BIT 315 KNOWLEDGE MANAGEMENT MODULE FOUR

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I am sincerely indebted to the following sources listed below from which a compiled the work for this course and many at times with extremely minimal editing their work:

(i) KM From A to Z. http://www.knowledge-management-tools.net/knowledge-information-data.php

(ii) Olatokun E. O. (2017). Requirement elicitation using knowledge Capturing techniques during the client briefing process for improved client satisfaction in the uk construction industry. Doctor of Philosophy Thesis at the University of Salford

(iii) Part II The Road Ahead: Implementing Knowledge Management: Chapter 4 The 10-Step KM Roadmap https://www.pearsonhighered.com/assets/samplechapter/0/1/3/0/0130128538.pdf

(iv) Sekaran R. A Course Material for IT2043 Knowledge Management at Sasurie College of Engineering

(v) Nonaka I. (1997) **Organizational Knowledge Creation**. Presentation at the Knowledge Advantage Conference held November 11-12, 1997

(vi) https://www.shareyouressays.com/knowledge/8-major-functions-of-a-multi-layered-architecture-in-knowledge-management/105379

To the BIT class of 2020/21 academic year for working through this work online due to COVID-19 that we could not have face to face classes

Since the materials used herein was open source for academic purposes, the collection of modules shall also be for Open use for academic purposes.

Contents

Module Four: Capturing Knowledge

Knowledge Capturing

One of the core Knowledge Management process is knowledge capturing. For knowledge to be created, shared, transferred, stored or re-used, there is a need to firstly identify the source of where the knowledge is coming from and how this knowledge can be properly captured. Knowledge capturing however, forms the basis for which all other Knowledge Management processes derives their functionality. Before we delve into the nitty-gritty of Knowledge capturing, a brief definition of what Knowledge capturing is will be ideal.

What is Knowledge Capturing?

Hari et al. (2005) state that capturing knowledge is the process of turning personal knowledge into corporate knowledge in order to be shared among those involved in projects. Therefore, identifying the critical knowledge sources in project is prerequisite for capturing knowledge. Egbu et al., (2003) considered individuals in projects as the most important knowledge source. Kivrak et al. (2008) identified some knowledge sources in organisations that could help facilitate the knowledge capture process, these include; Colleagues, Company's experience, Personal experience, Company documentation, Current project documentation, Project team meetings, Intranet, Personal library, Clients, Internet, Knowledge brokers external to the firm, External events (conferences, seminars) and so on. Another school of thought discussed by Kivrak et al. (2008) identifies knowledge capturing as the acquisition and retrieval of quantitative data, using statistical computer packages, which is then used to assist in decision-making and strategic planning. Another fundamental element of Knowledge capturing is organisational learning. An example of this can be seen in the work of Yang (2004) where he did a case study of Ritz Carton Chain Hotels where knowledge was captured from customers by means of detecting and recording their guest special interests at the first-time visit and providing personalized treatment based on the records afterwards which in turn reinforces customer loyalty. In the work of Becerra-Fernandez, et al (2004), knowledge capture is defined as a combination of knowledge elicitation and knowledge representation.

Creation of knowledge occurs during construction project processes which is a highly knowledge-intensive environment (Woo et al. 2004; Hari et al. 2005). This newly generated knowledge resides and is impeded in the mind of staffs, managers, employees and so on. The realisation that members of staffs involved in construction project possess an adequate amount of new knowledge fuels the motivation, inspiration and encouragement to capture this knowledge. Unless this created knowledge is captured, the knowledge has the tendency to be lost since only a small amount of this information makes it into project documentation (Fruchter 2002). Falqi (2011) asserts that majority of such knowledge gained during the construction project is lost if adequate attention is not given to the wealth of techniques available in capturing such knowledge and if those involved in the projects are not motivated to feed it back into future projects (Barlow and Jashapara 1998; Fruchter and Demian 2005). Knowledge capture as defined by an author is the process of eliciting

knowledge that resides within the minds of people, artefacts, or organisational entities, and then representing such knowledge in a format for later reuse or retrieval (Becerra-Fernandez and Sabherwal 2006; Schwartz 2006). For Knowledge capturing to be deemed successful, it involves the conversion of personal knowledge into corporate knowledge that can be shared and applied throughout the organisation for improved competitive advantage (Hari et al. 2005). The author also stated that Knowledge capturing is not only limited to formal knowledge such as documents but can be informal in nature such as the morale behind certain, intuition, or interaction between team members. Falqi (2011) mentioned that for Knowledge capturing to be effective, the type of mechanism and technology adopted for the conversion of tacit to explicit knowledge or vice versa is very important. Some of these mechanisms include the development of frameworks and the articulation of best practices or lessons learned. Others include on-the-job type of learning, learning by observation, and face-to-face meetings (Becerra-Fernandez and Sabherwal 2006).

Research has revealed that most organisational knowledge resides in their processes and the heads of people and IT mechanisms have not been able to fully capture some tacit knowledge without losing its context (Robinson et al. 2005). Other author's discus that knowledge repositories can only capture the explicit side of knowledge and not necessarily the tacit side of knowledge, which makes project knowledge captured and in parts and not fully used, this makes a large part of the knowledge to remain in people's heads (Wenger 2002). In as much as some part of project knowledge which is tacit in nature can be converted to explicit knowledge, it is however important to also note that not all project knowledge can be captured, because not all tacit knowledge can be converted into explicit knowledge which buttress the work of Polanyi which says people can know more than they think they know (Nonaka and Takeuchi 1995; Polanyi 1966). Knowledge capture is most times not a one off endeavour; it requires some level of commitment and time investment over a substantial period of time (Hari et al. 2005). For Knowledge capturing in Knowledge Management to be effective, Zack (1998) highlights four primary resources which are repositories of explicit knowledge; Refineries for accumulating knowledge which includes (refining, managing, and distribution of the refined knowledge); the role of organisations in executing and managing the refining process; and finally information technologies used in supporting those repositories and processes. A number of techniques for capturing knowledge during construction projects will be identified and discussed in due course. Some of the techniques that have been identified include CoP, Post project reviews, storytelling, and information systems tools (Anumba et al. 2005; Orange et al. 2000; Tan et al. 2010; Shapiro 1999). Another aspect of Knowledge capturing is knowledge elicitation as defined by Becerra-Fernandez, et al (2004).

Shadbolt and Smart (2015) define knowledge elicitation to consists of a set of techniques and methods that attempt to elicit the knowledge of a domain expert, typically through some form of direct interaction with the expert. They added that knowledge elicitation is a sub-process of knowledge acquisition (which deals with the capture of knowledge from any source), and knowledge acquisition is, in turn, a sub-process of knowledge management. Knowledge elicitation is also defined as the techniques used in data collection for the purpose of gathering knowledge or

information from human sources while knowledge representation is dedicated to representing information about the world in a form that a computer system can utilize to solve complex tasks such as diagnosing a medical condition or having a dialog in a natural language (Gaines, 2013; Becerra-Fernandez et al., 2004). A company's ability to exploit its collective knowledge can mean the difference between commercial success and failure (Nonaka and Takeuchi, 1995). Identifying and locating what knowledge is available for capture is usually the first step in the Knowledge Management framework, however, if after identifying the knowledge and such knowledge is not adequately captured, it is as good as a wasted effort (Shadbolt and Smart, 2015). Garza and Ibbs (1992) outlined knowledge acquisition techniques, each suited to capturing different types of knowledge. One way this can be achieved is by analysing the public domain knowledge which then allows the knowledge capturer to familiarise with the current thoughts on that particular subject. Another technique discussed by Garza and Ibbs (1992) is the use of interviews.

