possession'

view. From this perspective, knowledge is seen as an entity that can be made explicit and transferred from one person or group to another (Newell, 2006).

Brown & Duguid (1991) argue that implicit in most training courses, tends to endorse the valuation of abstract knowledge over actual practice and as a result to separate learning from working and, more significantly, learners from workers.

2.1.2. TYPES OF KNOWLEDGE (EXPLICIT & TACIT)

According to Mckenna (2006) knowledge can be viewed as consisting of two types; one tacit and the other explicit. Figure 2.1 shows a model of the two types of knowledge as suggested by Patel et al. (2000). Tacit knowledge is composed of an accumulation of experience in the form of insight and wisdom, which the person may have difficulty in communicating to others but can easily utilise in the performance of a particular task. Patel et al. (2000) defines tacit knowledge as the personal knowledge embedded in individual experience and involves intangible factors such as personal belief, perspectives, and values. Li & Gao (2003) believe that tacit knowledge is an elusive or maybe illusive term that its implication depends on the nature and resources of tacitness expected. They argues that most literature are keen on citing the fancy sentence "we know more than we can tell" by Polanyi, which further was amplified by another sentence "we know more than we realize". It

could be true in some contexts, however, in the real world it is often used as an excuse for unawareness, or inability or articulation, or even illiteracy of knowledge. An elusive border between tacitness and "ignorance" becomes uncertain. If it is just devised to encourage innovation activities in business organisation, it is constructive. But it could be costly to direct organisational resources for mining something that may not exist or possess little potential of tacitness (Li & Gao, 2003).

By contrast, the explicit knowledge lends itself to codification or classification and can easily be expressed. "The explicit knowledge created should be a strong reflection of best practice within the alliance group, should exhibit shared ownership, and should be able to be easily understood outside its linguistic, organizational and cultural context" (Rice & Rice, 2005).

While discussing knowledge retention and/or any knowledge management system we need to consider both types of knowledge tacit and explicit. Nonaka (1994) argues that organisational knowledge is created through a continuous dialogue between tacit and explicit knowledge. It is the mixture of tacitness and implicitness that reinforces the mystification of tacit knowledge (Li & Gao, 2003). Syed-Ikhsan & Rowland (2004) argues that organisations should identify where tacit and explicit knowledge resides when designing strategies, in order to ensure that knowledge is created and transferred to the

right individuals. However, knowledge, particularly tacit knowledge, is very difficult to transfer.

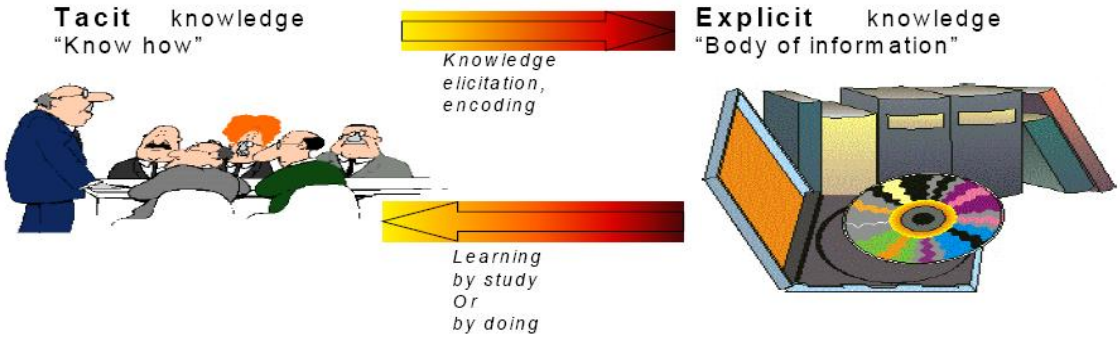

Figure 2.1.The two main types of knowledge (Patel et al, 2000)

2.1.3. IMPORTANCE OF KNOWLEDGE AND ITS RETENTION:

Chong (2006) argues that despite the importance of KM to organisational success, and despite a great deal of interest on the subject there is not yet a common consensus on the concept of KM. However, Pathirage et al. (2007) believe that the view that knowledge is a valuable organisational resource has become widely recognised and accepted in the business community. Consequently, within the last few decades, there has been an increasing interest in the tacit dimension of knowledge, which is perhaps hardest to manage, as it cannot be formally communicated and is often embedded within human beings. Patel et al. (2000) argue that most organisations are at a level of learning that enables them to cope with managing information, but

not necessarily to manage knowledge and that management of knowledge is a new and emerging data.

Dyerson and Mueller (1999) believe that three tasks of knowledge management are important in building technological capability: appropriation, team working and learning. `Appropriation' includes the retention and effective utilization of internal knowledge. `Team working' refers to the integration of diverse knowledge bases. `Learning' embraces the acquisition and exploitation of externally held knowledge. While, Marsh and Stock (2006) suggest that knowledge retention and interpretation activities positively impact a firm's new product development performance. In particular, practices that enable the retention and interpretation of knowledge improve new product development performance indirectly through the firm's enhanced ability to apply knowledge developed in prior product development projects to subsequent projects. Patel et al. (2000) argue that since the knowledge is an extremely valuable organisational asset, there should be a strategic framework within which it is generated/ captured, represented/codified, transferred and assimilated.

Maqsood and Walker (2007) argue that for an organisation to maintain its competitive edge and continually innovate it has to not only focus on transforming itself into a learning organisation but also to facilitate learning

throughout the whole supply chain (of which it is part) to become a learning chain. We include the word, "lifecycle" within knowledge management because it is evident that organisational knowledge does indeed have a lifecycle; it is discovered, captured, utilised, and eventually, retired rather than killed (Siemieniuch & Sinclair, 2004). The knowing organization possesses information and knowledge that confer a special advantage, allowing it to manoeuvre with intelligence, creativity, and occasionally cunning. The knowing organization is well prepared to sustain its growth and development in a dynamic environment (Choo, 2001).

National borders seem to be almost non-existent with an increase in international joint ventures, companies establishing subsidiaries and sales offices aboard. Such changes make it valuable to organisations if they are to be successful, to manage their knowledge and to transfer existing skills, knowledge and expertise effectively within the organisation, especially across national borders (Bender & Fish, 2000). Ayas and Zeniuk (2001) argue that as projects face higher degrees of technical complexity and interdependency across functional boundaries, even the success of a single project becomes increasingly dependent on the organisational capability to generate and share knowledge. Bender & Fish (2000) believe that today and increasingly in the future, in a knowledge age where national boundaries are of less importance to business, the transfer of knowledge and expertise, and the creation of a

"learning" organisation has become a critical factor to company success and competitiveness. Many organisations are concentrating their efforts on how knowledge, particularly tacit knowledge that exist in the organisation, can be transferred across the organisation (Syed-Ikhsan & Rowland, 2004).

2.2. INDIVIDUALS

2.2.1. FOCUSING ON INDIVIDUALS

While discussing knowledge retention, we should be aware of the importance of focusing on individual as important part of the knowledge retention progress. "Individuals are important not only because they, themselves, are a source of retained information, but also because they largely determine what information will be acquired and then retrieved from the other memory stores. As such, an examination of the nature of the individuals that compose the organisation can offer initial insights about the construct of organisational memory (Walsh & Ungson, 1991). Individuals are an excellent starting point for examining information acquisition, retention and retrieved processes (Walsh & Ungson 1991). Moreover, Nonaka (1994) believes that "The prime movers in the process of organisational knowledge creation are the individual member of an organization. At a fundamental level knowledge is created by individual". Although ideas are formed in the minds of individuals, interaction between individuals typically plays a critical role in developing

these ideas. That is to say, "communities of interaction" contribute to the amplification and development of new knowledge (Nonaka, 1994). An expanded understanding of what and how people know can help provide an enriched, more robust way of assessing, supporting, and honoring the epistemological dimension of all "real work," which alone gives life and power to such concepts as core competency, knowledge creation, knowledge work, and intellectual capital. (Cook & Brown, 1999).

Crossan et al. (1999) argue that the question of whether individuals have the motivation, understanding, capability, and opportunity to interpret their environment suggests the need to examine more than just individuals. They believe that it requires an examination of the link between interpreting and institutionalizing. Individuals may be motivated and capable, but if they turn their attention toward interpreting things that have little impact, the organization will reap few benefits from that learning. Furthermore, even if individuals are interpreting things of relevance, their learning needs to be integrated and institutionalized to realize its future value. This theory suggests it is not simply a matter of transferring data, information, or knowledge-it is a matter of organizational learning.

Dialogue and deconstruction have the potential to occupy important space in workplace learning and educational practice if allowed to examine social,

political, and economic issues without always privileging one particular perspective. This presupposes at least some time for dialogue and reflection in the conspicuously busy programs of postmodern managers (Rhodes & Garrick, 2003).

2.2.2. *EXPERTISE DEFINITION*

Expertise is specialised, deep knowledge and understanding in a certain field, which is far above average. Any individual with expertise is able to create uniquely new knowledge and solutions in his/her field of expertise. In this sense, expertise is gained through experience, training and education and it is built up from scratch over a long period of time by an individual and importantly remains with that person (Bender & Fish, 2000).

2.3. SUCCESS FACTOR

Spender (1996) argues that explicit memory systems are repositories, they store data rather than meaning and even falsified knowledge remains available, to be given meaning and used as considered appropriate.

In a study, which was done by Newell et al. (2006) , it was found that in the construction company the sharing of knowledge across projects was left to the regional management team to come on site and try to extract information on what lessons really were to be learned from the progression of a project. It

was found as well that the lack of interaction was motivated by the time pressure.

Creech (2005) argues that knowledge-sharing works best when it is closest to the level of implementation and impact. One has to build the capacity to gather and communicate knowledge at the project/activity/field level before one can begin to aggregate up to corporate systems and general knowledge marketing strategies.

2.4. ADVANTAGES AND DISADVANTAGES OF CODIFYING KNOWLEDGE:

"Before an organisation can establish a KM it must determine what knowledge to share, why share it, how to share it and with whom to share it" (Patel et al, 2000).

Seemann & Cohen (1997) argues that making knowledge explicit organizes it, preserves it, and makes it readily available. On the other hand, they believe that a major disadvantage of knowledge made explicit in a map, atlas, or document is that it starts to go out of date as soon as it is put down on paper or entered into a computer.

However, According to Watson (2003) if we attempt to codify (that is, to make explicit) all knowledge, we should ensure that tacit knowledge is not lost. Augier (2001) argues that contexts with many similarities can only emerge if

problem solvers have shared many common sectors of time and space prior to the problem solving in situ. Consequently, tacit knowledge sharing in solving complex unstructured problems will not take place if not being prepared for.

2.5. KNOWLEDGE MANAGEMENT MODELS

Bender & Fish (2000) argues that individual build his or her own knowledge by transforming and enriching information, and they define knowledge as what the individual transform information into by incorporating personal experience. They suggested knowledge hierarchy (figure-2.2) -a knowledge creation process- where individuals receive the knowledge from other sources (other individuals, books,..) in the form of data, and by that time the process begins as the recipient of the data adds meaning to transfer the data into information, then enriches the received information with his or her personal application. Patel et al. (2000) argue that the route of data-information-knowledge is bi-directional. Knowledge can be externalised into information, which can be broken down into data, and vice versa. In this sense, people can transfer data or information, but the knowledge itself has to be created in the head of the individual. (Bender & Fish, 2000)

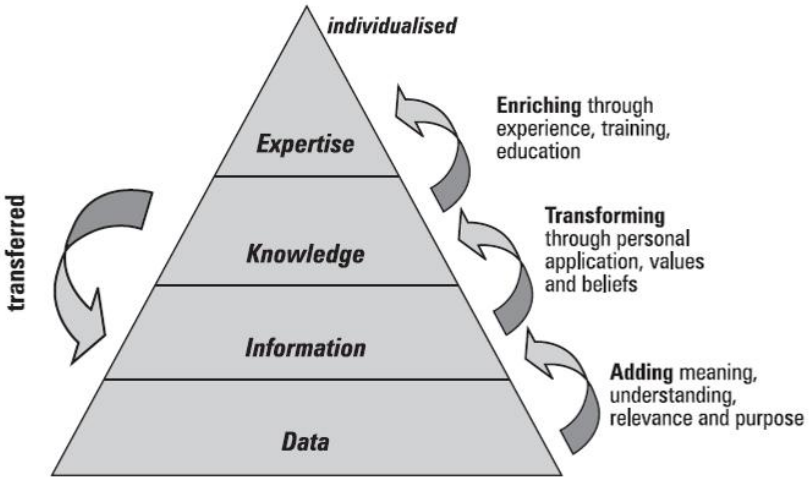

Figure-2.2 Knowledge Hierarchy (Bender & Fish, 2000)

Figrue-2.3 shows Boisot's model which considers knowledge as either codified or uncodified, and as diffused or undiffused, within an organisation. Boisot uses the term "codified" to refer to knowledge that can be readily prepared for transmission purposes (e.g. financial data). The term "uncodified" refers to knowledge that cannot be easily prepared for transmission purposes (e.g. experience). The term "diffused" refers to knowledge that is readily shared while "undiffused" refers to knowledge that is not readily shared (McAdam & McCreedy, 1999).

Newell et al, (2006) suggest knowledge management strategies as 'codification' and 'personalization'; codification focuses on making knowledge explicit so that others can acquire this knowledge rather than having to develop it for themselves. In contrast, personalization encourages participation in networks where people can learn through dialogue. This

strategy accepts that knowledge is closely tied to the daily activities of employees and needs to be shared mainly through face-to-face contacts.

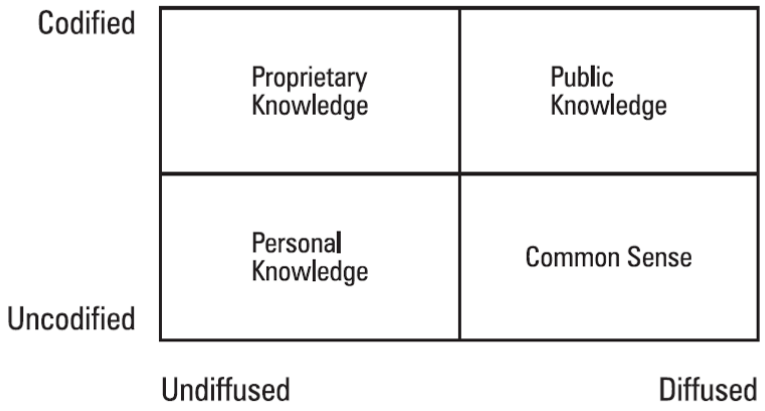

Figure-2.3 Boisot's knowledge category model (McAdam & McCreedy, 1999)

McAdam & McCreedy (1999) argues that Nonaka's model (figure -2.4) is an attempt at giving a high-level conceptual representation of KM and essentially considers KM as a knowledge creation process. The model assumes that tacit knowledge can be transferred through a process of socialisation into tacit knowledge in others and that tacit knowledge can become explicit knowledge through a process of externalisation. The model also assumes (bottom 2 squares) that explicit knowledge can be transferred into tacit knowledge in others through a process of internalisation, and that explicit knowledge can be transferred to explicit knowledge in others through a process of combination (McAdam & McCreedy, 1999).

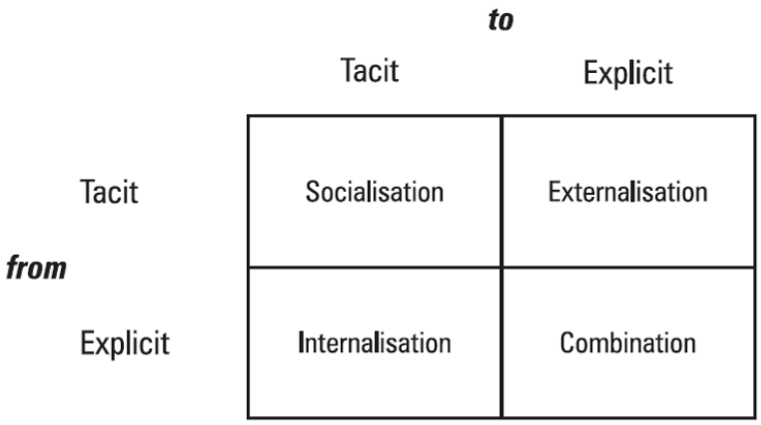

Figure- 2.4 Nonaka's knowledge management model (McAdam & McCreedy, 1999)

Figure-2.5 shows a SECI model which was adapted by Gray & Densten (2005). According to Rice & Rice (2005) the SECI model met with broad acceptance, especially among management practitioners, due to its intuitive logic and clear delineation of knowledge types between tacit and explicit knowledge—utilizing this knowledge delineation first espoused in management theory by Polanyi (1958). The model also embodied an interaction dynamic by which knowledge is transferred in a spiral process, allowing the knowledge value to be enhanced through exchange between individuals and groups within the organisation. Rice & Rice (2005) describe the four different notions of "Ba", which are defined in relation to each of the four quadrants of the SECI model and together make up the 'knowledge spiral', as follows:

1. The Originating Ba: a locale where individuals can share feelings, emotions, experiences and perceptual models.

2. The Dialoguing Ba: a space where tacit knowledge is transferred and documented to explicit form. Two key methods factors are through dialogue and metaphor creation.

