

Faculty of Engineering and Built Environment

Department of Construction Economics and Management



**APPLICATION OF THE FAST MODEL FROM VALUE ENGINEERING TO
CAPTURE AND COMMUNICATE PROJECT LESSONS LEARNT**

RESEARCH REPORT

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**A Research Report Submitted to the Department of Construction Economics and
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Abstract

Purpose – This research investigated the advantages of using a diagramming tool such as the Functional Analysis System Technique (FAST) model to enhance the effectiveness of capturing and communicating lessons learnt onto future projects. The research looked at current ways of capturing tacit knowledge within a projectized organisation to get a clearer picture and propose alternatives on how the knowledge can be communicated and transferred to novice team members in future. The idea is to capitalise on the graphical nature of the FAST model, presupposing the human mind can comprehend graphical tools better than going through long tedious reports.

Design – Focus Group Sessions were conducted using two groups from different business units within a project management and consultancy firm in South Africa. The participants represented the various project stakeholders that comprise a project team. The focus group session consists of a presentation on the background of the study and the FAST process. This served as a brainstorming session and a typical project scenario in capturing and communicating lessons learned was presented to the participants. The first diagram showed the activity log list as found on a project site for a particular lesson learnt process. The second diagram showed the same lesson learnt process presented in a FAST diagram. Afterwards, the participants evaluated the effectiveness of the FAST model to capture and communicate lessons learnt in a project environment. The responses were compiled and findings presented in table format.

Findings – The analysis of the data and the responses of the participants proved that the FAST diagram can enhance the effectiveness and efficiency of capturing and communicating lessons learnt. This knowledge transfer initiative provides cost benefits as it improves the project execution and competitive advantage of the organisation. Project execution efficiency is improved by codifying tacit knowledge and avoiding repeating the same mistakes on projects.

Practical Implications – Developing a culture of capturing lessons learnt on a project as the execution phase unfolds can be a challenging exercise. Most companies pay less or no attention at all to capturing lessons learnt. However lessons learnt documentation must be supported by a quality control system that is robust and allows easy navigation within a repository. The FAST model empowers project custodians through its dynamic structure to document activities on the project. This ensures the FAST diagram is continuously updated to tie in with the changes on the ground as the project unfolds.

Limitations: The results were generated in a controlled environment and require confirmation through longitudinal research of the use of FAST for this purpose in practise on live projects.

Keywords: lesson learnt, knowledge transfer, data repository, Function Analysis Systems Technique, tacit knowledge, Value Engineering, knowledge management, activity log-list

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1 Introduction

1.1 Introduction

Projects are based on the successful interaction of multiple disciplines; the ultimate aim is to provide the best solutions and answers from a global and diverse team (PMI, 2015). Projects go through many stages as they evolve to get to the final product but the process is temporary. This is a characteristic trait of all projects. In addition, people working on the project are usually redeployed after the project is complete. The human capital is deployed to other projects or departments within the organisation. In addition, large projects experience substantial team change at the end of a phase or large work package. This creates a problem as the knowledge and experience gained on the project is lost due to staff turnover because project specific information resides in the people's heads. The knowledge loss calls for a robust knowledge management system that enables capturing of lessons learned from one project and transferring the experience and information onto future projects, or phases.

Knowledge transfer is the methodical replication of the expertise, wisdom, insight, and tacit knowledge of key professionals into the heads and hands of their co-workers (PMI, 2015). Knowledge, or know-how, has to do with the process of learning, understanding, and applying information (Soo *et al.*, 2002). Knowledge is a very important resource for preserving valuable heritage, learning new things, solving problems, creating core competences, and initiating new situations for both individual and organizations now and for the future (Liao, 2003). Knowledge has long been recognized as a driver of productivity and economic growth (PMI, 2015). The most valuable and dynamic employees with experience, initiative, creativity, and a commitment to excellence possess the type of knowledge that sets an organization apart from the competition (PMI, 2015).

Much of the knowledge of project activities lies in people's heads. This makes it difficult to capture details of these project activities into repositories accessible to other team members. Some organisations have a formal culture of capturing lessons learned. This can be in a form of close out reports or project activity data, logged onto an information portal during the close out phase. The project activity log-list is used as an input to the project close out report. Other organisations rely on casual methods of capturing lessons learned through informal "coffee connection" discussions. When organizations have a culture that values knowledge transfer, they are far more successful at knowledge management (PMI, 2015). For the organisation to

use knowledge, it has to be supported by easy to use data repositories that effectively contribute to knowledge transfer. In some instances, cultures tend to stifle the transfer of knowledge within the organisation. As a consequence knowledge fades due to failure to transfer it through the organisational barriers. Even in an organisation with a supportive culture of appraising projects with documented lessons learned stored on an informational portal, there are several challenges in transferring and accessing the relevant data. The way people naturally are willing to share knowledge with each other, and how that willingness is related with the organizational culture builds a sense of trust amongst team members (Pemsel and Wiewiora, 2013). The failure of many knowledge transfer systems is often because of cultural factors rather than technological shortcomings (Ajmal *et al.*, 2008). However, the main challenge comes in analysing the captured lessons and in extracting useful learning points that are applicable on another project in future. Information on a portal or other recorded media may not be readily accessible due to complex navigational process that the systems pose to the end user.

The traditional methods of capturing lessons learnt often lack senior management buy in and are not entirely integrated into the organisational strategy. Even though the value of lessons learned documentation and communication is evident and formally recognised, the discipline is often neglected or only some elements of it are performed. Information about project management processes, best practices or project results can be written down, stored in information systems and becomes knowledge only if it is available to project team members for practical application (Pemsel and Wiewiora, 2013). The important factor is to have knowledge management integrated into organisational strategy. Supported by obtaining senior management buy in, this brings tangible results for the organisation. For the above to be true it entails analysing the current learning and knowledge management patterns within the project setup, to get a more lucid picture of how information is transferred and shared amongst project team members. The results of the analysis generate the problem solving process that helps address the needs identified. One such technique that meets this requirement is the Functional Analysis System Technique (FAST) model.

Pioneered by Charles Bytheway, the FAST model is a graphical tool for examining and illustrating the functional logical interconnection of facets that make up a system (Bonghezi, 2009). The FAST model is a tool that was developed to improve the Value Engineering (VE) methodology. For the sake of simplicity, the terms Value Engineering (VE) and Value

Management (VM) will be loosely used interchangeably to refer to the same concept. Graphical tools are easier to comprehend than long reports and some information portals do not offer easy navigational processes with data repositories of this nature. The disadvantage of reports is that, critical information applicable to a project can be omitted and not transferred properly due to poor ease of navigation within a data repository. The ultimate goal is to realise value by identifying opportunities and improving the structured thought process of functional interactions of subsets within the system.

The purpose of this study is to apply the FAST model to capture and communicate project lessons learned. To accomplish the aforementioned purpose of the study, the author will select a project within his organisation and compare the manner in which lessons learnt are captured using the traditional method such as the project activity log-list. The author will repeat the exercise using the FAST model for the same activity of the lesson learnt process. The outcome of the two systems will be presented to two different groups who will be evaluated and give feedback on the level of understanding of the project activities. The feedback reports will be used as a basis to compare the traditional model and the FAST model. The comparison will focus on the effectiveness of the FAST model in capturing and articulating lessons learned amongst team members within an organisational setup. The focus on this research shall revolve on projects within consulting firms. However, the ideas and body of knowledge to be developed in this research relating to the effective communication of lessons on a project is applicable in any project related environment. A consulting engineering firm was picked for the purpose of the research on the basis of easier proximity to the data gathering exercise that is relevant to this study.

Sharing lessons learned in a structured way documenting them and assuring their proper dissemination raise the rate of success for the future projects of the organisation (Bonghezi, 2009). The outcomes of the investigation and test will lead to a conclusion whether there is value in using the FAST model. Furthermore, the findings should help in establishing the improved efficiency and effectiveness of capturing and communicating project lessons learnt by utilising the FAST diagramming tool.

1.2 Background

The benefits of knowledge transfer have long been recognized in project-based organizations, its effectiveness is often suboptimal because knowledge created during projects is frequently misplaced (Norton and McElligott, 1995). Learning and knowledge are intertwined in an

iterative, mutually reinforcing process. While learning (the process) produces new knowledge (the content), knowledge impacts future learning (Vera and Crossan, 2003). The complexity encountered in identifying and capturing lessons learnt make it difficult to distinguish causality. Firms that are able to distinguish causality can identify the drivers and develop linkages to ensure lessons learned are captured and transferred from one project to another. The value of lessons-learned documentation and communication is evident and formally recognized in project based companies (Bonghezi, 2009). However, the discipline is often neglected or only some elements of it are performed (Bonghezi, 2009). This is mainly attributed to the thought process and effort required to generate written reports. Furthermore, the difficulty in comprehending written reports stifles the effective capturing and communicating of reports. In many instances, lessons learned are normally irrelevant, worthless and poorly formulated. Furthermore, there is widespread recognition that learning is usefully viewed as a process that is both a source of new knowledge and yet is shaped by prior knowledge (Scarbrough *et al.*, 2004). Capturing and disseminating of lessons learned is undermined mainly by the loss of important insights and knowledge due to the time lapse in capturing the knowledge, staff turnover and people's reluctance to share knowledge (Tan *et al.*, 2006). Conversely, the 'iterative, mutually reinforcing' nature of the learning-knowledge interaction makes it difficult to disentangle its constituent parts (Scarbrough *et al.*, 2004). Despite these difficulties, the problem can be solved by stimulating project based learning amongst team members. Project based learning is seen as encompassing the generation, capture and transfer of learning by individuals and groups within project settings (Scarbrough *et al.*, 2004).

Project success depends mainly on the right combination of skills and will of the people involved which itself is an output of their effective integration (Borza, 2011). As projects face a higher degree of technical complexity and interdependency across functional boundaries, they require a shift towards an information based organisation and a knowledge creating structure to enable integration of the people involved effectively (Ayas, 1996). Projects evolve throughout the life cycle until a final finished product is obtained and transcend into the operating phase. Looking at project management from a learning perspective will develop reflective practices to improve the ability to generate knowledge, make it explicit and capable of being shared within organisation, as new projects are undertaken (Ayas, 1996). By utilising the FAST technique, the capturing and communicating of lessons learned problem

can be disintegrated into functions. The functional system stimulates creativity and allows alternatives to be proposed which can improve effectiveness.

The functionality of the system is probed further, analysed to come up with improved and better means of performing the same function whilst obtaining the same results. The FAST model is built to map a plan to achieve an outcome and can be used to direct research to achieve a desired outcome (Ayas, 1996). It is worth noting that a FAST model is not the final solution but rather the first step in unpacking the different subsets of a system. The unpacking of subsets is achieved by proposing alternative solution approaches and analysis techniques. The diagram figure 1 overleaf serves to illustrate a typical FAST diagram.

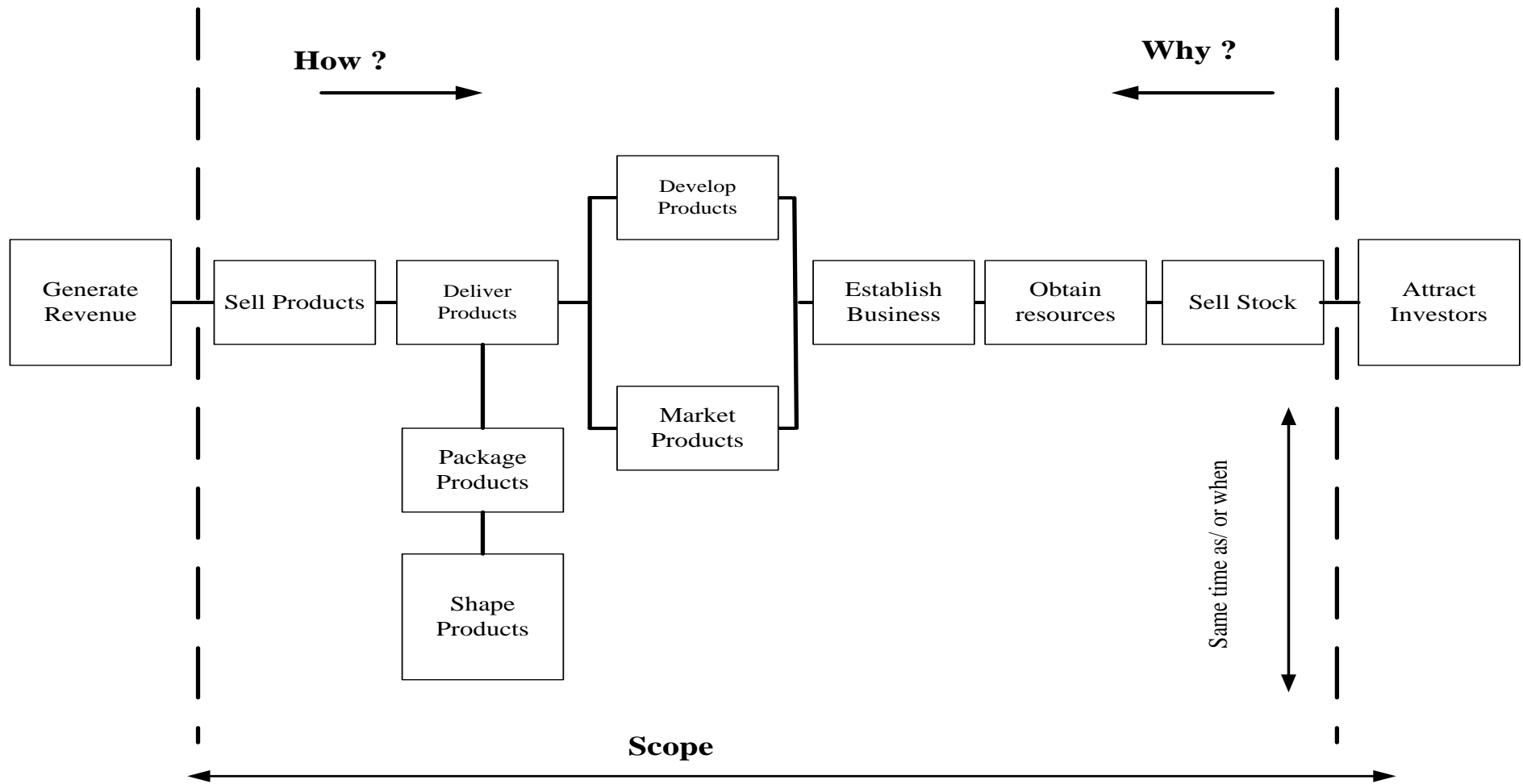


Figure 1-1: A Generic Integrated Business and Process FAST Diagram

The experience of building FAST models to assess how well current ways of doing things compare to alternative ways reinforces the advantage that this approach helps multi-disciplinary teams (Kaufman, 1998; Woodhead and McCuish, 2002; Kaufman and Woodhead, 2006). The FAST model is an 'idealised' representation that is unfettered by real world solutions; real world solutions (e.g. processes) are the means by which functions are performed. As such FAST models provide a way to coordinate the selection and substitution of real world methods in order to increase the notion of added value (Kaufman and Woodhead, 2006). This approach suits projects better as they occur and are executed in real world scenario thus, they exist as systems. In analysing functions of systems, it is imperative to ensure the dependency links are expressed clearly. This allows participants to understand how the full system actually works. This unique characteristic of the FAST model will be the focus point as the author explores its applicability to capture and communicate lessons learned effectively. In addition, the graphical nature inherent to FAST model will help in assimilating and communicating projects lessons learnt.

Projects involve team members from multi-disciplinary technical backgrounds and with different value systems. Tacit knowledge from project experiences is rarely codified and aforementioned problem requires an objective and practical solution. The solution should utilise a technique to capture and communicate lessons- learnt to avoid repetition of mistakes when executing future phases or projects.

Retrospective analysis of projects allows participants to think outside the box on how things could have been done differently and thus improving on efficiency in doing tasks in future. By utilising the FAST model to analyse project events in retrospect, one creates a space that stimulates creative and innovative ideas. These new ideas offer alternatives in performing certain tasks, which can turn out to be better, efficient and more effective. This study therefore seeks to explore this matter further by analysing how the FAST model from Value Engineering can be applied to capture and communicate project lessons learned.

1.3 Problem statement

The problem to be examined in this research may be stated as:

“Conventional written methods of recording lessons from problems encountered on a project are not captured and documented in a way that makes it easy to communicate them effectively to future projects.”

1.4 Research Questions

In order to address the problem statement above, the *main research question* for this dissertation is:

- I. Can utilising a diagramming tool such as the FAST model enhance the effectiveness of capturing and communicating codified knowledge to future projects?

The *sub research* questions for this study can be stated as:

- I. Is the cost penalty and effectiveness of the FAST model justified, in comparison to traditional approaches on the ease of sharing codified knowledge?
- II. How can the FAST model be utilised to enhance the ease of comprehension of project lessons learnt?

1.5 Aim of study

The aim of the study is to establish the effectiveness of the FAST model in capturing and communicating lessons learnt.

1.6 Research proposition

The research proposition to be examined in this study is:

Modelling problematic project activities during the entire life cycle using functional analysis can help enhance the capturing and communicating process of lessons learnt.

1.7 Research Objectives

- I. To test the effectiveness of the FAST model as a device for transmitting knowledge about lessons learned from one project to another project.
- II. To establish areas/activities that will enhance and reduce the cost of capturing and communicating project lesson learnt.
- III. To investigate ways of building relevant FAST diagrams to capture and communicate lessons learned to future projects.

1.8 Research Method

An exploratory research method using a sample project to test the effectiveness of FAST model to capture and communicate lessons learnt over traditional model within a projectized

organisation. A focus group session will be conducted to test the hypothesis that the FAST model is easier to comprehend due to its graphical outputs compared to traditional lessons-learnt written reports. The research will rely mainly on responses from participants working within a selected project environment to ascertain if there are any significant advantages of using a diagramming tool to capture and communicate lessons learnt over a traditional project close out report or activity log list.

1.9 Limitations

The research will focus on one typical project; thus the results obtained may not necessarily represent a general view of the FAST model. However, the research will be designed in such a way to minimize any obvious limitations. The availability of participants to attend the Focus Group sessions poses as a limitation to the research. The participants' opinions can be subjective thus affecting results and research outcome. The result will test immediate and short-term learning and retention of the material. However, it will not test longer-term learning effects. In addition the results were generated in a controlled environment and require confirmation through longitudinal research of the use of FAST for this purpose in practise on live projects. Another limitation is that one cannot test the efficacy of comparing the traditional written model to the FAST model of capturing and communication lessons learnt.

1.10 Structure of the research report

Chapter 1: Introduction

This chapter presents the background to the study. It states the problem statement and proposition of the research area. The chapter also frames the objectives and aim of the research.

Chapter 2: Literature review

This chapter reviews previous research work conducted on the subject on Value Engineering and its relationship to the FAST diagramming tool. It also covers the establishment of the definition and frames of reference with a full exploration of the strong and weak points from previous research initiatives on applying the FAST model to capture and communicate lessons learnt. Furthermore, it brings out guidelines on the criteria that are used to develop

FAST diagrams. To add on, it also highlights areas, which the current research will try to address, in particular the aspect of knowledge transfer.

Chapter 3: Research Methodology

This chapter discusses the data collection instrument design and administration and analysis proposed. It also dwells more into the research method in use and why it is appropriate to address the research objectives. The test will be conducted and the response gathered as data. The chapter also explores application of the focus group methodology. The focus group discussion is both qualitative and quantitative in nature and best suits to answer the research questions.

Chapter 4: Research Data Analysis and Interpretation

This chapter contains a summary and analysis of the data collected. It also presents a discussion of the findings from which a conclusion can be drawn.

Chapter 5: Discussion of Findings

This chapter explores and further discusses the research data based on the findings to establish if there is a correlation.

Chapter 6: Conclusion

This chapter highlights the conclusion drawn from the research data. Based on these conclusions a number of recommendations will be proposed and highlight further research areas of the subject matter.

2 Literature Review

2.1 Introduction

The literature review will focus on producing the concept and build the theoretical structure that can explain facts and the relationships between them (Verma and Beard). The objective of this literature review is to build a foundation based on prior literature and develop a compelling theory that serves to address the subject under study. Theory at the lowest level can be an ad hoc classification system consisting of categories which organise and summarize empirical observations. (Bowling 2002). The idea is to start with theory, deduce hypothesis from it and design a study to test these hypotheses (Punch 2005).

The process of closing off a project or phase is defined as the process of finalizing all activities across all the Project Management process groups, to complete the project or phase formally (PMI, 2013). This offers a conventional solution that captures lessons learned but presents a challenge, as reports are cumbersome and difficult to comprehend by future readers. Typically, project-debriefing sessions are conducted during the close out stage as a post implementation review process and capturing lessons learned in a formal document. The formal document usually termed the project close out report, details how the project unfolded through the various stages of the project life cycle. The benefits of the close project process are to provide lessons learned to the formal ending of the project work and the release of organisation resources to pursue new endeavours (PMI, 2013). Project knowledge management especially in complex projects is one of the important success factors in project management whilst lack of project knowledge management is one of the main reasons for project failure (Pemsel and Wiewiora, 2013). Opportunities for project-oriented organisations can be exploited, if organisations are willing to harness the knowledge gathered from previous projects to make informed decisions in the future. This allows organisations to be well positioned for the market challenges ahead of them as they can plan and be efficient in executing phases within a project.