Interviews can either be unstructured or structured. The advantage of unstructured interviews is that they allow the knowledge holder (the person being interviewed) to explain freely what they feel are key elements in their work that if missed or not given attention, will affect the end result.

Such information can then be refined and probed further with structured interviews.

The disadvantage of unstructured interviews is that the knowledge holder may digress from the problem being addressed. The opposite is the case for structured interviews; however, the disadvantage is that important points are not covered due to the way the interview is structured.

The advantage is that the points that the knowledge capturer (the interviewer) wants to address are covered (Welbank, 1983). Another technique identified was induction which allows governing rules and gaps in existing rules to be identified by the analysis of case studies. By documenting the factors that result in different outcomes, governing rules can be developed. For example, if one house was built with foundations and a second without, if the house without foundation collapsed, the governing rule could be: houses with no foundations collapse. Furthermore, Rezgui et al. (2010) identified lessons learned as one of the main sources of knowledge capturing in construction industry, alongside recorded documents, experiences and interactions. Hinds et al. (2001) noted that organisations must consider how to capture knowledge from experts who have it to novices who need to know. Researchers such as Kazi and Koivuniemi (2006) believed that knowledge is not transferred across the organisation for reuse in future projects and it unfortunately remains stored in the minds of project team members especially in construction industry. In the mid-1960s the Tavistock Institute (1966) embarked on a study stressing the need for the construction industry to concentrate on two aspects which are embracing socio-technical perspective and recognising the power of combing the application of techniques available to help revolutionize people's perspective in the release of their creative energies to their organisations.

They assert that knowledge creation; capturing, storing, sharing and retaining knowledge play a major role in the management of organisational knowledge.

In today's knowledge economy, knowledge is increasingly being considered as an asset that needs to be effectively managed to create added wealth (TWI, 2015). Within the architecture, engineering and construction (AEC) industry, companies recognise they can no longer afford to reinvent the wheel, and thus must learn to better capture the knowledge accrued on projects to improve the quality and effectiveness of future projects (Egan, 1998; Matsumoto, 2005).

According to TWI (2015), every construction project is unique with its own problems. Ideally, by carefully identifying potential problems at the planning and client stage of a project, preventive measures can be put in place. They defined knowledge capture as the use of variety of techniques to elicit facets of an individual's technical knowledge such that insights, experiences, social networks and lessons learned which is then shared to mitigate organisational knowledge loss. A variety of methods are used in Knowledge capturing and they vary according to each organisation's requirements but range from interviews and mind mapping to blogs and wikis (TWI, 2015). The knowledge capturing process is the first activity in the knowledge management framework which seeks to make tacit knowledge explicit and vice versa, thereby reinforcing the work of Nonaka and Takeuchi of the SECI model. Within the project-based architecture, engineering and construction (AEC) industry, knowledge capturing is also being recognized as a vehicle through which the industry can address its need for innovation and improved business performance (Egan, 1998; Egbu et al., 1999). The failure to capture and transfer project knowledge, especially within the context of temporary virtual organisations, leads to the increased risk of 'reinventing the wheel,' wasted activity, and impaired project performance (Siemieniuch and Sinclair, 1999).

For knowledge capturing to be deemed effective, it must be able to turn personal knowledge (tacit) into corporate knowledge (tacit and explicit) which can be widely shared and properly applied throughout the organisation so much so it gives the organisation added competitive advantage ((Kazi et al., 1999; McConalogue, 1999; Hari et al., 2005). Powers (2005) gave another perspective to the concept of knowledge capturing; he explains that for knowledge to be captured rightly, we need to firstly identify the critical knowledge that might be at risk in the organisation as a result of downsizing or retirements. Collison and Parcell (2001) put forth their views that knowledge capture means capturing know-how in such a way that it can be reused.

Ambrosio, (2000) stressed that there needs to be a link between capturing knowledge before during and after a project or task has been executed. He described an instance that took place in BP Amoco, which saved up to $50 million in drilling costs at the Schiehallion oil field, off the coast of Scotland, UK, by leveraging on knowledge captured from developing prior oil fields (Ambrosio, 2000). In addition, Rezgui et al. (2010); and Hari et al., (2005) asserted that there are various reasons as to why SMEs need formal systems for knowledge capture. Some of the reasons include the fact that knowledge resides in the minds of owners/senior managers of SMEs which is the financial strength of the organisation.

Most SMEs feel that the knowledge capture return on investment (ROI) figures do not generally add up, so knowledge capture initiatives are relegated to the level of a "luxury item", and therefore something to be considered in the future. SMEs could adopt the policies and practices of the larger, more prosperous companies. Some other organisations adopt the "wait and see" position with regards to the uptake of knowledge capture initiative. It is often a case of "let the rich big boys (large organisation) test the waters, and when they have validated its worth to all businesses, then we will act". In the meantime, SMEs continue in the way they know best: losing vital knowledge capital and competitive advantage daily (Hylton, 2002). The rate of technology advancement in the present global economy is rapid. To maintain a competitive edge and remain valuable in the market place, organisations must devise means to adequately and quickly capture, assimilate and use effectively "just in time" knowledge of their organisation. Large companies have honed in on the fact that it takes a long time for employees to gain the level of experience of the company's key processes to be able to translate them into valuable explicit and tacit knowledge. They also realise that their employees no longer have the luxury of time to acquire the knowledge. Effective knowledge capturing affords organisations the opportunity to innovate, improve project methodologies, cut costs, save client time and reduce time to market and project deliveries (Becerra-Fernandez and Sabherwal 2006; Hari et al., 2005).

Greenes, (2006) described knowledge capture as a very common method of transferring knowledge. Knowledge capture is process that involves identification, elicitation, distillation, packaging and publishing of captured knowledge. It sometimes could be stressful and time consuming, but under the right approach and management, it can enable the flow of knowledge from one to many regardless of time and space. Greenes provided some steps to help guide knowledge capturers through the main activities necessary to gather and capture knowledge;

- ✓ Collate any existing material upon which you can base your captured knowledge and look for general guidelines. Provide some context so that people can understand the purpose and relevance of the knowledge.
- ✓ Elicit or capture knowledge from individuals, teams and groups with relevant experience. This can be accomplished through retrospective interviews of individuals, or formal learning processes and meetings designed to glean and capture lessons learned, good practices and so on, from recent projects, activities or events.
- ✓ Publish the knowledge. Store and manage the knowledge in a space where it can be easily searched, found and accessed by its community or other potential users. Often this will be the company Intranet in the form of a digital knowledge asset.
- ✓ Initiate a feedback and ownership process. Encourage feedback from users, so that they pick up and eliminate any invalid recommendations. Instil a sense of obligation that 'if you use it, then you should add to it' (Greenes, 2006).

Olatokun and Pathirage (2015) define knowledge capture as the use of knowledge or requirement capturing techniques to capture client's tacit knowledge in the form of requirements during the

client briefing process for improved client satisfaction in the UK construction industry". This definition will be adopted throughout this research. Knowledge exists in the mind of clients which are being captured as requirements. These requirements are captured with the use of certain Knowledge capturing techniques which are identified and discussed in the next sub-section.