3. The Systematizing Ba: a virtual space, where information technology facilitates the recombination of existing explicit knowledge to form new explicit knowledge and;

4. The Exercising Ba: a space where explicit knowledge is converted into tacit knowledge.

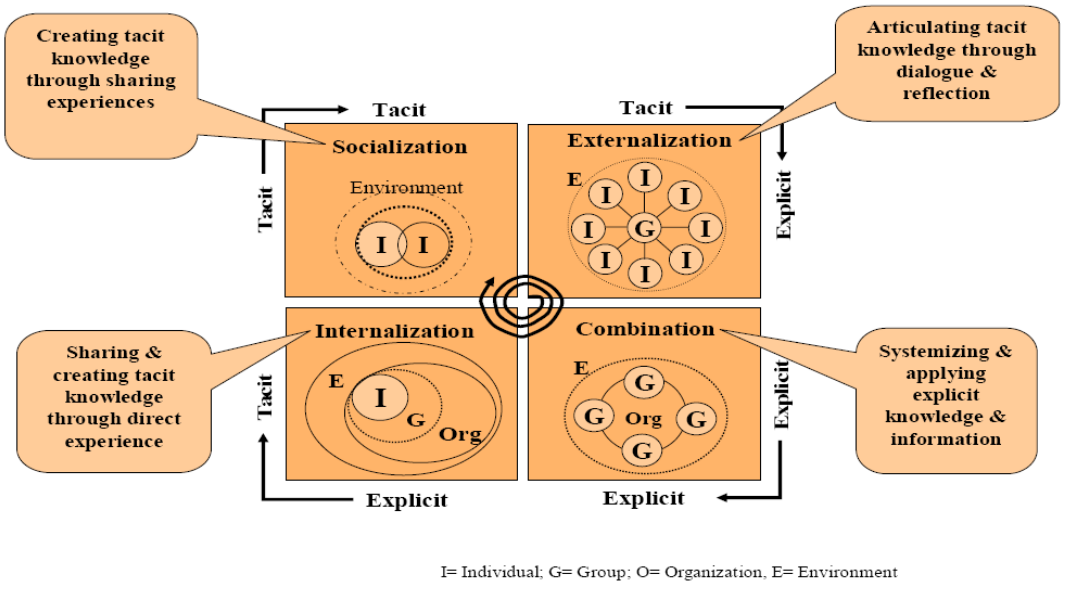

Figure 2.5: SECI Process Model of Knowledge Creation. (Gray & Densten, 2005) Adapted from Byosiere & Luethge (2004, p. 245) and Nonaka & Toyama (2004, p. 98).

2.6. KNOWLEDGE RETRIEVAL

Gammelgaard and Ritter (2005) suggest four knowledge retrieval means (figure 2.6). The first one is the "individual memory" which is developed through a person's observations, experiences, and action and is not considered a part of the organizational memory. The second mean is the "databases"; by using them, more people, or at least their written documents, serve as sources of information to the individual knowledge workers. The third one is "social capital" which refers to the value of an individual's relationships with other individuals in helping to get things done in a firm. The last mean is "virtual communities of practice" which are groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis.

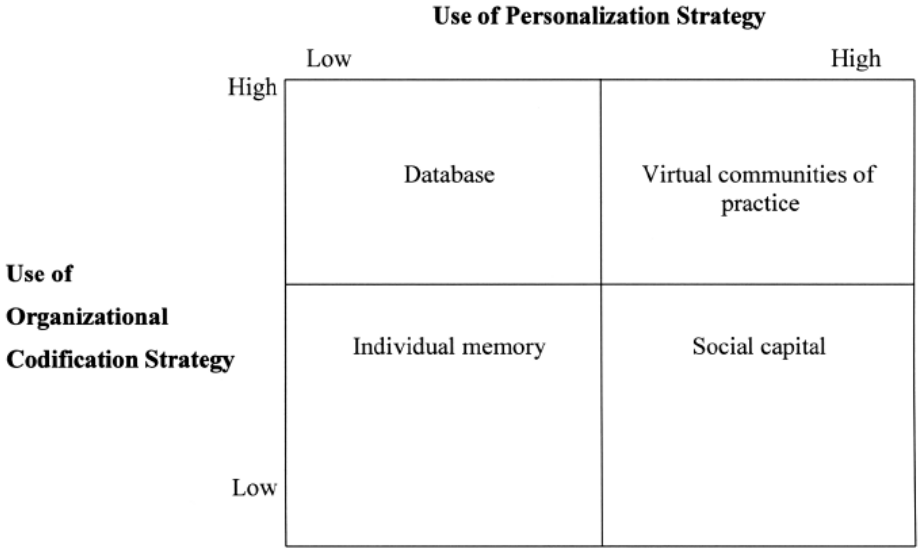

Figure 2.6: Knowledge retrieval means (Gammelgaard and Ritter, 2005)

Knowledge retrieval is an essential step in knowledge management and retention. According to Gammelgaard and Ritter (2005) knowledge which is trapped inside the minds of the key employees, in filling drawers and databases is of little value if not supplied to the right people at the right time. Seemann & Cohen (1997) argue that without a guide to organizational knowledge, mistakes tend to be repeated because people don't have ready access to past experience. They often make do with mediocre or faulty local knowledge because it is more accessible than the better knowledge which almost certainly exists in the organization.

The purpose of a KM system is to allow people other than the key players to use or apply the same decisions rules; thus, employees can seek assistance from the database of knowledge that has been gained and stored from the experts of the organization. Evaluation must be performed in order to determine the effectiveness of the applications (McManus, Wilson, & Snyder, 2003).

In order to guarantee the access to the stored knowledge and the ability to access it, the organisation memory should be structured in a way that supports the knowledge retrieval. Walsh & Ungson (1991) argue that one reason for the difficulty in defining organizational memory is that it is unclear whether or not information-processing ideas that are derived primarily from

work on biological organisms can be extended to social and organizational phenomena-that is, the proposition that organizations have memories raises questions about anthropomorphism. They suggest a model for the structure of the organisation memory (figure 2.7), in which retention facilities consist of five main sections. Firstly, individuals who have their own recollections of what has transpired in and about organizations and retain information based on their, own direct experiences and observations. The second one is the organisational culture, which is defined as a learned way of perceiving, thinking, and feeling about problems that is transmitted to members in the organization. The third one is transformation; it is the logic that guides the transformation of an input (whether it is a raw material, a new recruit, or an insurance claim) into an output (be it a finished product, a company veteran, or an insurance payment) is embodied in these transformations. The forth one is the structure which must be considered in light of its implications for individual role behaviour and its link with the environment. It reflects and stores information about the organization's perception of the environment. Finally the workplace ecology, which has an efficient role in retaining information about an organization and its membership.

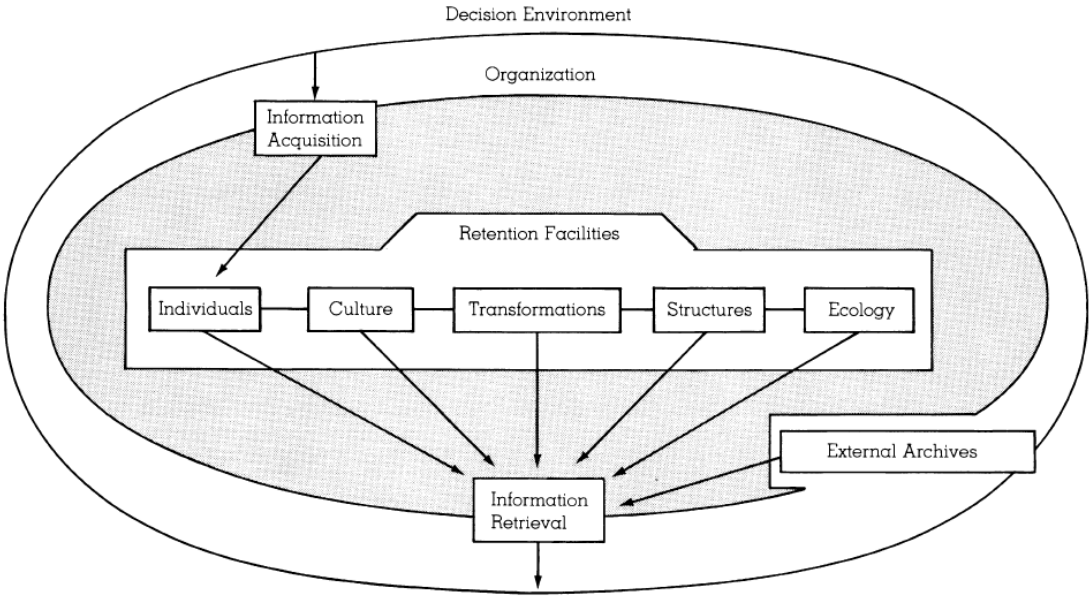

Figure 2.7: The structure of organisational memory (Walsh & Ungson 1991)

Watson (2003) believes that using knowledge is the element that links the cycle, since it is likely that new insight might be created into the knowledge when it is used.

2.7. ABOUT EXISTING PRACTICES AND BARRIERS TO KNOWLEDGE SHARING:

The transfer of knowledge is, however, not an easy process. Barriers to knowledge transfer can be roughly categorized into three categories: fragmentation, overload and de-contextualization (Gammelgaard & Ritter, 2005).

Patel et al. (2000) define another barrier related to individuals, which is protecting their own position within the organisation. Syed-Ikhsan &

Rowland (2004) argue that Knowledge transfer requires the willingness of a group or individuals to work with others and share knowledge to their mutual benefit.

Based on an exploratory study, qualitative investigation of 13 unrelated projects across six UK organizations, operating in different sectors (healthcare, public services, utilities, automotive, construction, and biosciences), which was done by Newell et al. (2006) and aimed at understanding the processes by which project-based knowledge and learning are created and transferred in organizations across sectors. Two key issues appeared to be important in understanding barriers to cross-project knowledge transfer: first the focus of learning and second the type of learning. Many limitations to sharing knowledge across projects using the existing project review practices:

- lack of systems and tools for reporting experiences

- The focus on successful delivery of project milestones also distracted from reflection on processes. For this reason project members did not see the benefit of documenting and sharing lessons learned on a systematic basis

- What was documented at project reviews and milestones was not lessons learnt but outputs achieved. (type of knowledge)

- Lack of awareness that knowledge transfer has occurred or is needed.

An important reason why databases were not used was because they contained knowledge about what was done but not how and why it was done.

2.8. WHY SUGGESTING A NEW MODEL FOR THIS RESEARCH:

Six models were introduced in the previous sections; the first model (knowledge hierarchy) explains the creation of knowledge process, and how the data is transferred to knowledge, however it does not explains the process of sharing, communicating or retaining knowledge in organisation.

The second model is the Boisot's knowledge category model, this model defines four categories for knowledge : codified, uncodified, diffused and undiffused. This model discusses essential ideas in the knowledge retention process, such as that the personal knowledge is considered uncodified and undiffused and for the knowledge to become public codification is required. On the other hand, this model does not show a complete process of the knowledge retention.

Nonaka (1994) has suggested another model (SECI) that considers the knowledge management as a knowledge creation process. This model suggests four processes for knowledge: socialisation, externalisation, internalisation and combination. The four processes are responsible for transferring knowledge from tacit-to-explicit and vice versa. This model does talk about the process of knowledge, however it does not define where and when each process happens.

The fourth model is a SECI model adapted by Gray & Densten they define spaces (Bas) where the process which Nonaka has defined. This adapted model can be considered more specific and clear about the process, however; it does not include the organisational memory where the knowledge should be stored. The fifth and the sixth models (knowledge retrieval means & organisational memory) define where knowledge is stored (individual's memories, databases, social capital, organisation structure...etc). In addition to, explaining the knowledge retrieval means and facilities.

The six models will be used as a basis for developing the new model which will include the process knowledge creation, the process of transferring knowledge, organisational memory, knowledge retrieval and renewal of knowledge.

2.9. SUMMARY OF THE LITERATURE REVIEW

In this chapter, literature about knowledge management/ retention was reviewed. Knowledge is viewed by all the researchers as a valuable asset for organisation and there is a great emphasis for managing knowledge well and protecting it from being lost. There are two types of knowledge tacit and explicit, the difficult task in knowledge retention will be the codifying of the tacit knowledge without losing parts of it. However, both types are to be considered while retaining knowledge, Nonaka (1994) argue that organisational knowledge is created through a continuous dialogue between tacit and explicit knowledge. Individuals are viewed by researchers as the prime movers of knowledge and there should be a focus on them in any knowledge retention process. Many researchers have written about and emphasized the importance of the knowledge retention, however; there is no real identification of characteristic of organisations, which apply knowledge retention. In this research the main aim will be creating a model which identify the process of knowledge retention and the list of knowledge retention requirements.

The next chapter will consist of two main sections, the first one is developing a customised model for knowledge retention based on the literature and the existing model, which were already discussed in this chapter. The second one

is explaining the data collection methodologies which will be used to conduct this research. The model will summarise the process of knowledge retention in four steps. The first step is socialization where individuals share their own tacit knowledge. We have previously discussed in this chapter the importance of individuals in the knowledge sharing process, therefore, this step will be the foundation of the knowledge retention process. The second step is the codification, in this step the shared knowledge will be codified (converted from tacit to explicit knowledge) in order to enable it for being stored. The third step is the construction of the knowledge and the organisational memory, where knowledge will be stored. The last step is the knowledge retrieval, which is an important step in the process because there is no point in storing knowledge if it will not be retrievable. Based on the four steps in the developed model and the reviewed literature a list of requirement for applying knowledge management in the organisations will be prepared and will be used as a tool for identifying the level of the knowledge retention in organisations.

CHAPTER -3-

RESEARCH METHODOLOGY

3.0. INTRODUCTION

In the previous chapter, a literature review was conducted and several knowledge management models were picked up from the reviewed literature and explained. In this chapter, a new model will be developed, based on the concepts of knowledge management, which were already discussed and included in the models in chapter-2.

In addition to the model explanation, this chapter contains data collection methodologies, which are surveys/ questionnaires, interviews and real observations during the visits. The study was performed in three engineering consultancies organisations. The three of them have similar characteristics in terms of the large scale, the engineering field, and being international and UK based. The data gathered using the three techniques will be used collectively with the model to describe a case study for each organisation.

3.1. KNOWLEDGE RETENTION MODEL

Pre-existing models for knowledge retention/ management were gathered and explained in chapter -2, by using the existing models and combining

them in a way that matches the research objectives a new model has been developed.

In order to create and develop a model for assessing knowledge retention in organization several steps and levels should be considered. "Because the acquisition, retention and retrieval of memory is an ongoing process, it is difficult to pinpoint exact boundaries between these processes. Even so, Walsh & Ungson (1991) believe that researchers must decide how to parse the process into ecologically meaningful stages that are subject to verifications and measurements" .Therefore when we talk about knowledge retention, we need to consider a continuous/ongoing process. In the developed model four steps are identified, as follow:

3.1.1. STEP-1: SOCIALIZATION / INDIVIDUAL – TO- INDIVIDUAL (TACIT- TO – TACIT)

The first step involves socialization and sharing knowledge at individual level. Individuals are important not only because they, themselves, are a source of retained information, but also because they largely determine what information will be acquired and then retrieved from the other memory stores. As such, an examination of the nature of the individuals that compose the organisation can offer initial insights about the construct of organisational memory. Bender & Fish (2000) suggest that in order to build and sustain their

competitive advantages, the knowledge and expertise of an organisation's staff need to be seen as a critical strategic resource.