To achieve this for this study, the focus was on the following sub-tops: learning process, knowledge management, knowledge transfer, and project life cycle in consulting environment. In addition, the study will look at capturing of lessons learnt, organisational knowledge management culture and applying the FAST technique in capturing and communicating lessons learnt.

2.2 Defining learning and what constitutes the lessons learnt process

Learning processes are present at the population and community levels most prominently in the form of vicarious learning from the experience of other (Levitt and March, 1988; Lant and Mezias, 1990; Miner and Haunschild, 1995). Learning is defined as a relatively permanent change in knowledge or skill resulting from experience (Weiss, 1990). Project lessons learned is the knowledge gained during a project which shows how project events were addressed or should be addressed in the future with the purpose of improving future performance (PMI, 2013). Lessons learned on projects include gathering information on the use of a particular technique on a specific situation other than the one utilised to achieve objectives. A lesson must be significant in that it has a real or assumed impact on operations; valid in that it is factually and technically correct; and applicable in that it identifies a specific design, process, or decision that reduces or eliminates the potential for failures and mishaps, or reinforces a positive result (Secchi *et al.*, 1999). A lesson can be regarded as positive in instances where a project is successful. In contrast, a negative experience could be because of undesired negative outcomes. Nonetheless, in both instances, the experiences give rise to lessons learnt and these should be documented for future use. This definition emphasises that lessons can be positive or negative and that they must have an impact on the project and can be used to provide competitive advantage when used properly (Carrillo *et al.*, 2013).

The importance of the process of capturing lessons learnt lies in improving productivity and efficiency in executing future projects. The process of capturing lessons learnt involves capturing routines or innovative ideas that lead to successes and processes that lead to failure. Lessons learnt sessions are traditionally conducted at the end of projects. However, best practices suggest that lessons must be captured throughout the project life cycle. Thus, the lessons learnt process is a continuous activity that is kept active from planning up to close out of a project.

The organisational learning process is dynamic and iterative and has to be constantly refined to suit current needs. The situation is worse for long-term projects since, in some cases, lessons learned have not been captured as they happen and have not been systematically archived (Kaufman and Woodhead, 2006). The importance of the lessons-learnt capturing process lies in improving productivity and efficiency in planning and executing future projects. The lessons learnt process involves capturing and disseminating routines or innovative ideas that lead to successes and discarding processes that lead to failure. The

documented information on successes and failures can be used in future projects to promote repeatability of good practices. The real value obtained from lessons learned is the ability of the organisation to establish and sustain a culture of consistent project management improvement (Rowe, 2008).

The lessons-learnt process can be divided into five activities that are clustered into two process groups (Rowe, 2008). Capturing lessons learned includes the first two activities: identify and document while applying lessons learned includes the last three activities: analyse, store and retrieve as shown in Figure 2.1 below.

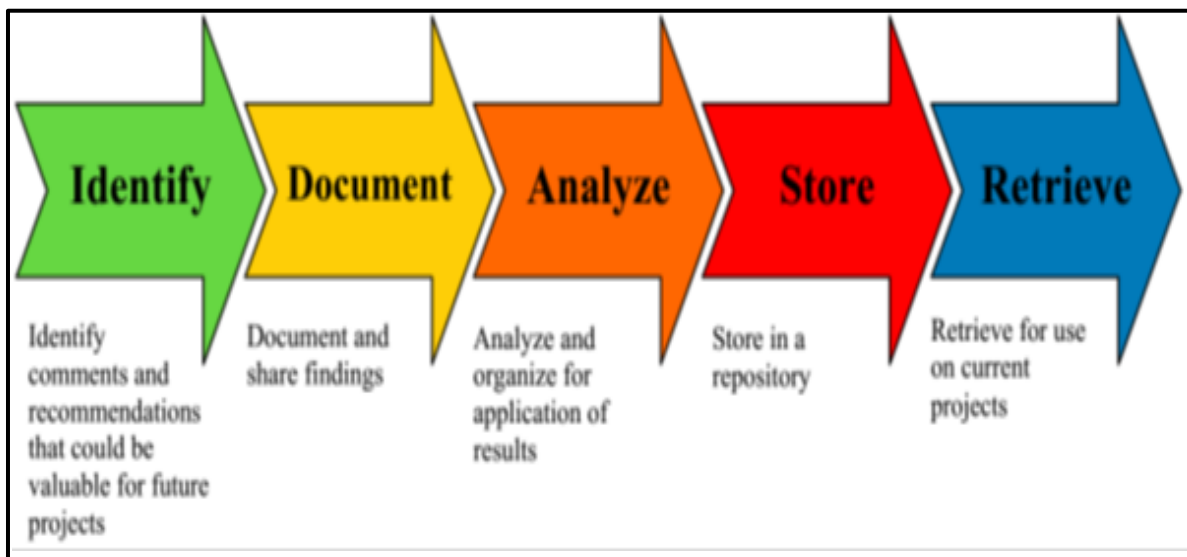


Figure 2-1: Lessons learned processes (Rowe, 2008) and (Rowe and Sikes, 2006b; 2006a).

A root cause analysis should be conducted for each project after the lessons have been captured to give the organization a better understanding of what can be improved (Rowe, 2008). The repeated use of the good practices that bring desired outcomes from previous projects results in a normative standard termed best practise. The analysis team should identify best practices so they can be incorporated into existing methodologies, processes, procedures, and to improve training programs (Rowe, 2008). Best practice techniques are developed, refined and adopted from lessons learnt processes. Best practice is defined as *“process, technique or innovative use of resources that has a proven record of accomplishment of success in providing significant improvement in cost, schedule, quality, performance safety, environment or other measurable factors that influence health of project”* (Holloway and Nwaoha, 2013: 74). A post mortem of the project implementation

enables one to document the positive development that led to achieving the desired goal: thus developing into a best practice routine.

2.3 Lessons Learnt and Knowledge management

Lesson learning processes also overlap with the broader areas of knowledge management and organisational learning which helps promote innovation depending on the organisation's absorptive capacity (Cohen and Levinthal, 1990). The literature on the knowledge-based theory of firms suggests that the key capability of a firm is its capacity to learn (Grant, 1996a; Dosi *et al.*, 2000). An organisation work place is an establishment where knowledge integration begins. Many organizational activities are intended to acquire information or knowledge (Baum and Ingram 1998). The interpretation of experience is difficult, as lessons must be drawn from a relatively small number of observations in a complex and changing environment (Prencipe and Tell, 2001). This stifles creativity and makes the identification and capturing of lessons learnt cumbersome. The complexity encountered in identifying and capturing lessons learnt make it difficult to distinguish causality. However, firms that are able to distinguish causality can identify the drivers and develop linkages to attain the desired outcomes.

When an organization formulates a new strategy, one of the key considerations is its ability to exploit opportunities that enable the organization to achieve some well-defined goals or objectives (Desouza and Evaristo, 2004). This involves initiating projects that add value. Consequently, projects have become a game changer in the business world. With the shift from a traditional hierarchical structure to a more self-managing setup, the challenge for organisations is to view a data repository as a strategic tool. However, organisations that recognise a data repository as a strategic tool, understand the importance of a functional knowledge management system. In project-based organisations, it is important that the information produced in one project will be accessible to a subsequent phase or project. This contributes to effective knowledge sharing and linkage to avoid repeating mistakes or wasting resources on repeating past mistakes (Venkataraman and Pinto, 2008). The capturing of lessons learnt across different functional disciplines can aid improvement in the execution of another downstream phase or on a future project.

From experience, one has to understand the problems that arise from a failure, learn from them in order to appreciate the gravity of the problem. Having a good lesson learnt capturing programme that is supported by a good knowledge management system can help organisation

become competitive and deliver projects within acceptable tolerances. Projects that belong to a programme have related goals and could gain synergistic benefits from information sharing (Kasvi *et al.*, 2003). This can only be possible when project team members, stakeholders and other project support staff communicate and share ideas on project experiences to attain common goals. Facilitating such intra- and inter-organisational interaction requires not only new kinds of communication and knowledge management practices and competences but also tools that support these practices (Kasvi *et al.*, 2003). The lack of knowledge sharing often leads to a non-organic and non-effective use of previously gained experience, thus stifling creativity, inhibiting the exploitation of useful knowledge and past methodologies

The sharing of information benefits, large multi-project-based firms developing complex products or systems that face the simultaneous management of multiple projects as an everyday situation (Payne, 1995). However, conventional efforts toward the effectiveness in managing single projects do not suffice in multi-project settings (Payne, 1995). The multi-project settings require project organisations to adopt a systematic system that is formalized to identify, collect/capture, store and transfer critical knowledge on to future projects.

Formal information capturing that is common in most project centred firms is known as retrospective reporting. However, the shortcoming is that it does not benefit the projects in a programme in that the results are collected into an end-report when the programme is already completed (Kasvi *et al.*, 2003). Whilst this is a noble and acceptable lessons learnt capturing practice it has its own weakness as people can forget the critical information that would have been in their minds during project implementation. People working in projects may not always find time or motivation to write down detailed reviews and assessments (Kasvi *et al.*, 2003). They are normally occupied with pressing project tasks, and documenting and reporting is often neglected due to these pressures.

The key to learning for project centred firms revolves around having an efficient knowledge management system that enables employees to learn from past project experience. People need to feel that they gain personal benefit from documentation and perceive its utility (Landes *et al.*, 1999). Individuals have the capability of restructuring knowledge so that it is applicable to the situation and context they are in. One of the main challenges of project management is the minor and tangled accumulation of knowledge (Kasvi *et al.*, 2003). Knowledge is an important resource to build sustainable competitive advantage (Liao and Hu, 2007). This knowledge need to be properly identified, acquired, stored and disseminated

in a systemic manner through a good knowledge management system for it to add value. The majority of Knowledge Management (KM) practitioners focused on what software to use and what content to include, rather than the processes required to generate, capture, use, and maintain content (Holloway and Nwaoha, 2013). Information systems used to support project collaboration and reuse of experiences are still mostly restricted to document sharing. The objective of a Knowledge Management System (KMS) is to support creation, transfer, and application of knowledge in organizations (Rao 2012).

Knowledge Management (KM) involves distinct but interdependent processes of knowledge creation, knowledge storage and retrieval, knowledge transfer, and knowledge application (Alavi and Leidner, 2001). Knowledge management in a project is considered to consist of four groups of activities:

- Knowledge creation, for example collection, combination and refinement within and outside the organisation.
- Knowledge administration, for example storage, organisation and retrieval.
- Knowledge dissemination (distribution within and outside the project.)
- Knowledge utilisation and productisation, for example integration into products and decisions, and application in other projects (Kasvi *et al.*, 2003).

Knowledge management is also known as a systematic, goal-oriented application of measures to steer and control the tangible and intangible knowledge assets of organizations, with the aim of using existing knowledge inside and outside of these organizations to enable the creation of new knowledge, and generate value, innovation and improvement (Wunram, 2000). The sequence of the knowledge management processes can be delineated further as knowledge creation, knowledge validation, knowledge presentation, knowledge distribution and knowledge application (Alavi and Leidner, 2001). The integration of the systemic functions of the knowledge management processes is vital to ensure critical knowledge is not lost along the project life cycle. If organizational knowledge remains inaccessible or non-integrated the value of knowledge generation and codification is diminished (Bhatt, 2001). A conceptual framework that highlights the systemic association of the knowledge management facets is proposed as illustrated in figure 2.2 overleaf.

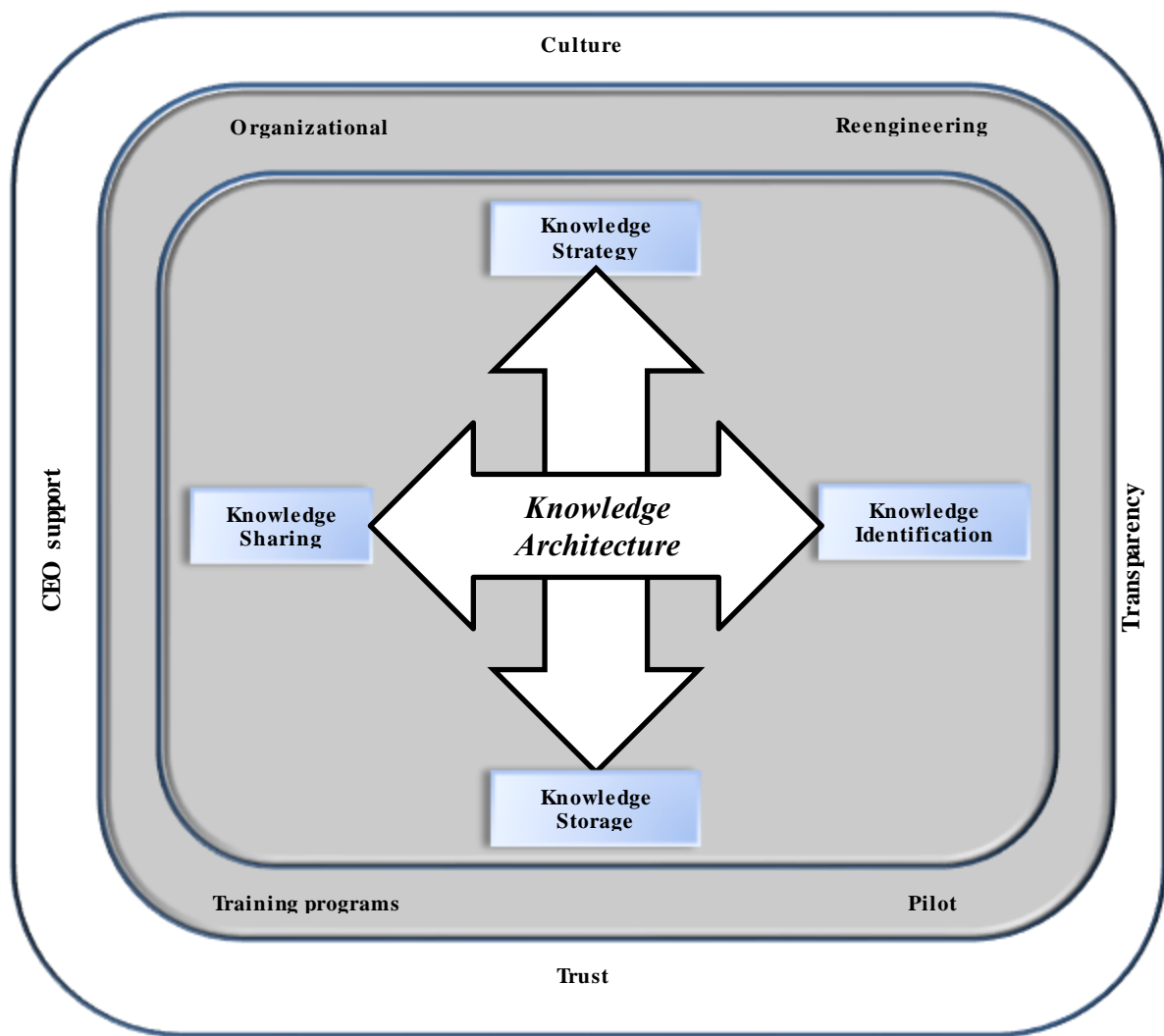


Figure 2-2: Conceptual framework for a knowledge management system (Akhavan et al., 2006)

For a deeper understanding of the KM processes, an attempt to express the hidden meaning of data, information and knowledge is necessary (Akhavan *et al.*, 2006). Data can be interpreted as a record of events that transpired within an organisation. Information is data with attributes of relevance and purpose, usually having the format of a document or visual and/or audible message. Knowledge is linked to the users' experience, being strongly connected to pattern recognition, analogies and implicit rules (Wakefield, 2005). Maintaining motivation to provide a steady stream of knowledge contributions is especially difficult, if the knowledge content is highly structured and people are required to append appropriate keywords and other meta-data to their documents (Hahn, 2000).

2.4 Organizational learning and knowledge management model

Earlier studies recognize that it is critical for knowledge acquired in one project to be stored for further reuse in other projects (Prencipe and Tell, 2001; Goh, 2002; Sydow *et al.*, 2004). A firm's ability to formulate solutions by using knowledge acquired on multiple topics and combining this knowledge into a workable solution gives the organisation competitive

advantage. The definition of competitive advantage is when an organization acquires knowledge from outsiders and uses it to strengthen its core competences and develop the organization's own competitive advantage (Liao and Hu, 2007). In order to systematically manage knowledge created in a project, the projects themselves must be systematically managed (Kasvi *et al.*, 2003). Instilling a corporate culture that embraces identifying and documentation of knowledge from projects is instrumental in achieving the learning organisation model. For many organizations, in particular projectized entities, the corporate culture needs a significant paradigm shift to obtain and use lessons learned efficiently (Garon, 2006). If the learning project model is adopted throughout the life cycle of a project from ideation to completion, lessons learnt in one project can be transferred to the other as depicted in figure 2.3 below:

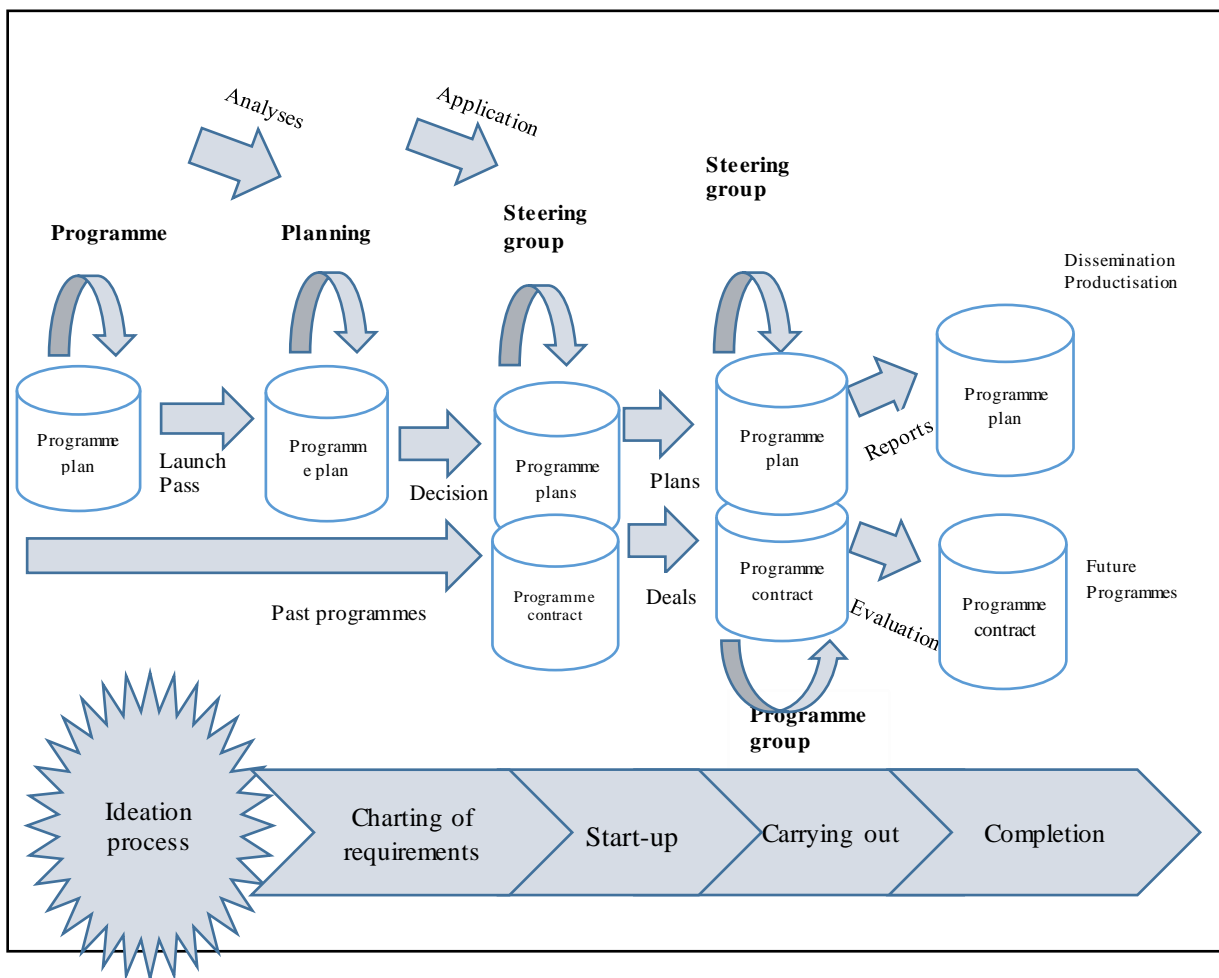


Figure 2-3: A Learning Programme Model has to cover the programme process from ideation to completion (Kasvi *et al.*, 2003).