Knowledge Capturing Techniques

Based on the operational definition of this research, the knowledge capturing techniques discussed in this section are the key instruments needed in capturing or eliciting the right knowledge or requirement depending on the sector under consideration. According to Shokri-Ghasabeh and Chileshe (2014), different techniques of capturing knowledge from projects have been proposed by researchers among which the following studies have been investigated. Von (2003), Carillo (2005), Williams (2007), Kululanga and Kuotcha (2008), Fuller *et al.,* (2011) and Henderson *et al.,* (2013) identified some Knowledge capturing techniques which include;

- ✓ **Interviews**

Shokri-Ghasabeh and Chileshe (2014) describe the interview technique as one of the most common and important technique used in capturing or eliciting client requirements. They added that one basic way this is achieved is by creating a meeting opportunity where the professional sits with the client and questions on what they need is asked. These planned meeting needs to be planned way ahead of time based on the type of requirements you're looking for. There are many good ways to plan the interview, but generally you want to ask open-ended questions to get the interviewee to start talking and then ask probing questions to uncover requirements (Shokri-Ghasabeh and Chileshe, 2014). Group interviews are similar to the one-on-one interview, except that more than one person is being interviewed usually two to four. These interviews work well when everyone is at the same level or has the same role. Group interviews require more preparation and more formality to get the information you want from all the participants. You can uncover a richer set of requirements in a shorter period of time if you can keep the group focused (Shokri-Ghasabeh and Chileshe, 2014).

- ✓ **Facilitated workshops**

In a facilitated session, you bring a larger group (five or more) together for a common purpose.

In this case, you are trying to gather a set of common requirements from the group in a faster manner than if you were to interview each of them separately (Carillo, 2005).

- ✓ **Requirements Workshops**

In the work of (Carillo, 2005), requirements workshop is a generic term given to a number of different types of group meetings where the emphasis is on developing and discovering requirements for a software system. There are many different forms of requirements workshops

including cross functional which involves different types of stakeholders from various areas of the business, Co -operative Requirements Capture where like JAD there is a defined set of activities and the development community is especially involved, and Creativity which encourages innovative thinking and expression. Another variation of requirements workshops often used in market analysis is the Focus Group.

- ✓ **Request for proposals (RFPs)**

If you are a vendor, you may receive requirements through a RFP. This list of requirements is there for you to compare against your own capabilities to determine how close a match you are to the client's needs (Williams, 2007, Carrilo, 2005).

- ✓ **Brainstorming**

In certain projects, knowledge is not captured or elicited as much as they should be. Some of these solutions are new concepts and needs to be created as a set of ideas that people can agree to. In this type of project, simple brainstorming may be the starting point. The appropriate subject matter experts get into a room and start creatively brainstorming what the solution might look like. After all the ideas are generated, the participants prioritize the ones they think are the best for this solution. The resulting consensus of best ideas is used for the initial requirements (Sheng-Tun and Fu-Ching, 2009).

- ✓ **Collaboration**

Some of the authors describe collaboration or Group work as a very common and often default technique for knowledge capturing or requirements elicitation. Collaboration is particularly effective because it involves and commits the stakeholders directly and promotes cooperation.

These types of sessions can be difficult to organize due to the number of different stakeholders that may be involved in the project. Managing these sessions effectively requires both expertise and experience to ensure that individual personalities do not dominate the discussions. Key factors in the success of collaboration are the makeup of participants and the cohesion within the group. Stakeholders such as clients and users must feel comfortable and confident in speaking openly and honestly, and it is for this reason that group work is less effective in highly political situations (Kululanga and Kuotcha, 2008, Sheng-Tun and Fu-Ching, 2009).

- ✓ **Sketches and Diagrams**

Sketching is simply referred to as a simple and rough drawing with a lack of details Wang et al,

(2012). The idea of sketching has been a tool used in supporting various kinds of creative works.

In previous history, architecture design, industrial design and graphic design have seen sketching as a technique used in "capturing, developing, exploring, communicating and evaluate ideas" (Wang et al, 2012). Sketching has different characteristics in various fields of design, but it has three basic purposes: to structure thoughts and to form ideas, to externalize or elicit ideas (tacit in nature) and to communicate with oneself, and others by offering something to reflect upon.

Sketching is a way to structure thoughts and to form ideas which are in form of tacit knowledge.

Without such external representations, new possibilities and combinations of ideas can be difficult to see. Sketching is a way of externalizing an idea quickly (Tholander et al., 2008). Sketches "facilitate memory by externalizing the basic design elements" (Wang et al., 2012). This external representation allows architects to think about other properties of the elements, such as spatial arrangements and functions. The finding of the feature of sketches to represent spatial information has its roots in human cognition – sketches have the attribute of representing three dimensional visual experiences by using abbreviated two-dimensional lines. These lines can provoke visual experiences resembling that associated with the objects or scenes represented. Thus, sketches can be used to depict spatial scenes and convey the conceptions of reality (Wang et al., 2012).

- ✓ **Scenario Analysis**

Scenarios are widely used in requirements elicitation and as the name suggests are narrative and specific descriptions of current and future processes including actions and interactions between the users and the system (Mochal, 2008). Like use cases, scenarios do not typically consider the internal structure of the system, and require an incremental and interactive approach to their development. Naturally it is important when using scenarios to collect all the potential exceptions for each step. A substantial amount of work from both the research and practice communities has been dedicated to developing structured and rigorous approaches to requirements elicitation using scenarios. Scenarios are additionally very useful for understanding and validating requirements, as well as test case development (Cooke, 1994; Mochal, 2008).

- ✓ **Post-Project Reviews (PPR)**

The PPR technique aims to review both failed and successful projects to capture project knowledge by analysing the project, identifying the best practices and addressing the success and failure factors in a project (Kululanga and Kuotcha, 2008). This will lead to improve both the performance of organisations and their future projects as knowledge can be transferred to subsequent projects. Furthermore, they added this technique will enable involved individuals in projects to consult and learn from others who have done similar tasks in the past. The only drawback to this technique is that it does not consider how to capture knowledge during a project, which is the most important and valuable knowledge. PPR does not advice on how the captured knowledge should be disseminated and reused in future project; however, the beneficiaries of this technique are future projects, not current one, which makes the individuals reluctant to engage in activities (Kululanga

and Kuotcha, 2008). The effectiveness of this technique is a function of the quality of time allocated for involved individuals in projects toparticipate in PPR meetings (Kululanga and Kuotcha, 2008).

- ✓ **Questionnaires**

Questionnaires are much more informal, and they are good tools to gather requirements from stakeholders in remote locations or those who will have only minor input into the overall requirements (Zedtwitz, 2003). These questionnaires can also be used when you have to gather input from dozens, hundreds, or thousands of people.

- ✓ **Prototyping**

Prototyping is a relatively modern technique for gathering requirements. In this approach, you gather preliminary requirements that you use to build an initial version of the solution a prototype. You show this to the client, who then gives you additional requirements. You change the application and cycle around with the client again. This repetitive process continues until the product meets the critical mass of business needs or for an agreed number of iterations (Williams, 2007).

- ✓ **Observation**

This technique is especially helpful when gathering information on current processes. You may find, for instance, that some people have their work routine down to such a habit that they have a hard time explaining what they do or why. You may need to watch them perform their job before you can understand the entire picture. In some cases, you might also want to participate in the actual work process to get a hands-on feel for how the business function works today (Williams, 2007).