Nonaka (1994) argues that the prime movers in the process of organisational knowledge creation are the individual member of an organization and that at a fundamental level, knowledge is created by the individual. Walsh & Ungson (1991) consider individuals as an excellent starting point for examining information acquisition, retention and retrieved processes

When we talk about knowledge retention, our main concern is the tacit knowledge which is distinctly personal concept. Nonaka (1994) argues that the key to acquiring tacit knowledge is experience. Without some of the shared experiences, it is extremely difficult for people to share each others' thinking processes. He suggests as well, constructing a field or "self-organising team" in which individual members collaborate to create new concepts. He believes also that it is a critical matter for an organisation to decide when and how such a "field" of interaction in which individuals can meet and interact. These communities reflect the way in which people actually work as opposed to the formal job description or task-related procedures specified by the organisation. In order for self-organising team to start the process of concept creation, it needs first to build mutual trust among members (Nonaka, 1994).

An essential requirement to be considered the base of the knowledge sharing, is the face-to-face communication. Nonaka (1994) argues that dialogue, in the form of face-to-face communication between persons, is a process in which one builds concepts in cooperation with others. It also provides the opportunity for one's hypothesis or assumption to be tested. Bender & Fish (2000) argues as well that the development of knowledgeable people and the retention of expertise though becomes problematic if organisations rely simply on real-time access to information without the benefit of face-to face contact. Sharing allows the distribution of captured knowledge throughout the organisation to individuals or groups that may require this relevant information (McManus, Wilson & Snyder 2003).

Bender & Fish (2000) argue that individual build his or her own knowledge by transforming and enriching information, and they defined knowledge as what the individual transform information into by incorporating personal experience. They suggested knowledge hierarchy (a knowledge creation process) where individuals receive the knowledge from other sources (other individuals, books,..) in the form of data, and by that time the process begins as the recipient of the data adds meaning to transpose the data into information, then enriches the received information with his or her personal application. In this sense, people can transfer data or information, but the knowledge itself has to be created in the head of the individual.

Renewing knowledge is another concept that comes from sharing the knowledge. New knowledge is created by people who share and transfer their knowledge and expertise throughout the organisation from individual to individual, individual to a team or group, team or group to individual, or team or group to team or group. (Bender & Fish 2000)

However, problems will always occur when developing new systems. In this respect, Greengard (1998) identified three cultural barriers organisations are usually confronted with when adopting a knowledge management initiative. First, people do not like to share their best ideas, second, people do not like to use other people's ideas, and third, people like to consider themselves experts and prefer not to collaborate with others." (Bender & Fish 2000). Syed-Ikhsan & Rowland (2004) argue that Knowledge transfer requires the willingness of a group or individual to work with others and share knowledge to their mutual benefit.

3.1.2. STEP -2: CODIFICATION (TACIT-TO-EXPLICIT)

This step involves the conversion of tacit knowledge into documented explicit knowledge. Rice & Rice (2005) argue that the greatest challenge in the multi-organisational context is that tacit knowledge is generally seen as contextually and culturally constrained and embedded within individuals and small groups. Within the multi-organizational project situation, the use of creative

reporting and compilation systems are vital. The use of graphical representations of knowledge challenges the authors to avoid hyperbole and jargon. The use of open compilation systems and non-verbal communications processes allows for the generation of shared understandings, and not just the 'cut and paste' of textual contributions from various contributors. Here, the use of presence (either real or virtual) is important. The explicit knowledge created should be a strong reflection of best practice within the alliance group, should exhibit shared ownership, and should be able to be easily understood outside its linguistic, organizational and cultural context (Rice & Rice, 2005).

Patel et al. (2000) define explicit Knowledge as the most common type of knowledge. It is 'readily available' and can be codified and structured in a way that makes it easily transmissible. It is the kind of knowledge that is recorded, and allows people to find it and use it. It can be found in a range of diverse sources, such as human resources data, meeting minutes and the Internet. While they define tacit knowledge as being hard to articulate with formal language. It is personal knowledge embedded in individual experience and involves intangible factors such as personal belief, perspectives, and values. Gammelgaard & Ritter (2005) argue that the transfer of knowledge is, however, not an easy process. Barriers to knowledge transfer can be roughly categorized into three categories: fragmentation, overload and de-contextualization.

3.1.3. STEP -3: KNOWLEDGE CONSTRUCTION & ORGANISATIONAL MEMORY

In order to construct an organisational memory we need first to understand the roles it plays. According to Walsh & Ungson (1991) a consideration of organisational memory reveals that it plays three important roles within the organisation. First, it plays an informational role; the information content that is housed in memory's retention facilities can contribute to efficient and effective decision making. Second, organisational memory fulfils a control function; it can reduce the transaction costs that are often associated with the implementation of a new decision. Third, organisational memory can play a political role. Walsh & Ungson (1991) suggest five storage bins for retention facilities; individuals, culture, structure, transformation & ecology.

McManus, Wilson & Snyder (2003) argue that the knowledge must be arranged in an organised coherent or systematic form, and that the determination of how to properly package the knowledge so that it can be available when and where needed based on necessity.

Future knowledge in the form of data and information can be stored in a variety of ways with access for all employees. It is also transferred in various ways such as e-mail, groupware, Internet, intranet, and videoconferencing. In this sense, information technology should be seen as a necessary tool, but

technology and its use is not of itself knowledge management or indeed knowledge transfer. (Bender & Fish , 2000)

3.1.4. STEP -4: KNOWLEDGE RETRIEVAL

Walsh & Ungson 1991 :

- What kind of events or circumstances trigger the controlled search for information from memory?

  - How do various organisational attributes moderate the response to such triggering stimuli?

At the organisational level, one example of automatic retrieval occurs when present behaviours are based on previous practices and procedures that have been shared and encoded in transformations, role structure, culture, and workplace ecology. However, the misuses and abuses of memory can occur as a result of automatic retrieval processes of which the individual may not be as conscious. (Walsh & Ungson, 1991).

Gammelgaard & Ritter (2005) argues that the retrieval consists of search and decoding processes. Search is the process by which retained information is selected as relevant to a particular problem or goal. Decoding is the reconstruction of the selected information to satisfy the user's request. It is,

therefore, useful to divide the retrieval process into two steps: the identification of knowledge, and the receivers' individual decodification of the accessed knowledge. The filtering of particular information from memory that supports a particular agenda can serve as a mean to enhance and sustain power (Walsh & Ungson, 1991). The KM system must incorporate the ability to adapt to new knowledge so that it can be refreshed. (McManus, Wilson, & Snyder, 2003) The four steps are shown in (figure-3.1) and summarized in table (table-3.1) which consist of list of requirement to be obtained at each step in order to achieve certain level of knowledge retention.

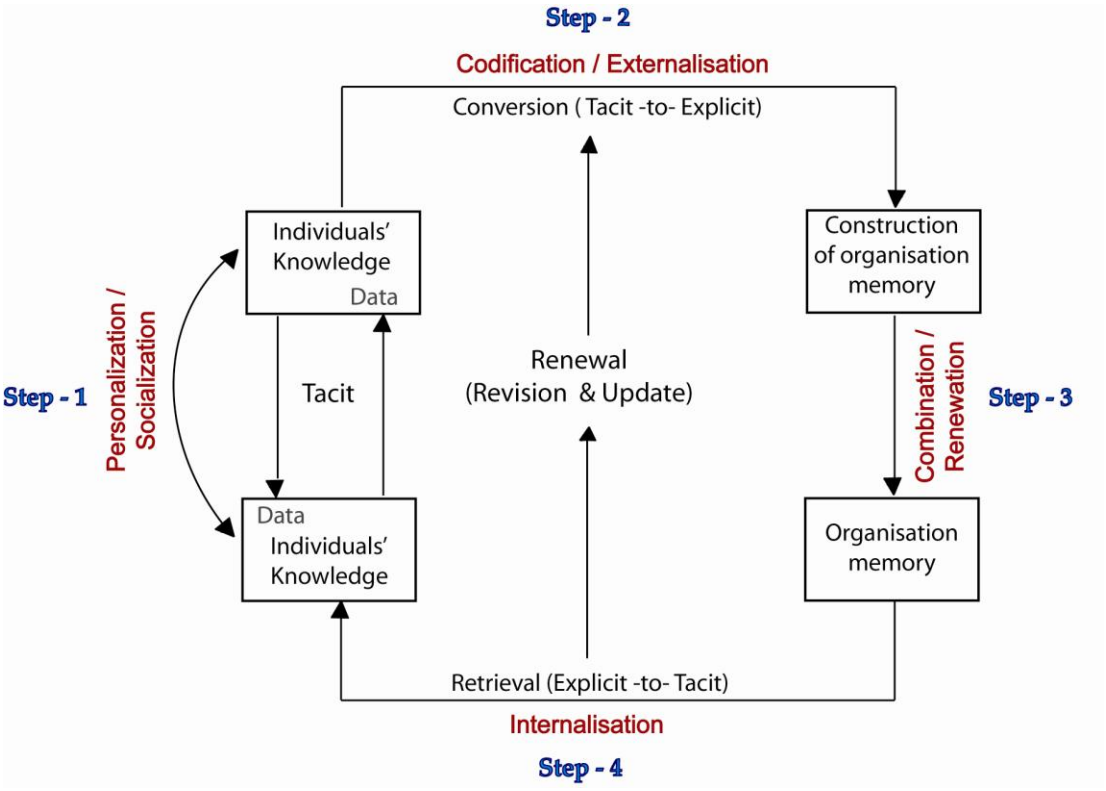

Figure - 3.1: Model of Knowledge Retention Process

On this basis four levels has been identified :

Level-1: The knowledge is shared amongst the organisation employee.

Level-2: The shared knowledge is documented (transferred from tacit to explicit)- How useful is the type of knowledge documented.

Level-3: The documented knowledge is stored.

Level-4: The stored knowledge is accessible, can be retrieved and used easily.

All the requirements, which are listed in the table, will be checked in each organisation. The data will be collected using, surveys, interviews and observations.

Table 3.1 Knowledge retention requirements

Requirements		Level- 1 Shared at Individual level	Level-2 Codified/ Documented	Level-3 Stored/ retained	Level-4 Retrieved/ Used
Face-to-face communication meetings (formal & informal)	Nonaka & Newell et al.	How often meetings are held?	Are they minuted?	Are they stored? If yes, where?	Are they accessible? Is it retrievable?
Sharing thinking process: brain storming session	Nonaka (1994)	How are problem solved?(individually/ collectively)	Are the problems and solutions recorded?	Is it stored? If yes, where?	Is it accessible? Is it retrievable?
lessons learnt (at the end of the project phases, or at the handing over ?		Is the project problems discussed at the end?	Are those lessons learnt documented?	Where is it stored?	Are people aware of its existence?
Job rotation (between different branches in different cities and countries)	Bender & Fish (2000)	Does the org. support job rotation system?	N/A	N/A	N/A
Renewing Knowledge	Bender & Fish (2000)	Is the retrieved knowledge discussed before using?	Are the feedback / new knowledge documented?	Is the stored knowledge updated?	Is the updated knowledge accessible?
Self organised teams	Nonaka (1994)	Do they exist? Is trust among employees Built?	Is the created knowledge and ideas documented?	Is it stored? If yes, where and how?	Is it accessible? Do people know how to retrieve it?
Training & Coaching system		Are trainings held regularly?	Are the trainings / new knowledge documented?	Are they stored? If yes, where and how?	Is the training manual accessible for all employees?
Competition and award system		Is there is any award for knowledge sharing?	Is there is any award for documenting knowledge?	Is there a system allows people to store documents?	Is it accessible? Is it retrievable?

3.2. DATA COLLECTION METHODOLOGY

3.2.1. SURVEY/ QUESTIONNAIRES

Owing to the fact that the subject of KM, especially the investigation of success factors is a relatively new area, a questionnaire-based survey would allow the exploration of a significant number of issues (Chong,C.S, 2006)

The surveys will be conducted by completing the questionnaire (see Appendix-A). In order to guarantee full responses to the questions, closed questions types will be used. All question will have several choices for the respondent to select. The questionnaires will be distributed randomly to 40 employees in each company. The sample will included people from all specialists (engineers, CAD people, secretaries, accountants...). The questionnaire consist of 11 main questions, in addition to 10 sub questions:

1. **Does your company encourage face-to-face communication?** This question is designed to measure companies' support for sharing knowledge at individual level and to check whether employees are involved in knowledge sharing process. The answer to this question will be "Yes" or "No". The results of this question will be used to fill the first requirement in the table of requirement (Table 3.1) for each organisation.

a) **How often do you attend meetings?** The aim of this question is to obtain data about the frequency of the meetings. The answer should be selected from already given multiple choices (more than once a week, once a week, once a month or rarely/occasionally). The frequency of the meetings will indicate the support of the face-to-face communication by the company.

b) **What are the types of those meetings?** Knowing the types of the meetings can be useful in terms of determining the causality of the relationship in the company. In addition to , the variety in the answers will indicate whether the company has certain system or not.

c) **Are they minuted?** This question indicates whether the shared knowledge between individual through all types of meeting is documented or not. This will help in identifying whether the organisation meet the requirement at the third level (codification / documentation)

2. **In case of problems facing the company in running any project, are you involved in solving them?** This question is used to measure individuals' involvement in solving problems and the sharing of knowledge process amongst individuals.

a) **How are the problems solved?** The used methods for problem solving such as, brainstorming sessions, management decisions and correspondence. The more brainstorming session are used the more people are involved in sharing thinking process. This question will be used to fill the second requirement in the table.

b) **Are the problems, the solution, and the procedures documented?** The purpose of this question is to know whether the company has any sort of documentation system for problems and their solutions. The answers to this question are either "Yes" or "No" and by calculating the survey result we can fill the second level (codification / documentation) of the second requirement (sharing thinking process) in the table (Table 3.1).

3. **How do you classify the communication and knowledge sharing within the same department and between different departments in your company?** This question aims to obtain employees' classification / evaluation of the knowledge sharing in their organisations.

4. **Does the company support or encourage teamwork?** This question indicates the organisations' support and awareness of the importance of teamwork. This question will be used to get data about the existence of self organising team.

5. **Does your company support or encourage knowledge sharing?** This question indicates the organisations' support and awareness of knowledge sharing. This question will give supportive data to the three requirements, the sharing thinking process, face-to-face communication and self organised team.

6. **Is there any type of awards for people who contribute to the knowledge sharing or documentation in the company?** The aim of this question is to check whether the company has any mean of award or encouragement for knowledge sharing. The answers are “Yes “or “No” and this question will give data to fill the last requirement in the table of requirement.

7. **Is there any accessible body of knowledge in the company?** This question is to check the availability of the documented knowledge in the organisations. The negative answers in the companies, which already have an accessible body of knowledge, indicate that the people are not aware of the existing of such systems.

8. **Are you clear about the type of knowledge you are sharing with others?** The purpose of this question is measuring employees' awareness of importance of knowledge sharing.

9. **How many people do you think you have shared your knowledge with?** This question is to measure how widely the employees are communicating their knowledge in the organisation.

10. **Is there any system in the organization for documenting and sharing information?** This question is to check whether the organisation has an *"organisation memory"*. The following sub-questions a, b, c, d & e give data about employees' evaluation of the efficiency of existing system in documenting, searching and retrieving knowledge and give as well data which will be used to fill the level 3 & 4 in the table of requirement**:**

    a) **What is it?** This question to check how the knowledge is being stored, and where it can be found (server, database, intranet, hardcopies…)

    b) **How often do you use it?** This question was top check the regularity of the systems' usage.

    c) **Do you find what you are looking for?** The purpose of this question is to measure how useful is the documented knowledge, and if it is meet the employees and the job requirements.

d) **Is it user friendly?** This question is to measure how people are familiar with the system and to what extend the system is user friendly.

e) **When new information or area of knowledge added to the system, are you informed?** This question is to measure employees' involvement in the documented knowledge and the updating of this knowledge.

11. **Please rate your level of satisfaction with knowledge retention (knowledge sharing/ documentation/ storage/retrieval) in your company**. The last question is to collect data about employees overall satisfaction with the knowledge retention in their organisations.

The data obtained from the questionnaire will be used for conducting the surveys/statistic which will be analysed in detail in chapter-4.