Furthermore, a systematic project knowledge management is needed, in order to turn a project organisation into a learning organisation and to distil results and lessons from one project and deliver them into another (Kasvi *et al.*, 2003). A systematic project knowledge

management processes requires senior management support in order to be inherent within the organisational functional model. Thus, project learning is too important to be left to chance or to the initiative of motivated individuals (Joia, 2000). In large construction projects with a long life cycle, it is imperative to have a system in place to continuously gather information as the danger exists that procedural knowledge could be forgotten due to large delays (Schindler and Eppler, 2003). This inherent nature of large construction projects calls for a learning model that evolves as the project unfolds for it to remain relevant. The Project Learning Model that relies on systematic repetition of project workshops that update the contents of two dynamically evolving project documents: the project plan and the team contract (Vartiainen *et al.*, 1999).

The project plan can be seen as a repository for 'hard' project knowledge including project definition, activities and results. On the other hand, the team contract contains organisational knowledge like experiences and capitalisation of lessons learned (Kasvi *et al.*, 2003). The systematic management of team contract and project plan through the project life cycle results in project learning as the project unfolds as illustrated by the figure 2.4 below

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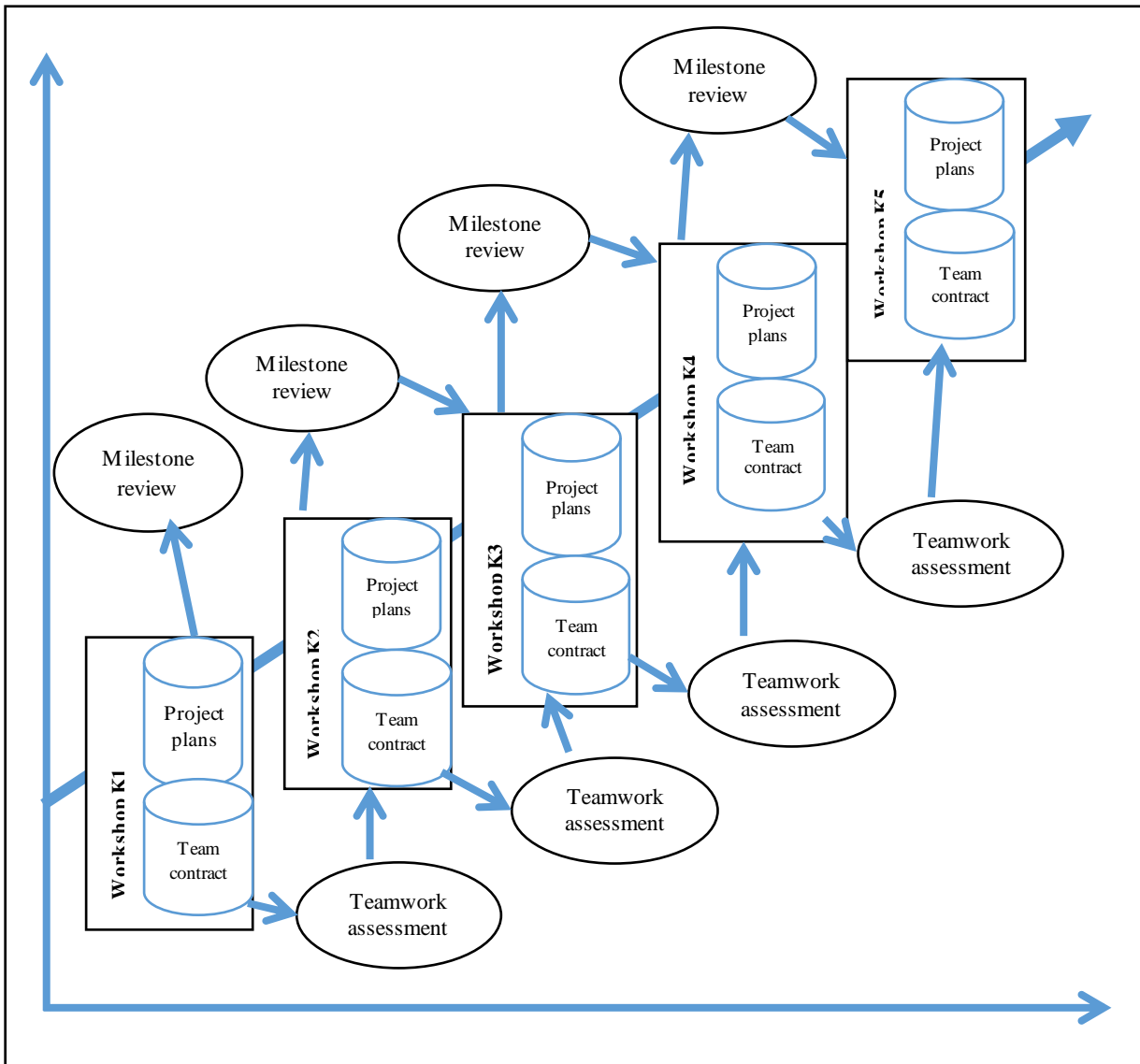


Figure 2-4: Project Learning Model with two knowledge repositories (Vartiainen et al., 1999)

The value benefits of adopting a project-learning model can be increased by having a formalised stage-based knowledge base. Each project will have several status check-points, which are used to identify and store knowledge items associated with the task at hand (Schindler and Eppler, 2003). The staged knowledge base enables information to flow in throughout the project life cycle and allows critical decisions to be taken at significant milestone stages. Wu and Wang (2007) developed a staged based framework of the project specific information model applied in a knowledge intensive domain to support project execution. This is illustrated in the figure 2.5 overleaf

Project Name

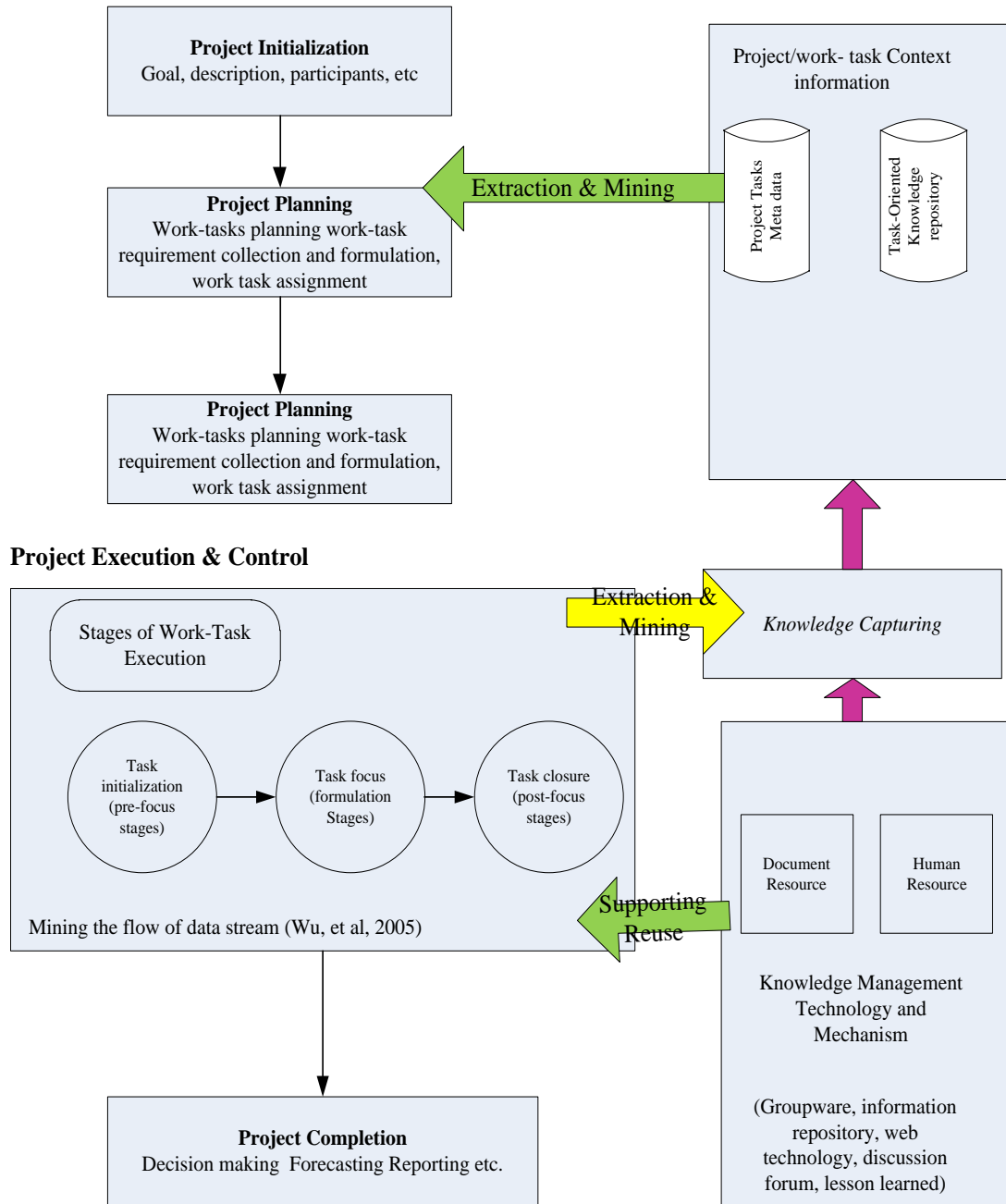


Figure 2-5: Stage-based Framework for Project Domain (Wu and Wang, 2007).

The cross-pollination of data across project phases allows team members to share experience and techniques amongst members during the life cycle of the project. Furthermore, a growing body of empirical evidence indicates that organizations that are able to transfer knowledge effectively from one unit to another within the organization are more productive and more likely to survive than organizations that are less adept at knowledge transfer (Baum and

Ingram 1998). The ability to diffuse knowledge across and within organizations is today recognized as a major strategic capability for gaining competitive advantage (Van Wijk *et al.*, 2008).

2.5 Project Management life cycle in consulting firms

Consulting firms are typically project-based entities whose survival is dependent on actively participating throughout the project life cycle. In its ideal form, the project-based firm is organised solely around projects (Wu and Wang, 2007). Consulting firms act as the link between the client (project owner or end user) and the contractor (company executing the construction works). The consultant who normally is the lead engineer of a specific discipline manages the discipline specific tasks that pertain to a particular project. The consulting firms' team includes engineers, technologists, technicians and project support staff who work together to ensure project objectives are met. Within a pure project-based firm, projects "*embody most, if not all, of the business functions normally carried out within departments of functional or matrix organisations*" (Hobday, 2000: 874). The aforementioned functional matrix act as the main mechanisms for co-ordinating and integrating projects. This functional organisational structure and nature of work shows that the consultant engineers' inherently assumes project management duties to lead and coordinate project activities. Successful project management is based, on the one hand on accumulated knowledge, and, on the other hand, on individual and collective competences (Kasvi *et al.*, 2003). The consultant applies expert knowledge to produce a realistic design data pack that includes relevant project drawings, equipment schedules, equipment data sheets and project specifications. Mastering the concepts of the deliverables takes time and it is a learning process that is dependent on other system facets. The system facets that influence the learning process include the capability of an individual, group/project set up and organisational culture.

Three learning processes have been identified namely: experience accumulation, knowledge articulation and knowledge codification. The three processes formulate a framework to analyse the learning abilities of project-based firms (Prencipe and Tell, 2001). The mechanisms for inter-project learning draw upon these learning processes, these can be found at various levels of the project-based firm (Zollo and Winter, 2002). These are further grouped into a matrix structure to emphasise aptitude in the following areas; experience accumulation, knowledge articulation and knowledge codification. Firms invest in a variety of tools and mechanisms to try to capitalise on the knowledge developed during the execution

of one project and transfer it across the organisation (Prencipe and Tell, 2001). Knowledge is captured and disseminated differently at each level of analysis. A (3×3) matrix is used to categorise the various project-to-project learning mechanisms. The horizontal dimension of the matrix show experience accumulation, knowledge articulation and knowledge codification as key focus areas for learning firms. Along the vertical dimension, the matrix maps the project-to-project mechanisms on to the individual, project, and organisational levels (Prencipe and Tell, 2001). An in depth analysis of the vertical dimension determines the learning mechanisms project firms take to disseminate knowledge across projects and within the organisation. The learning mechanisms can include empirical instances such as brain storming sessions; lessons learnt meetings, informal encounters, job rotation, professional networks etc. The analysis of both the horizontal and vertical dimensions combined enables the identification of what is termed a firm's learning landscape in relation to project-to-project learning (Prencipe and Tell, 2001).

Learning landscape is defined as the mix of project-to-project learning mechanisms adopted and implemented; this reflects the multidimensional nature of the firms approach to project learning. Figure 2.6 overleaf serves to illustrate how experience accumulation, knowledge articulation and knowledge codification is attained in a project centred entity.

Level of analysis	Learning processes		
	<i>Experience accumulation</i>	<i>Knowledge articulation</i>	<i>Knowledge codification</i>
Individual	<ul style="list-style-type: none"> • On-the-job training • Job rotation • Specialisation • Re-use of experts 	<ul style="list-style-type: none"> • Figurative thinking • “Thinking aloud” • Scribbling notes 	<ul style="list-style-type: none"> • Diary • Reporting system • Individual systems design
Group/Project	<ul style="list-style-type: none"> • Developed groupthink • Person-to-person communication • Informal encounters • Imitation 	<ul style="list-style-type: none"> • Brainstorming sessions • Formal project reviews • De-briefing meetings • Ad-hoc meetings • Lessons learnt and/or post-mortem meetings • Intra-project correspondence 	<ul style="list-style-type: none"> • Project plan/audit • Milestones/deadlines • Meeting minutes • Case writing • Project history files • Intra-project lessons learnt database
Organisational	<ul style="list-style-type: none"> • Informal organisational routines, rules and selection processes • Departmentalisation and specialisation • Communities of practice 	<ul style="list-style-type: none"> • Project manager camps • Knowledge retreats • Professional networks • Knowledge facilitators and managers • Inter-project correspondence • Inter-project meetings 	<ul style="list-style-type: none"> • Drawings • Process maps • Project management process • Lessons learnt database

Figure 2-6: Inter-project learning mechanisms (Prencipe and Tell, 2001).

An engineering consulting firm's ability to apply its capabilities in the form of knowledge resources to perform important activities is increasingly viewed as a critical source of competitive advantage in many industries (Kogut and Zander, 1992; Grant, 1996b; Pisano *et al.*, 1997). The consulting engineering firms' success hinges on the intellectual skills of its employees. The capacity to manage human intellect and to transform intellectual output into a service or a group of services embodied in a product is fast becoming the critical executive skill of this era (Prencipe and Tell, 2001). The volatile economic environment has resulted in firms adopting lean methodologies to reduce waste and improve the financial bottom line. Lean principles state that non-value-adding activities are considered to be waste and should be the focus of long-term improvement efforts (Quinn, 1992).

The core activities of the consulting entity: i.e. what the firm chooses to produce and sell, as well as the boundaries of the firm, are determined by the knowledge a firm possesses (Prencipe and Tell, 2001). Consultants work on billable time: time that can be directly booked to an active project on work done to accomplish a task. Although employees can benefit from obtaining and using knowledge that exists in other parts of the firm to perform competitive tasks, sharing knowledge across sub units within a project based firm can be problematic (Liker, 2004). On several occasion the knowledge management system is so weak that important information is lost during the capturing process. Such teething problems in the system can be addressed by adopting Value Engineering (VE) methodologies that ensures the knowledge capturing and management system encompasses all functional stages.

2.4.1 Regulation

The Engineering Council of South Africa (ECSA) regulates the conduct of professional consulting engineers within the South African environment. ECSA was formed as a result of the Engineering Profession Act 46 of 2000, which sought to establish a juristic person to provide for the registration of professionals, candidates and specified categories in the engineering profession (RSA, 2000). The gazette published by ECSA provides guidelines on identification of engineering work; as well as the costing assorted thereof (ECSA, 2015). The disciplines under review are civil, mechanical and electrical engineering practising in the construction industry in South Africa. In the South African context construction engineering refers to production, building and civil infrastructure encompassing the following industries: process, mining, oil/gas exploration, commercial buildings, hospitals, roads, railways and

other infrastructure. An engineering project in a consulting firm goes through the following stages:

- Inception
- Preliminary design (Concept and Viability)
- Detailed Design (Design Development)
- Document and procurement
- Contract administration and Inspection
- Close out

The manner in which the phases are set up, act as stage gates for reviewing project status and decision-making throughout the life cycle of the project. Due to high staff turnover, job rotation and other resource allocation factors common to projects, it is highly unlikely to have the same team working on a project throughout the six phases. Thus, it is imperative that at the end of each stage, lessons-learnt workshops are conducted to capture and codify the highlights of the phase. The lessons-learnt workshop will document and give a description of what went well or what went wrong. In addition, it will focus on area of improvement and routines that have been successful to be adopted as best practices. Annexure A serves to illustrate in detail the scope of work that is expected to be delivered with each stage.

The figure 2.7 over leaf shows typical sequential flow of an engineering project within a consulting entity:

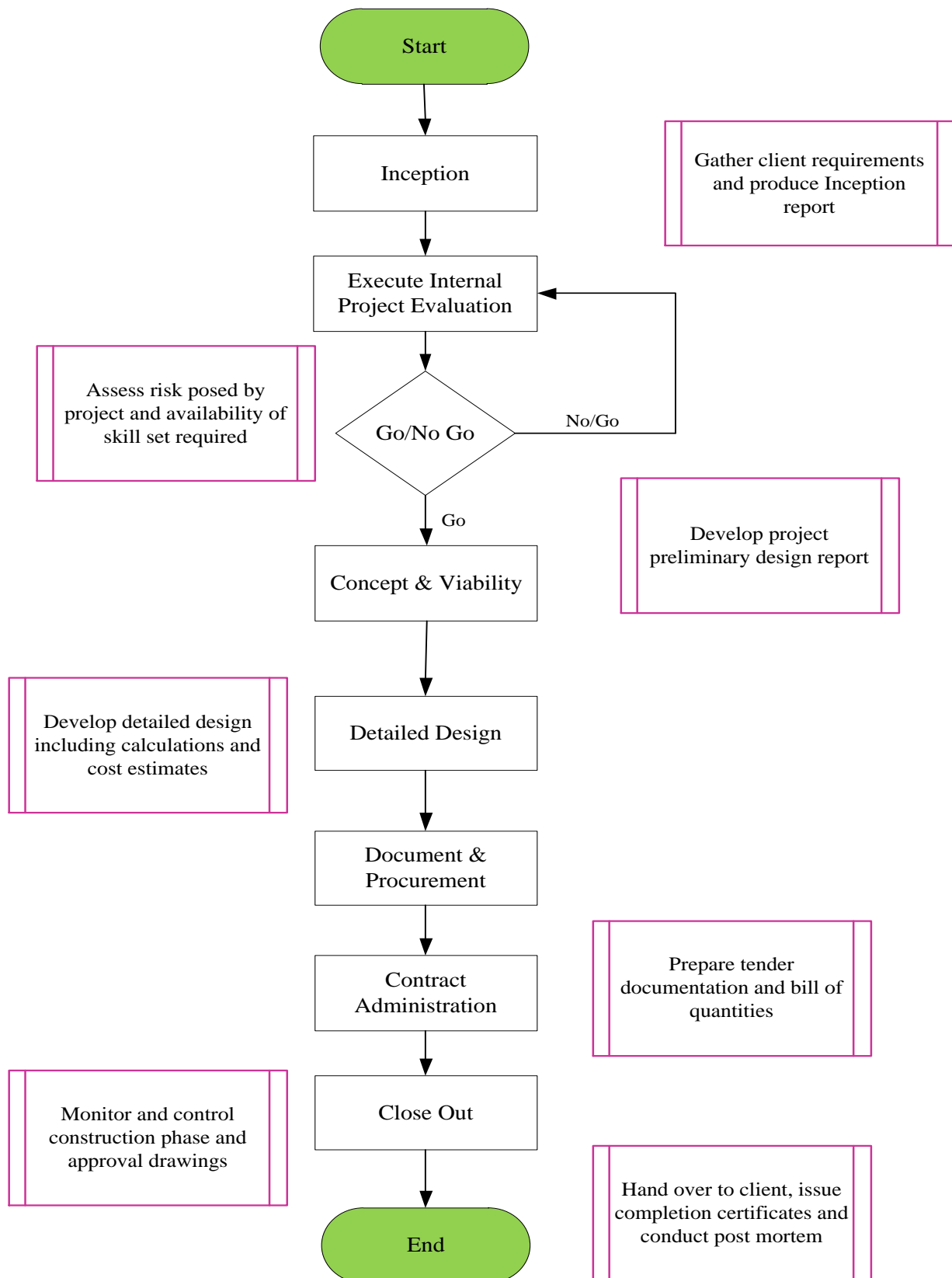


Figure 2-7: Project Cycle flow chart (Author)

2.6 FAST Technique

Value Engineering is a management tool designed to improve essential functions of a product, service or project by lowering the cost (Zhang *et al.*, 2009). Thus the value can be realised from the project, product or service by refining the function or by reducing overall costs. For simplicity sake, the terms Value Engineering (VE), Value Analysis (VA) and Value Methodology (VM) will be used interchangeably to refer to the same concept. Value Engineering has a strong functional analysis, which gives the technique an edge over other systems in capturing and reusing of lessons learnt. Function analysis is one of the key components of VM methodology, which distinguishes VM from other cost reduction activities (Haas and Hansen, 2005). VM has become a proactive, problem solving or solution seeking process, which can be used to enhance the functional value of a project by managing its development from design concept to operational use, and eventual decommissioning (Hayles *et al.*, 2010). The workshop approach used for VM aims to exploit the synergistic benefits derived from gathering relevant project stakeholders together as a group (Bowen *et al.*, 2010). This is achieved through structured, team-oriented and open-dialogue exercises, which recommend alternatives or confirms existing solutions, and appraise subsequent decisions, by reference to the value requirements of the client (Hayles *et al.*, 2010).