- ✓ **Building Information Modelling (BIM)**

The problem within the construction industry is the failure to deliver the client requirement due to inadequacy within the briefing process including among other issues, lack of systematic and structured methodology, less focus towards clients' real needs, ineffective usage of information technology (IT) and most importantly ;failure to provide clarity and traceability towards client requirement (Shahrin et al., 2010) . All these attributes provide vague and implicit client requirement which could be improve through an integrated process which clarified what the client values and delivering client requirements that reflects their needs. Client is the key to the whole construction process and understand their needs is paramount and it can be done by getting the brief right in order to meet client expectations and having an effective project delivery (Shahrin et al., 2010). Building information modelling can be acknowledged as a collaborative tool (Salmon, 2009; Singh *et al,* 2009) and it also allows the client and stakeholders of the project to link their

requirements to live data (Salmon 2009). BIM is believed to offer opportunities for dealing with clients more effective in capturing, translating and delivering client requirement issues and particularly in its use to clarifying project objectives, assist collaborative working and the clarification of objectives. The benefit of BIM is also related to the level of commitment given by the client (Howard & Bjork, 2007; Linderoth 2009) and training received by the architect (Kaner *et al*, 2008). The main point that needs to be established here is; BIM should be seen as a tool which needs both parties (the client and architect) to have the same vision of what they are getting (Shahrin *et al*, 2010). Bacerra-Fernandez et al., (2004) posit that knowledge capturing is a combination of knowledge elicitation and knowledge representation. In the context of this research however, elicitation and capturing are used interchangeably because they address the same purpose of extracting knowledge from a source. The following section looks at knowledge elicitation and the various wealth of techniques available in eliciting requirement knowledge.

Knowledge Elicitation (KE)

Knowledge elicitation involves the use of data collection techniques for certain disciplines such as cognitive science, counselling, education, knowledge engineering, management, philosophy, psychology and so on in gathering knowledge or information from people (Andersen and Taylor, 2010; Gavrilova and Andreeva, 2012). Knowledge elicitation adopts the use of certain techniques in eliciting knowledge or information from people and this knowledge is mostly tacit in nature.

Many of the knowledge capturing techniques identified in the course of this study have a correlation with those of the knowledge elicitation techniques as the aim of both techniques is to capture or elicit certain requirements or knowledge from people (Rollnick et al., 2007; Hashem, 2008; Gavrilova and Andreeva, 2012). This research will use the term KE and KC interchangeably. Two distinct roles have been identified in knowledge elicitation processes and these are expert and analyst (Waterman, 2004; Kendal and Creen, 2006). An expert is someone who has valuable knowledge that is of interest to an organisation, and thus needs to be elicited.

Knowledge management address employees with some sort of knowledge that is valuable to the organisation as "experts". The analyst on the other hand is someone who is responsible for eliciting knowledge from an expert. An analyst is an important characteristic from the knowledge engineering perspective, as they possess the skills and knowledge that enable then elicit knowledge from the expert. An analyst also has a mandate from an organisation to spend time and effort on knowledge elicitation, and holds responsibility for the success of this task. In relation to the traditional procurement route in the UK construction industry, the client is the one with the requirement knowledge which needs to be captured or elicited while the analyst is the architect using Knowledge capturing techniques or technologies in capturing the client's requirement (Gavrilova and Andreeva, 2012). A key difference between KE and Knowledge Management however, is that the role of analyst does not exist in the latter, however, Knowledge capturing during the client briefing process assumes a similarity with KE as it involves the use of certain

techniques by the architect in capturing or eliciting the clients requirements during the briefing process in order to produce a quality brief document.

Several years ago, the interest of knowledge engineering researchers has been primarily the techniques and tools that help knowledge capture, not only for the development of intelligent systems but also for knowledge management practices. These tools are concerned with knowledge elicitation procedures that facilitate knowledge sharing and reuse (Burge, 1996; Gavrilova and Laird, 2005; Voinov and Gavrilova, 2008). One major question that arises from the many techniques available is the challenge of choosing the appropriate knowledge capturing or elicitation method that would fit a specific purpose and its requirements. The importance of this research however, is the interaction between the architect and the client during the briefing process hence some techniques that do not involve engagement and interaction between these parties will be excluded (Coffey and Hoffman, 2003; Kwong and Lee, 2009). The methods of KE were divided into three categories such as the level of involvement of an expert and an analyst, and type of interaction/collaboration between them. Two of these three categories can be labelled as ‘‘passive’’ and ‘‘active’’ methods respectively (from the perspective of the level of involvement of an analyst as compared to the efforts of an expert), and the third category implies more or less equal involvement of both parties. By ‘‘active’’ (analyst-leading) methods the authors mean the techniques that require the active position of an analyst, who ‘‘pulls’’ the knowledge from the expert with the help of specially prepared questions. By ‘‘passive’’ (expertleading) methods the authors mean the techniques that imply that the analyst’s interference into the process in which the expert is engaged is very limited (Gavrilova and Andreeva, 2012). This research leans towards the active (analyst-leading) category where the architect takes full responsibility of capturing or eliciting the client’s requirement during the client briefing process.

Nevertheless, one of the Knowledge capturing techniques identified and tested using the questionnaire analysis is observation which is a good example of a ‘‘passive’’ method, where the role of the analyst is just to observe/listen and then analyze, though this technique requires very little interaction between the client and the architect.

(i) Analyst-leading methods.

One specific form of communication between the analyst and the expert is Interview, where the analyst asks a number of questions prepared in advance in order to gain a better understanding of a specific knowledge area (Belanovsky, 2003; Bradburn et al., 2004; Rollnick et al., 2007; Hashem, 2008). There are different views on interviews in journalism, healthcare, sociology, marketing and other sciences. The interview may have different levels of organisation (structured, unstructured, semi-structured) that gives the analyst different levels of freedom. Interview is the most popular technique because of its apparent simplicity of conducting.

However, experience shows that best practices in interviewing need years of training and practical fieldwork. The main mistakes are based on the short and superficial stage of preparation to this

method of knowledge elicitation (Gavrilova and Andreeva, 2012, Gavrilova, 1993). Due to their character, interviews are generally aimed at elicitation of tacit knowledge from individuals. Another technique is the use of questionnaire, which is a highly formalized method, targeted mainly at data collection. Andersen and Taylor, (2010) mention that questionnaires do not work at all for elicitation of tacit knowledge, as by their nature they address only already verbalized, formalized knowledge and do not allow for deeper probing. In such method, the analyst formulates a list of questions in advance and presents them to a number of experts who then responds by filling out the questionnaire.

(ii) Expert-leading methods.

Expert-leading methods can be split into individual-focused and collective methods. Types of individual-focused methods are observation and storytelling, while collective methods include round-table and brainstorming. The observation method implies that the analyst is located in direct proximity to the expert, observing closely his professional activities or their imitation. A video recording can be helpful given that the expert has provided consent. The key precondition of this method is the avoidance of any intrusion by the analyst into the work of the expert. This makes the method perceived as the only ‘‘pure’’ method, because the observer is excluded from interventions or influence on the cognitive process, this may develop some accidental unfolding of pieces of tacit knowledge (Gavrilova and Andreeva, 2012). Storytelling on the other hand seems to be a rather simple method. Storytelling is probably one of the oldest forms of knowledge sharing or transfer which can also be a good form of knowledge capture based on how the story delivery is made interesting. In order to be efficient, storytelling requires not only the expert’s ability to prepare and conduct lectures, but also the recipient’s ability to listen, transcribe and understand the material (Gibbs, 1989). On the one hand, the experience of experts (architect) varies and they may or may not have the required expertise and talent to tell stories. If the expert has storytelling experience, the knowledge transfer or sharing in the form of a story could represent a concentrated and structured knowledge fragment.