3.2.2. INTERVIEWS

Semi-structured interviews will be conducted using a list of open question (See Appendix-B & C). Fellows & Liu (2003) argues that semi-structured interviews fill the spectrum between the structured and the unstructured extremes. The purpose of doing the interviews is to get a wider picture and more detailed information about the knowledge sharing process and

practices. Moreover, it allows for non-verbal communication or body language which has an impact on the responses. Three people will be interviewed in each company, one of them is the regional manager, and two other employees. The interviews will take place in the office of each interviewee. There will be no time limitation, the interviewees will be able to explain and talk about their company system with no limitation. The planned questions do not have to be in specific order, flexibility will be given to people to talk without much restriction of rigid question or check lists. This flexibility will give the chance to people to explain in detail the system they have in their companies, in addition to, real demonstration of those systems. (IT, presentations….) Each interview was done in one sitting.

The first person who will be interviewed in each company is the general manager who has explained the systems they had and has shown examples of the documented knowledge. The aim of those interviews is to get an overall idea about the system in the whole organisation, the current practices and the systems under developing. In addition to, giving supportive data to the surveys through real observation during the meetings and through two way discussions. Each interview will take around one hour, in which answers to the following questions were obtained:

1. **Can you please give me a brief about your organization?** The aim of this question is to get a description of the organization, its fields, etc...

2. **What is the number of employees? In UAE? Worldwide?** This question as designed to get an idea about the organisation size.

3. **Would you mind if I mention the name of the organization in my study? Or you prefer to keep it private?** This question was just to obtain permission for doing the case studies in each organisation and for mentioning the names.

4. **Can you give me a brief about the existing system of knowledge management in the company?**

5. **What types of knowledge you can find in the system? (Technical, meeting, lessons learnt)**

6. **System characteristics:**

   a. ability to retrieve knowledge
   b. type of knowledge documented
   c. awareness of what is really documented
   d. usefulness of the information documented
   e. time consuming (documenting & searching)
   f. Accessibility

The aim of those three questions (4, 5 & 6) is to get a general idea about the existing knowledge management system and the general practices to retain knowledge in each organisation. In addition to, getting a chance to observe those system and get an idea about the managers' satisfaction of the existing system(s).

7. **How do you deal with the problem of loosing knowledge of people who leaves the company (retirement, resignation)? Does the existing system support the retention of employee's knowledge?** This question was designed to collect data about existing practices to deal with knowledge retention.

8. **Are you satisfied with it?** The question aim to measure managers' satisfaction with the existing knowledge retention system (if any).

9. **How often the employees get trainings? Is there is any place where the company training manuals are stored?** The questions here are desgined to check the frequency of the training systems and the availability of the training manuals and document for all the employees in the organisation.

10. **At what level do you classify knowledge sharing in your organisation?**

a) Individual level (shared)
b) Documented.
c) Stored.
d) Retrievable.

This question is designed to obtain the general manger opinion of the existing system and the evaluation of this system (at which level of knowledge retention is the organisation).

11. **Is there any job rotation system, to support knowledge sharing among the branches in different countries and different cities?** The aim of this question is to check how far does the company support and apply the job rotation system .

Two more employees will be interviewed in each organisation; each interview should take between 30-60 minutes. The answers to the questions (Appendix-C) will be obtained through a two-way conversation rather than asking and answering certain question. The question of those interviews are more or less similar to the ones of the survey, however, the difference is only that you can get more information and elaboration through two way discussion rather than asking question with multiple choices answers. The answers will be used as supportive data to the surveys to describe the case studies and to fill the lit in table of requirement.

1. **Does your company or encourage face-to-face communication with other employees? How?**

2. **Can you give me a brief about the existing system of knowledge management in the company?**

3. **What types of knowledge you can find in the system? (Technical, meeting, lessons learnt)** The answer to the question indicates how useful is the system and if people are really aware of what is there on the system and if they can find the knowledge they need.

4. **System characteristics:**

   a. ability to retrieve knowledge
   b. type of knowledge documented
   c. awareness of what is really documented
   d. usefulness of the information documented
   e. time consuming (documenting & searching)
   f. accessibility

5. **In your opinion, and according to your experience with the system, Does it need to be improved and if so, how?** The aim of this question is to obtain some recommendation from the employees who are considered the end users of the existing systems.

6. **Is the existing system support the retention of employee's knowledge? If yes, How? If no, why not?** This question is to check

whether there is any knowledge retention system and to measure employees' awareness of the knowledge retention system.

7. **How often do you get trainings? Is there any place where the company training manuals are stored?** This question is to check whether the employees get regular trainings and whether they have access to the information from the trainings which they have or have not participated in.

8. **Is there any award system for people who contribute to the documentation of knowledge?** This question is to measure the supportiveness and the awareness of the organisation of knowledge retention importance.

9. **Are the previous project lesson learnt documented? Are they stored?** The answer to this question gives an idea about the documentation of one of the important area of knowledge which is the past experience (lessons Learnt).

10. **At what level do you classify knowledge sharing in your organisation?**

    a. Individual level (shared)
    b. Documented.

c. Stored.
d. Retrievable.

3.2.3. OBSERVATIONS

The main objective of this method is to give a real time assessment, and to get a clear idea about the practices and the existing system in each company. The observation will be done during the visits; a demonstration to the IT system was done by the interviewed people. In addition to demonstration of some of the documents and the presentations which were done by the employees. The observation will be used in the data analysis as supportive data for the explanation of each case study in chapter-4.

3.3. DATA ANALYSIS METHODOLOGY

The data collected from the surveys will be analysed, first by using chi square method, in order to check whether there is significance difference between the results obtained from the organisations or not. The P value will be calculated and the chi square test will be done at 95% confidence, which means if the p value is less than 0.05 there will be a significance difference between the result of the three companies. Secondly, the survey results and percentages will be compared amongst the three companies. Based on the data obtained from the surveys, the interviews and the real observation the model (table 3.1) will be

filled and used to evaluate the level of knowledge retention status in each organisation. If the answer is no / doesn't exist it means that there is a gap that needs to be filled, either in the system itself or in applying the system. The results will be presented in the format shown in table (3.1) where the grey cells are where the requirements are met and the blank cells where the gaps exists.

Requirements		**Level- 1**	**Level- 2**	**Level- 3**	**Level- 4**
Face-to-face communication meetings (formal / informal)	Nonaka				
Sharing thinking process: brain storming session	Nonaka				
L.L (at the end of project phases, or at handing over ?					
Job rotation (between different branches)	Bender & Fish		N/A	N/A	N/A
Renewing Knowledge	Bender & Fish				
Self organised team	Nonaka				
Training & Coaching system					
Competition and award system					

Table- 3.2 an example of applying the finding into the table of requirement.

The knowledge retention process as suggested in the model will only function if the organisations' knowledge is managed and achieved at the four levels.

The next chapter the data obtained will be analysed. The analysis will be first based on the survey result (questionnaires); a chi square test will be performed at 95% confidence. The mean will not be calculated because the data is not continuous, and thus the chi square will be used only to determine whether there is a significance difference or not. Secondly, the interviews and the real observations will be used as supportive data to the survey result. Then, the model will be used to determine at which level each organisation is.

CHAPTER -4-

DATA ANALYSIS

4.0. INTRODUCTION:

In the previous chapter, a model was developed to identify the steps required in a knowledge retention process. In addition to, a table for list of requirements for applying and measuring the status of knowledge retention in organisation has been identified. By using the model, the table and the three data collection methodologies which have been described in the previous chapter, the data will be collected and analysed in this chapter. Three case studies were done for three engineering consultancies companies. The aim of those case studies is to evaluate the knowledge retention status in each company, to define the gaps and the best practices that exist in each system. The data was collected through visits to the companies, observations, interviews and survey questionnaires as described in details in chapter-3. In each organisation, a sample of 29 employees which were randomly selected from all specialists have participated in the surveys. In addition, three interviews were done, one with a manager in each company and two with other members of the staff. The results will be used finally to fill the table of requirement which has been defined in the previous chapter and thus, define

the status of knowledge retention in each organisation. Therefore, the recommendations can be listed accordingly case by case.

4.1. SURVEYS DATA ANALYSIS

The surveys described in chapter-3- (Appendix-A) were distributed among 120 employees in the three companies. A total of 87 responses were obtained, 29 responses from each company. All the surveys were distributed randomly in all departments (engineering, administration, IT,...) with neither supervision nor time limitation. The results of the surveys were used to conduct a comparison between the knowledge retention statuses in the three companies. The analysis of data was done at 95% confidence and a chi square test was performed for all the questions (See appendix-D). The mean was not calculated because the data is not continuous, and thus the chi square was used only to determine whether there is a significance difference or not.

Face-to-face communication: The first question was to check whether the company encourages face-to-face communication; table 4.1 shows a summary of the collected data. The p-value was 0.0028 (less than 0.05) which means that there is significance difference. The three companies appear to encourage the face-to-face communication, however; in Atkins all the answers were "Yes" while there were 8 employees in Halcrow (28%) and 2 employees in Hyder (7%) who believes that their company does not encourage the communication.

Q1- Does your company encourage face-to-face communication?		
	Yes	**No**
Hyder	93%	7%
Halcrow	72%	28%
Atkins	100%	0%

Table 4.1 Data summary of question-1

Questions 1.a, 1.b & 1.c were about meetings: how often, what are the types and whether they are minuted or not. Tables 4.1.a, 4.1.b & 4.1.c summarize the data of responses to those questions. Chi square tests were performed and p-value was calculated. Question 1.a has given a p-value of 0.1087 greater than 0.05, which means that there is no significance difference. While the p-values of the result of questions 1.b & 1.c were 0.0006 & 0.0008; both are less than 0.05, which means that there is significance difference. Although the chi square test has given no significance difference for question 1.a., we can still notice differences in the findings. In Atkins a total of 65% were given to the answers "more than once a week" and" once a week" while 35% was given to the other two answers "once a month" and "rarely". However, in Halcrow 57% of the people are rarely attending meetings. In Hyder almost equal percentages were given to all answers of question 1.a. The frequency in the meeting and the existence of informal meeting indicates that the three organisations do encourage face-to-face communication.

Q-1.a. How often do you attend meetings?				
	More than once a week	Once a week	Once a month	Rarely/ Occasionally
Hyder	22.2%	33.3%	14.8%	29.6%
Halcrow	23.8%	9.5%	9.5%	57.1%
Atkins	31.0%	34.5%	17.2%	17.2%

Table 4.1.a Data summary of question-1.a

Question Q1.b is used to get an idea about the most common type of meetings in each company; the total of all the answers does not give 100% because the answer can be more than one selection. In the three companies a mixture of all the choices were selected, and there was no specific indicator to the most common type of meeting used in each company. The responses to this question generally have shown inconsistency in the same company, which indicates that there is no company-wide policy.

Q-1.b. What are the types of those meetings?				
	Formal	Informal	Scheduled	Unscheduled
Hyder	37.0%	55.6%	66.7%	14.8%
Halcrow	33.3%	42.9%	9.5%	76.2%
Atkins	31.0%	51.7%	72.4%	34.5%

Table 4.1.b Data summary of question-1.b

The results of question 1.c. have indicated that in the three companies only formal meetings are being minuted and documented. Moreover, around 30%

of the people in the three companies attend formal meeting. Therefore, we can conclude that probably only 30% of the meetings are documented.

Q-1.c. Are they minuted?				
	Always	**Often**	**Only formal ones**	**Not at all**
Hyder	14.8%	3.7%	63.0%	18.5%
Halcrow	9.5%	9.5%	28.6%	57.1%
Atkins	6.9%	27.6%	58.6%	6.9%

Table 4.1.c Data summary of question-1.c

Sharing thinking process / brainstorming sessions: a chi square test was performed for questions 2, 2.a & 2.b, p-value was calculated, and the results were 0.644, 0.2006 & 0.3945. All the p-values are greater than 0.05, which means that there is no significance difference. However, the results show that in the three companies the majority of the respondents (60%) or more were involved in problem solving.

Q-2 In case of problems facing the company in running any project, are you involved in solving them?		
Q2	**Yes**	**No**
Hyder	59%	41%
Halcrow	59%	41%
Atkins	69%	31%

Table 4.2 Data summary of question-2

Tables 4.2, 4.2.a & 4.2.b summarize the data obtained from questions 2, 2.a & 2.b. The purpose of question 2.a is to identify the most common used methods

for problem solving. The results has shown that the highest percentage in Halcrow (76%) was given to management decision, whereas the highest percentages in Hyder (59%) and Atkins (55%) were given to brainstorming sessions. This results indicate that people are involved in sharing thinking process in Hyder and Atkins more than Halcrow. The sum of the results for each company here does not equal 100% because the question allows for selecting more than one answer.

Q-2.a How are the problem solved?			
	Brainstorming session	**Correspondence**	**Management decisions**
Hyder	59%	47%	41%
Halcrow	35%	29%	76%
Atkins	55%	35%	40%

Table 4.2.a Data summary of question-2.a

Although the chi square test has given no significance difference between the three companies, the data shows that in the three companies high percentage of positive responses were given for the documentation of the problem solving procedures. Based on this data we can make an assumption that the three companies have certain level of awareness about the need of documenting knowledge and that employees are aware of the existence of such documents.

Q-2.b Are the problems, solutions and the procedures documented?		
	Yes	**No**
Hyder	65%	35%
Halcrow	82%	18%
Atkins	80%	20%

Table 4.2.b Data summary of question-2.b

People's evaluation of knowledge sharing in the company: the third question was used to evaluate the status of knowledge sharing based on employees' opinion. A chi square test was performed. The p value was calculated and found 0.0236 (less than 0.05) which means there is significance difference between the three companies. The highest percentages of people in Hyder (72%) and in Atkins(52%) have rated the knowledge sharing as "good", while in Halcrow the highest percentage (41%) have rated the knowledge sharing as "average".

3. How do you classify knowledge sharing in your company?				
Q3	**Poor**	**Average**	**Good**	**Excellent**
Hyder	0%	24%	72%	3%
Halcrow	17%	41%	38%	3%
Atkins	3%	31%	52%	14%

Table 4.3 Data summary of question-3

Organisations' support for teamwork and knowledge sharing: the fourth and fifth questions were designed to evaluate the level of the three

organisations' support for teamwork and knowledge sharing. The chi square test for those two questions shows no significance difference. Tables 4.4 summarize the obtained data for the fourth, which shows positive answers from most of the people in Halcrow (93%), and all the people from Atkins & Hyder (100% for each).

4. Does your company support or encourage teamwork?		
	Yes	**No**
Hyder	100%	0%
Halcrow	93%	7%
Atkins	100%	0%

Table 4.4 Data summary of question-4

Whereas Tables 4.5 summarize the obtained data for the fifth question, which shows positive answers from the majority in Halcrow (90%), Hyder (97%) and all the people from Atkins (100%). The results of both Q4 & Q5 indicates that the three companies strongly support teamwork and knowledge sharing as they are aware of the importance of knowledge sharing.

5. Does your company support or encourage knowledge sharing?		
	Yes	**No**
Hyder	97%	3%
Halcrow	90%	10%
Atkins	100%	0%

Table 4.5 Data summary of question-5

Competition & award system: the sixth question was to check whether the company has any kind of award system for people who contribute to knowledge management. The p-value was calculated and found 0.00, less than 0.05, which means there is significance difference. Atkins was found as the only company which has award system, the majority of the responses (71%) were positive only in Atkins consultant while the majority were negative in both Hyder (69%) and in Halcrow (93%).

6. Is there any type of awards for people who contribute to the knowledge sharing or documentation in the company?		
	Yes	**No**
Hyder	31%	69%
Halcrow	7%	93%
Atkins	71%	32%

Table 4.6 Data summary of question-6

Question 7 was to check whether there is any body of knowledge stored somewhere in the system of the company. The P value was calculated and gave a result of 0.0365 greater than 0.05 which means that there is a significance difference. In Hyder and Atkins the majority gave poitive answers 76% (for Hyder) and 83% (for Atkin). While in Halcrow 55% gave negative answers. The result to this question does not necessarily mean that

there is or there is no body of knowledge. It might indicate as well people's awareness of the existence of the documented knowledge.

7. Is there any accessible body of knowledge in the company?		
	Yes	**No**
Hyder	76%	24%
Halcrow	45%	55%
Atkins	83%	38%

Table 4.7 Data summary of question-7

IT system in the organisation: the question 10, 10.a, 10.b, 10.c, 10.d & 10.e were about the existing knowledge documenting systems in the three organisations, how often they are used, and whether they are useful and user friendly or not. A chi square test was performed and p-value was calculated. Only p-value of questions 10 & 10.d was less than 0.05, which means that there is significance difference, while responses to questions 10.a, 10.b, &10.c does not give significance difference. The responses to the six questions are summarized in tables 4.10, 4.10a, 4.10b, 4.10c, 4.10d & 4.10e. The question no. 10 was to check whether each organisation has a knowledge sharing/documenting system or not. In Hyder consultant 100% of the responses were positive while only 66% in Halcrow and 79% in Atkins were positive.