Value Engineering (VE) is a concept that emanated from the need to satisfy and meet company objectives from a pool of limited resources. The lesser amount of resources utilised to meet the same level of expectation amongst stakeholders the better the value realised out of the initiative. The goal of value engineering is to balance the different perception of what constitutes value and enable an organization to achieve maximum progress toward its stated goals with the minimum use of resources (Bytheway, 2007). The idea was made popular by the lack of raw materials to manufacture essential components during World War II. The problems of innovation during the war, where the ability to describe parts in terms of the function they performed enabled substitution, adaptation and innovation; the solution thus gave birth to VE (Venkataraman and Pinto, 2008).

The strength of VE lies in the ability to unpack a complex system into functions. A function is defined as an essential contribution that a component or element of a system performs via different solutions or real world processes (Kaufman, 1990). By conducting an in-depth analysis of the system and using an active verb and measurable noun to describe the function; one can stimulate a creative mind-set. New ideas that suggest alternatives in performing the

same function are born, as the mind is free from physical environmental factors that can influence decisions. By focusing on functions, teams and individuals can focus on what is truly important and not be constrained by physical feature of products or processes, leading to a better definition of the problem and a clear path to solutions (Berawi, 2006).

This fundamental shift in the way of thinking gave birth to the Functional Analysis System Technique (FAST). Charles Bytheway developed the concept and named it FAST (Function Analysis System Technique), which utilizes ‘why-how’ logic to address the difficulty of getting agreement on the basic function of an assembly or component (Kaufman, 1990). The FAST model from VE will form the basis of the research to ascertain its applicability in capturing and conveying project lessons learned amongst team members and within the organisation. Bytheway enhanced the function analysis process by developing a graphical representation tool for examining functionality called FAST model. The FAST is a powerful mapping technique that can graphically model strategies, plans, systems, projects, products, processes and procedures in function terms (Bonghezi, 2009).

The basis for the FAST concept was that the way things look and work limits imagination to existing products and methods, but if we concentrate on what they do or what we want- the function- the result is unlimited creativity (Snodgrass and Kasi, 1986). The FAST model is a graphical tool for examining and depicting the functional logical interconnection of facets that make up a system (Bytheway, 2007). The FAST model is centred on its ability to translate the task activities of complex systems into simplified functions performed by the system. A function is defined as something that we want or need, a goal, objective, something we are willing to pay for, and functions must be defined in a specific way to foster creative development (Bytheway, 2007).

The ‘why-how’ logic and features of the FAST are summarized in the following statement: the *“result of writing down the functions as they relate to each other generated a visual diagram which showed how each function is performed by merely observing the functions posted immediately to the right of any given function”* (Bytheway, 2007). By the same token, if one desired to know why a given function is required, the function posted at its immediate left provided the answer (Bytheway, 2007). It is interesting to note that people who worked in unrelated fields to their inventions made some of the greatest inventions that change the world. Examples include; the inventor of the light bulb, Thomas Edison was a vendor at the market and Samuel Morse who is credited with inventing the telegraph was a portrait painter.

Their success was based on personal decisions to think more deeply about things they observe from day to day (Bytheway, 2007). The ability to dis-integrate the lessons into functions creates opportunities that can help in effectively capturing lessons learnt and disseminating them onto future projects. The FAST technique clarifies the problem by breaking it down into functions and determines the region to apply creativity to effectively capture and communicate lessons learnt from one project to another.

Annexure B serves to illustrate demonstrate a systematic approach on how to create FAST diagrams.

2.5.1 Functions

Naming Functions

The idea of function naming comes to mind in answering the “Why-How” logic questions. Names are given to function to define their purpose in the entire FAST diagram sequence. The first word of the name is always an active verb and the last word of the name is always a noun. In the context of the research “Capture lessons learnt” and “Communicate lesson learnt” are the buzz phrases. In the earlier phrase “Capture” is the active verb whereas in the latter “Communicate” is the active verb. In all instances the lessons learnt is the noun. Ideally, the name given to a function describes what is to be accomplished without disclosing the method of accomplishment. However, the function name must act as a catalyst for creative thinking. The brainstorming exercise gives rise to a number of recorded functions that pertains to the problem.

Basic Function Identification

In identifying the basic function, all the parts that allow each function to be performed are named. This approaches divorces a person’s thinking from the various parts that allow the product to exist and permits him or her to solely concentrate on functions. To determine the basic function one has to ask the following question:

“If I were to omit this function would I still be mandated to perform the other function recorded”

If the answer to the above question is a no; then the function identified is deemed a basic function. The basic function, come with other associated functions that are listed in the

brainstorming process. To eliminate the unnecessary functions, one needs to assess them to identify the interaction in the system in order to see the patterns emerging.

One further prompts question by asking the relevance of the listed functions utilising the following statement:

“If I were to omit this function would it change the end state? Why do I have to perform the function?”

Experience has shown the response to the above statement normally prompts another high-level function to be identified. Alternatively, the listed function can act as a supporting function, which is necessary but not critical to get to the end state. Any function that requires you to make a decision rather than express your creativity produces a function that supports the function you are analysing (Bytheway, 2007). A properly identified and documented function does not need a decision. If it falls in the decision requirement realm, then it does not meet the criteria and thus fails to serves its purpose of stimulating creativity. The naming and identification of Basic functions takes time to master; an art developed over time that takes in depth thinking. Intense concentration, even what appears to be overconcentration of mental work on these functions, forms the basis for unexpected steps of advancement of value in the product or service assessed (Bytheway, 2007).

Substituting Functions

The basic function name must open a window of opportunity to allow individuals to be imaginative and bring on-board different ways in which that function can be substituted without fundamentally deviating from the objective. The idea is to find ways of conceiving alternative functions but maintaining the end state of the system. A system is defined as a set of parts that interact and affect each other, thereby creating a larger whole of a complex thing. Functions substitution is synonymous to pattern identification/recognition. The human cognitive thinking mind-set is aligned to pattern recognition and by correctly identifying and naming the pattern; a substitute function can be identified easily. By inserting the identified functions into the “how-else” question leads to creative response for each function.

By asking “how-else”, I can perform this function?

This allows one to brainstorm and give rise to systemic way thinking called the “butterfly effect”. The “butterfly effect” is referenced to how tiny variations to function performance can have a tremendous impact on the magnitude of the outcome of a system.

The answer to the “how-else” question leads to a single function or several functions. Since the resultant function/functions are entirely dependent upon the function inserted into the “how-else” question; the new functions are deemed to be lower level or dependent functions. The figure 2.8 below serves to illustrate the point below:

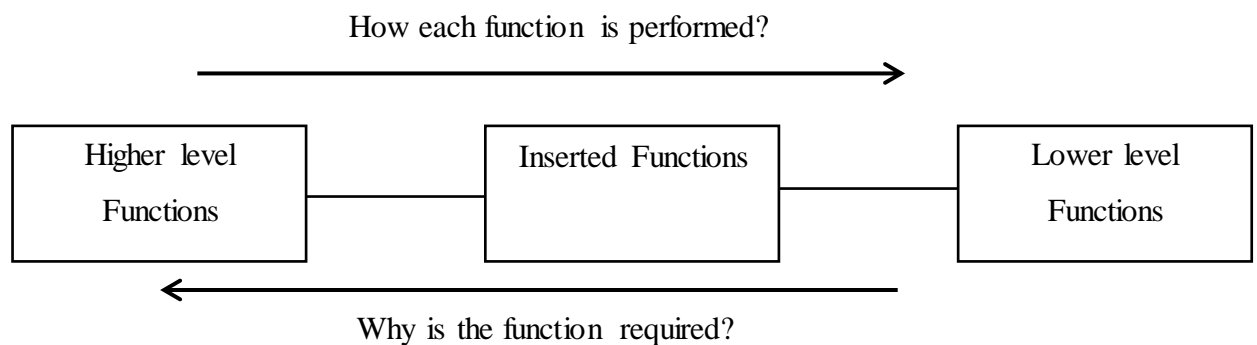


Figure 2-8: Visually displaying higher and lower level functions (Bytheway, 2007)

By interrogating, the lower functions further and ask “why” and “how”, iterating the process repeatedly resulted in increased understanding of the problem or project. This great discovery of analysing functions gave birth to the Functional Analysis System Technique commonly known by the acronym FAST. The diagram used to analyse the relations functions is called the FAST diagram.

2.5.2 FAST Diagram

The FAST diagram visual depiction used to show “*how each function is performed*” by merely observing the functions posted immediately to the right of any given function. Equally, if one needs to know “*why a given function is required*” the function posted at its immediate left provides the answer. Each function in a FAST Diagram should possess these same relationships if the relationships have been verified by asking the *Why-How Logic Questions* (Bytheway, 2007). In reality the FAST diagram is a logic diagram developed from the “*why-how*” logic. The logic allows functions in a diagram to be tied together into a cause

and effect relationship. To check the causality of the functions one can throw in the verification question:

Does “*this how function*” helps “*it’s why function*”?

If the functions identified and named the logic holds and are true in either direction then fundamentals of the FAST diagram are satisfied. However, if the functions retain a false result then it means the logic is not correct and there is information missing. This means more probing of the identified functions is required to obtain the missing information. A yes response to the verification question means the logic holds whereas a no means the logic does not hold. The “function name dropping” exercise results in a list of verb noun functions. To ensure the list is manageable; limits are imposed on the lengths of the FAST diagram. This is to avoid complexity and to ensure the fundamentals of the systems are maintained to archive the intended objective. However if the situations dictates that the number of functions grow exponentially resulting in many functions, a modified version called a FAST Functional Family Tree can be adopted. It is similar to the FAST diagram and created utilising the “*why-how*” logic question. The difference is that the functions are typed as line items in the word document to allow the functions to expand vertically instead of horizontally. Since the logic diagram grows vertically like a tree hence the name FAST Tree but utilizes the same concepts as FAST diagram. The main objective in the analysis is to move into areas one has not considered. The approach is to expand the logic diagram upward and to the left in search of higher-level function that will motivate and prompt creativity (Bytheway, 2007).

2.7 Summary and concluding remarks

Whilst the process of capturing lessons learned during the project life cycle is tedious, the rewards are worthwhile. Applying the FAST technique allows the opportunity to dis-integrate the lessons and map them as functions, thus opening alternative creative options. Future projects tend to benefit from efficient and effective processes provided the lessons learned process is diligently documented throughout the project life cycle. Construction projects are complex in the sense that they may require bringing together different multi-disciplinary teams, materials, systems, budgets and schedule for a limited period of time (Daniels *et al.*, 2014). In addition, people involved in projects are normally geographically dispersed, thus when they finish they move on. In many cases they are not retained by the same organisation resulting in valuable tacit knowledge being lost. Tacit knowledge is the experience and expertise kept in the construction professional's mind, company culture, lessons learned,

know-how, and other elusive yet valuable information (Lin *et al.*, 2005). Furthermore, as companies, strive to remain relevant and competitive, they are driven to review process orientation. This results in reduction of workforce through retrenchments, resigning of duties and normal movements. The acquired lessons or knowledge leaks away and is lost forever unless it is captured and shared (Davenport *et al.*, 1998). By breaking, the barriers associated with the traditional methods of capturing and communicating lessons learnt, one could analyse the building blocks and propose substitutes.

A reflection of Max Boisot work and its implications for organization studies, serves to articulate crucial aspects of knowledge management within organisations. Boisot's most cited works are connected with Epistemological-Space (E-Space) and Culture-Space (C-Space) frameworks and the Social Learning Cycle (SLC) (Child *et al.*, 2014). Essentially the E-Space constitutes a conceptual tool for analysing the organization of information subject to two economizing strategies: coding and abstraction (Boisot, 1987; Boisot, 1995). The focus of the E-Space framework is on the degree to which information is structured. On the other hand the C-Space framework is concerned with the social structures that affect the degree of information codification and diffusion. It introduces a dimension in which the information is diffused. Organizations unaware of the different cultures that operate within their boundaries can miss opportunities to exploit knowledge strategically and may succumb to the pathologies that stem from their cultural diversity (Child *et al.*, 2014).

Combining the E Space and C-Space culminates to a three-dimensional Information- Space (I-Space) framework for the mapping of structures and processes associated with the creation, organization, communication and exploitation of different types of knowledge assets in different contexts. The Social Learning Cycle (SLC) traces the path taken for the generation and development of innovation through a learning process that links exploration with exploitation by traversing several information-structuring and -sharing modes in the I-Space (Child *et al.*, 2014). Boisot created a knowledge-based lens for studying complex organizational phenomena and argued that the ways agents process information have fundamental implications for our understanding of groups and organizations. Boisot's key insight was his recognition that the form and communication of information lie at the heart of human learning and social organization, and underpin the creation and realization of the economic value and utility of knowledge assets (Child *et al.*, 2014).

If properly leveraged, lessons learned can be a primary vehicle for continuous improvement and effectively maturing a PMO (Boehringer, 2009). Organisational learning is target-oriented, is based on historical experience, and stored in routines (Levitt and March, 1988). Routines are an outcome of trial-and-error and reflect the accumulation of experiential wisdom (Gavetti and Levinthal, 2000). Few project centred organizations are able to systematically convert their lessons learned into improvement actions (Chan *et al.*, 2005). Organizations unaware of the different cultures that operate within their boundaries can miss opportunities to exploit knowledge strategically and may succumb to the pathologies that stem from their cultural diversity (Child *et al.*, 2014).

As discussed in the literature review, it is sufficient to conclude that applying the FAST method adopted from VE can stimulate creativity and innovation. Utilising the why-how logic, the author documented “active verb” and “measurable noun” guidewords to apply the FAST technique in capturing and communicating lesson learned. Guided by the procedures of developing a FAST Diagram as suggested by Charles Bytheway (2007) and the guidewords and FAST tree diagram as listed in Annexure C; a FAST Diagram for capturing and communicating lessons learned from one project to another has been developed by the author as shown in Annexure D1.

The process flow diagram figure 2-9 overleaf serves to illustrate how the FAST system will be applied to identify, solve problems and subsequently capture lessons from the projects.

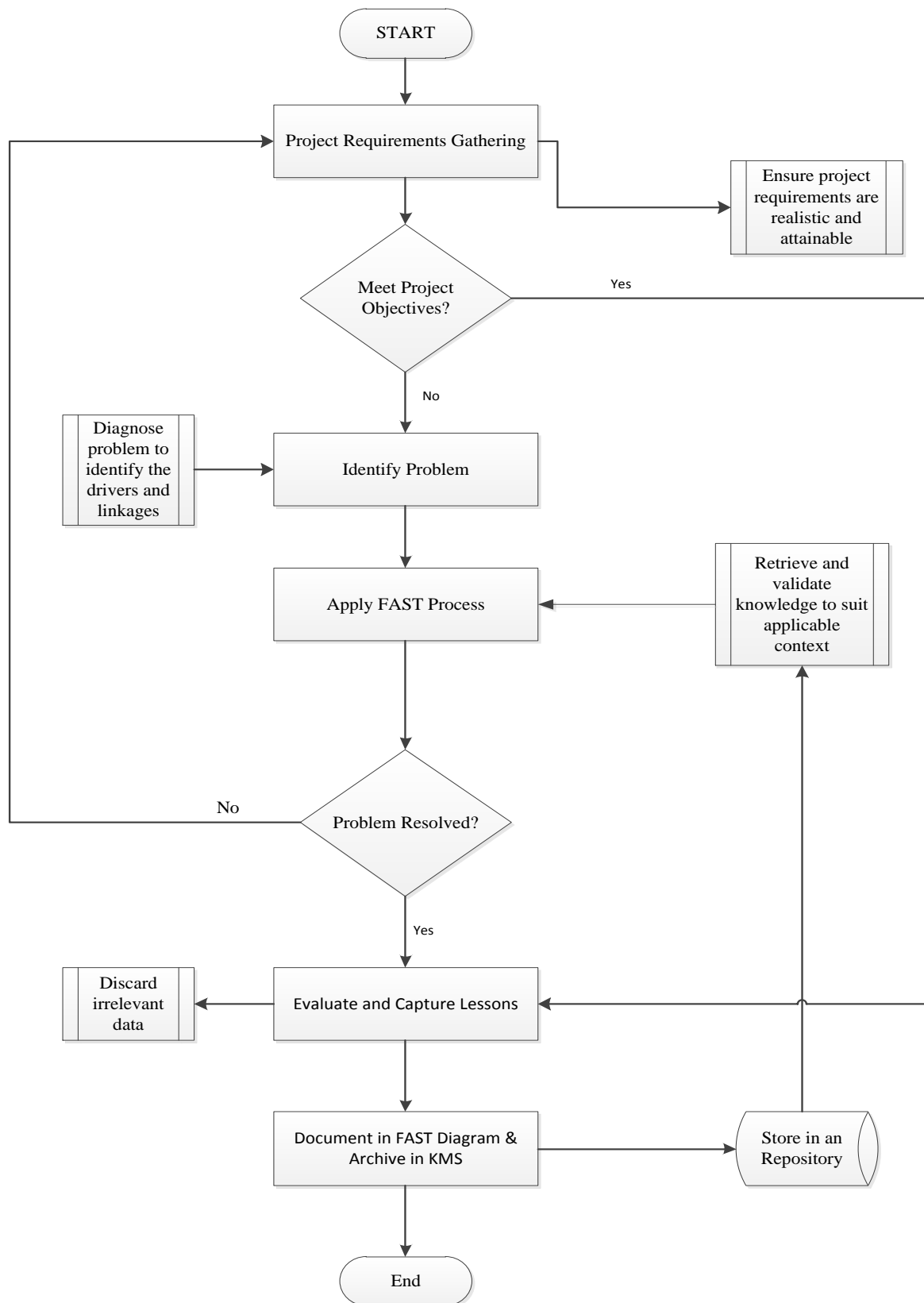


Figure 2-9: FAST process diagram (Author)

The challenge is that learning in project firms is always localised. There is no room to apply similar methodologies in a project running concurrently or on future projects. In order for project based firms to be competitive and survive the economic environment there is need to adopt the “*Knowledge Age*” framework. An organization in the “*Knowledge Age*” is one that learns, remembers, and acts based on the best available information, knowledge, and know-how (Mishra, 2009). This is supported by the advent of knowledge bases that support capturing of tacit knowledge into explicit knowledge. These developments have created a strong need for a deliberate and systematic approach to cultivating and sharing a company’s knowledge base — one populated with valid and valuable lessons learned and best practices.

When considering knowledge transfer within organizations, an effective understanding of the underlying mechanisms is specifically missing in the context of project-based firms. This is due to uncertainty and complexity making project based firms different from other organizations. In spite of significant investments in lesson capture systems, their ability to promote knowledge sharing is limited (Fisher *et al.*, 1998; Weber *et al.*, 2001). Organisations need to correctly diagnose the problem and apply the correct remedial action with the aid of the FAST diagram. Instead of perusing through a pile of project files in pursuit of solutions, a picture paints a thousand words. A quick examination and application of the FAST diagrammatic tool to a problem saves time and leads to the most appropriate solution.

The next chapter will present the research methodology that will be used to determine the applicability of the FAST Diagramming Technique from VE to capture and communicate lessons learnt to answer the question of this research. The objective is to empirically test if the proposal of adopting the FAST tool will actually achieve the goal of transferring the knowledge to the next project. In comparing the communication processes i.e. FAST method and the traditional written report; one will be able to ascertain the superior method of the two.

3 Research Methodology

3.1 Introduction

The chapter describes in detail the research methodology selected and utilised for this study. This chapter also covers the data collection instrument design and administration and analysis proposed. In addition, an outline of the available research methods was documented including the selection of appropriate research method and reasons for selecting them to achieve the address the research objective.