On the other hand, potential knowledge recipients may also differ in their capacity to absorb knowledge, which could also be a function of the quality of the story delivered. Storytelling also allows a significant degree of freedom; however, the topic and objectives of the story should be clearly formulated in advance (Gavrilova and Andreeva, 2012). The round-table method is used while engaging a discussion on a given topic by a number of experts, which have equal right in giving their opinions or suggestions. The number of participants can vary from three to seven.

The analyst is required to make the additional effort of both an organisational (e.g. preparation of location, coordination of time, place, etc.) and a psychological kind (e.g. ability to input relevant comments, good memory for names, etc.). When transcribing and analyzing records of round-table discussions, the peer pressure effect, along with established relations between participants, should be carefully considered (Andersen and Taylor, 2010). The brainstorming method is aimed at

facilitating new ideas void of any criticism. One rule of the brainstorming session is the prohibition of criticism as it is believed to impede creative thinking, so the essence of brainstorming is to divide the process of idea generation from critical analysis and valuation of the ideas that emerge. A valuation of ideas accumulated during the brainstorming session is usually done by a group of experts who have not participated in the session. The method is exciting but not very fruitful from the knowledge elicitation point-of-view, and also because the traditional procurement strategy is largely characterised by the major involvement of the architect and client (Gavrilova and Andreeva, 2012). The next section discusses on the importance of KC and why this Knowledge Management process needs to be given adequate attention in the construction industry.

Importance of Knowledge Capturing

As the global economy begins to recover and competition increases, companies are more stressed than ever due to increasing complexity and plant incidents and adding to the stress are the continuous departures of experts from the industry (Jallow et al., 2008). A strong majority of the existing workforce will be eligible for retirement in the next 10 years, predict experts, leaving a large vacuum of needed professionals in the energy industries where there are already shortages. As such, it has never been more important than now to capture the knowledge from these professionals and make it readily shareable before the expertise of their experience is lost forever. Not only is it important to preserve the knowledge, but the real value is derived from applying it in decision support applications to enhance the role of the organisation's personnel in the event of abnormal conditions (Jallow et al., 2008). In the construction industry, buildings are expensive and long-lasting acquisitions. For the organisations which occupy them, good buildings can result in high productivity, a positive working environment and high staff morale, with the reverse being true of poorly-performing buildings. However, the costs of disposing of a poorly performing building and obtaining a satisfactory replacement can be high and sometimes prohibitive.

Good architects will do their best to give clients the buildings they want. However, if they are unable to determine what clients really need their task is difficult, if not impossible. This is where capturing client's requirements for a good briefing come in. It seeks to minimise the likelihood of a client receiving an unsatisfactory building by ensuring that project requirements are fully explored, captured and communicated as clearly as possible. Whilst good briefing cannot guarantee that a building will be perfectly suited to its occupants, it can help avoid serious mistakes (Constructing Excellence, 2004). According to Knowledge Management online (2005):

(i) Effective knowledge capturing has the capacity to reduce costs. Most individuals, teams and organisations are today continually 'reinventing the wheel'. This is often because they simply do not know that what they are trying to do have already been done by elsewhere. They do not know what is already known, or they do not know where to access the knowledge. Continually reinventing the wheel is such a costly and inefficient activity, whereas a more systematic reuse of knowledge will show substantial cost benefits immediately.

(ii) Effective knowledge capturing can increase our speed of response as a direct result of better knowledge access and application**.** Effective knowledge management, using more collective and systematic processes, will also reduce our tendency to 'repeat the same mistakes'. This is, again, extremely costly and inefficient.

(iii)*Effective knowledge capturing can improve quality of products and/or services***.** Better knowledge of client's requirements, stakeholder needs, customer needs, employee needs, industry needs, can improve and strengthen relationship which will positively impact on the overall delivery of the project. The benefits of knowledge capturing for improved excellence, is simply 'one side of the coin', as there are more benefits and importance it generates for those who use it effectively.

(iv)Effective knowledge capturing, especially those used in creating knowledge, is the driver for innovation. Increasingly, products and services are becoming 'smarter' and more knowledge based, hence our ability to better collaborate in physical and virtual teams, as knowledge workers, is driving the process of new knowledge creation. Ideas can now be turned into innovative products and services much faster. Organisations are learning faster, and that means that individuals are learning faster. People are developing their competencies and confidence faster in organisations that practice effective knowledge capture in their knowledge management processes (KM online, 2005).

The operational definition of knowledge capturing for this research is "Knowledge capturing is the use of knowledge capturing techniques to accurately capture client's tacit knowledge in the form of requirements during the client briefing process for improved project performance in relation to client satisfaction. Some of the factors described in the operational definition have already been addressed in this session such as the various techniques used in knowledge capturing, however, the subsequent sections sheds more light on the role of Knowledge Management especially Knowledge capturing in the construction process and client/client briefing process (Jallow et al., 2008). Researchers have investigated theoretical findings to help overcome issues that exist in implementation of Knowledge Management in construction industry. Having discussed the role of knowledge capturing in KM, the next section seeks to examine the barriers affect the use of these Knowledge capturing techniques in organisations. It is therefore good practice to identify what these barriers are in order to address them.

Barriers and Enablers to Knowledge capturing Process

The most common barriers to knowledge capturing include:-

(i) Having no proper guideline or process for lessons learned documentation. Williams (2007) confirmed lack of guideline as a barrier to lessons learned documentation. Potential strategies for overcoming this barrier include having a better process of sharing knowledge as this would benefit the firm or organisation (Martensson, 2000). It is also suggested that appropriate interventions and mechanisms such as technological networking tools would

facilitate knowledge capturing (Wong, 2005). Fuller et al. (2011), suggests that finding appropriate ways of capturing and embed learning emerging from projects is important to the success of any construction project (Shokri-Ghasabeh and Chileshe 2013).

(ii) Without the *proper management support* knowledge capturing has been shown to be positively associated with employees' perceptions of a knowledge capturing culture and willingness to share same (Lin, 2007). Lack of senior management support which may directly cause or magnify the other capturing barriers, is one of the major barriers to organisations performing effectively as a result of inadequate capturing process (Carillo et al., 2004; Crosman, 2002; Pan and Flynn, 2003) (Shokri-Ghasabeh and Chileshe 2013).

(iii) *Lack of employee time.* According to Williams (2007), lack of time available to undertake capturing lessons learned is a barrier that was identified by Keegan and Turner (2001) and Von Zedtwitz (2002). Similarly, in the survey conducted by Carillo et al., (2004), 67.9 per cent of the respondents identified "not enough time" as a main barrier to learning which is similar to Williams' (2007) statistics (67 per cent). The recommended strategy for overcoming this barrier involves the freeing up time for their employees to perform Knowledge Management and organisation learning activities such as knowledge sharing (Wong, 2005). "Time" has also been identified as one of the critical elements in the creation and implementation of a Knowledge Management strategy (Martensson, 2000) (Shokri-Ghasabeh and Chileshe 2013).

(iv) Another barrier identified is *Lack of human resources.* Human resources are so critical in the learning process that Bresnen et al. (2002) considered them as one of the key factors enabling organisational learning. Researchers have identified the following human resource related causes which result in not having eligible human resources to capture constructive lessons learned; Lack of attention, personal interest and ability (Von Zedtwitz, 2002), Insufficient willingness for learning from mistakes of the person involved (Schindler and Eppler, 2003), Lack of incentives (Bresnen et al., 2002) just to mention a few (Shokri-Ghasabeh and Chileshe 2013). Carrillo et al., 2012 elucidated that in the process of capturing clients requirements during the briefing process, there exist certain barriers that affect the successful capturing of clients requirements using Knowledge capturing techniques.