10. Is there any system in the organisation for documenting and sharing information?		
	Yes	**No**
Hyder	100%	0%
Halcrow	66%	34%
Atkins	79%	21%

Table 4.10 Data summary of question-10

The question 10a was to check what are the available system(s) in each company; the data shows that in the three companies hardcopies, softcopies (on servers), databases & intranet are used. This means that there is no one system applied all over the company which indicates that the knowledge is probably fragmented**.**

10.a. What is it (the system)?				
	Hardcopies	**Softcopies on the server**	**Database**	**Intranet**
Hyder	41%	79%	52%	72%
Halcrow	53%	58%	37%	32%
Atkins	57%	91%	43%	52%

Table 4.10a Data summary of question-10a

The majority of responses to question 10.b (Hyder 52%, Halcrow 63% & Atkins 61%) were for the daily use answer, which indicates that the existing systems are essential tools for day-to –day use.

10.b. How often do you use it?			
	Daily	**Weekly**	**Rarely**
Hyder	52%	24%	24%
Halcrow	63%	5%	32%
Atkins	61%	13%	26%

Table 4.10b Data summary of question-10b

The question 10.c was to measure the efficiency of the existing system in terms of finding the required data/information. Most of the employees in the three companies answered by either "yes" or "often". This means that the knowledge is organised in the three companies where people can find what they are looking for.

10c. Do you find what you are looking for?				
	Yes	**Often**	**rarely**	**Not at all**
Hyder	10%	86%	3%	0%
Halcrow	42%	47%	11%	0%
Atkins	26%	70%	4%	0%

Table 4.10c Data summary of question-10c

The system friendliness was measured by the responses to the question 10.d. The p-value of the responses to this question was calculated and found 0.0246 (less than 0.05) which means there is significance difference. All the people (100%) in Halcrow had positive response, while in Hyder there was 69% positive responses and 83% in Atkins.

10d. Is it user friendly?		
	Yes	**No**
Hyder	69%	31%
Halcrow	100%	0%
Atkins	83%	17%

Table 4.10d Data summary of question-10d

The question10.e was to check whether the additional/new knowledge is being communicated through the organisations' staff. Majority of responses in Halcrow(74%) and in Atkins (78%) were positive, while in Hyder only around half of the responses (52%) were positive.

10e. When new knowledge added, are you informed?		
	Yes	**No**
Hyder	52%	48%
Halcrow	74%	26%
Atkins	78%	22%

Table 4.10e Data summary of question-10e

The last question was used to evaluate employees' satisfaction about the existing system. A chi square was performed and p-value was calculated and found 0.0143 (less than 0.05) which means there is significance difference. In Hyder consultant most of the employees (62%) were satisfied with the system, few of them (7%) were very satisfied and 31% were neither satisfied nor

dissatisfied , while none of them were dissatisfied . However, in Halcrow the majority (59%) were satisfied , while the rest were divided between very dissatisfied, dissatisfied, neutral and very satisfied . In Atkins, none of the employees were very dissatisfied, few of them (11%) were dissatisfied, while the rest were distributed between neutral, satisfied and dissatisfied.

11. Rate your satisfaction.					
	Very dissatisfied	**Dissatisfied**	**Neutral**	**Satisfied**	**Very Satisfied**
Hyder	0%	0%	31%	62%	7%
Halcrow	7%	7%	17%	59%	10%
Atkins	0%	11%	21%	32%	36%

Table 4.11 Data summary of question-11

4.2. CASE STUDIES:

4.2.1. CASE STUDY- 1 (HYDER CONSULTING)

Organisation profile: Hyder Consulting is an engineering consultant and project managers. It provides consultancy and project management services in the fields of: transport, highways, building, land development, telecommunications, health and education.

It has around 4000 employees worldwide, 1050 of them are based in Middle East and 450 are UAE based. A study was done to find the answers to the

questions of the knowledge requirement in order to assess the knowledge retention level.

Based on the model described in chapter-3-, the observations, the surveys and interviews during the visit to the organisation, the existing status of knowledge retention in Hyder consulting was evaluated.

During the interviews it has been noticed that the organisation does encourage the communication through all types of meetings; formal, informal, within the same department and between managers from different departments. However, only formal meetings are minuted. The surveys has given supportive data to the observation, 93% of the people said that their organisation support the face-to-face communication, almost equal percentages were given to all types of meeting, and 63% of the answers were that only formal meetings are minuted. In addition to, that all the people who attend only informal meetings have chosen the answer "not at all" for the question of minuting the meetings.

Although the survey has given a result of 100% for encouraging the teamwork in the organisation, there are no special activities for knowledge sharing rather than the regular interdepartmental meetings and the meetings between different departments.

The organisation appears to depend mainly on the management and senior staff for solving problems. The result of the survey of a sample of 29 employees has shown that 59% of them were involved in solving the problems while 41% were not involved and were mainly the junior staff and the new joiners. The survey has shown as well that the problems are solved through brainstorming sessions, management decision and correspondence. In addition, a result of 65% was given for documentation of the problems' solving procedures.

The system of the organisation includes documentation of best practices and monthly reports about the projects, however; it is not searchable by topic (i.e. people cannot search for example for all lesson learnt of hotels' projects).

The existing knowledge in the system is regularly updated under the supervision of the knowledge manager. However, there is not much evidence whether the employees give their feedback on the knowledge obtained from the system for improvement and renewal of knowledge.

The organisation management is aware of the importance of job rotation in enhancing knowledge sharing, however; the job rotation system is not applied except in case of demand of certain experience or certain amount of resources in one region. In such cases, resources are allocated for 3 or 6 months period then they go back to their main offices.

During the interviews, it has been confirmed that each employee receives one training per year. In addition to the available e-learning which is supported by a subscription with Harvard university. The employees can finish some modules through online learning. In addition, trainings are being conducted twice a month in each office on the intranet usage; however, the survey has shown that 31% of the sample cannot easily access and use the organisation's intranet system.

Around 70% of the surveys and all the interviewed people stated that there are no systems of awards for encouraging the knowledge sharing and retention.

Description of the existing knowledge sharing IT systems:

Hyder consultant has employed a knowledge manager based in UK, whose job is to think about sharing and structuring knowledge. In addition, a knowledge champion in each region. The IT system of knowledge sharing in Hyder consulting consists of two main sections.

The first one is the company's server, which is shared between all employees in the emirates. It has all the information about all the projects filed by code and in similar way to allow for easy retrieval.

The second one is the intranet based system of knowledge management which is done by using a Microsoft 'SharePoint' platform. The system is called "Hybis.info", and its main purpose is to achieve global communication and knowledge management. In addition, establishing a one-way system in all the company's offices. It consist of nine main sections:

1. **Sys**: this includes several areas of knowledge:

   - Global system: information about global company system and regional information about best practices, bidding procedures, commercial procedures, general management, project management and organisation structure.

   - Professional: consist of information about human resources, management of working capital, skills expected from staff and marketing plan.

   - Feedback: there are two main sections under the feedback OPALs (Operation Problem Action List) and SIRs (System Improvement Request). The OPALs are defined as anything which is worth capturing and keeps employees away from working professional inside and outside the office. All employees can load an OPAL and then meeting are held every

three months to review and approve OPALs and publish them. Whereas, the SIRs are used for requests for solution for problems and suggestion to improve oneway.sys. The only weak point in the feedback that people can not search by topic.

2. **Library:** it contains international standards and the applicable standards for each region. It is empowered by search engine to search for the area of interest (i.e. a search for health and safety in UAE region gives results such as the civil defence regulations)

3. **News:** News about Hyder's regional and global magazines are published in this section. In addition, announcement about any new area of knowledge added to the Hybis.

4. **People:** This section is accessible to all employees contains employees' CVs Database, internal vacancies, skills matrix and e-learning. The skills' matrix is a very useful tool for manager to locate the skilled people in certain fields. It shows how many people have skills in certain area, what is the level of their skills and in which region they are based. E-learning is supported by a subscription in Harvard, the employees can finish some modules using online learning. In addition to the training they can find about computer softwares.

5. **Commerce:** It contains some commercial data with limited access.

6. **Keys:** This section contains some confidential information about finance, clients and forecast margins. It has restricted access, since it contains private information.

7. **Tools:** consists of employees' personal profile where they can view the status of their leaves and fill their weekly timesheets and their reports. In addition to, projects review; a report done on monthly basis for each project and includes financial, contractual and health and safety.

8. **Guides:** This section provides guidance to employees in writing their CVs, Database management system, salary modelling, e-mails and opportunity tracking system (i.e. loosing the bid for same client several times)**.**

9. **Files:** in the file section the softcopies and projects information can be found. The usage of this section in Middle East region offices is limited due to the slow network.

The access to the system is being during induction phase (rephrase), each employee complete a form which consists of their requirement according to

their field and their interests. The forms go to the line managers who will decide the required permissions of the access to the Hybis.

Generally, the company is aware about the importance of knowledge management, however; high percentage of the employees are not aware and not participating in the knowledge sharing system implementation. As stated during the interviews only 50 -60% of people are aware of SharePoint. Moreover; the surveys has given as well a percentage of 24% for people who said that there is no accessible body of knowledge in the company, which indicates that not all the employees are aware of the existing knowledge sharing system.

The main threats of the system are the flow of information and the time consumed in both update and search for information. Currently, there are studies going to combine the information and in the several systems in order to avoid both the overflow of information and wasting time. The knowledge retention status was evaluated by the employees as between level three and four (knowledge is stored but not completely retrievable).

4.2.2. CASE STUDY- 2 (HALCROW INTERNATIONAL)

Organisation profile: A multi discipline consultancies specializing in planning, design and management services for infrastructure development. In

addition to, several key sectors such as the property business, the structural engineering work, water services and transportation. Halcrow employs nearly 6000 people in more than 70 countries, 1200 of them are based in the Middle East region and 900 in UAE.

A study has been conducted in order to fill in the knowledge retention model developed in chapter-3.

knowledge retention in Halcrow was evaluated by using the model described in chapter-3-, the observations, the surveys and the interviews during the visit to the organisation.

It has been noticed that Halcrow does encourage the communication through all types of meetings; formal, informal, within the same department, between managers from different departments. However, only formal meetings are minuted. The survey has given 72% of the people said that their organisation support the face-to-face communication, with higher percentages for unscheduled and informal meetings which are mainly not minuted. In addition to, that all the people who attend informal meetings only have chosen the answer "not at all" for the question of minuting the meetings.

Building trust amongst teams within the organisation is a very important factor in allowing and encouraging teamwork and knowledge sharing. The

survey has given 93% result for encouraging the teamwork in the organisation. Although there are no special activities for knowledge sharing, Halcrow encourages social activities which enhance the relation and build trust amongst the teams.

The organisation appears to depend mainly on the management and senior staff for solving problems. The result of the survey of a sample of 29 employees has shown that 59% of them were involved in solving the problems while 41% were not involved. The survey has shown the highest percentage for problems being solved by management decision and low percentage to problems being solved through brainstorming sessions. In addition a result of 82% was obtained for documentation of the problem solving procedures.

The system of the organisation includes documentation of best practices, lesson learnt and technical knowledge, however; many people in the UAE region do not know about its existence. This is due to the time pressure and the fast track project in the region.

The existing knowledge is being updated mainly by the publishers in UK. In addition to that there is an opportunity for people to send their feedback to the publishers of the pages.

Job rotation is applied only when required for certain types of project specialist and expert can be transferred from one region to the other. However, job rotation is still associated with many difficulties such as the pressure of work in certain regions (i.e. Dubai & Abu Dhabi).

The average of technical trainings instance is around once a year for each employee. Moreover; the available e-learning on Halnet, that includes trainings on business skills and IT trainings on Microsoft applications.

All the interviewed people answers and 93% of the surveys stated that there are no systems of awards for encouraging the knowledge sharing and retention.

Description of the existing knowledge sharing IT systems:

Intranet system (Halnet), it consists of seven main sections:

1. **Notices and news**: This includes all the news and the updates on Halnet, business updates (i.e. operation reports), and electronic copy of Halcrow's publishes. There are two main publishes the first one is connection; Halcrow's internal magazine, and the second one is Zeigeist; Halcrow's client magazine.

2. **Our Clients**:

It consist of gifts and hospitality register and list and contacts of Halcrow's key clients, strategic Relation development and client contact system which includes the client's portfolio, add contacts, search for contacts, and relationship quality tracking reports. In addition to, frameworks such as NEECA: National Engineering Environmental Consultancy Agreement and SFRM: Strategic Flood Risk Management.

3. **Our organization:**

It consist of :business excellence, Halcrow's foundation, health & safety Business principles & business policies, organization Structure, vision & strategy and environmental management which contains the standard and the key performance indicators and awareness rising. Moreover; business groups which includes information about Halcrow's five business groups: consulting, maritime, property, transportation, and water & power. Under each business group, there is information about the business development, management, resources, skill groups, trainings, finance and operation.

4. **Business Development:** this section contains market sectors divided by business groups and bids & submissions which includes bidding support system and practices example.

5. **Knowledge:**

   • Communities: it consists of three main subject; dealing with contractors, Halnet publishers, managing physical asset.

   • Cross business guidance: this includes guidance on contract and procurement, dispute resolution, expert witness, legal agreements and private finance advice.

   • E-learning: consist of two sections: business skills which has e-learning modules, and IT skills which includes trainings on Microsoft applications.

   • Internal business knowledge: this includes e-reports (i.e. Halnet statistics), health and safety, proposal & CVs and reports.

   • Internal services: This includes Graphic design skill group page, and work system & CAD skill group page; it includes topics such as database design & administration, design control &

coordination, graphic modelling & design, GIS system development, knowledge management.

- Knowledge management: it includes knowledge sharing forum, Halnet website awards and a list of the benefit of knowledge management: such as better performance, reduced duplication of work, learning from own/ other mistakes, reduced dependence on key individuals, effective teamwork & partnering, superior capability, reduces time on problem solving, accelerated learning, creativity & innovation and reduced frustration/ increased job satisfaction.

- Library: This includes e-books and e-reports of many areas of technical knowledge, in addition to the international standard.

- Research and Development in Halcrow.

- Skill groups.

- Staff development programmes: project excellence and project management.

- Technology and innovation sub-committee.

6. **Business systems:**

- Commission management system: it is used for storing commission governance and provides comprehensive reporting to senior management.

- Corporate data change: it provides a change control process for key data items, which maintain consistency of corporate management reporting and guard against potential fraud.

- Halcrow's Facilities: provides information on facilities throughout the organisation, including office facilities.

- Legal agreements: this unit provides an advisory service to the Halcrow Group Worldwide.

- MIS, management information services: supports Halcrow group with all information, communication and process needed.

7. People:

This page has two main sections. The first section is the Indago page, which enables each individual to view and update their personal information including work experience, CVs, skills and contact information. In addition to searching and locating other employees by skill, by office location or by job title. The second

one is human resources: this includes vacancies and recruitment, people information, staff surveys, training, discussion and HR bid/ proposal information.

In addition to, Cordis: an additional section, which is being developed now, will be a single database of information about Halcrow's people and will enable Halcrow to meet its information and management requirements in the years ahead.

The knowledge retention status was evaluated by the employees as between level three and four (knowledge is stored but not completely retrievable).

4.2.3. CASE STUDY- 3 (ATKINS)

Organisation profile: Atkins is a multi-discipline architectural engineering consultant. It is the 4th largest in the world. It has around 300 disciplines in 200 different offices around the world; varying from design to heavy civil engineering management. The organisation has around 17000 employees worldwide, 2000 of them are based in Middle East and 1200 are UAE based. A third case study was done in Atkins consultant as part of this research.

An evaluation of knowledge retention status in Atkins was done based on the model described in chapter-3-, the observations, the surveys and the interviews during the visit to the organisation.

It has been realised through the meetings that Atkins does encourage the communication through all types of meetings and special activities such as architectural Fridays, Excellency awards & mentoring sessions. The survey has strongly supported this data; 100% of people said that their organisation support the face-to-face communication. It has also been said during the meeting that only formal meetings are minuted, this information was supported by 60% given to the answer of "only formal ones" through the surveys. For each project, a weekly meeting is being held and often minuted.