3.2 Research Approach

For this particular research, a qualitative methodology was adopted with an emphasis on the focus group approach. This method is typically related to explanatory cases that are characterised by “how” and “why” questions (Yin, 2003). The strategy adopted for this research is summarized in the figure 3.1 below:

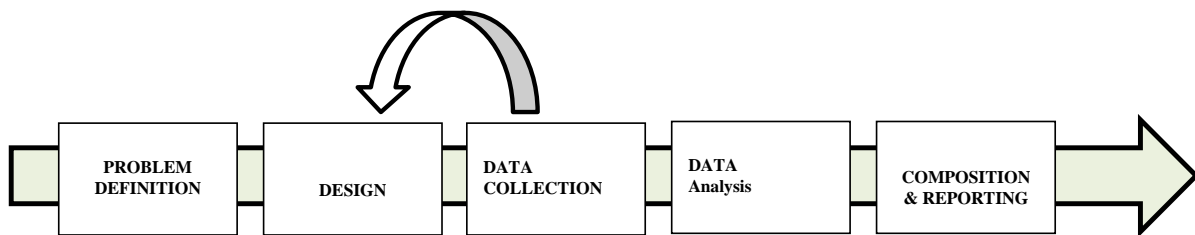


Figure 3-1: The Research Strategy Adopted (Yin, 2003)

Guided by the proposition:

“Conventional written methods of recording lessons about problems encountered on a project are not captured and documented in a way that makes it easy to communicate them effectively in future projects.”

A research design is developed which then leads to the data collection process. The data collection process is iterative and needs to fit into the design before the process moves to data analysis and subsequently synthesis and reporting. The main goal of scientific research is to systematically test a value proposition. The real value obtained from lessons learned is the ability of the organisation to establish and sustain a culture of consistent project management

improvement (Rowe, 2008). A proposition is a model or statement expressing relationships among constructs (Osterwalder, 2004). Constructs or concepts form the vocabulary of a domain. In research design activities, models represent situations as problem and solution statements (Osterwalder, 2004).

Each research method has its own limitations, however the two research methods discussed above can be used in a complementary manner. The author decided to use the pragmatic research approach. The approach allows the author the flexibility to have a focus group for discussion and articulating of project objectives and then use a questionnaire to measure ease of comprehending and transferring of knowledge through quantitative means. An evaluation questionnaire is developed to measure the level of understanding and knowledge capturing capability of lessons-learnt from one project. Further measurements on the ease of retrieving, validating and disseminating of lessons-learnt onto another phase or project are obtained. The response from the questionnaire will be analysed in an appropriate statistical manner.

The choice of the research approach that best fits the objectives of the research as the type of questions being asked are the explanatory “why” and “how” questions which require the participants to express their views and opinions (Yin, 2003). Focus group sessions often use an analytic framework. Furthermore, focus group hinge on a network of linked concepts and classifications to understand an underlying process; that is a sequence of events or constructs and how they relate (Miles and Huberman, 1994)

3.3 Research methods

A research method is influenced by the objectives to be attained from the research. When research is conducted to investigate a research hypothesis or research question, data is collected from the objects of enquiry in order to solve the problem concerned (Welman *et al.*, 2005). The key success measurement criteria that will be utilised to determine if the research objectives were met; formed the basis of identifying influencing factors of the research methodology. The influencing factors are drawn from the main research question – “*Can utilising a diagramming tool such as the FAST model enhance the effectiveness of capturing and communicating codified knowledge to future projects?*”

The most common research methods are qualitative and quantitative research. The philosophical roots of qualitative and quantitative research are respectively found in the naturalistic and positivistic approaches (Newman and Benz, 1998). The two approaches

(qualitative and quantitative) differ in research purpose, methods of inquiry and data collection strategies (Kumar and Phrommathed, 2005). Both types of data can be useful for descriptive, investigative, exploratory, inductive, opening up purposes (Miles and Huberman, 1994). Figure 3.1 below serves to illustrate how the knowledge claims, the strategy of enquiry and the method, leads to the approach and research design process.

Elements of Enquiry

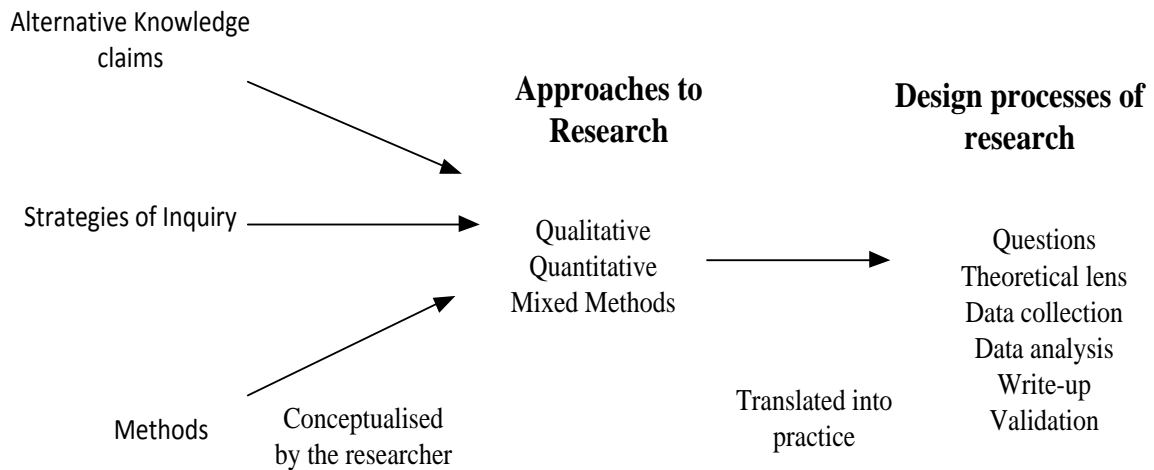


Figure 3-2: Knowledge claims, strategies of inquiry and methods leading to approaches and design process Creswell (2004)

3.3.1 Quantitative vs. Qualitative Research Method

Quantitative research is defined as “An approach for testing objective theories by examining the relationship among variables” (Creswell, 2014: 33). In quantitative research, numerical data is gathered and analysed using mathematical methods. In short, quantitative deals with measurement of a variable and presented as statistics and numbers. Thus quantitative research is essentially about collecting numerical data to explain a particular phenomenon (Muijs, 2010). Quantitative research enables us to obtain three different classifications of numbers: market measures, customer profiles and attitudinal data. The following are methods in which quantitative research method are achieved

- Self-completion survey
- Direct measurement
- Interviewing

(Creswell, 2012)

The shortcomings of quantitative research are that it is unlikely to be very helpful when you want to understand the detailed reasons for particular behaviour in depth. In the researcher's context, the objective is to bring out the advantages of using a diagrammatic tool such the FAST model to capture and communicate lessons learnt. There is need for a workshop or round table setup to articulate and explain the FAST model. In addition such a setup will give the researcher the opportunity to illustrate how the FAST model applied in the context of the research. Furthermore, the workshop scenario affords participants to ask questions and have a better understating of the proposed FAST model before completing and responding to the research questionnaire. This approach ensures responses are valid and based on good understating of the FAST model proposition articulated.

Another drawback of quantitative research is the possibility of assigning numbers to fairly abstract constructs such as personal opinions, this approach risks making them spuriously precise (Muijs, 2010). With the advent of computers and software such as SPSS the analysis of quantitative data has been streamlined. Wide ranges of techniques are available such as test for correlation, to identify relationships between a set of data. Alternatively, one can perform hypothesis testing to identify differences between a set of data. All the aforementioned techniques can be utilised to make a deductive conclusion of the data. However, in the context of the subject under study the quantitative research option cannot solely be used to give conclusive results on the advantages of the FAST model.

The shortcomings highlighted above calls for exploring an alternative method which can best fit the research scenario. It is important to note that the quantitative method does not fit all research situations. Another option common in research is qualitative research. Qualitative research is an inquiry process of understanding based on a methodological tradition that explores a problem, to construct a complex, holistic picture, detailed views of informants, analysis of words and reports in a natural setting (Bacon-Shone, 2013). A qualitative approach entails inquiry through the collection of data in a natural setting sensitive to the people and places under study, and data analysis that is inductive or deductive and establishes patterns or themes (Creswell, 2012). The qualitative paradigm is arguably more concerned with context and provides richness not easily achieved with quantitative measures (Bacon-Shone, 2013). The procedures of qualitative research are inductive, emergent and shaped by the researchers experience in collecting and analysing the data (Creswell, 2012). The following are methods in which qualitative research methods are achieved

- Focus groups
- In depth interviews
- Secondary data (from previous research attempts)
- Participant observation (Creswell, 2012)

The strength of the qualitative method of research lies in it being able to identify social norms, socioeconomic status, gender roles, and ethnicity. Qualitative research bring the advantage of flexibility in the research design, and the ability to avoid reliance on researchers pre-determined assumptions (Griffin, 1986). In the context of the research under study, qualitative research can be used to collect data in the natural setting and establish any links with the research proposition. In addition, qualitative research brings the ability to focus on the meanings of key issues for participants especially any contradictions or inconsistencies in their perspectives (Griffin, 1986). The description articulated above in particular the method of focus group fit well into the realm of the intended research study.

3.3.2 What is Focus Group Study?

The focus group study method consists of a group of selected individuals who gather in order to elicit information on aspects of project lessons learnt. The individuals are selected from within a consulting firm as they will be readily available to elicit the required information. To add, the participants are familiar with how projects are managed within a consulting firm thus their input will be based on experience and objective. The focus group method affords the researcher an opportunity to interact with the research participants in a workshop setup and thus allow for better understating of the FAST model beforehand. In addition, it allows participants to be fully aware of the background of study to avoid preconceived ideas that can negatively influence research outcomes. Furthermore, the interactive prowess allows other participants to listen in, as the conversation progresses and this can have an impetus in generating new ideas around the topic under discussion. However, the focus group method can also have limitations in breaking down the logical thinking process and come up with a convincing conclusion of the subject under study. Thus this can be counteracted by the use of a quantitative method to establish the relationship of capturing and communicating lessons learnt using the FAST diagrammatic tool.

3.3.3 Validity and reliability of research method

In light of the aforementioned advantages that fit well into the research under study, qualitative research methods have drawbacks that need to be closely monitored and controlled to avoid distortion of results. Since qualitative data is drawn from different sources within a wide sampling spectrum, this makes the analysis of the sourced data time consuming. Nonetheless, it is imperative to get a true reflection of the responses to the research question from the sampled results. Furthermore to obtain good credible data is labour intensive as well as expensive thus limiting the participation in the research in certain circumstances. To mitigate the risk associated with cost of data collection but at the same time obtaining a credible sample to allow conclusive results; the author intends to use participants from within the same company but from different offices, business units and specialized disciplines. The rationale of selecting participants from the same company is close proximity of participants to the researcher. Thus it is easy to get a sizable number of individuals in a room to conduct the focus group session. To bring in diversity and different opinions, the individuals were drawn from different offices and speciality fields. This also helps in addressing the complex aspect introduced in the research through different office cultural behaviours. Cultural behaviour can bring in a different connotation on how participants behave under certain constraints and in order to get an objective response it is imperative to sample from two different offices. Other limiting factors include having the researcher being part of the data gathering exercise which can influence results outcome- lack of data collection independence. In addition, the quality and validity of the research outcomes is dependent on the skills of the researcher and thus making repeatability a problem. However the two aforementioned factors will be controlled during the research by the use of a standard power point presentation to allow data independence and repeatability. Notwithstanding the challenges discussed above, it is envisaged that the research objective of bringing out the ease communicating of lessons learnt on projects using the FAST methodology shall be accomplished. Nonetheless the selection of an appropriate qualitative approach should always be dictated by the research question under investigation (Griffin, 1986).

Qualitative and quantitative research techniques are not mutually exclusive. Both types of research are often carried out with qualitative methods giving the insights and quantitative research the measurements. A combination of the quantitative and the qualitative methods is termed the mixed method methodology (Teddlie and Tashakkori, 2009). This approach is the most appropriate as it brings the best of both methods into establishing the effectiveness of

the FAST tool in capturing and communicating lessons learnt. In addition, by knowing the pros and cons associated with each technique, help the researcher to control the negatives without distorting the result outcomes of the research. However, qualitative research methods still have a place within the research context and are employed in many different academic disciplines, traditionally social sciences but also in market research and further contexts. This is despite the reluctance of many academics, practitioners and policy makers to take qualitative research seriously (Griffin, 1986).

3.4 Research Design

The research design is defined as the plan according to which we obtain research participants (subjects) and collect information from them. In it we describe what we are going to do with the participants with a view to reaching conclusions about the research problem (Welman *et al.*, 2005). Many data that do not naturally appear in quantitative form can be collected in a quantitative way. This is done through designing research instruments aimed specifically at converting phenomena that don't naturally exist in quantitative form into quantitative data, which we can analyse statistically (Muijs, 2010). If the research instruments are not structured, redundant information will be collected. Subsequently, an overload of data would compromise the efficiency and power of the analysis (Miles and Huberman, 1994).

Two focus groups denoted as Focus Group A and B convened in separate boardrooms in different locations for a session that was facilitated by the author. Three to seven members constituted a focus group with participants having varying roles and responsibilities on previous or ongoing project. Each group consisted of technical personnel, project administrators, project managers and project principals. The project principals represent senior management within the organisation, as they are involved in matters of corporate governance, high-level decision making and the ensuring the business strategy is adhered to. To avoid bias and maintain independence, the group of participants for each focus group session were taken from two different offices with different discipline specific functions within the same organisation. The participants would have worked or were currently working on similar but not necessarily the same projects within a specific business line.

To ensure all the participants understand the objective of the research, a briefing session was conducted to orient participants with the FAST diagram and capturing of lessons learned. To ensure repeatability is maintained amongst participants, a PowerPoint presentation was used by the author to guide the briefing session. A log-list of lessons learned activities captured

during the implementation phase of a project were used as a guideline in developing the FAST diagram and conventional project closure report. Annexure E serves to illustrate a typical lessons learned activity log list. The two focus groups, Group A and Group B were presented with the activity log list used in the development of the conventional project closure report and the FAST diagram generated from the lessons learned activity log list. The author facilitated a brainstorming session whereby the participants in each group were allowed to deliberate and perform retrospective analysis of a typical project – such as building a pump station. At the end of the session, the author evaluated how well the participants of each focus group understood the task presented to them. Both Focus Groups, A and B were evaluated on how well they understood and comprehended the problems that were encountered during the project implementation phase by utilising the FAST diagram as compared to just analysing the activity log list used in the generation of conventional project closure report. The participants were then requested to complete a set of structured questions in order to test the level of comprehension and understanding of the lessons learned. Figure 3.3 overleaf serves to summarize and illustrate the process that was followed:

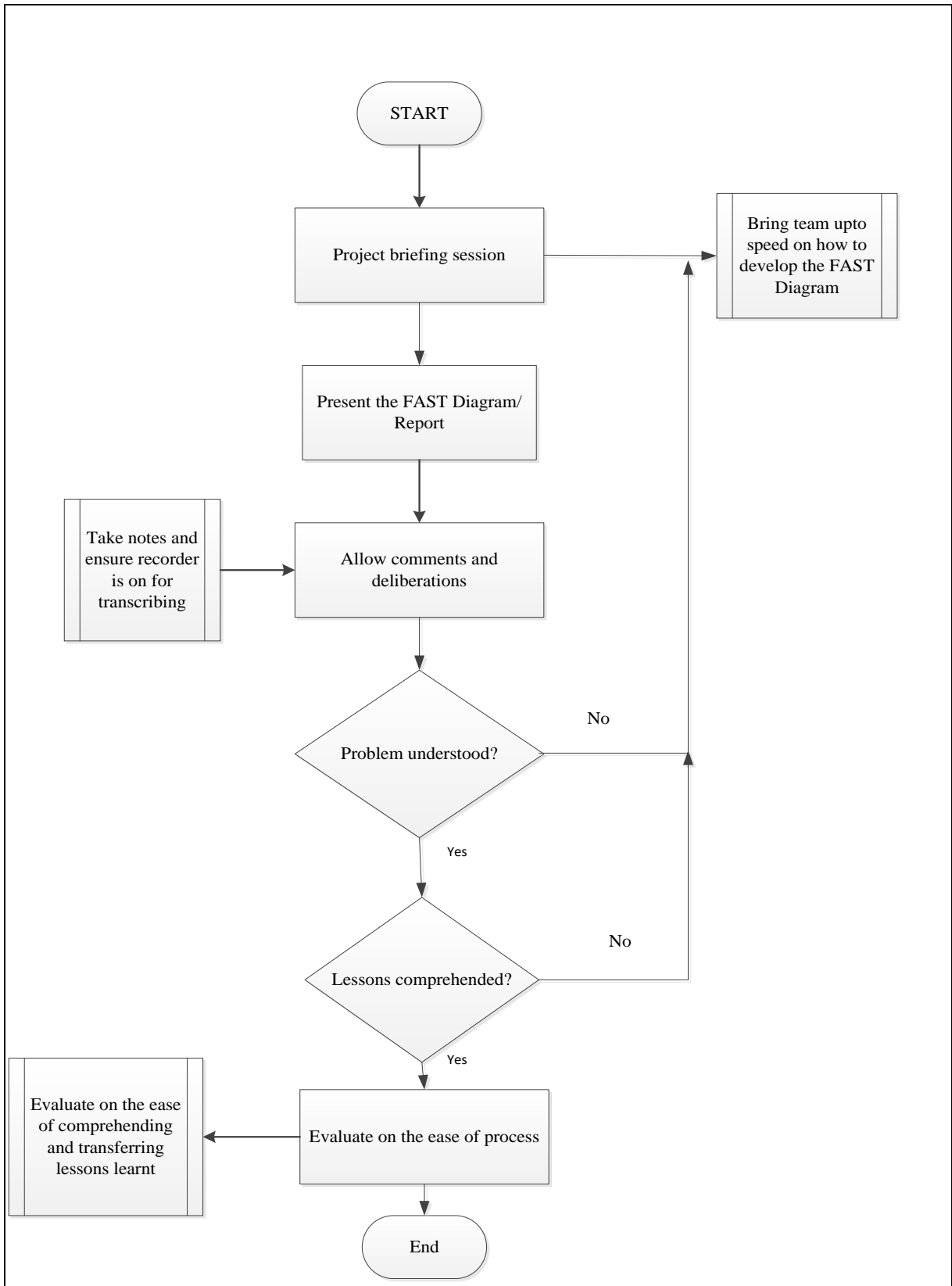


Figure 3-3: Focus Group FAST Process (Author)

The important aspect to recognise is that what happens in life or project set up depends on not just how well we think but also how we think (Sternberg, 1999). With this in mind, the structured questions presented to participants had to encompass and bring out the thinking style profiles. Understanding styles can help people better understand why some activities fit them and others don't and even why some processes fit them and others don't (Sternberg, 1999). To avoid dominant voices during the discussion period, the author adopted De-Bono's "Six Thinking Hats" approach as a guide to moderate the Focus Group Discussion (De Bono, 1985).

The premise of the six thinking hats approach is that the human brain thinks in a number of distinct ways that can be challenged. The human brain tends to think and process information in a logical manner. This notion has to change if the focus group discussion intends to yield a substantive resolution. To mitigate the risk and avoid bias the "Six Thinking Hats" and the associated idea parallel thinking provide a means for groups to plan thinking processes in a detailed and cohesive way, and in doing so to think together more effectively (De Bono, 1985). Utilizing the six thinking hats approach allows thoughts from the discussion, which are contradictory not to be argued about but rather laid down in parallel (De Bono, 1989). In the final stage of the process, the parallel ideas converge to design a cohesive way forward. Table 3.1 below serves to summarise the six thinking hats the associated attributes and the invoking questions for each colour hat.

Table 3-1 – Summary six thinking hats

Colour Hat	Attribute	Invoking questions
Blue	Managing	What is the subject? What are we thinking about? What is the goal? Can look at the big picture
White	Information	What information is available, what are the facts?
Red	Emotion	Intuitive or instinctive gut reactions, gut reaction statements
Black	Discernment	Logic applied to identifying reasons to be cautious and conservative. Practicality and realistic
Yellow	Optimistic response	Logic applied to identifying benefits, seeking harmony. Sees the brighter, sunny side of situations.
Green	Creativity	Statements of provocation and investigation, seeing where a thought goes. Thinks creatively, out of the box

In utilising the six thinking hats approach, the author also followed guidelines as described by De Bono on how to moderate the process. Each focus group participant is encouraged to wear the hat of the moment to enable creativity and new ideas to be thrown for deliberation.

Figure 3.4 below serves to illustrate how the six thinking hats approach will be adopted and utilised during the focus group discussion.