Other barriers include:

(i) Inadequate communication,
(ii) Inexperienced Clients,
(iii) Inadequate identification and representation of needs and requirements during the briefing process

Unstructured approaches for knowledge capturing (Wang and Noe, 2010) and lack of process for knowledge capture is another essential protocol that needs to be addressed as many Knowledge capturing process does not take into consideration the process involved in knowledge capturing.

This should include a pre-process and a post process review process and should be adequately documented for reuse in the future. Other factors as identified by (Shokri-Ghasabeh and Chileshe 2013, Greenes 2006, Carillo et al., 2012, Carillo et al., 2004) include;

(i) Misunderstanding and misinterpretation of client needs and requirements
(ii) Communication gaps between client and architect
(iii) Lack of proper documentation and or changes
(iv) Lack of proper participation of client in the briefing process
(v) Inadequate attention given to the wealth of techniques available
(vi) Lack of process knowledge for capturing knowledge
(vii) Lack of Trust
(viii) Lack of Knowledge of the architect
(ix) Lack of good Relationship

Greened (2006) further added that it's been observed in some organisations that certain barriers and problems occur during the implementation phase of knowledge capturing, some of these barriers include;

(i) Trying to capture too much - Knowledge capture efforts should focus on what customers for that knowledge need, and not attempt to capture everything that is known about a particular topic. The basics of how to do something or foundational knowledge are probably already documented somewhere in a manual, guide, etc. Emphasis should be on what isn't widely known, new learning, and other knowledge that isn't typically documented in the usual manner.
(ii) Underestimating time and effort - It's a laborious process to harvest knowledge and present it in a manner that people can make sense of it for re-use and adoption. For example, it may take eight hours to distil a handful of powerful knowledge nuggets or insights from a one hour interview with an expert.
(iii) Capturing knowledge that isn't used – unless you have identified what the potential customers for the captured knowledge are interested in, there's a good chance it's not what others will find useful.
(iv) Assuming one size fits all - when it comes to methods for presenting captured knowledge it's important to understand people's preferences as receivers of knowledge. Some people find reading text a useful way to learn something. Others prefer to learn by listening and observing. In these cases, an audio version of the knowledge shared by the source and a video of someone speaking or performing an activity are often very effective (Greenes, 2006). Collison and Parcell (2001) and Achammer, (2009) suggest that knowledge capture means capturing knowhow in such a way that it can be reused. A few challenges have been identified through a thorough review of literature from the social and technology perspective for knowledge capture.

(v) Lack of capturing of clients and (or) supply chain knowledge in an effective formal way. Most knowledge capturing processes are not given the adequate attention and formality required to make the process efficient
(vi) Type of organisational culture encouraged for knowledge capture. If an organisation does not create a suitable culture that supports knowledge capturing, this could demean the potency and power of knowledge capturing in an organisation.
(vii) Most knowledge capturing process does not consider wealth of techniques available to adequately capturing knowledge. During requirement elicitation in client briefing, several knowledge capturing techniques need to be identified and used in order to ascertain the effectiveness of such techniques.

The benefits of proper Knowledge capturing should also be identified and spelt out to encourage the organisation see the importance of properly capturing knowledge. Lack of time allocated to knowledge capturing process (William and Walter 2014). The more time allocated to the knowledge capturing process, the more quality document would be produced from the process. This can be made possible by the support of management. Lack of management support can also contribute to less effective knowledge capturing process (William and Walter 2014). Barriers to knowledge capturing in the construction industry shows that this could be a major deterrent to the progress of construction projects and delivery of quality output. Some organisations feel that the knowledge capture Return on Investment (ROI) figures do not add great value to the organisation hence are seen a "luxury item", and therefore something to be considered in the future (Lee et al., 2005). This has made other organisation adopt the "wait and see" approach with regards to the uptake of knowledge capture initiative. This approach has created a gap and a continued loss in vital knowledge capital and competitive advantage daily (Lee et al., 2005).

Challenges Associated with Knowledge Capturing

Collison and Parcell (2001) identified a few challenges through a thorough review of literature from the social and technology perspective of knowledge capturing. Some of these challenges include;

(i) **Social Issues** which is related to issues such as culture, people, motivation, communication and network issues. Cultural challenge has been identified as one of the main challenges to knowledge capturing in the construction industry. Many experienced construction professionals see knowledge as power which makes them horde knowledge and unwilling to share.
(ii) **People Issues.** In small organisations, most knowledge capturing is done through informal networks, but as organisations grow, these networks cannot possibly be aware of the entire knowledge. They may result to getting some experts or contractors repeatedly which then affects them their fully responding to their duties. For example, some employees find it difficult to access key documents without the help of experts within each department,

leaving the experts feeling overwhelmed by calls that make poor use of their time. It is however advantageous to capture the knowledge of experts to guide seekers to their appropriate documents and experts.

(iii) **Motivation Issues**. Knowledge capture activities are to be rewarded in an appropriate and meaningful way. This has been a challenge for some organisations. Motivation has been identified as a major factor that helps construction personnel to exploit knowledge capture. However, organisation team leaders and those involved in job client and matching skills to jobs, need to devise means necessary to make organisational staffs interested in their jobs. They would also need to understand and accommodate the needs and expectations of these staffs. Training however, can be seen as a motivation tool for employees especially when the knowledge is highly needed in making their job successful.

(iv) **Communications and Networks Issues:** The geographical separation of sites, both from one another and from the regional offices, would have a detrimental effect on the capture of knowledge because of the importance placed on social networks and contacts. The establishment of a network throughout the organisation (each with its own internal and external, networks and contacts) provides a base of knowledge and support that individual employees could draw upon to help them diffuse ideas and expertise within their own context of work. This seemed to be a challenge for four organisations in the study that had regional offices spread across UK.

(v) **Organisational structures**: Egbu's (2000) carried out a study which asserted that organisational structures were found to influence knowledge capturing. He added that the size and structure of the organisation enables the use of certain tools (techniques and technology) for knowledge capture that may encourage/discourage cross-regional and cross-project codification.

(vi) **Financial Issues:** Cost may be in conflict with the pressures of a specific project, such as completion on time and within budget. If there are inappropriate or non-existing incentive structures to address this inherent conflict, knowledge capture policies would be inadequate. Capturing knowledge or requirements properly can reduce the risk of cost and time overrun in a project. In addition, the process of accumulating and documenting (i.e. capturing) 'lessons learned' is more tactical in nature, as it involves costs attributable to a specific project (for example employee time to document and compile reports).

(vii) **Process Issues:** No single approach to knowledge capture can suit every organisation. It is good knowledge to know however, that knowledge codification also has its merits. In client briefing, the aim of the professional is to capture and codify the tacit knowledge of the clients in form of requirement. Without codification, the ability to allow explicit knowledge to disseminate is severely limited. From an organisational perspective, the capture and maintenance of knowledge can be time-consuming, labour intensive, and costly. It is a challenge to keep track of discussions, decisions, and their rationale when teams work on short term projects (Hari et al., 2004). This research take into consideration the different barriers and challenges to Knowledge capturing which are essential in

understanding the strategy to be used in reducing, avoiding or exploiting them. Since the overall aim of this research is the satisfaction of the client in the UK construction industry, the study aim to use effective Knowledge capturing techniques to capture client's knowledge in form of requirements during the briefing process in order to limit negative barriers and challenges and exploit positive ones.