Atkins has some activities such as "Mentoring" which encourages teamwork and knowledge sharing between individuals (both senior and junior staff). The survey has given a supportive result of 100% for encouraging the teamwork in the organisation.

The organisation appears to involve the employees in problem solving. The result of the survey of a sample of 29 employees has shown that around 70% of them were involved in solving the problems. The survey has shown the highest percentage for problems being solved by brainstorming sessions. In addition, a result of 85% was given for documentation of the problems' solving procedures.

Documents are being prepared during and after each project and saved on the server. This includes information about the used technology. Although this

can be of great value, it needs to be updated prior to using because technology is often developed. The organisation management and employees are aware of the importance of updating knowledge prior to using it.

Atkins strongly supports the idea of job rotation and it is part of its policy, however; sometimes and due to the lack of resources the managers are reluctant to release their good employees and send them somewhere else.

Each person gets around three trainings per year, and he/she keeps the training booklets in a specific space where others can borrow them at any time. However, they are more like skills development than technical. In addition to, weekly seminars held by manufacturer for describing certain technology.

The company has some programmes for encouragement of knowledge sharing. "Rising Star Programmes" is a competition of innovative ideas, where all employees can participate with their own ideas, those ideas then have to be approved by management. Each candidate then prepares a poster explaining their ideas and the knowledge they have gathered about it and they have to present their posters. The topics can be either about some technical or environmental issues. The winner is awarded cash prizes. There are two of those programmes a Middle East one and a global one. The survey

has given supportive data, 71% was given to the answer "yes" for the existence of the awards system.

People are encouraged to share their knowledge and best ideas with others through:

- "Architectural Fridays": it is an activity for sharing knowledge between people in the architectural department, on each session an architect prepare and present a power point presentation, then the subject is discussed. This gives opportunity for people to present their ideas, share it, discuss it and get feedback from other employees.

- "Rising Star Programmes": it is a competition of innovative ideas, where all employees can participate with their own ideas, those ideas then have to be approved by management. Each candidate then prepares a poster explaining their ideas and the knowledge they have gathered about it and they have also to present their posters. The topics can be either about some technical or environmental issues. The winner is awarded by cash prizes. There are two of those programmes a Middle East one and a global one.

- "Mentoring": where junior and senior staff can meet to share knowledge and where senior staff can give the help and support to juniors in certain fields.

- Regular meetings at managerial level where knowledge is shared.

- Knowledge sharing sessions: it is being done once a month, the main purpose of it is to share the knowledge and lesson learnt. Once any job is done a presentation will be done and people will present the good and bad point and discuss those points with other employees. The power pint presentation will be then available on the server.

- During lunch breaks people are encouraged as well to share knowledge and discuss certain issues.

Description of the existing knowledge sharing IT systems:

The existing and used systems are databases, server and intranet. The intranet does not contain any technical knowledge yet, it consist of information like procedures and risk assessment tools and rarely used by employees. However; a project for developing SharePoint system is running since 3 years, around 30 people are working on preparing it.

A private room on the internet website for the organisation's employees to share knowledge.

The server contains:

- The files and library which is used to produce designs and drawings.
- Feedback reports from classified by project (name or code) not by project type.
- Technology review papers: the engineers document their research which they go through during designing any project. The documentation includes any new technology they have introduced during their research and design. This document becomes a very useful tool for others who will do similar project, however; they have to update it in order to be up to date with the new technology.
- Design solutions, specifications and the organisation's standards ways of solving problems.
- British Standards.
- Introduction booklets.
- Notes for unusual jobs.

- Training & knowledge related to sustainable design: how to make green design, which is part of the organisation's programme of sustainable environmental design.

The systems are accessible to all employees except some confidential data such as financial ones.

Hardcopies are available as well, such as books, which are stored in the library, and, training booklets. Each employee files the booklets, which he got from trainings, at certain place, where others can borrow them at any time.

The main threats, which are facing the system implementation, are firstly the time required for documentation, each paper takes a lot of time to be prepared. The second threat is the need of continuously updating the knowledge (i.e. in Dubai regulation changes very often, therefore the knowledge on the server has to be updated). In addition to that not many people know what is there in the system, however; it is easy to find if people know of it is existence.

The knowledge retention status was evaluated by the employees as between level two and three (knowledge is documented but not completely stored) and within one year it will be between level three and four.

4.3. ASSESSING LEVEL OF KNOWLEDGE RETENTION IN EACH ORGANISATION

In chapter-3 a table of requirement was used to measure the knowledge retention status in organisations (Table 3.1). It will be filled according to the data obtained from the surveys, interviews and real observations. The black fill indicates that the organisation meet the requirement listed in this cell (the answer is "yes"). The grey fill indicates that the organisation does not fully meet the requirement, whereas the blank cell indicates that this requirement has not been met at all. N/A indicates that the requirement is already not applicable at this level.

Hyder Consulting: Table 4.12 shows the knowledge retention list of requirement table filled with the findings in Hyder consulting. The first requirement which is the face-to-face communication was found at the forth level (retrieved); however still not 100% retrievable due to the overload of information, and the difficulties for some people to be familiar with using the intranet system. The second requirement (sharing thinking process) is still not completely met, not even at the first level. Some of the problems are solved through brainstorming session; however, there is no specific system which is implemented to encourage sharing thinking process and sharing ideas. The third requirement is the documentation of lesson learnt; Hyder has its system for regular reports about project and the documentation of those lessons

learnt. In addition to, the OPALs (already explained in the case study description). The L.L can be considered still at the third level because not all the people are aware of its existence, how to retrieve it, and some of them do not have access to it. The forth requirement (job rotation) is applied but only when it is required, not regularly and not as a company system. The fifth requirement (renewing knowledge) in Hyder consulting there is a knowledge manager whose job is to manage, update and control knowledge. Then the updated knowledge is loaded back to the system. The sixth requirement (constructing self-organised team), Hyder does encourage sharing knowledge ad face-to-face communication, however, there is no system for enhancing trust amongst employees and building self-organised teams. The seventh requirement (training and coaching system), regular training are being held and some of the trainings are available on the intranet system (Hybis). The last requirement is the competition and award system; there is no award system for knowledge sharing. We can conclude that the organisation is between the second and the third level because most of the requirement are met at the first level up to certain extend, some of them are met at only first and second and only few of them are partially met at the first three levels. However, only two of them are partially met the forth level. Therefore, the knowledge retention status in Hyder consulting is where knowledge is documented, not completely stored and partially retrieved. This means that some steps in the knowledge retention process (figure 3.1) are still missing.

Hyder Consulting:					
Requirements		**Level- 1** Shared at Individual level	**Level- 2** Codified/ Documented	**Level- 3** Stored/ retained	**Level- 4** Retrieved/ Used
Face-to-face communication	Nonaka (1994)				
Sharing thinking process: brainstorming sessions	Nonaka (1994)				
L.L (at the end of project phases, or at handing over ?					
Job rotation (between different branches)	Bender & Fish (2000)		N/A	N/A	N/A
Renewing Knowledge	Bender & Fish (2000)				
Self organised teams	Nonaka (1994)				
Training & Coaching system					
Competition and award system					

Table 4.12 Table of Knowledge retention requirement (Hyder Consulting)

The requirement is completely met

The requirement is Partially met

The requirement is not at all met

N/A Not applicable for this level

Halcrow International: Table 4.13 shows the knowledge retention list of requirement table filled with the findings in Halcrow International. The first requirement (face-to-face communication) was found at the third level (partially stored). The second requirement (sharing thinking process) is still not completely met; most of the problems are solved at managerial level and the company does not have specific system which encourages sharing thinking process. The third requirement is the documentation of lesson learnt; this is at the third level. It does exist, however, not all the people are aware of its existence. The fourth requirement (job rotation) is applied only when certain experience is required for certain project or as part of resources management. The fifth requirement (renewing knowledge) it is being done in UK since most of the documents on the system are related to the UK projects. The problem with the knowledge update that it is not communicated at individual employees' level. The sixth requirement (self-organised team), Halcrow does encourage sharing knowledge ad face-to-face communication, however, there is no system for enhancing trust amongst employees and building self-organised teams except some social activities. The seventh requirement (training and coaching system), training are being held and some of them are available on the intranet system. The last requirement is the competition and award system; there is no award system for knowledge sharing. In general, we can say that the knowledge retention is between the

second and third level; knowledge is documented, partially stored but not completely retrievable.

Halcrow International					
Requirements		**Level- 1** Shared at Individual level	**Level- 2** Codified/ Documented	**Level- 3** Stored/ retained	**Level- 4** Retrieved/ Used
Face-to-face communication	Nonaka (1994)				
Sharing thinking process: brain-storming session	Nonaka (1994)				
L.L (at the end of project phases, or at handing over ?					
Job rotation (between different branches)	Bender & Fish (2000)		N/A	N/A	N/A
Renewing Knowledge	Bender & Fish (2000)				
Self organised teams	Nonaka (1994)				
Training & Coaching system					
Competition and award system					

Table 4.13 Table of Knowledge retention requirement (Halcrow International)

The requirement is completely met

The requirement is Partially met

The requirement is not at all met

N/A Not applicable for this level

ATKINS: Table 4.14 shows the knowledge retention list of requirement table filled with the findings in ATKINS. The first requirement (face-to-face communication) was found at the forth level (partially retrieved). The second requirement (sharing thinking process) is at the third level, ATKINS encourages activities for sharing knowledge and thinking process such as architectural Fridays & mentoring sessions. The third requirement is the documentation of lesson learnt; ATKINS does support the documentation of technical information about project, which is most of the cases part of the process prior to doing the project. The forth requirement (job rotation), it is part of ATKINS system to rotate employees. The fifth requirement (renewing knowledge), employees are aware of the need for renewing and updating the existing knowledge. The sixth requirement (constructing self-organised team), ATKINS encourages the self-organised teams through encouraging informal discussion sessions during the lunch break. The seventh requirement (training and coaching system), training are being held regularly inside and outside the organisation and trainings manual are available for people to share knowledge and learning. The last requirement is the competition and award system; there are several types of awards such as "rising star programmes" which encourages people to document and to share their own knowledge and their findings with others. We conclude that ATKINS has a solid base for knowledge sharing, however; the four levels are not fully achieved. The

knowledge retention can be considered at the third level, and by introducing new IT system such as intranet, it will achieve the fourth level.

ATKINS					
Requirements		**Level- 1** Shared at Individual level	**Level- 2** Codified/ Documented	**Level- 3** Stored/ retained	**Level- 4** Retrieved/ Used
Face-to-face communication	Nonaka (1994)				
Sharing thinking process: brainstorming sessions	Nonaka (1994)				
L.L (at the end of project phases, or at handing over ?					
Job rotation (between different branches)	Bender & Fish (2000)		N/A	N/A	N/A
Renewing Knowledge	Bender & Fish (2000)				
Self organised teams	Nonaka (1994)				
Training & Coaching system					
Competition and award system					

Table 4.14 Table of Knowledge retention requirement (ATKINS)

The requirement is completely met

The requirement is Partially met

The requirement is not at all met

N/A Not applicable for this level

4.4. SUMMARY OF BEST PRACTICES

Table (4.15) gives a summary of the best practices of knowledge retention in the three companies, based on the cases studies described previously.

	Hyder	**Halcrow**	**Atkins**
Face-to-face communication			Architectural Fridays / Mentoring session/ Informal meeting
Self organised teams		Social activities	Lunch break discussions
Sharing thinking process/ brainstorming session			Architectural Fridays / Mentoring session/ Lunch break discussions
Reports & lessons learnt	OPALs/..		Project Research Documents
Renewing Knowledge	Knowledge manager		
Job rotation			Applied as a company system
Training & coaching system	IT trainings & Modules from graduated programmes available on intranet	IT trainings & Modules from graduated programmes available on intranet	Files for the training manuals of each person
Competition & award system			Rising star programme

Table- 4.15: Summary of best practices

4.5. PRACTICES IN THE UAE

A common statement was given during the interviews in the three organisations is that the system is developed, used & updated more in the UK than the UAE. Therefore, employees in the UAE are not taking full advantages of the existing systems (especially intranet). The main two reasons contributing to this are the time pressure and that the stored knowledge/ information is customised mainly for people in the UK.

By looking at the table of requirement for the three companies, it can be noticed that none of the companies is at the forth level, where knowledge is retrievable. Therefore, none of them achieves the full process of knowledge retention. Only one of the three companies has established a good base at the first level (sharing knowledge at the individual level) while the other two are trying to establish knowledge management system without a solid base at the individual level.

In the second chapter, we have discussed the importance of knowledge management and how are the organisations dealing with it. We have mentioned as well that according to Chong (2006) despite the importance of KM to organisational success, and despite a great deal of interest on the subject there is not yet a common consensus on the concept of KM. However; Pathirage et al. (2007) believe that the view that knowledge is a valuable

organisational resource has become widely recognised and accepted in the business community. We can see clearly from the data analysed in this chapter that knowledge is really considered as a valuable organisational resource. However, the three studied organisations are still not in a level that enables them to fully manage and retain knowledge. Patel et al (2000) argue that management of knowledge is a new and emerging data and that most organisations are at a level of learning that enables them to cope with managing information, but not necessarily to manage knowledge.

In the next chapter, some recommendation will be suggested based on the analysed data, the suggested models and the best practices found in each company. In addition to a brief summary about how the model and table of requirement can be used to asses and to apply knowledge retention in organisations.

CHAPTER -5-

RECOMMENDATION & CONCLUSION

5.0. INTRODUCTION:

In the previous chapter, a study has been done in three organisations to assess the knowledge retention status in each of them. The data was collected through questionnaires, interviews and real observations. The findings were analysed and summarized in a table for each company which shows a list of requirement for applying knowledge retention in organisations. The three organisations were found between the second and the third level, where knowledge is documented and partially stored but not completely retrievable. A table of best practices in each company was prepared as well. This chapter will include firstly a summary and conclusion of this research. Secondly, recommendation will be listed for better application of the knowledge retention process in the three companies, in addition to general recommendation. And Finally, a brief on how the model can be used for assessing and applying knowledge retention in the organisation will be as well included in this chapter.

5.1. SUMMARY OF THE RESEARCH

The research aimed to introduce method/system/process of retaining knowledge. One of the main objectives of this research was developing a model for assessing and applying the knowledge retention in organisations. In order to achieve this objective, a model (framework) of knowledge retention (KR) was developed through reviewing various KM & KR models proposed by leading KM researchers and recent survey evidences. The second objective was to develop list of requirements for organisations, which enables them to implement a new knowledge retention systems or enhance their existing system. This was achieved by developing a list of requirement that identify levels of knowledge retention, this list was used in this research to assess the level of knowledge retention in three organisations. The first chapter of the research was the introduction which consist of aims and objective of the research. The second chapter was the review of the relevant literature. In the third chapter, the model was developed and explained, based on the literature review and the concepts, which were suggested by researchers such as, codification, personalisation, organisational memory and knowledge retrieval. In addition to, explanation of the list of requirements for applying and assessing level of knowledge retention and the collection methodologies. The data was collected using surveys/questionnaires, interviews and real observation. The collected data/ the findings were

analysed in chapter-4 using the chi square method, the developed model and the table of requirement. It was found that none of the organisations meets all the requirements, and specifically none of them does achieve the knowledge retrieval level. In this chapter, recommendations will be listed for each of the organisations, in addition to general recommendations for applying knowledge retention.

5.2. CONCLUSION

As a conclusion, it can be stated that knowledge retention is not a simple IT system that can be applied, it is more than that. It is a full process where individuals are considered the "prime movers" and the knowledge sharing amongst them is the base of the system. In order to apply a knowledge retention system this base should be reinforced by building a good and open communication system. The documentation of the shared knowledge and information is the second step of the knowledge retention process. At this stage, care needs to be taken to avoid losing knowledge and avoid codification mistakes. Then, the storing of this knowledge should be done, the IT system must be selected at this stage (databases, servers, intranet..etc). The selection of such system depend on many factors such as the need, the size of the organisation, the type of knowledge, information overflow and the people who are going to use it. In the three cases, which were done in this research,

the preferred system was the intranet, because it helps to share the knowledge globally between all the company branches. Finally, retrieving the knowledge; without this step all the other steps in the process have no meaning. Any documented and stored knowledge must be retrievable; otherwise the system does not function. Unfortunately this step was found partially missed in the three studied companies, the reasons were mainly that: people are not aware of the existing knowledge, or they do not have time to search, or the system is too slow and not user friendly.