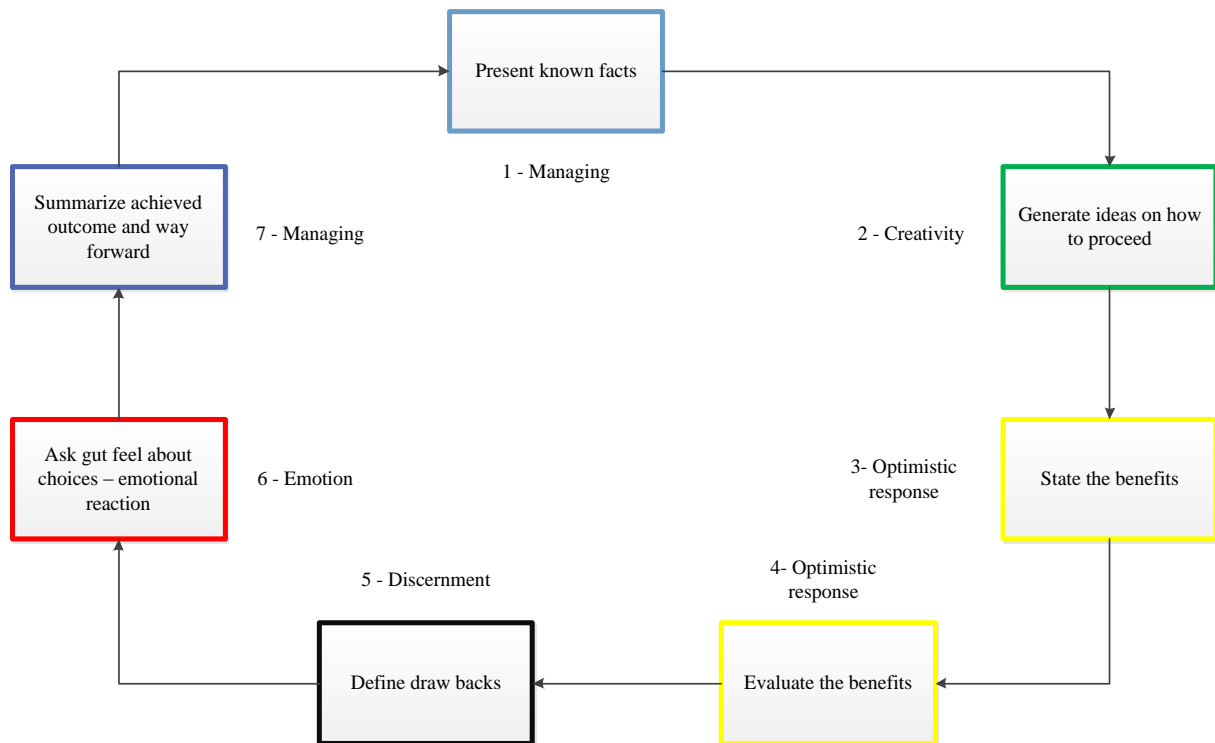


Figure 3-4: Process of adopting six thinking hats approach (De Bono, 1985)

The benefits of using the six thinking hats approach can be summarized as below:

- Allows us to say things without risk
- Create awareness of multiple perspectives on the issue at hand.
- Mechanism is a convenient for thinking in deliberate new ways
- Offers a convenient mechanisms of thinking with – Set rules for the game thinking
- Allows participants to focus their thinking
- Leads to more creativity in our thinking through unhampered dialogue
- Improves communication since egos are not threatened,

- Improves decision making, because attention is given to all aspects of a problem/opportunity (De Bono, 1985).

The careful measurement, generalisation of samples, experimental control, and statistical tools of good quantitative studies are valuable assets (Miles and Huberman, 1994). Nevertheless, when they are combined with the up-close, deep, credible understanding of complex real-world contexts that characterise first-rate qualitative studies, the researcher is granted a practical and powerful research tool (Miles and Huberman, 1994). This research design adopted for this research is explanatory and deductive research combining both qualitative and quantitative methods. Thus, it is more than simply collecting and analysing both kinds of data; it also involves the use of both approaches in tandem so that the overall strength of a study is greater than either qualitative or quantitative research (Creswell and Clark, 2007). An explanatory research focuses on the “why” question and identifying the causal relationships of events.

Reading a set of structured statements a participant is asked to rate, themselves on a likert type response format of 1-5 where each rating corresponds to how likely they will perform a task described in the statement that follows:

1 = Never; 2 =Rarely; 3 = Sometimes; 4 = Often; 5 = Always;

Annexure G serves to illustrate the evaluating criteria tool to be used in the research study and how the rating process is applied.

The evaluating criteria questions used to elicit information from participants of the subject under study need to relate the research questions, proposition and objectives in Chapter 1. Below is a detailed explanation of the information elicited by each question posed to the participant and how it links to the problem statement, research questions and objective of study.

1. *When starting a project, I prefer to look on previous close out reports on similar projects to obtain lesson learnt and avoid falling in similar pit.*

The author intends to ascertain if there is a culture of capturing and documenting of lessons learnt within the organisation. If the past project events activities are documented; is the manner done in such a way that it promotes an easy way to communicate the lessons learnt

onto future projects Furthermore, the question will test the future user's appreciation of the use of lessons learnt to avoid repeating problems encountered on previous projects when executing future projects.

2. *If I have lessons learnt information on current project, I prefer to talk about it rather than document it in a form of report*

The question brings out the behavioural traits of the participants in communicating lessons learnt. The question establishes whether it's done formally through a documentation process or rather it can be informally through verbal conversation. The response from the question will test if utilising a diagrammatic tool will enhance the effectiveness of capturing and codifying knowledge onto future projects.

3. *A formal setup in a project environment is preferable to an informal discussion to communicate lessons learnt.*

The question serves to establish if the environment and the manner in which the information is packaged can influence how it is perceived by the end users. Thus to establish the activities that will enhance and reduce the cost of capturing and communicating project lessons learnt one has to decide whether to use an informal or formal environment. In both instances the lessons are captured and communicated however the cost factor can hinder future sessions using similar setups. The question relates to the sub-research question which determines whether the cost penalty and effectiveness of the FAST model can be used to justify future use of the diagrammatic tool to communicate lessons learnt.

4. *I find it easier to comprehend lessons learnt from analysing a FAST diagram compared to a traditional project close out report.*

The question relates to the research objective of testing the effectiveness of the FAST model as a device of transmitting knowledge about lessons learned from one project to another. A picture tells a thousand words. Thus the question tests the effectiveness of a diagrammatic tool to capture and convey a compelling message on lessons learnt from one project to another. In addition, the question also determines the ease of comprehending lessons learnt from analysing a diagrammatic tool such as the FAST model as compared to reading through a lengthy close out report.

5. *I find it convenient transferring and communicating lessons learnt from analysing a FAST diagram compared to a traditional project close out report*

The question also relates to the research objective of testing the effectiveness of the FAST model as a device of transmitting knowledge about lessons learned from one project to another. A picture has the potential of conveying a story that might require ten pages to effectively express it and takes time to comprehend the literature such as a project close out report. It may require going through the literature of the project close out report more than once, an exercise which is time consuming and also frustrating. Thus the question tests the convenience of using the FAST diagrammatic tool to capture and articulate lessons learnt in a short space of time. A tool that is convenient to use is easily adaptable amongst users and also it serves time as the correct message is conveyed in a short period.

6. *I like to collect and disseminate lessons learnt in the traditional way that has been used in the past without looking at the FAST diagram*

The question relates to the research objective of investigating ways of building relevant FAST diagrams to capture and communicate lessons learnt. By obtaining the participants preference in collecting and disseminating lessons learnt; one can develop ways that can be incorporated and improve the way FAST diagrams are perceived by end users. If the alternative ways of building FAST diagrams are easily matched to what participants are familiar to; it's easier to sell across the idea of using diagrammatic tool to capture and communicate lessons learnt. In linking the preferences to the advantages, a change end users perception on the use of FAST diagrams can be realised.

7. *The FAST diagram gives an overall picture of lessons learnt events that transpired during the life cycle of the project without getting into too much detail.*

The question relates to the research proposition which states that modelling problematic project activities during the entire life cycle using functions can help enhance the capturing and communicating process of lessons learnt. By presenting the lessons learnt in a pictorial format and as functions give the entire picture of the links of the various functions associated with that knowledge area without divulging much detail. It will assist in conceptualizing and visualising what lies ahead in a project and thus lay down appropriate measures to avoid the obvious pitfalls. In so doing one is able to test the ease of comprehension of project lessons

learnt by using a diagrammatic tool such the FAST model compared to long worded close out report.

8. *The FAST diagram outlines the co-relationship of lessons learnt events and provides enough detail to make informed decisions on future projects pitfalls*

The author's proposition articulates the view that a diagrammatic tool aided by the use of functions will illustrate the relationships and convey a better compelling message with enough detail to enable one to make an informed decision. In so doing, one can avoid obvious pitfalls from occurring on future projects. The above question brings out if the co-relationship of lessons learnt will add value in the decision making process.

9. *Pictorial or diagrammatic systems like FAST aid in capturing lessons learnt during project life cycle.*

The statement relates to the research question by testing the effectiveness of the FAST model as a device for capturing transmitting knowledge about lessons learned from one project to another. One can test if the approach of using a diagrammatic tool such as the FAST can enhance the effectiveness of capturing and disseminating codified knowledge. If the diagrammatic approach aids and makes the capturing and communicating of lessons learnt easier; then it can be concluded that FAST methodology is an effective model and relates to the research proposition.

10. *The ease of comprehension and cost benefits warrants the use of FAST diagram in transferring lessons learnt onto future projects.*

The statement relates to the sub research question which deals with the cost penalty associated with the use of the FAST diagram. Investing time and resources in developing the FAST model has a cost attached to it and the questions tests if the benefits associated with use of the FAST model in capturing and communicating lessons learnt outweighs the overall cost. It helps to justify the use of FAST model on future projects as it stands to benefit the organisation at large in avoiding pitfalls from previous project experiences.

Yes/No Questions

1. *I prefer to use the traditional project close out report to capture and communicate lessons learnt on projects.*

Yes/No question tests the participants' preference in capturing and communicating lessons learnt. It also serves to test if the participant appreciate the value of lessons learnt and if he/she has a culture of capturing project lessons learnt.

2. *In utilising the FAST diagram, did you manage to identify at least 5 lessons from the project?*

The author tests the ability of the participants to identify at least 5 lessons from the FAST model presented during the focus group session. This relates to the problem statement which argues that conventional written methods of recording lessons of problems encountered on a project are not captured and documented in a way that makes it easy to communicate them effectively onto future projects. The test will measure the impact and effectiveness of the FAST model if used consistently in capturing and communicating lesson learnt. It will also establish the ease of comprehending lessons learnt when presented in a diagrammatic format.

Open ended Question

1. *Do you think diagrammatic tool like FAST have a future in capturing and communicating lessons learnt within projectized environments? Give a reason for your answer*

The question is presented in an open ended format to allow the participant to explain in his/her own words if the FAST model is a tool that can be relied on to capture and communicate lessons learnt. Based on the participation in the focus group discussions, the author intends to test the opinion of the participants if they think the FAST model can make a difference within the subject area in the near future. In addition, the participant is compelled to give the reasoning behind his/her comments regarding the FAST model and this will give a insight of the FAST model from the participants view point.

2. *Do you think utilising the FAST diagram in capturing and communicating lessons learnt stimulates creativity and stirs project teams to adopt alternative ways of performing tasks differently in the project environment. Give a reason for your answer*

The question structured in an open ended format as it tries to establish if the FAST model approach can stimulate creativity. By stimulating creativity in the capturing and communicating lessons learnt of projects can aid in bringing alternative ways of

performing the tasks. This can lead different viewpoints regarding the FAST that are worth noting and discussing in the conclusion chapter.

3.5 Calculation of scores

The structured discussions will help develop answers to the research question on a likert type response format and steer the conversation to conclusive outcomes, which will form the basis of the research findings and recommendations. The scores are calculated by establishing the mode and median of each participant responses. To determine the mode and median, the participants' response scores to the ten questions are arranged in order from smallest to largest. Since each participant's data set consists of ten responses from the evaluating criteria questions, thus the data set is an even number of items. The median is obtained by taking the mean (average) of the two middlemost numbers when the data set is arranged in chronological order from smallest to largest. The mode is the number that occurs the most from each participant's data set thus a count of how many times each number occurs. This gives a result between 1 and 5 for both the mode and median values. Depending on the score achieved, each participant is grouped into one of the five categories available. For the sake of this research, the average of the median and mode values will be used to determine a conclusive modifier that will suit the collected likert type responses. The five categories use a modifier to describe one's perception of the FAST diagram. Table 3.2 below serves to illustrate a hypothetical example of typical scores from a focus group discussion. The table serves to summarize the computation involved in quantifying the data and how the computed results will be grouped into different categories by the author.

Table 3-2 – Example of Focus Group Discussion typical scores

Modifier	Category	Difference	Group A	Group B
Very High	(80% – 100%)	20	4.1 – 5.0	4.1 – 5.0
High	(60% - 80%)	20	3.1 – 4.0	3.1 – 4.0
Middle	(40% - 60%)	20	2.1- 3.0	2.1- 3.0
Low	(20% - 40%)	20	1.1 – 2.0	1.1 – 2.0
Very Low	(0% - 20%)	20	0.1 – 1.0	0.1 – 1.0

For the closed Yes/No questions the evaluation is straight forward as it will test the participant's preference in capturing and communicating lessons learnt. Furthermore the second question will test the participant's ability to identify at least 5 lessons learnt from the FAST diagram presented during the focus group session. Thus the responses are precise and clearly articulate the participant's opinion regarding the subject matter being asked.

The open end questions were thrown into the foray to allow the participants to fully express their opinion and thought process regarding the subject under research. The open ended questions were structured in such a way that they illicit meaningful responses and at the same time allowing the participants to express their knowledge regarding the topic under research. This posed a challenge in the analysis of the open ended question, however the author managed circumvent this by using the thematic approach. The following process was used to analyse and interpret the open ended questions:

- a) The author read the question and underlined the main information that was to be drawn out from question.
- b) The author further went to read through the open ended responses repetitively for 3 times until he fully understood the context of the responses.
- c) The author categorised the responses based on the themes articulated by the participants into three categories,
 - i. Participants who are for and see value in the FAST diagramming tool
 - ii. Participants who are indifferent and cannot ascertain the merits of the FAST diagramming tool
 - iii. Participants who are against and do not see any merit in the FAST diagramming tool.
- d) The author went on to identify certain key words and document themes emanating from the responses and assign a category that best fits the open ended description.
- e) The author went further to then analyse the responses and make an informed judgement and conclusion based on the participants' information at hand.
- f) The final analysis from the participants was then incorporated into the discussion of results section.

3.6 Interpretation of results

The interpretation of the modifiers is the next step that follows once the scores from the research questions are grouped into the respective modifier categories. Each modifier

category describes the participants' perception of the FAST model. The table 3.3 below serves to illustrate hypothetically how each modifier category is interpreted.

Table 3-3: Hypothetical example of interpretation of results

Modifier	Description	Interpretation
Very High	Strongly Agree	You have all the characteristic traits to strongly agree on the proposition that the FAST diagram enhances capturing and communicating lessons learnt
High	Agree	You have many of the characteristic traits to agree on the proposition the FAST diagram enhances capturing and communicating lessons learnt
Middle	Intermediate	You have at least some characteristic traits to agree but at the same time you also indifferent to the FAST diagram methodology. No conclusive answer can be obtained.
Low	Disagree	You have no dominant characteristic trait to agree with proposition and would prefer conventional close out reports
Very Low	Strongly disagree	You strongly disagree with proposition and FAST diagram is not your style and prefer the traditional reports

The structured questions as described in Annexure G presented in a likert type response format will be used to rate the ease of comprehension of lessons learned. In addition, the ease of knowledge assimilation, communication and ability to transfer lessons learned from one project to the other will be analysed quantitatively to obtain a clear distinction on the advantages of the FAST diagram. The responses of the participants from each focus group are tallied and analysed statistically with the aid of the interpretation statements as illustrated in table 3.3.

3.7 Data

Data collection can pose a challenge in any research thus it is imperative to obtain unbiased data. The choice of participants was selected to ensure they were from two different offices within the same company. A selection of individuals encompassed participants working as project administrators, project managers, site engineers who experience project activities on a daily basis. The level of expertise varied from junior engineers who just joined the organisation as well as experienced engineers with a number of years in project management. The data to be collected will consist of focus group discussions as well as questionnaire responses to evaluate level of comprehension and understanding of lessons learned. The varying levels on the understanding will be tabulated and analysed statistically.

The choice of participants from different offices tries to remove the bias associated with office culture that participants could have inherited over time. In addition, this approach allowed the author to improve data validity from a small sample available. A project is defined as a temporary endeavour undertaken to achieve a unique product, service or result (PMI, 2013). At organisational level, the company sets out guidelines under which projects are to be managed. One would expect to find the same *modus operandi* applied onto projects across the various organisational functional structures and offices. However, it is common that the implementation and application of principles can differ from office to office and from one functional structure to the other depending on what the projects entails. Thus participants from different offices are bound to have different perceptions to the research under study on what would seemingly be organisational practice. This further substantiates the need to spread the data collection process for the research across the two different offices. By spreading the sample data across two offices allows the researcher to elicit objective responses as participants will be able to share views and opinion around the subject matter based on their personal experiences. In addition, it made the data collecting process easy from a logistical view point by having a small manageable number of participants. This further contributed to the better coordination and moderation process during the focus group sessions.

3.8 Limitations

The focus group session conducted from different offices can be detrimental in attaining the objective of the research. It is against this background that the author argues that it is important for intra –organisational differences not to be apparent as it will distort the validity of the data collected. It is assumed that intra –organisational differences are subtle and will not have an impact in attaining the objectives of the research. It is important to maintain neutrality as the facilitator across the two focus groups. However, below are some of the limitations to the research that the researcher anticipates to encounter:

- The findings may not be comparable or projectable in the same way as quantitative results due to the smaller sample size. However by choosing participants from different business lines, offices and area of specialities allow for a reasonable sample size to come up with conclusive results applicable to subject under research.
- The more experienced participants can dominate the session and influence the outcome of the session and ultimately giving a biased research output. This is

mitigated by adopting the six thinking hats to avoid dominant voices during discussion. Each participant's thought process or idea is treated equally and placed in parallel as the discussion progresses. In concluding the session, the presented thoughts will be converged to come up with an inclusive conclusion on the subject. This will moderate the effects of the experienced people during the discussion.

- The brain storming session conducted to bring the participants up to speed with the project can end up influencing the outcome of the research findings. However, the author intends to use a practical FAST example which is similar but different to the research FAST diagram. The brain storming session will be kept as short as possible and presented in a power point slide just to give the participants an introduction to the subject but ensuring the FAST concept is articulated to the participants.
- There are limitations on time and locations as you may not be able to get a fair number of participants in one location at the same time. Due to the varying projects demands and personal circumstances, it will be impractical to have all the recipients of the focus group invites into one session. Some projects demand the target participants to be on site or attending meetings. This was mitigated by sending to as many people as possible and also requesting the recipients of the invite to confirm participation. In addition the invitation to participate in the focus group discussion will be sent out a month in advance to ensure we obtain the sufficient number of participants for research purposes. Furthermore, the author will travel to the various locations to conduct the focus group sessions and minimize the need of the participants having to travel to where the author is based.
- The participants can introduce uncertainty on the validity of the data as it will be dependent on personal circumstances and how they comprehend report or FAST diagram. The control mechanism comes in wearing the different hats to avoid bias and stirring discussion to a point that can influence the participant to a particular outcome of the study. However the standard presentation and brain storming session will be conducted in such a manner to even the play field and promote a realistic and logical conclusion to the research study.

3.9 Brain storming session

In conclusion, the work of Bytheway (2007) was used as a guideline to construct the research instrumentation for the brainstorming session. The project lessons learned activity list was used to develop the higher order functions and subsequently the FAST tree. The FAST tree

was in turn used as a guideline to develop the Lessons Learned FAST Diagram as illustrated as Annexure D1 and D2.

3.10 Ethical Issues

Ethics is an important subject in research especially in a study that deals with people as the subject matter. Ethics is defined as the norms for conduct that distinguish between acceptable and unacceptable behaviour (Welman *et al.*, 2005). Research ethics is informed by wider philosophical debate and encompass a set of issues that permeate the research process (Bell (Bell and Wray-Bliss, 2009). There are certain ethical considerations that are concerned with plagiarism, interventions in gathering the data and honesty in reporting results. Ethical considerations are relevant to all methods utilized, and affect choice of method, relationships with the participants, and the presentation of the data collected (Bell and Wray-Bliss, 2009). One may also define ethics as a method, procedure, or perspective for deciding how to act and for analysing complex problems and issues (Resnik, 2011). There are several reasons why it is imperative to abide to ethical norms. Chief amongst them, ethical norms promote the aims of research, such as knowledge, truth, and avoidance of error. Furthermore research often involves a great deal of cooperation and coordination among many different people in different disciplines and institutions, ethical standards promote the values that are essential to collaborative work, such as trust, accountability, mutual respect, and fairness (Resnik, 2011). However, organisational research has an effect, cumulative or immediate on the participants and this cannot be assumed to be beneficial to all (Bell and Wray-Bliss, 2009) .