Evaluating the Expert

Indicators of expertise:

The expert commands genuine respect. The expert is found to be consulted by people in the organization, when some problem arises. The expert possess self-confidence and he/she has a realistic view of the limitations. The expert avoids irrelevant information, uses facts and figures.

The expert is able to explain properly and he/she can customize his/her presentation according to the level of the audience. The expert exhibits his/her depth of the detailed knowledge and his/her quality of explanation is exceptional. The expert is not arrogant regarding his/her personal information.

A single expert is ideal in building a simple KM system with only few rules and ideal when the problem lies within a restricted domain. The single expert can facilitate the logistics aspects of coordination arrangements for knowledge capture. In such circumstances the problem related/personal conflicts are easier to resolve. The single expert tends to share more confidentiality.

3.1.2 Disadvantages of working with a single expert:

- ✓ The single expert usually provides a single line of reasoning.
- ✓ They are more likely to change meeting schedules.
- ✓ Often, the expert's knowledge is found to be not easy to capture.
- ✓ The knowledge is often found to be dispersed.

3.1.2 Advantages of working with multiple (team) experts:

- ✓ Expert Evaluation
- ✓ Complex problem domains are usually benefited.
- ✓ Stimulates interaction.
- ✓ Listening to a multitude of views allows the developer to consider alternative ✓ ways of representing knowledge.
- ✓ Formal meetings are sometimes better environment for generating thoughtful ✓ contributions.

3.1.3 Disadvantages of working with multiple (team) experts:

- ✓ Disagreements can frequently occur.
- ✓ Coordinating meeting schedules are more complicated.
- ✓ Harder to retain confidentiality.
- ✓ Overlapping mental processes of multiple experts can result in a process loss.
- ✓ Often requires more than one knowledge developer.

3.1.5 Experts qualifications:

- ✓ The expert should know when to follow hunches, and when to make exceptions.
- ✓ The expert should be able to see the big picture.
- ✓ The expert should possess good communication skills.

- ✓ The expert should be able to tolerate stress.
- ✓ The expert should be able to think creatively.
- ✓ The expert should be able to exhibit self-confidence in his/her thought and actions.
- ✓ The expert should maintain credibility.
- ✓ The expert should operate within a schema-driven/structured orientation.

Expert Evaluation

- ✓ The expert should be able to generate enthusiasm as well as motivation.
- ✓ The expert should share his/her expertise willingly and without hesitation.
- ✓ The expert should use chunked knowledge.
- ✓ The expert should emulate an ideal teacher's habits.
- ✓ Experts levels of expertise:
- ✓ Highly expert persons.
- ✓ New experts.
- ✓ Capturing single vs multiple experts' tacit knowledge:

Developing a Relationship with Experts

Creating the right impression: The knowledge developer must learn to use psychology, common sense, and technical as well as marketing skills to attract the experts respect and attention.

Experts are usually found to use one of the following styles of expression:

Procedure type: These type of experts are found to be logical, verbal and always procedural.

Storyteller type: These type of experts are found to be focused on the content of the domain at the expense of the solution.

Godfather type: These type of experts are found to be compulsive to take over.

Salesperson type: These type of experts are found to spend most of the time dancing around the topic, explaining why his/her solution is the best.

Fuzzy Reasoning and the Quality of Knowledge

Sometimes, the information gathered from the experts via interviewing is not precise and it involves fuzziness and uncertainty.

The fuzziness may increase the difficulty of translating the expert's notions into applicable rules.

Analogies/Uncertainties:

In the course of explaining events, experts can use analogies (comparing a problem with a similar problem which has been encountered in possibly different settings, months or years ago).

An expert's knowledge or expertise represents the ability to gather uncertain information as input and to use a plausible line of reasoning to clarify the fuzzy details.

People may use different kinds of words in order to express belief.

Belief, an aspect of uncertainty, tends to describe the level of credibility.
These words are often paired with qualifiers such as highly, extremely.

Understanding experience:

Knowledge developers can benefit from their understanding/knowledge of cognitive psychology.

When a question is asked, then an expert operates on certain stored information through deductive, inductive, or other kinds of problem-solving methods.

The resulting answer is often found to be the culmination of the processing of stored information.

The right question usually evokes the memory of experiences that produced good and appropriate solutions in the past.

Fuzzy Reasoning & Quality of Knowledge Capture

Sometimes, how quickly an expert responds to a question depends on the clarity of content, whether the content has been recently used , and how well the expert has understood the question.

Problem with the language:

How well the expert can represent internal processes can vary with their command of the language they are using and the knowledge developer's interviewing skills.

The language may be unclear in the following number of ways:

Comparative words (e.g., better, faster) are sometimes left hanging.

Specific words or components may be left out of an explanation.

Absolute words and phrases may be used loosely.

Some words always seem to have a built-in ambiguity.

Knowledge Capturing Techniques

They include:-

1. **On site observation**: Onsite observation gives the knowledge to the students within the working world of the expert, in the form of visuals and live exposures.
   On-site observation or action protocol involves knowledge-capture through direct observation. By observing the expert's actions and work, the knowledge developer (KD) is able to witness first-hand the processes in completing the tasks and responsibilities of the expert. During the process, the knowledge developer is able to ask questions but does not correct or modify, in any way, what the expert is doing.
   This process enables the KD to witness the expert's work first-hand, but also poses problems:
   (a) The KD's presence may be distracting to the expert, affecting adversely the expert's work.

(b) Possible problem with the accuracy or completeness with which the knowledge captured is recorded, since there exists a gap from when the knowledge is observed and when it is documented.

(c) Some experts do not like to be observed. They prefer to explain rather than demonstrate their expertise.

(d) The reaction of others in the observation setting can be a distracting problem

2. **Brainstorming:** Brainstorming is an unstructured approach to generate ideas about a problem for a creative solution. E.g.: group discussions, meetings.

   There are several steps involved in brainstorming:

   a. Introduction of the session along with the problem to be addressed.
   b. Prompt the experts to generate ideas. Ideas need to be given by the group on how to solve the problem.
   c. Watch for signs of convergence. Once the ideas begin to focus on one or a few solutions, the group should come to a consensus. If a decision cannot be made, a vote could decide the solution. Throughout the session, all ideas should be considered and none cut short or shot down.

   Students may come up with all kinds of brainstorming examples. For example, one topic might be "How many exams should be given in this course?" "How should the text material be covered?" "How should course projects be solved—individually or via teams?"

3. **Delphi method**: It is a survey of experts. A series of questionnaires are used to pool the expert's responses in order to solve a difficult problem. E.g.: Need based curriculum of MSBTE.

   Delphi essentially implies a method for structuring a group communication process so that it is effective in allowing the group as a whole deal with complex problems [8]. Knowledge from multiple KS is gathered through an iterative survey process to find solution to crucial problems in a specific knowledge domain.

   In describing the original Delphi technique which was entirely paper based, [9] explains that in the Delphi technique "Iterations refer to the feedback process. The process was viewed as a series of rounds; in each round every participant worked through a questionnaire which was returned to the researcher who collected, edited, and returned to every participant a statement of the position of the whole group and the participant's own position. A summarization of comments made each participant aware of the range of opinions and the reasons underlying those opinions".

   Breaking this statements into an algorithm gives:

   Step 1: A problem domain is identified and the problem defined.

   Step 2: Experts are given ample explanation of the problem.