By using the developed model the main steps of the knowledge retention can be defined in order to find any problem in the organisation system. In addition to the model, the list of requirements can be used to help organisation find the exact gaps in their system, what is missing and what needs to be implemented.

5.3. RECOMMENDATIONS FOR THE THREE STUDIED ORGANISATIONS

5.3.1. FOR HYDER CONSULTING

In Hyder consulting it is recommended firstly to focus more on individuals to establish a good base for knowledge sharing. This can be achieved by encouraging informal meeting and the documentation of those meeting at least in the form of few notes, headlines or briefs to allow the discussed

knowledge to be shared by others. As part of knowledge sharing at individual level, trust need to be built amongst employees in order to encourage self-organised teams. The trust can be built through enhancing the relationships between individuals through social activities. Brainstorming sessions are a good opportunity for people to share ideas and thinking process, therefore, all employees (including new joiners and junior employees) should get the chance to participate in such sessions. Moreover, employees should be more involved in discussing the existing knowledge as a part of the renewal and update process.

Discussing the projects after the handing over would significantly help in avoiding the same mistakes in the future projects, however; the lessons learnt report should be documented and stored on the system. It is recommended that projects are stored on the IT system classified by project type such as buildings (hotels, hospitals, residential...), roads, marine work...etc.

Job rotation can be useful in terms on enhancing individuals' knowledge by working in different places and communicating with different people. It is useful as well for the company to benefit from the people's knowledge and skills in different department and branches. Moreover, many people are multi-skilled and by rotating them they are getting the chance to improve

their different skills, benefiting the company by the skills they have and sharing their knowledge and ability with bigger number of people.

In order to encourage employees to participate in the knowledge sharing process and documentation of their own knowledge and the knowledge related to the company project, an award system needs to be implemented. The award system can be in the form of bimonthly competitions or an open opportunity for employees to document the knowledge, and this documentation will be evaluated and then award will be given.

IT trainings and some modules are already provided on the intranet system; however, technical trainings should be added on the intranet system. This can be done by loading manuals of all the trainings which are being held inside or outside the organisation to give a chance for employees to benefit whether they have attended the trainings or not. Moreover, Trainings to be held more regularly for using the intranet system in order to make knowledge retrievable for all employees and to make them aware of the types of knowledge they can find there.

Finally, the IT system for knowledge sharing needs to be improved by filtering the information to avoid the overload and to allow for easier finding the desired knowledge. In addition to, providing more search engines to enable people easily find the information they are looking for.

5.3.2. FOR HALCROW INTERNATIONAL

In order to ensure that the first level/step of knowledge retention process is achieved, knowledge should be shared at individual level. Therefore, it is recommended to encourage informal meeting and the documentation of those meetings. In addition to, encouraging and organising more social activities at workplace (during lunch breaks) and outside the workplace. This can help the employees in building trust between each others, and thus building self-organised teams where they can work together and share their knowledge. Moreover, all employees should be in title to participate in problem solving and in brainstorming session even if they are juniors or new joiners.

The existing IT system contains wealth of knowledge; however, employees are not fully aware of this knowledge. Therefore, holding regular trainings for the IT system is recommended to keep people up-to-date about the knowledge which they can find on it and enable them to retrieve this knowledge and use it.

Implementing awards and competition systems is recommended to encourage individuals to share knowledge and participate in the retention process.

Another recommendation is to find IT solution to increase the speed of the intranet, because one of the main barriers of using such system is that it is time-consuming.

5.3.3. FOR ATKINS

ATKINS already has good base for knowledge retention since the knowledge sharing at the individual level is well established, however; developing IT system for knowledge sharing such as intranet is still required. The system should include the libraries, lesson learnt, technical knowledge, training manuals... etc

5.4. GENERAL RECOMMENDATIONS FOR APPLYING KNOWLEDGE RETENTION

For any organisation to establish a knowledge retention system, the four steps must be implemented. Any problem in achieving the requirement of each step will result in preventing the knowledge retention system from functioning, i.e. if the meeting is not minuted it cannot be neither stored nor retrieved, and thus the knowledge will be lost.

The first step is the socialization and sharing knowledge amongst individuals. This step requires focusing on individuals and building a suitable environment for knowledge sharing. Individuals are the prime mover and the main barrier as well for sharing knowledge; therefore, by managing them and

building trust between them better knowledge sharing process can be achieved. Informal sessions can be arranged and encouraged by the organisations where knowledge can be shared and discussed. A monthly workshop outside the workplace might also help in building relationship between employees and thus build kind of trust.

The second step is codification, in which the tacit knowledge is converted to explicit knowledge and documented. Documenting procedures has two concerns the first one is that they are time-consuming, for this reason it is essential to decide what is to be documented and for what purpose. The second concern is that some of the tacit knowledge might be lost while codifying; therefore, care should be taken while deciding the codification /documentation method(s).

The third step is the knowledge construction & organisational memory, in this step knowledge is stored in an organisational memory which may take a form of IT system such as servers, databases, intranet...etc. The main purpose of using such systems is to store knowledge and to make it available for people to retrieve and use. In order for such system to serve its purpose it should be accessible to employees, searchable, fast, safe (regular backup systems), user friendly and well organised.

The forth step is retrieving knowledge, in this step the previously stored knowledge will be retrieved by the end-users (the organisations' employees). All employees should be well trained for using the system and should be aware about the types of knowledge which exist in this system. The individuals receive this knowledge in the form of data, that what makes the interpretation of this data important, therefore; the knowledge should be as clear as possible and the employees should be aware about the purpose of documenting this knowledge. The ability to retrieve the information will depend on how efficient the system is (i.e. search engine...) and on how well the individuals are trained.

5.5. HOW TO USE THE DEVELOPED MODEL?

A model for knowledge retention process was developed in chapter 3, this model can be used for assessing knowledge retention status in organisation and for implementing knowledge retention as well. This model can be used through filling a check list for the requirement to be met at each step, in chapter 3 a table was prepared for those requirements. For each requirement there are several questions, by answering those questions it can be determined at which level is the organisation, where and what are the gaps in the existing system, and what needs to be done to improve the knowledge retention process. When the answers are yes to all the questions at that time

only the knowledge retention process will function properly. However, even if the organisation seems to be at the forth level, regular monitoring is required.

REFERENCES

1. Augier, M., Shariq, S. Z. and Vendelo M. T., 2001: Understanding context: its emergence, transformation and role in tacit knowledge sharing. *Journal of Knowledge Management* Vol. 5 (2), pp. 125-136. Available from:

   http://www.emeraldinsight.com/Insight/viewPDF.jsp?Filename=html/Output/Published/EmeraldFullTextArticle/Pdf/2300050201.pdf [Accessed on 24/04/07]

2. Ayas, K. and Zeniuk, N., 2001: Project-Based Learning: Building Communities of Reflective Practitioners. *Management Learning* [online]. Vol. 32 (1) pp.61-76. Available from:

   http://mlq.sagepub.com/cgi/content/abstract/32/1/61 [Accessed on 13/04/07]

3. Bender, S. & Fish, A., 2000: The transfer of knowledge and the retention of expertise: the continuing need for global assignments. *Journal of knowledge management.* [online] Vol. 4 (2). pp.125-137. Available from:

   http://www.emeraldinsight.com/Insight/viewPDF.jsp?Filename=html/Output/Published/EmeraldFullTextArticle/Pdf/2300040204.pdf [Accessed on 26/01/07]

4. Brown, S. J.& Duguid, P., 1991: Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning, and Innovation. *Organization Science* [online]. Vol. 2, No. 1, Special Issue: Organizational Learning: Papers in Honor of (and by) James G. March., pp. 40-57. Available from:

   http://links.jstor.org/sici?sici=1047-7039%281991%292%3A1%3C40%3AOLACTA%3E2.0.CO%3B2-3 [Accessed on 07/05/07]

5. Chong, S.C., 2006: KM critical success factors; a comparison of perceived importance versus implementation in Malaysian ICT companies. *The Learning Organization* [online]. Vol. 13 (3), pp. 230-256. Available from:

http://www.emeraldinsight.com/Insight/viewPDF.jsp?Filename=html/Output/Published/EmeraldFullTextArticle/Pdf/1190130303.pdf [Accessed on 07/05/07]

6. Choo, C. W., 2001: The knowing organization as learning organization. *Education + Training* [online]. Vol. 43 (4/5), pp. 197-205. Available from:

   http://www.emeraldinsight.com/Insight/viewPDF.jsp?Filename=html/Output/Published/EmeraldFullTextArticle/Pdf/0040430402.pdf [Accessed on 04/04/07]

7. Creech, H., 2005: Success Factors in Knowledge Management, an IISD Knowledge Communications. International Institute for Sustainable Development. [online] Available from:

   http://www.iisd.org/pdf/2006/networks_km_success.pdf [Accessed on 10/09/07]

8. Crossan, M. M., Lane, H. W. & ; White, R.E., 1999: An Organizational Learning Framework: From Intuition to Institution. *The Academy of Management Review*. [Online] Vol. 24 (3), pp. 522-537. Available from:

   http://links.jstor.org/sici?sici=0363-7425%28199907%2924%3A3%3C522%3AAOLFFI%3E2.0.CO%3B2-B

   [Accessed on 21/04/07]

9. Dyerson, R. & Mueller, F. U., 1999: Learning, teamwork and appropriability: managing technological change in the department of social security. *Journal of Management Studies* [online]. Vol. 36(5), pp. 629-652. Available from:

   http://www.blackwell-synergy.com/doi/pdf/10.1111/1467-6486.00152 [Accessed on 04/04/07]

10. Fellows, R. & Liu, A. 2003: Research Methods for Construction . 2nd ed. Oxford, UK: Blackwell Science Ltd.

11. Gammelgaard, J. and Ritter, T., 2005: The knowledge retrieval matrix: codification and personalisation as separate strategies. *Journal of knowledge management.* [online] Vol. 9 (4). pp. 133-143. Available from:

    http://www.emeraldinsight.com/Insight/ViewContentServlet?Filename=/published/emeraldfulltextarticle/pdf/2300090410.pdf [Accessed on 09/02/07]

12. Gray, J. H & Densten, I. L., 2005 : Towards an integrative model of organizational culture and knowledge management. *International Journal of Organisational Behaviour*. [Online] Vol. 9 (2), pp. 594-603. Available from:

http://www.usq.edu.au/resources/volume9no2gray.pdf [Accessed on 01/06/07]

13. Li, M. & Gao, F., 2003: Why Nonaka highlights tacit knowledge; A critical review. *Journal of knowledge management* [online]. Vol. 7 (4), pp. 6-14. Available from:

http://www.emeraldinsight.com/Insight/viewPDF.jsp?Filename=html/Output/Published/EmeraldFullTextArticle/Pdf/2300070401.pdf [Accessed on 04/04/07]

14. Maqsood, T. and Walker, D., 2007: Extending the "knowledge advantage": creating learning chains. *The Learning Organization* [online]. Vol. 14 No. 2, 2007 pp. 123-141. Available from:

http://www.emeraldinsight.com/Insight/viewPDF.jsp?Filename=html/Output/Published/EmeraldFullTextArticle/Pdf/1190140203.pdf [Accessed on 04/04/07]

15. Marsh, S. J. & Stock G. N., 2006: Creating Dynamic Capability: The Role of Intertemporal Integration, Knowledge Retention, and Interpretation. *Journal Production Innovation Management* [online]. Vol. 23, pp. 422–436. Available from:

http://www.blackwell-synergy.com/action/showPdf?submitPDF=Full+Text+PDF+%28169+KB%29&doi=10.1111%2Fj.1540-5885.2006.00214.x [Accessed on 13/02/07]

16. McAdam, R. & McCreedy, S., 1999: A critical review of knowledge management models. *The Learning Organization* [online]. Vol. 6 (3). pp. 91-100. Available from:

http://www.emeraldinsight.com/Insight/ViewContentServlet?Filename=/published/emeraldfulltextarticle/pdf/1190060301.pdf [Accessed on 09/02/07]

17. Mckenna, E. 2006: *Business Psychology and Organisational Behaviour. A student's handbook.* 4th ed. East Sussex: Psychology Press.

18. McManus, D. J., Wilson, L. T. & Snyder, C. A., 2003 : Assessing the Business Value of Knowledge Retention Projects: Results of Four Case Studies [online]. Available from:

http://www.knowledgeharvesting.org/documents/Assessing%20the%20Business%20Value%20of%20Knowledge%20Retention%20Projects.pdf [accessed on 29/01/07]

19. Newell,S., Bresnen,M., Edelman,L., Scarbrough, H. and Swan, J ., 2006: Sharing Knowledge Across Projects: Limits to ICT-led Project Review Practices. *Management Learning* [online] Vol. 37(2), pp167–185. Available from:

http://mlq.sagepub.com/cgi/content/abstract/37/2/167 [Accessed on 13/04/07]

20. Nonaka, I., 1994 : A Dynamic Theory of Organizational Knowledge Creation. *Organisation science.* [online] Vol.5 (1), pp. 14-37. Available from:

http://links.jstor.org/sici?sici=1047 7039%28199402%295%3A1%3C14%3AADTOOK%3E2.0.CO%3B2-G [Accessed on 13/04/07]

21. Patel, M., MeCarthy, TJ., Morris, PWG. & Elhag, TMS., 2000 : The role of IT in capturing and managing knowledge for organisational learning on construction projects. Centre for research in the management of projects (CRMP), UMIST,UK. Available from:

http://itc.scix.net/data/works/att/w78-2000-674.content.pdf

[Accessed on 09/02/07]

22. Pathirage C. P., Amaratunga, D. G. and Haigh, R.P., 2007: Tacit knowledge and organisational performance: construction industry perspective. *Journal of Knowledge Management.* Vol. 11 (1), pp. 115-126. Available from:

http://www.emeraldinsight.com/Insight/ViewContentServlet?Filename=/published/emeraldfulltextarticle/pdf/2300110108.pdf [Accessed on 21/05/07]

23. Rhodes, C. & Garrick, J., 2003: *Project-Based Learning and the Limits of Corporate Knowledge.* Journal of Management Education [online]. Vol. 27(4), pp. 447-471. Available from:

http://jme.sagepub.com/cgi/reprint/27/4/447 [Accessed on 13/04/07]

24. Rice, J. L. & Rice B. S., 2005: The applicability of the SECI model to multi-organisational endeavours: An interactive review. *International journal of organisational behaviour.* [online] Vol. 9 (8), pp. 671-682. Available from:

http://www.usq.edu.au/resources/vol9no8rice.pdf [Accessed on 13/04/07]

25. Scott D. N. Cook; John Seely Brown, 1999: Bridging Epistemologies: The Generative Dance between Organizational Knowledge and Organizational Knowing. *Organization Science,* Vol. 10 (4), pp. 381-400. Available from:

http://links.jstor.org/sici?sici=1047-7039%28199907%2F08%2910%3A4%3C381%3ABETGDB%3E2.0.CO%3B2-G

[Accessed on 14/04/07]

26. Seemann, P. & Cohen, D., 1997 : The Geography of Knowledge: From Knowledge Maps to the Knowledge Atlas. *Knowledge and Process Management* [online]. Vol. 4 (4), pp 247- 260 . Available from:

http://www3.interscience.wiley.com/cgi-bin/fulltext/61003893/PDFSTART

[Accessed on 28/02/07]

27. Sinclair, M.A. & Siemieniuch C.E., 2004: CLEVER: a process framework for knowledge lifecycle management. *International Journal of Operations & Production Management* [online]. Vol. 24 (11), pp. 1104-1125. Available from:

http://www.emeraldinsight.com/Insight/viewPDF.jsp?Filename=html/Output/Published/EmeraldFullTextArticle/Pdf/0240241102.pdf [Accessed on 28/04/07]

28. Spender, J.C., 1996: Organizational knowledge, learning and memory: three concepts in search of a theory. *Journal of Organizational Change Management* [online]. Vol. 9 (1), pp. 63-78. Available from:

http://www.emeraldinsight.com/Insight/viewPDF.jsp?Filename=html/Output/Published/EmeraldFullTextArticle/Pdf/0230090105.pdf [Accessed on 04/04/07]

29. Syed-Ikhsan, S.O.S. & Rowland, F., 2004: Knowledge management in a public organisation: a study on the relationship between organisational elements and the performance of knowledge transfer. *Journal of knowledge management* [online]. Vol. 8 (2), pp. 95-111. Available from:

http://www.emeraldinsight.com/Insight/ViewContentServlet?Filename=/published/emeraldfulltextarticle/pdf/2300080208.pdf [Accessed on 28/04/07]

30. Walsh, P. J. & Ungson, G., 1991: Organisational memory. *The Academic of Management Review.* [online] Vol.16 (1), pp. 57-91. Available from:

http://links.jstor.org/sici?sici=0363-7425%28199101%2916%3A1%3C57%3AOM%3E2.0.CO%3B2-E [Accessed on 21/04/07]

31. Watson, I. 2003: Applying knowledge management, techniques for building corporate memories. USA: Elsevier Science.

32. Chi square calculator [online], available from:

http://www.fourmilab.ch/rpkp/experiments/analysis/chiCalc.html

BIBLIOGRAPHY

33. Fellows, R. & Liu, A. 2005: Doing your research Project . 4th ed. England : Judith Bell.

APPENDICES

Appendix - A

Survey Questions

Purpose of the questionnaire: educational purpose (conducting research about knowledge management and retention in organisations)

Profession: _____ Job Title: _____

Years of Experience: _____ Years in the organization: __

2. Does your company or encourage face-to-face communication with other employees, (i.e. internal meetings)?

○ ○

Yes No

If yes, please answer the followings:

a) How often do you attend meetings?