Prior to commencement with the data gathering process the principal researcher briefed the participants on the research objectives and articulated the importance of focus group sessions particularly in areas of qualitative research. The briefing session gave an insight on the guidelines on how the focus group session was to be conducted. Furthermore, during the briefing session the principal researcher highlighted to participants that there were free to withdrawal anytime during the focus group session. In addition it was brought to the participants' attention that there are no known threats posed by having people participating in the focus group research initiative. To ensure participants are fully aware of the implications of the research, the principal researcher arranged for participants to sign consent forms. Gaining informed consent from people involved researched is central to ethical research practice (Wiles *et al.*, 2007). However the adequacy of form filling as a method of ensuring that participants understand the implications of consenting to participate in a research

investigation has been questioned by several commentators (Edwards and Mauthner, 2002; Bhattacharya, 2007). Furthermore, consent is contingent and situated, varying according to whom one is dealing with and how definitions are operationalised a process that relies on an ongoing process of negotiation which cannot be adequately addressed by getting participants to sign a form (Wiles *et al.*, 2007). One can argue the requirement to obtain signed consent has the potential to adversely affect the participation of particular groups in research such as those who wish or need to remain anonymous because for example they are involved in committing illegal acts, by increasing rather than reducing their anxiety about participating in research investigation (Coomber, 2002; Nelson, 2004). While informed consents protect research participants from harm, it does not allow for the possibility of participants causing harm to others (Koro-Ljungberg *et al.*, 2007). It is the researcher's moral right to reveal everything that harms people or makes them suffer conversely, researchers have no moral right to reveal decide that something is wrong or absurd if the actors do not think so (Czarniawska, 2005).

To help maintain high level of ethical conduct the author will be guided by the University of Cape Town's code of ethics enforced by the ethics committee. The code of ethics have intrinsic value in protecting the rights of humans and animals who may become involved in research but also serve a professional and organisational function (Welman *et al.*, 2005). It is important to uphold these ethical considerations to ensure the data collected is not weighted against the ill will that could be potentially generated by practising unethical conduct. The general principles usually invoked in codes of research ethics are firstly no harm shall be fall the research subjects. Secondly, the subjects shall take part freely based on informed consent (Welman *et al.*, 2005). Thirdly the experiments must be good for the society and sufficient prior research must have been done to avoid undue suffering and harm (Bell and Wray-Bliss, 2009). Fourthly, the participants' identities will be kept anonymous and will be denoted as Focus Group A and Focus Group B. In addition, the data collected from the focus group interview will only be used in this research only and will no way be used or shared with the company management and thus will be kept confidential.

There were no known potential conflicts of interests at the time of the research process. The principal researcher funded the focus group sessions individually with no help from the company or any organisation which might have direct or indirect interest in the research outcome. As such, the data collected was based on factual statements picked up during the

focus group session discussions and responses provided by participants. However, one had to listen attentively to the conversions and discussion points brought forward to ensure statements are not misinterpreted. Furthermore, the researcher had to moderate the focus group session at the same time avoiding telling participants what to do (Alvesson and Ashcraft, 2009). However, the data was deemed authentic and there was enough time during the focus group interviews for the participants to reflect on their contribution and change if necessary (Cassell, 2009). In the related activities of insight, critique and transformative redefinition, critical researchers attempt at once to honour, challenge and change participant perspectives – certainly no simple balancing act (Alvesson and Ashcraft, 2009). The focus group discussion presented an opportunity to challenge participants on the subject matter by encouraging them to consider hidden consequences and alternatives to their own reality (Alvesson and Ashcraft, 2009).

4 Research Findings

4.1 Introduction

The research was conducted using Focus Group sessions. Participants were invited from within the organisation, an international project management and consulting firm. The organisation has carried out multi million rand projects across the country and also boasts of international experience on some big projects. Thus participants had the requisite experience and knowledge to provide answers to the proposition. Infrastructure projects implemented by state or public entities are obtained through an open tender competitive bidding process. The selection criterion includes functionality hurdles and then price and preference to determine the successful bidder. This means the project is generally awarded to the lowest bidder that meets the functionality criteria. Projects differ in complexity thus the company obtain value in executing the project at the lowest possible cost to maintain competitiveness and generate profit.

4.2 Analysis of Participants

A total of nine participants with experience ranging from junior level to senior project managers took part in the Focus Group discussion. The participants came from three different offices within the organisations spread across the globe. For Group A and B, the sessions were conducted face to face in a board room with the participants. Participant B5 is based in local office with other Group B members however during the time of the session B5 was overseas on secondment and the session was conducted via a webinar over Skype for business call. The identity of the participants is not revealed in the report and as such the participants are identified as A1, A2, A3 and A4 for Group A participants. Likewise, B1, B2, B3, B4 and B5 denote Group B participants. Table 4.1 overleaf serves to summarize the roles, skills and experience of the participants within the company.

Table 4-1: Analysis of Participants, skills and experience

Participant	Experience	Job Title	Engineering discipline	Focus Area
A1	Over 15	Design Technologist	Civil & Structural	Public buildings and multi-storey office complexes, petro-chemical process structures and agro-chemical.
A2	5-10 years	Project Manager	Mechanical	Public buildings and multi-storey office complex, HVAC and Wet Services
A3	Over 15	Design Engineer	Mechanical	Public buildings and multi-storey office complex, Hotels and shopping malls
A4	5- 10 years	Project Manager	Electrical	Public buildings and multi-storey office complex. Electrical reticulation, lightning and electronic systems
B1	1-5 years	Project Engineer	Civil and Water Technology	Water and waste water treatment facilities, Bulk Water conveyance structures and systems, Dams and Hydro-structures
B2	Over 15 years	Project Principal	Civil and Water Technology	Water and waste water treatment facilities, Bulk Water conveyance structures and systems, Dams and Hydro-structures
B3	Over 15 years	Project Finance Administrator	Across all engineering disciplines	Financial management, reporting and budget forecasting.
B4	5-10 years	Project Technologist	Civil and Water Technology	Water and waste water treatment, Bulk Water conveyance systems, Dams and Hydro-structures
B5	Over 15 Years	Project Manager	Civil and Water Technology	Water and waste water treatment facilities, Bulk Water conveyance structures and systems, Dams and Hydro-structures

4.3 Roles definition and clarification

Project Principal – This is the most senior person on the project and responsible for corporate governance and making decisions that align with the business unit strategy. They are not involved on a day to day basis, however their presence and input has an impact in shaping out as the project unfolds during the implementation phase. They are mainly involved in the high level client liaison relations

Project Manager- This role involves coordination of stakeholders and managing of the implementation of a project. The incumbent ensures the various discipline specific technical personnel are managed and deliver their deliverables on time, within budget and of the right quality. In addition, the project manager is responsible for the overall financial budget to

ensure the execution phase is done adequately. This person normally is appointed from the discipline with the highest fee portion in a project.

Design Engineer: The person is responsible in delivering the final design pack to the project Manager for submission to the end user or client. The design engineer works with a team of technologist and technicians to assimilate the client requirements to produce a compelling end state. The incumbent is also responsible in doing all the engineering calculations and signing off of design drawings as per regulation.

Design Technologist: works closely with the design engineer and assist in designing and producing design drawings and specifications.

Project Engineer: The person represents the engineer on site and responsible for site activities, inspection of contractor's works and ensures the quality control processes are adhered to. The project engineer is in charge of the implementation phase and attends to technical clarifications to ensure project objectives and client's requirements are met.

Project Technologist: The technologist runs the implementation phase of the project attending to technical clarifications during the implementation phase. Normally they will be junior personnel with less experience who intend to apply theoretical expertise in a more practical way. He/she is more involved in the inspection of contractors work and certifying payments for work done as per project specifications.

Project Finance Administrator: The role of the PFA is to ensure the financial aspects of the project look healthy. He/she assist the project manager in managing the financial aspects of the project. This includes invoicing the clients, preparation of budgets and forecast to ensure resources are adequately planned within the financial means agreed upon by the client and the organisation. The PFA also ensure sub consultants/contractors are paid on time and liaise with project manager to give an early warning if more funding is required to complete the project.

4.4 Research Findings and Analysis

The author delivered a presentation which formed the briefing session giving a background of the research and objectives. In addition, a PowerPoint slide presentation was prepared in order to articulate the FAST process. The presentation gave an in-depth process of how a FAST diagram is developed in reality using an empirical example. The PowerPoint

presentation had a simple empirical example of a “Pencil” broken down into the constituent functions. The functions were then grouped into basic and secondary functions to illustrate the co-relationship between the functions. By applying the why-how logic, the functions were arranged and presented in a FAST diagram format.

The briefing session was followed with a presentation to the participants of a typical project activity log list. The activity log list is designed to capture project successes or failures during the implementation stage. It’s a high level format that will be used as an input to the project close out report. Annexure E serves to illustrate a typical Activity log list format. For purposes of illustration and articulating the concept of capturing and communicating lessons learnt, the author focused on the activity of approval of drawings. However due to the lack of the relational linkages it will not serve its intended purpose of effectively communicating lessons learnt from previous projects. The log list focuses on the outcomes and neglects the secondary functions that need to be planned and catered for to avoid falling into similar problems. A FAST diagram of the same problem, i.e. approval of drawings was developed by the author and presented during the Focus Group Discussion for the participants to comment. After the Focus Group the participants from each group were asked to respond to the questions to evaluate thoughts surrounding the FAST proposition. The Table 4.2 and 4.3 below show the summary of the responses obtained from the nine participants per question.

Table 4-2: Summary of the Likert Type Questions responses

Summary of Likert Type Question responses													
<i>Participant</i>	<i>Question 1</i>	<i>Question 2</i>	<i>Question 3</i>	<i>Question 4</i>	<i>Question 5</i>	<i>Question 6</i>	<i>Question 7</i>	<i>Question 8</i>	<i>Question 9</i>	<i>Question 10</i>	<i>Mode</i>	<i>Median</i>	<i>Average</i>
Participant A1	4	4	5	5	4	4	3	5	3	4	4	4	4
Participant A2	2	3	3	3	3	3	4	4	4	4	3	3	3
Participant A3	5	4	5	5	4	5	5	5	5	5	5	5	5
Participant A4	4	3	5	5	5	5	5	5	4	5	5	5	5
Participant B1	2	5	4	5	5	5	4	4	4	5	5	4.5	4.75
Participant B2	3	4	2	4	3	5	5	5	4	4	4	4	4
Participant B3	3	3	4	5	5	5	5	5	5	5	5	5	5
Participant B4	4	4	3	4	5	5	5	5	5	5	5	5	5
Participant B5	3	2	3	5	4	4	5	5	4	5	5	4	4.5

Table 4-3: Summary of the Yes/No responses from participants

Participant	A1	A2	A3	A4	B1	B2	B3	B4	B5
Question 1 (Y/N) - I prefer to use the traditional project close out report to capture and communicate lessons learnt on projects.	No	No	Yes	No	No	No	No	No	No
Question 2 (Y/N) - In utilising the FAST diagram, did you manage to identify at least 5 lessons from the project.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4-4: Summary of responses for the open-ended questions

Participant	<i>Question 1 (Open)</i> - Do you think diagrammatic tool like FAST have a future in capturing and communicating lessons learnt within projectized environments? Give a reason for your answer	<i>Question 2 (Open)</i> - Do you think utilising the FAST diagram in capturing and communicating lessons learnt stimulates creativity and stirs project teams to adopt alternative ways of performing tasks differently in the project environment? Give a reason for your answer
Participant A1	It is pictorial and stitches out easily. Thus it would be easy to tick boxes and update/cross check with a known standard for each project stage.	The FAST presentation helps to see if they could be room for improvement.
Participant A2	Yes, it summarizes the inputs and sequences of events to accomplishing a task in simple and logical way.	Yes, you are able to identify the pitfalls and decide on the best way to execute tasks on a project.
Participant A3	Yes- As more people get to know and realise the value of the FAST diagramming process they will start using the tool on future projects.	Yes – because they now understand how to use the FAST diagramming process they can analyse and adopt FAST tool to suit their current projects.
Participant A4	Yes- because it gives an overall picture of the lessons learnt on the project without going into too much detail and simplifying the decision making on other employees who were not involved on the project.	Yes- because from the FAST diagram you can develop a new approach for your new project to avoid any negative lessons and improve on the positive ones. That will help in reducing time spent on task/function and the project can be completed in an efficient way.
Participant B1	Yes- It is a simple way to articulate lessons learnt and avoid misinterpretations. However the process of recording the lessons learnt can be very time consuming and discouraging to adopt and implement in our fast paced industry.	Yes- not only can one rely on the opinions based on one experience, but it gives the opportunity for recorded lesson to be continuously improved based on a variety of opinions as recorded by the project team members.

Participant	Question 1 (Open) - Do you think diagrammatic tool like FAST have a future in capturing and communicating lessons learnt within projectized environments? Give a reason for your answer	Question 2 (Open) - Do you think utilising the FAST diagram in capturing and communicating lessons learnt stimulates creativity and stirs project teams to adopt alternative ways of performing tasks differently in the project environment? Give a reason for your answer
Participant B2	Yes- Engineers like diagrams/flow charts picture worth a thousand words	Yes – You get a broader picture and context of the whole project.
Participant B3	Yes it will, simply put it will make reading and interpretation easy and faster.	Yes, it will stimulate creativity – However, it will entail a little bit of work to analyse the FAST tool. “A picture says a thousand words”, very true. Thus using the FAST diagramming tool simplifies the decision-making process on a project.
Participant B4	Yes – FAST diagram provide a pictorial view and a picture is worth a thousand words, or so they would say. Pictures are easier to spark communication and creative discussions in a group/team meeting,	Yes – It encourages team members to think outside the box and explore alternatives in doing certain routines as opposed to being spoon-fed.
Participant B5	Yes – because the FAST tool demands to identify the events as they happen as well examine the linkages. Going forward the FAST tool seem to align well with best practise as documented in PMBOK and elsewhere in the project management literature . FAST processes can be time lined and the linkages can effectively be used to establish dependencies in a Gantt chart and process flow diagrams.	Yes – Because the FAST tool will stretches the thinking minds of role players to go back in time and analyse the cause and effect chain. Thus mitigating on rippling project effects of failures on future projects. Ideally, the relevant activities and linkages could be captured as they happen. However, this requires an organisational culture change.

4.5 Data Interpretation and Analysis

Data analysis is an iterative and on-going process requiring validation and legitimation (Miles and Huberman, 1994). The interpretation of the likert type response questions is summarised in the Table 4.5 below

Table 4-5: Interpretation of the scores

<i>Participants</i>	<i>Score</i>	<i>Description</i>	<i>Interpretation</i>
A3;A4,B1, B3,B4, B5	Very High	Strongly Agree	You have all the characteristic traits to strongly agree on the proposition that the FAST diagram enhances capturing and communicating lessons learnt
A1, B2	High	Agree	You have many of the characteristic traits to agree on the proposition the FAST diagram enhances capturing and communicating lessons learnt
A2	Middle	Intermediate	You have at least some characteristic traits to agree but at the same time you also dislike the FAST diagram. No conclusive answer can be obtained.
	Low	Disagree	You have no dominant characteristic trait to agree with proposition and would prefer conventional close out reports
	Very Low	Strongly disagree	You strongly disagree with proposition and FAST diagram is not your style and prefer the traditional reports

Focus Group A session

Participants A1 and A3 appreciated the FAST proposal from the onset, however the two participants acknowledge people may be utilising the FAST diagram without them knowing. An example is when participant A1 narrated how he gave the logical flow of how to do a design to a technician he is mentoring using block diagrams. The aspect of using diagrams to articulate a design process and communicate lessons learnt from previous projects was apparent in that case. However all the participants agreed the diagram will need enhancement for it to be valuable. Hence, the FAST proposal as articulated and presented by the principal

researcher seems to be useful in capturing and communicating lessons learnt. As the FAST diagram briefing progressed, participant A4 started appreciating the impact of pictorial blocks in communicating lessons learnt and shared the same sentiments with participants A3 and A1. However participant A2 was bit confused and did not get the concept of the FAST diagram from the single presentation. The benefits of FAST were understood by everyone however, participant A2 struggled to understand the development process of the diagram. For participant A2 the development process proved to be tedious and complex. This meant more time required in creating a FAST diagram. Normally this has a cost attached to it and ultimately has negative impact on the final revenue realised on project. Nonetheless, the rest of the participants agreed that once the FAST diagram is in place the benefits outweigh the cost incurred during the development process. Thus, the high cost of having resources participate in a FAST diagramming session to capture and communicate lessons learnt can be recovered in the long term through improving project efficiency and effectiveness. In addition, once a FAST diagram is developed for a particular project, it can be re-worked to improve execution of future projects. Thus, a FAST diagram is a dynamic tool that can be continuously improved and lessons from current and past projects can be adopted to mitigate repeating similar mistakes in future projects.

Focus Group B session

All the participants converged to a common understanding on the FAST drawing. It has its merits of easier comprehension and intuitive in the process by giving the relational linkages of the functions involved. However, participant B3 weighs in with a suggestion that it needs to be able to drill down to the specifics. This was seconded by participant B1 who proposed that possibly by having another layer of items that can be presented as a checklist format for each function. Thus for each function with an action verb and measurable noun as a descriptor on moving the mouse or clicking on the function, it shows the list of items that needs to be ticked before moving the next adjacent function. All the participants agreed the FAST diagram objective is to simplify the capturing and communication of the lessons learnt; however, the lack of sufficient detail means project managers will repeat similar mistakes. Participant B1 raised a concern that the verb-noun combination does not incorporate all the items relevant to the function block. Thus, a proposal to look at making the FAST diagram dynamic based on a high-level computer program. This will help project managers working

on future projects as the high level computer program gives more detail and aids in guiding the communication of lessons learnt from previous project experiences.

Participant B2 added that it will make sense if the FAST Diagram can be limited to avoid information over load. The dependency on the size of project means the FAST diagram can grow uncontrollably. However, Participant B2 suggested the function block can embody macros or links that will refer or direct the user to another document that will give broader detail of information pertaining to that function. Participant B2 highlighted the FAST concept brings value to the team especially when used at the stage gate before transition to another project phase or at the project kick off meeting. It helps to communicate relevant message that would have taken a number of pages to document and articulate to the project stakeholders.

Participant B2 weighed in and suggested it will be important to define the scope before engaging the stakeholders. In addition, participant B2 suggested that the engage stakeholders function block can be expanded in the background to give a detailed list of the stakeholders that are pertinent to such a project. Furthermore, participant B2 agreed to the benefits of the FAST model and by ticking the function box as you progress with the FAST diagram; it ensures most of the work is done prior to executing the project. This notion was supported by all Focus Group B participants as it has a direct benefit of improving the efficiency of the project execution phase. It also supports a hands on approach as it compels the stakeholders to participate thus encouraging them to put on their “thinking hats” in approaching the problems encountered on a project. Furthermore, participant B1 also added that the FAST model could be linked to the company Quality Control Process and aid to improve the project documentation process.

Participant B5 indicated the best you can get from a project as lessons learnt could be an activity log list at the end of the project. For long lead projects, one might find nothing and at close out the stakeholders will only give items that come to mind first. It is impossible to recall and capture what transpired during the implementation phase of a project at the end thus a FAST diagram is a dynamic system which serves to cater for that. In addition, B5 added that the FAST model can be enhanced and adopted for use on site. This involves the use of sticky notes that are pasted on a large A0 chart in the project office and can be rearranged as the project progresses to capture lessons learnt. Furthermore, the FAST diagram is a mindful process as described and commended by participant B5. FAST model

introduces creativity in executing projects. An improvement as stakeholders are attentive to detail thus leaving less room for missed functions or error. It also builds anticipation and interest on the project as the stakeholders will know how the tasks they performed earlier on during the project, fit into the entire project matrix. At times project team members perform tasks of which they do not know the rationale or benefits behind them when executing those tasks. The project team members will only be able to know the reason later on in the project. However if they had known earlier, as presented by the FAST diagram, the team members become motivated and expectant. It also prompts and challenges their minds to think outside the box for alternatives solutions to problems at hand. This result in value creation as costs are reduced and the efficiency of project execution is amplified. Furthermore, it improves the learning cycle as it allows iteratively reviewing of suggestions until the best-fit function is identified and agreed on by all stakeholders.

In addition, participant B5 saw a window of opportunity in using the FAST as an intelligent model from the relational links of the functions, one can timeline them to develop a robust project program. Participant B5 went on to highlight that a program is not a series of random events on a timeline. However, in developing a FAST diagram to capture and communicate lessons learnt, someone has thought through the process and project managers can leverage it to develop a robust program that is realistic and ensure all sub-task are kept in control. Furthermore, the project manager can drill down and even allocate resources to suit a particular function so giving a better forecasting of the resource workload and utilisation on the project. This makes planning better and serves to give early warning signals before the problem happens.

4.6 Summary of Results

To summarize the results, the reception of the FAST model was positive amongst all the participants from the two groups. Only participant A2 was indifferent however, participant A2 appreciated the positives that the FAST model could bring to projectized entities. However, both groups acknowledged there are still areas that need to be researched further for the FAST process to mature within project management entities. Furthermore, an interesting thought that came out from both groups was the manner the author presented the FAST diagrammatic process. The author always used the right to left approach in describing and articulating the FAST model concept something that is different from conventional human mind reading process. This stood out as a positive remark associated with FAST as it

meant increased level of concentration of the FAST session by the participants. By doing the opposite of what the human mind is used to do meant increased level of awareness thus a more robust and realistic FAST diagram is developed. This opens a window of opportunity to list and cover all areas thus mitigating potential pitfalls later on during project implementation.