   Step 3: Experts present their opinion on viable solutions to the problem

   Step 4: Moderator accepts their solution and summarizes it.

   Step 5: Moderator presents these summaries back to the each of the expert for further clarification.

   Step 6: Steps 3, 4 & 5 are repeated a few times and eventually a final summary is prepared when the opinions have converged into a consensus – the final solution.

4. **Decision Tree**: It is an alternative solution in the decision making graphic tool used to evaluate each alternative solution in the decision-making

   A decision tree model consists of a set of rules for dividing a large heterogeneous population into smaller, more homogeneous groups with respect to a particular target variable (Larose, 2005).

   The target variable is usually categorical and the decision tree model is used either to calculate the probability that a given record belongs to each of the categories, or to classify the record by assigning it to the most likely class. Decision trees can also be used to estimate the value of a continuous variable, although there are other techniques more suitable to that task (Larose, 2005).

5. **Protocol Analysis**: Sometimes the experts may or may not be able to deliver the knowledge to satisfy the knowledge seeker, then the best method is to adopt the alternative ways. E.g.: Synchronization of theory and practical sessions.

   Protocol analysis is a technique which requires asking the expert to perform a knowledge-based task, and to explain why he's doing each action as he performs it. The expert's words are then transcribed, and the result is known as a protocol. The technique is best carried out while the expert is solving a real problem, although it can be done by retracing a previous scenario. If there are good reasons why the expert should not be distracted by a knowledge engineer while performing the task (as in a case where knowledge engineers elicited knowledge from air traffic controllers), then "shadowing" is possible, in which one expert performs the task and another expert describes what is being done.

   This technique is good for capturing what an expert really does, as opposed to what he claims he does.

   It's good for working with experts who are not used to discussing their work in abstract terms; asking about concrete actions nearly always elicits a response. It's also good for finding out what interactions take place with people or information sources, and whether there are any real-time restrictions on these interactions. The role which the expert takes is particularly important in determining how the prospective KBS should offer its advice. Does the expert act as an oracle, in which his advice is considered superior to the opinions of anyone consulting him? Is the expert a servant, attending to the needs of those who call on his time? Or are the expert and his 'clients' on an equal footing, with the best course of action being negotiated between them?

   Knowledge which can be elicited from this technique is normally represented as a sequence of actions which are performed, with some description of why those actions are performed, and what alternative states might occur. This can be represented in a flow chart, a decision tree, a Common KADS inference structure, or another similar diagramming technique.

   Drawbacks of this technique include the need for a transcript (although analysis is no more onerous than for a structured interview), the need for video recording and/or very careful note taking, and the problems of interfering with an expert's problem solving process by asking about it. However, none of these problems are serious enough to prevent it being a good weapon in the knowledge engineer's armory.

6. **Decision making techniques**: It identifies and selects a course of action to deal with a specific problem. E.g.: Organization of an event such as competitions, conferences and training programs.
   Majority rule refers to a decision-making rule in which each member of the group is given a single vote and the option receiving the greatest number of votes is selected. This technique has remained popular, perhaps due to its simplicity, speed, ease of use, and representational fairness. Research also supports majority rule as an effective decision-making technique. The robust beauty of majority rules in group decisions. However, those who did not vote in favor of the decision will be less likely to support it.
7. **Consensus decision-making**: Involves making a choice from available or generated alternatives. E.g.: In a meeting, the consensus of all the members of the committee don‘t come to the same conclusion, because of differences, but commitment of the members to the implementation of the solutions is assured.

   Consensus is another decision-making rule that groups may use when the goal is to gain support for an idea or plan of action. While consensus tends to require more time, it may make sense when support is needed to enact the plan. The process works by discussing the issues at hand, generating a proposal, calling for consensus, and discussing any concerns. If concerns still exist, the proposal is modified to accommodate them. These steps are repeated until consensus is reached. Thus, this decision-making rule is inclusive, participatory, cooperative, and democratic. Research shows that consensus can lead to better accuracy. Why convene rater teams: An investigation of the benefits of anticipated discussion, consensus, and rater motivation. It helps members feel greater satisfaction with decisions. Cognitive diversity and consensus in group decision making: The role of inputs, processes, and outcomes. However, groups take longer with this approach, and if consensus cannot be reached, members tend to become frustrated. Can you have too much of a good thing? The limits of voice for improving satisfaction with leaders.

   Consensus decision making usually follows brainstorming. It is effective if and only if each expert has been provided with equal and adequate opportunity to present their views. In order to arrive at a consensus, the knowledge developer conducting the exercise tries to ally the experts towards one or two alternatives. The knowledge developer follows a procedure designed to ensure fairness and standardization. This method is democratic in nature. It can be sometimes tedious and can take hours.
8. **Nominal group technique (NGT):** An alternative to consensus technique the nominal group technique provides an interface between consensus and brainstorming. E.g.: Governing body committee, Board of studies of autonomous polytechnics.

   Nominal Group Technique (NGT) was developed to help with group decision making by ensuring that all members participate fully. NGT is not a technique to be used routinely at all meetings. Rather, it is used to structure group meetings when members are grappling with problem solving or idea generation. It follows four steps. First, each member of the group begins by independently and silently writing down ideas. Second, the group goes in order around the room to gather all the ideas that were generated. This process continues until all the ideas are shared. Third, a discussion takes place around each idea, and members ask for

and give clarification and make evaluative statements. Finally, group members vote for their favorite ideas by using ranking or rating techniques. Following the four-step NGT helps to ensure that all members participate fully, and it avoids group decision-making problems such as groupthink

9. **Concept mapping**: It is unique tool to represent the knowledge in graphs. This tool helps in designing complex structures to design large websites. It consists of nodes and links. Nodes represent a concept and a link represents the relationship between the concepts. E.g.: figure showing the relationship between explicit and tacit knowledge.

   This is a tool used for knowledge capture. The domain expert classifies and categorizes a problem domain using his/her own model. The grid is used for capturing and evaluating the expert's model. Two experts (in the same problem domain) may produce distinct sets of personal and subjective results.

   The grid is a scale (or a bipolar construct) on which elements can be placed within gradations. The knowledge developer usually elicits the constructs and then asks the domain expert to provide a set of examples called elements. Each element is rated according to the constructs which have been provided.

10. **Black boarding**: Bringing a group of experts together in a room to solve a problem using the blackboard as their workspace. The essence of this technique is the independence of expertise in an atmosphere that discourages compliances or intimidation.

    There are several characteristics of black boarding:

    a. Black boarding allows for diverse approaches to problem solving, thus allowing the various viewpoints of multiple experts to be accounted for.
    b. Black boarding must also use a common language (including charts, diagrams, etc.) so all may communicate on the same level.
    c. Flexibility exists concerning the representation of information as long as all the experts can understand.
    d. The blackboard stores all the knowledge input and provides easy access to the information.
    e. Black boarding is organized. Since only one expert may respond at a time, the session becomes more controlled and organized.
    f. The structure of black boarding promotes a step-by-step building process, since each expert adds to or refines what the previous expert did.

    The basic model is comprised of the knowledge sources, the blackboard, and a control mechanism. The knowledge source is the expert, the blackboard is the memory structure/database, and the control mechanism controls the flow and pattern of the problem solution.

11. **Problem solving**: It is an important skill, which determines whether a problem is solved properly or not. This also depends on the individual's ego state. This skill is required at all levels-institute heads, staffs, and supervisors, students at different categories in engineering and non-engineering sections.