○ ○ ○ ○

More than once a week Once a week Once a month Rarely/ Occasionally

b) What are the types of those meetings? (Note: you can select more than one choice, as applicable)

○ ○ ○ ○

Formal Informal Scheduled Unscheduled

c) Are they minuted?

○ ○ ○ ○

Always Often Only formal ones Not at all

3. In case of problems facing the company in running any project, are you involved in solving them?

○ ○

Yes No

If yes, please answer the followings:

a) How are the problems solved?

○ ○ ○

Brainstorming sessions Correspondence Management decisions

b) Are the problems, the solution, and the procedures documented?

○ ○

Yes No

4. How do you classify the communication and knowledge sharing within the same department and between different departments in your company?

○ ○ ○ ○

Poor Average Good Excellent

5. Does the company support or encourage teamwork?

○ ○

Yes No

6. **Does your company support or encourage knowledge sharing?**

○ ○

Yes No

7. **Is there any type of awards for people who contribute to the knowledge sharing or documentation in the company?**

○ ○

Yes No

8. **Is there is any accessible body of knowledge in the company?**

○ ○

Yes No

9. **Are you clear about the type of knowledge you are sharing with others?**

○ ○

Yes No

10. **How many people do you think you have shared your knowledge with?**

_____

11. **Is there is any system in the organization for documenting and sharing information?**

○ ○

Yes No

If yes, please answer the following:

a) What is it? (Note: you can select more than one choice, as applicable)

○	○	○	○	○
Hardcopies in the archive	Softcopies in the server	Database system	Intranet	Others

If others, please specify ……..

b) How often do you use it?

○	○	○
Daily	Once a week	Rarely/ Occasionally

c) Do you find what you are looking for?

○	○	○	○
Yes	Often	rarely	Not at all

d) Is it user friendly (easy to search)?

○	○
Yes	No

e) When new information or area of knowledge added to the system, are you informed?

○	○
Yes	No

12. **Please rate your level of satisfaction with knowledge retention (knowledge sharing/ documentation/ storage/retrieval) in your company**:

○	○	○	○	○
Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied

Appendix - B

Interviews Questions (with general managers)

1. Can you please give me a brief about your organization?
2. What is the number of employees? In UAE? Worldwide?
3. Would you mind if I mention the name of the organization in my study? Or you prefer to keep it private?
4. Can you give me a brief about the existing system of knowledge management in the company?
5. What types of knowledge you can find in the system? (Technical, meeting, lessons learnt)
6. System characteristics:
   a. ability to retrieve knowledge
   b. type of knowledge documented
   c. awareness of what is really documented
   d. usefulness of the information documented
   e. time consuming (documenting & searching)
   f. Accessibility
7. How do you deal with the problem of loosing knowledge of people who leaves the company (retirement, resignation)? Does the existing system support the retention of employee's knowledge?

8. Are you satisfy with it?

9. How often the employees get trainings? Is there is any place where the company training manuals are stored?

10. At what level do you classify knowledge sharing in your organisation?

e) Individual level (shared)

f) Documented.

g) Stored.

h) Retrievable.

11. Is there any job rotation system, to support knowledge sharing among the branches in different countries and different cities?

Appendix - C

Interviews Questions

Profession: _____Job Title:_____

Years of Experience:_____Years in the organization: _

1. Does your company or encourage face-to-face communication with other employees? How?
2. Can you give me a brief about the existing system of knowledge management in the company?
3. What types of knowledge you can find in the system? (Technical, meeting, lessons learnt)
4. System characteristics:
    g. ability to retrieve knowledge
    h. type of knowledge documented
    i. awareness of what is really documented
    j. usefulness of the information documented
    k. time consuming (documenting & searching)
    l. accessibility
5. In your opinion, and according to your experience with the system, Does it need to be improved and if so, how?

6. Is the existing system support the retention of employee's knowledge? If yes, How? If no, why not?
7. How often do you get trainings? Is there any place where the company training manuals are stored?
8. Is there any award system for people who contribute to documentation of knowledge?
9. Are the previous project lesson learnt documented? Are they stored?
10. At what level do you classify knowledge sharing in your organisation?
    e. Individual level (shared)
    f. Documented.
    g. Stored.
    h. Retrievable.

Appendix - D

Survey Results and Chi Square Test

1. Does your company encourage face-to-face communication?

Q1	1	2	TR
Hyder	27	2	29
Expected	26	3	
Deviation	0.07	0.53	0.60
Halcrow	21	8	29
Expected	26	3	
Deviation	0.85	6.53	7.38
Atkins	29	0	29
Expected	26	3	
Deviation	0.43	3.33	3.77
TC	77	10	87

X^2 =	**11.75**
Df =	**2**

P value = 0.0028 < 0.05

Significance difference

1.a. How often do you attend meetings?

Q1	1	2	3	4	TR
Hyder	6	9	4	8	27
Expected	7	7	4	9	
Deviation	0.15	0.36	0.01	0.07	**0.58**
Halcrow	5	2	2	12	21
Expected	5	6	3	7	
Deviation	0.04	2.43	0.33	3.94	**6.74**
Atkins	9	10	5	5	29
Expected	8	8	4	9	
Deviation	0.29	0.55	0.18	2.07	**3.09**
TC	20	21	11	25	77

X^2 =	**10.40**
Df =	**6**

P value = 0.1087 > 0.05

No Significance difference

1.b. What are the types of those meetings?

Q1	1	2	3	4	TR
Hyder	10	15	18	4	47
Expected	9	13	14	10	
Deviation	0.11	0.17	1.04	3.91	5.23
Halcrow	7	9	2	16	34
Expected	7	10	10	8	
Deviation	0.04	0.06	6.64	9.63	16.37
Atkins	9	15	21	10	55
Expected	11	16	17	12	
Deviation	0.22	0.04	1.18	0.37	1.81
TC	26	39	41	30	136

X^2 =	**23.41**
Df =	**6**

P value = 0.0006 < 0.05

Significance difference

1.c. Are they minuted

Q1	1	2	3	4	TR
Hyder	4	1	17	5	27
Expected	3	4	14	7	
Deviation	0.55	2.07	0.72	0.38	3.71
Halcrow	2	2	6	12	22
Expected	2	3	11	5	
Deviation	0.03	0.39	2.47	8.23	11.12
Atkins	2	8	17	2	29
Expected	3	4	15	7	
Deviation	0.32	3.74	0.30	3.63	7.99
TC	8	11	40	19	78

X^2 =	**22. 83**
Df =	**6**

P value = 0.0008 < 0.05

Significance difference

2. In case of problems facing the company in running any project, are you involved in solving them?

Q1	1	2	TR
Hyder	17	12	29
Expected	18	11	
Deviation	0.06	0.09	0.15
Halcrow	17	12	29
Expected	18	11	
Deviation	0.06	0.09	0.15
Atkins	20	9	29
Expected	18	11	
Deviation	0.22	0.36	0.59
TC	54	33	87

X^2 =	**0.88**
Df =	**2**

P value = 0.6440 > 0.05

No Significance difference

2.a. How are the problem solved?

Q1	1	2	3	TR
Hyder	4	1	17	22
Expected	3	4	15	
Deviation	0.35	2.35	0.29	2.98
Halcrow	2	2	6	10
Expected	1	2	7	
Deviation	0.31	0.01	0.09	0.41
Atkins	2	8	17	27
Expected	4	5	18	
Deviation	0.75	1.75	0.09	2.59
TC	8	11	40	59

X^2 =	**5.98**
Df =	**4**

P value = 0.2006 > 0.05

No Significance difference

2.b. Are the problems, solutions and the procedures documented?

Q1	1	2	TR
Hyder	11	6	17
Expected	13	4	
Deviation	0.28	0.89	1.17
Halcrow	14	3	17
Expected	13	4	
Deviation	0.09	0.29	0.38
Atkins	16	4	20
Expected	15	5	
Deviation	0.04	0.14	0.18
TC	41	13	54

X^2 =	**1.74**
Df =	**2**

P value = 0.3945 > 0.05

No Significance difference

---

3. How do you classify knowledge sharing in your company?

Q1	1	2	3	4	TR
Hyder	0	7	21	1	29
Expected	2	9	16	2	
Deviation	2.00	0.58	1.82	0.50	4.90
Halcrow	5	12	11	1	29
Expected	2	9	16	2	
Deviation	4.50	0.76	1.39	0.50	7.15
Atkins	1	9	15	4	29
Expected	2	9	16	2	
Deviation	0.50	0.01	0.03	2.00	2.54
TC	6	28	47	6	87

X^2 =	**14.59**
Df =	**6**

P value = 0.0236 <0.05

Significance difference

4. Does your company support or encourage teamwork?

Q1	1	2	TR
Hyder	29	0	29
Expected	28	1	
Deviation	0.02	0.67	0.68
Halcrow	27	2	29
Expected	28	1	
Deviation	0.06	2.67	2.73
Atkins	29	0	29
Expected	28	1	
Deviation	0.02	0.67	0.68
TC	85	2	87

X^2 =	**4.09**
Df =	**2**

P value = 0.1293 > 0.05

No Significance difference

---

5. Does your company support or encourage knowledge sharing?

Q1	1	2	TR
Hyder	28	1	29
Expected	28	1	
Deviation	0.00	0.08	0.09
Halcrow	26	3	29
Expected	28	1	
Deviation	0.10	2.08	2.18
Atkins	29	0	29
Expected	28	1	
Deviation	0.06	1.33	1.40
TC	83	4	87

X^2 =	**3.67**
Df =	**2**

P value = 0.1596 > 0.05

No Significance difference

6. **Does your company support or encourage knowledge sharing?**

Q1	1	2	TR
Hyder	9	1	29
Expected	10	1	
Deviation	0.17	0.08	0.09
Halcrow	2	3	29
Expected	10	1	
Deviation	6.72	2.08	2.18
Atkins	20	0	29
Expected	10	1	
Deviation	9.04	1.33	1.40
TC	31	4	87

X^2 =	**24.76**
Df =	**2**

P value = 0.00 < 0.05

Significance difference

---

7. **Is there any accessible body of knowledge in the company?**

Q1	1	2	TR
Hyder	9	1	29
Expected	10	1	
Deviation	0.17	0.08	0.09
Halcrow	2	3	29
Expected	10	1	
Deviation	6.72	2.08	2.18
Atkins	20	0	29
Expected	10	1	
Deviation	9.04	1.33	1.40
TC	31	4	87

X^2 =	**6.62**
Df =	**2**

P value = 0.0365 < 0.05

Significance difference

8. Are you clear about the type of knowledge you are sharing with others?

Q1	1	2	TR
Hyder	27	2	29
Expected	26	3	
Deviation	0.07	0.53	0.60
Halcrow	25	4	29
Expected	26	3	
Deviation	0.02	0.13	0.15
Atkins	25	4	29
Expected	26	3	
Deviation	0.02	0.13	0.15
TC	77	10	87

X^2 =	**0.90**
Df =	**2**

P value = 0.6376 > 0.05

No Significance difference

---

10. Is there any system in the organisation for documenting and sharing information?

Q1	1	2	TR
Hyder	29	0	29
Expected	24	5	
Deviation	1.20	5.33	6.54
Halcrow	19	10	29
Expected	24	5	
Deviation	0.92	4.08	5.00
Atkins	23	6	29
Expected	24	5	
Deviation	0.02	0.08	0.10
TC	71	16	87

X^2 =	**11.64**
Df =	**2**

P value = 0.0029 < 0.05

Significance difference

10.a. What is it (the system)?

Q1	1	2	3	4	TR
Hyder	12	23	15	21	71
Expected	15	24	14	17	
Deviation	0.76	0.06	0.06	0.00	0.89
Halcrow	10	11	7	6	34
Expected	7	12	7	8	
Deviation	0.92	0.03	0.01	0.00	0.96
Atkins	13	21	10	12	56
Expected	12	19	11	14	
Deviation	0.06	0.18	0.11	0.00	0.35
TC	35	55	32	39	161

X^2 =	**2.20**
Df =	**6**

P value = 0.9 > 0.05

No Significance difference

PS: This question allows for more than one answer; the chi square test cannot be performed

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10.b. How often do you use it?

Q1	1	3	4	TR
Hyder	15	7	7	29
Expected	17	4	8	
Deviation	0.18	1.40	0.07	1.66
Halcrow	12	1	6	19
Expected	11	3	5	
Deviation	0.10	1.28	0.16	1.54
Atkins	14	3	6	23
Expected	13	4	6	
Deviation	0.04	0.09	0.00	0.13
TC	41	11	19	71

X^2 =	**3.33**
Df =	**4**

P value = 0.5041 > 0.05

No Significance difference

10.c. Do you find what you are looking for?

Q1	1	2	3	4	TR
Hyder	3	25	1	0	29
Expected	7	20	2	0	
Deviation	2.24	1.03	0.25	0.00	3.51
Halcrow	8	9	2	0	19
Expected	5	13	1	0	
Deviation	2.62	1.43	0.81	0.00	4.86
Atkins	6	16	1	0	23
Expected	6	16	1	0	
Deviation	0.04	0.00	0.07	0.00	0.11
TC	17	50	4	0	71

X^2 =	**8.48**
Df =	**6**

P value = 0.1827 > 0.05

No Significance difference

10.d. Is it user friendly?

Q1	1	2	TR
Hyder	20	9	29
Expected	24	5	
Deviation	0.57	2.56	3.14
Halcrow	19	0	19
Expected	16	3	
Deviation	0.78	3.48	4.26
Atkins	19	4	23
Expected	19	4	
Deviation	0.00	0.01	0.01
TC	58	13	71

X^2 =	**7.41**
Df =	**2**

P value = 0.0246 < 0.05

Significance difference

10e. When new knowledge added are you informed?

Q1	1	2	TR
Hyder	15	14	29
Expected	19	10	
Deviation	0.92	1.80	2.71
Halcrow	14	5	19
Expected	13	6	
Deviation	0.16	0.32	0.48
Atkins	18	5	23
Expected	15	8	
Deviation	0.51	0.99	1.50
TC	47	24	71

X^2 =	**4.69**
Df =	**2**

P value = 0.0958 > 0.05

No Significance difference

---

11. rate your satisfaction

Q1	1	2	3	4	5	TR
Hyder	0	0	9	18	2	29
Expected	1	2	7	15	5	
Deviation	0.67	1.69	0.75	0.67	1.85	5.64
Halcrow	2	2	5	17	3	29
Expected	1	2	7	15	5	
Deviation	2.61	0.06	0.45	0.32	0.84	4.27
Atkins	0	3	6	9	10	28
Expected	1	2	7	14	5	
Deviation	0.65	1.16	0.04	1.98	5.36	9.19
TC	2	5	20	44	15	86

X^2 =	**19.09**
Df =	**8**

P value = 0.0143 < 0.05

Significance difference

Note :P value was calculated using the df & X^2 values and the calculator available from:
http://www.fourmilab.ch/rpkp/experiments/analysis/chiCalc.html