5 Discussion

5.1 Discussion of research findings

This chapter serves to discuss the research findings and evaluating the effectiveness of the study. The section argues in detail on the research that was undertaken to enable a compelling conclusion to be realised. In order to appropriately make recommendations action items from the research initiative; it is imperative to revisit the research objectives and research questions that prompted the author to explore further the subject matter. The main research question is captured as follows:

- I. Can utilising a diagramming tool such as the FAST model enhance the effectiveness of capturing and communicating codified knowledge to future projects?

The above questions led to the development of the following proposition:

“Modelling problematic project activities during the entire life cycle using functions can help enhance the capturing and communicating process of lessons learnt.”

The level of participation and interaction shown by focus group members portrayed a positive outlook of the FAST diagram in the near future to aid in capturing and communicating lessons learnt. Thus the research has proven that graphical methods such as the FAST methodology enhance the capturing process and communicating of lessons learnt. This is evident in the manner in which the focus group participants managed to comprehend and identify lessons learnt from a typical project. The positive response and comments from the participants on the ease of comprehension of the FAST tool further emphasize the enhancement of the capturing and communication of lessons learnt. This ties in and effectively answers the main research question. Furthermore, it substantiates the proposition articulated earlier in the research. Thus the author can conclude that modelling problematic project activities during the entire life cycle using functions can help enhance the capturing and communication process of lessons learnt. The functions have an added benefit of being able to show the relationship between the preceding block and successive activities. This means the planning can be more organised thus enhancing the effectiveness and efficiency of project execution and management.

The following is a summary and recommendations for each research objectives based on the author's assessment as the research process unfolded:

- I. *To test the effectiveness of the FAST model as a device for transmitting knowledge about lessons learned from one project to another project.*

The FAST model can be used as a device for transmitting knowledge about lessons learned from one project to another. The technique of breaking down the process into functions and using the two- descriptor words to substitute the function name has the power of allowing stakeholders to understand the context in detail. This essential task entails understanding the system with appropriate depth and clarity to explore alternative opportunities that are applicable in performing the function under scrutiny. In addition, FAST diagram removes the barriers that stifle creativity by being limited by the function name as opposed to what the function actually does. Furthermore, by understanding the casual relation of the adjacent functions, one can identify the barriers that prevent the effective attainment of set goals and objectives. Creativity is the main driver in new knowledge creation and the generation of innovative outputs. Those firms that gain the most, from their ability to source and absorb knowledge and information are those that apply it creatively (Soo *et al.*, 2002). In safeguarding organisational memory and communicating lessons learnt, the author recommends using the FAST model. The outcome of a particular project may be less important than the overall increase in the ability of an organization to implement projects successfully (Reich, 2007).

- II. *To establish areas/activities that will enhance and reduce the cost of capturing and communicating project lesson learnt.*

The activities that will enhance and reduce the cost of capturing and communicating lessons learnt including having senior management support regarding the initiative. During the focus group session a discussion regarding senior management, converged to the conclusion of requiring active support of the senior management team for the lesson learnt gathering concept to be successful. It is common knowledge that although each project is unique there are some processes that are repeatable and thus, there is scope to transfer learning from previous projects (Carrillo, 2005). This entails change in organisational cultural norms and embrace change as concluded by the focus group participants. Although this was highlighted as an important activity, the challenge comes in unlearning old habits and bringing in fresh

ideas to the project team members. A few project stakeholders embrace change but most are stuck in doing things the old traditional way. There is overwhelming evidence to resistance to change. When organizations have a culture that values knowledge transfer, they are far more successful (PMI, 2015). An organizational culture that is based on a commitment to truth and inquiry empowers individuals to: (i) reflect on their actions, (ii) consider how these actions can contribute to problems, (iii) recognize the necessity for change, and (iv) perceive their own roles in the change process (Senge, 1994).

The perceptions of value, regarding lessons learnt differ and are conflicting amongst the team members. Notwithstanding the fact that the cost of convening lessons learnt sessions is substantial; utilising the FAST methodology could reduce the overall profit margin realised from a project due to the additional tasks associated with the FAST process. However, the FAST methodology is worth implementing as it mitigates repeating similar mistakes on comparable future projects and thus improves overall project execution efficiency. Overall the execution rate is improved as well as the productivity thus potentially realising better profits from future projects. The cost benefit justifies the use of the FAST system to capture and communicate lessons learnt. The direct benefits realised include improving efficiency of performing certain work packages on projects and risk mitigation methods. Other benefits that can be linked to the application of the FAST model include increased sense of project execution awareness amongst team members and building a knowledge repository within the organisation. Chances are that this will filter through to the bottom line and ensure organisations realise better profits from such FAST diagramming lesson-learnt initiatives. This calls for harnessing of formal and informal project de-briefing sessions by allowing structured time slots on sharing lessons learnt to take place within the organisational setup. This promotes the codification of knowledge collected and discusses appropriate application mechanisms of the gathered information. A good way of ensuring adherence and promoting a culture of conducting lessons learnt is to incentivise the knowledge sharing workshops something that needs to be driven from the top management. This also helps in motivating the team members and allows the creative mind-set to flourish without restricting innovative potential of the participants.

III. To investigate ways of building relevant FAST diagrams to capture and communicate lessons learned to future projects.

Building relevant FAST diagrams is not a once off event; it is an iterative process involving continuity, discipline and consistency in applying the FAST methodology throughout the life cycle of the project in order to get positive benefits. The focus group deliberated on some points that the author will discuss further in trying to articulate how they support building relevant FAST diagrams.

In order to build relevant FAST diagrams, the process hinges on project organisations systematically converting lessons learnt to improve impending activities on projects. Lessons learnt are elements of both organisational learning and knowledge management (Carrillo, 2005). Such mechanisms ought to enhance the creative side of teams, in order to provide new insights, and undertaking tasks that add value in project execution. In building relevant FAST diagrams it is imperative to be able to deduce the appropriate verb-noun combination to describe a function. A well-defined function shapes a creative mind-set for finding alternative methods of achieving the same end state. The function descriptors are collected and stored on a data repository for future use. For many organizations, informal channels of communication have been a rich source of information and knowledge that cannot be found in company databases and manuals (Soo *et al.*, 2002). Embracing such information systems can help collate data and help in building the relevant FAST diagrams applicable for future projects. Building on past experiences and referring to a data repository of collected function descriptors allows for the appropriate verb-noun combination for each function to be easily defined. Another way is to have a well-designed knowledge management structure that addresses the common problems encountered in accessing data stored on a repository. The common problems include but are not limited to handling and managing of explicit and tacit knowledge. It will also support individual and organizations in effectively managing knowledge gained through exposure in executing different complex projects. The ability to properly capture lessons learnt from previous projects is dependent on the organisational systems. One important aspect of a knowledge management system is that it must be human centred for it to be effective. Members of the organisational team should abide by certain rules in order to control and monitor data capturing and deleting of obsolete information to ensure continual improvement is realised. Ultimately, success factors of project management are determined by how well the project has been executed using least resources and the resultant profit margin realised.

5.2 Summary of findings

The proposal articulated by the paper of using the FAST diagram to capture and communicate lessons learnt is valid and relevant in project centred organisations. The competitive advantage of a firm lies in its "ability to create, transfer, assemble, integrate, and exploit knowledge assets (Teece, 1998). In the same context; every organization has its own way of dealing with data, information and knowledge, and creates its own structures, jobs and systems for that purpose (Nonaka *et al.*, 2000).

To validate the concepts of using graphical methods to articulate ideas and transfer knowledge amongst team members, the author utilised a practical scenario on how lessons of one project process, are captured within a project environment. An activity log list was used to illustrate how lessons learnt are normally captured on a project more particularly by site personnel. From the list of the activity log list items, the author focused on one project process to illustrate how lessons are captured and ascertain whether the project process was a success or failure. The same project process was utilised to demonstrate the influence of visual diagrams to aid comprehension. Using the powerful concept of the why-how logic; a FAST diagram was developed for the project process used to articulate the methodology to project participants. Colleagues from the selected project management and consulting firm participated in a focus group discussion session. The session stirred the discussion to critically analyse the FAST diagram and document areas for future research.

6 Conclusions

6.1 Conclusions

The chapter concludes by highlighting some of the research aspects that extend beyond the scope of this minor dissertation and makes recommendations based on the research findings. In addition, the chapter also covers the limitations faced in the research and areas pertinent for future research within the context of the subject matter.

The purpose of the research was to test the effectiveness of the FAST methodology, a diagram-oriented tool to capture and communicate lessons learned from one project to another. Based on the value engineering proposal, if project mistakes and lessons are codified, it will make the execution of similar tasks more efficient and effective in the future. This notion is only valid when the lessons learned from previous projects are well documented and can be articulated easily onto future projects by participants. One way of doing this effectively is via the use of a diagrammatic tool such as the FAST methodology. The research encompassed convening two focus groups who participated in a session to test the effectiveness of capturing and communicating lessons learned based on an active project. The findings of the research were quite encouraging as most of the participants concurred with the view that diagrammatic tools such as the FAST diagram aid in effectively communicating lessons learned from one project to another.

The research objectives were fully met as the use of pictures in capturing and communicating lessons learned was more effective compared to going through the traditional tedious close-out report. In addition, by using the FAST diagram tool, the participants were able to comprehend the message conveyed better compared when the lessons learned were embedded in a report format. Furthermore, by avoiding repeating mistakes, organisations tend to be more efficient in executing projects of similar tasks, thus improving the bottom line. Rework on projects has a direct effect on the cost as more time needs to be spent to correct the mistakes and ultimate project performance is affected. The feedback obtained from the participants also concluded that in order to build relevant FAST diagrams, the process is iterative and hence can only get better with time. Thus, the hypothesis test on the effectiveness of the FAST diagram returned a true result.

Notwithstanding the fact that capturing of lessons learnt is difficult to quantify and measure; it is worth noting the impact the lessons learnt process has on project and business success. Project knowledge on a data repository is meaningless if companies cannot apply knowledge on lessons learnt to add value onto future projects. Organisations need to develop means that enable the firm to capitalise on the captured knowledge and gain competitive advantage through its application. The earlier lessons learnt are articulated and communicated to project stakeholders, the better the execution results of future projects. Thus, the use of FAST methodology addresses this aforementioned challenge by exploiting the graphical aspect of the methodology to aid comprehension. Organizational culture has the potential to constrain or facilitate knowledge creation and transfer within an organization (Ajmal and Koskinen, 2008). Most organisations interest are in the realm of lessons learnt thus organisations strive to do projects tasks and processes better to maximise on returns. When essential knowledge is captured and shared, organizations see improved results across the range of project metrics, including cost savings, time-on-task, error rates, and innovative solutions (Davenport and Prusak, 1998). The development of a body of knowledge termed the “Engineers Compendium” help outline the processes to be followed to attain a desired outcome. Improving project delivery using graphical methods in particular the FAST model to capture and communicate lessons learnt contributes to the critical success factors of projects. This in turn leads to the prolonged existence of companies in a challenging and competitive environment as they are able to tap on the knowledge base to improve execution results. Companies are able to obtain 80% of the project results or deliverables by only applying 20% effort utilising project lessons from previous project. Thus one can conclude that the FAST diagrammatic tool can aid in capturing and communicating of lessons learnt. In addition the graphical depiction of knowledge using the FAST methodology aids in comprehending lessons learnt better than reading a tedious close out report or an activity log list.

The causative relationships of the functions making up the project process encompass the facets of the tasks or process that will need attention during the execution phase. The strength of the casual relationship helps classify if a particular process has negative or positive effects to the overall project success. If the deductive process points to a negative project outcome, proactive measures can be put in place using the knowledge acquired from a previous project to mitigate impact on the overall project result. Likewise, if the deductive process results in a positive outcome, organisations can reinforce the success criteria to ensure continual favourable project execution results in the near future.

6.2 Limitations of Study

The limitations of the study include not being able to include enough senior management representatives into the focus group sessions. Some participants invited could not turn up for the sessions. In addition, due to the geographical dispersion and different time zones affecting one participant, the author had to do the session via a Skype for business call. This approach managed to elicit the required information from the participant. The focus group sessions were conducted within a single organisation but to obtain objective findings the participants were drawn from different business lines and advisory groups. Furthermore, the research used a limited study utilising two groups due to time and resource availability constraints.

6.3 Recommendations

The recommendations based on the findings of this research could be used to elicit more information on the research subject matter. The aspect of capturing and disseminating lessons learnt has become a holy grail in project management firms. The systems that promote capturing and disseminating lessons learnt can be devised and put in place; however if there is no management support and willingness amongst project participants nothing will materialise. The ever challenging operating environment calls for a more vigorous and robust approach in maintaining a competitive advantage. The findings need to be confirmed in a more rigorous qualitative study with a statistically valid number of groups. With that in mind the author recommends the following based on the research findings:

- Broaden organisation sample area- It will be worth noting and interesting to obtain views from focus groups drawn from different companies. The correlation from the random focus groups drawn from different organisation should converge to a more objective conclusion. This will serve to substantiate the proposition articulated on using graphical methods to capture and communicate lessons learnt. In addition it will also remove barriers that tend to restrict participants to only think within the organisational culture realm. Organisational culture can influence the research as it can be biased towards a certain outcome. By having different organisational views can help narrow down the findings to an objective outcome.
- Expand geographical location- By exploring companies operating in different geographical locations will help address aspects such as the influence on location and environment on project participants to capture and communicate lessons learnt. In

addition it will also give a perception on whether lessons learnt are deemed valuable or not that can improve project success.

- Executive management participation- Whilst the research was more focused on the day to day activities conducted within a projectized environment, there is a need to look at capturing and disseminating lessons learnt as a strategic tool for the organisation. This requires executive management participation so that the benefits can easily be translated into monetary value and the impact on profit can be evaluated. Furthermore the augmentation that comes with using the FAST diagramming tool to aid comprehension of project lesson learnt can be used as leverage and helps persuade executive management to incorporate a similar approach in the organisation strategic plan. A top down approach with key performance metrics can ensure the FAST model can be adopted for every project and not only left to the discretion of the project manager.

6.4 Areas for future Study

The way of interpreting a FAST diagram can differ amongst individuals. However, this is an area in which further research can be explored to converge to a common understanding regarding the FAST diagram and avoid ambiguity. In addition the use of information technology systems such as software programming applications and data base functionality to link relevant functions and give further details pertaining that function under review. This will provide more information to the participants to enable informed decision-making. By clicking on a function, it should zoom in and give further insights on what the high-level function entails however; this can be limited to two levels below the high level to avoid confusion. Further research can explore ways of using the FAST methodology to capture and communicate lessons learnt and can enhance the organisations maturity. Organisations mature as they master the concepts of executing projects efficiently and can use that as a competitive advantage.

7 References

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Annexure A – Project life-cycle stages

The Engineering Council of South Africa (ECSA) regulates the conduct of professional engineers within the South African context. ECSA was formed as a result of the Engineering Profession Act 46 of 2000, which seek established a juristic person to be known as the Engineering Council of South Africa; to provide for the registration of professionals, candidates and specified categories in the engineering profession (RSA, 2000).

A normal project cycle in a consulting world follows the following process:

Stage 1 – Inception

The inception phase is defined as establishment of client requirements, preferences, refine user needs, and options, appointment of necessary consultants, establish the project brief including project objectives, priorities, constraints, assumptions aspirations and strategies (ECSA, 2015). The ECSA gazette highlights the typical deliverables for stage 1 as follows:

- Agreed services and scope of work
- Signed agreement between client and consultant
- Report on project site and functional requirements
- Schedules of required surveys, test, analyses, site and other investigations.
- Schedule of consents and approvals

Stage 2 – Preliminary design (Concept and Viability)

The preliminary design phase encompasses the preparation and finalisation the project concept in accordance with the brief, including project scope, scale, and character, form and function, plus preliminary programme and viability of the (ECSA, 2015). It is also known as the concept and viability phase and the ECSA gazette highlights the typical deliverables for stage 2 as follows:

- Concept design
- Schedule of required surveys, tests and other investigations and related reports
- Process design
- Preliminary design
- High level cost estimates as required

Stage 3 – Detailed design (Design development)

The detailed design phase consists of development of the approved concept to finalise the design, outline specifications, cost plan, financial viability and programme for the project (ECSA, 2015). The other name common for this stage is design development. The ECSA gazette highlights the typical deliverables for stage 3 as follows:

- Design Development Drawings
- Outline project specifications
- Local and other authority submission drawings and reports
- Detailed estimates of construction costs

Stage 4 – Documentation and Procurement

The documentation and procurement phase involve preparation of procurement and construction documentation, confirmation and implementation of the procurement strategies and procedures for effective and timeous procurement of necessary resources for execution of the project (ECSA, 2015).

The ECSA gazette highlights the typical deliverables for stage 4 as follows:

- Project Specification (Particular, detailed and standard)
- Services co-ordination
- Working drawings
- Budget construction costs
- Tender documentation
- Tender evaluation report
- Tender recommendations
- Priced contract documentation

Stage 5 – Contract Administration and Inspection

The contract administration and inspection phase consists of the management, administration and monitoring of the construction contracts and processes including preparation and

coordination of procedures and documentation to facilitate practical completion (ECSA, 2015).

The ECSA gazette highlights the typical deliverables for stage 5 as follows:

- Schedules of predicted cash flow
- Construction documentation
- Drawings Register
- Estimates for proposed variations
- Contract instructions
- Financial control reports
- Valuation for payment certificates
- Progressive and draft final accounts
- Practical completion and defects list
- All statutory certification and certificates of compliance as required by local and other statutory authorities.

Stage 6 – Close Out

The close out phase tasks are fulfil and complete the project close-out including necessary documentation to facilitate effective completion, handover and operation of the project (ECSA, 2015).

The ECSA gazette highlights the typical deliverables for stage 5 as follows:

- Valuation for payment certificates
- Work and final completion lists
- Operation and maintenance manuals, guarantees and warranties
- As- Built drawings and documentation
- Final Accounts

Annexure B – How to create FAST Diagram

FAST Diagram

The focus of this section is to concisely demonstrate a systematic approach on how to create FAST diagrams. The logical sequence has been extracted from Bytheway (2007b) who is the architect of the FAST technique. The logic questions involved in this technique are self-stimulating. Each answer is used to formulate two new questions. Both of these new questions force thinking into higher levels of understanding and into other methods of performing the same task (Bytheway, 2007).

The first step involves developing the problem statement after which one needs to identify tasks required to solve the problem. In identifying the tasks, one asks “why” is the task required to solve the problem. The answer to the first “why” question; leads in invoking the second “why” question and this process repeats itself over and over again. With time, one matures in the FAST processes, and understands the reason why it is done. This further prompts one to starts asking “how” do you do this and “how” do you do that over and over again: he wants to know how to do it himself.

The “why”-“how” logic is the heart and meat of this creative technique. Maturity and experience help people to think deeper in many different areas when people ask the same proven “why” and “how” questions. These two questions bring together facts so that people can logically connect them and understand them. They stimulate your creativity so you feel better about yourself as you experience an increase in your level of thinking and satisfaction in your accomplishments (Bytheway, 2007). The figure over leaf adopted from the functional performance specification serves to illustrate the building blocks of the why-how logic and how it fits into the FAST realm.

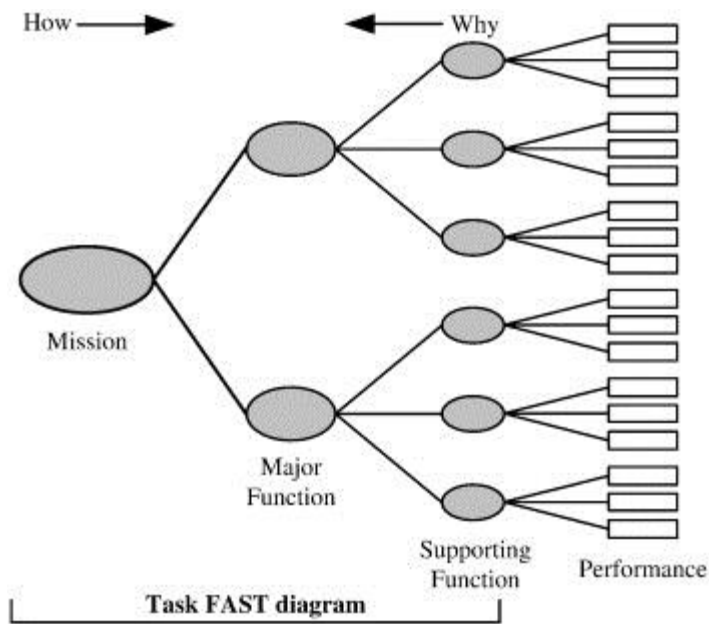


Figure B-1 Structure of Functional Performance Specification (Luo and Shen, 2008).

The “Why-How” logic questions tend to lead to other thought provoking questions that broaden the understanding of the problem and stimulate creativity.

Annexure C - Guide words applicable to capturing and communicating lessons learned.

Capture lessons Learnt

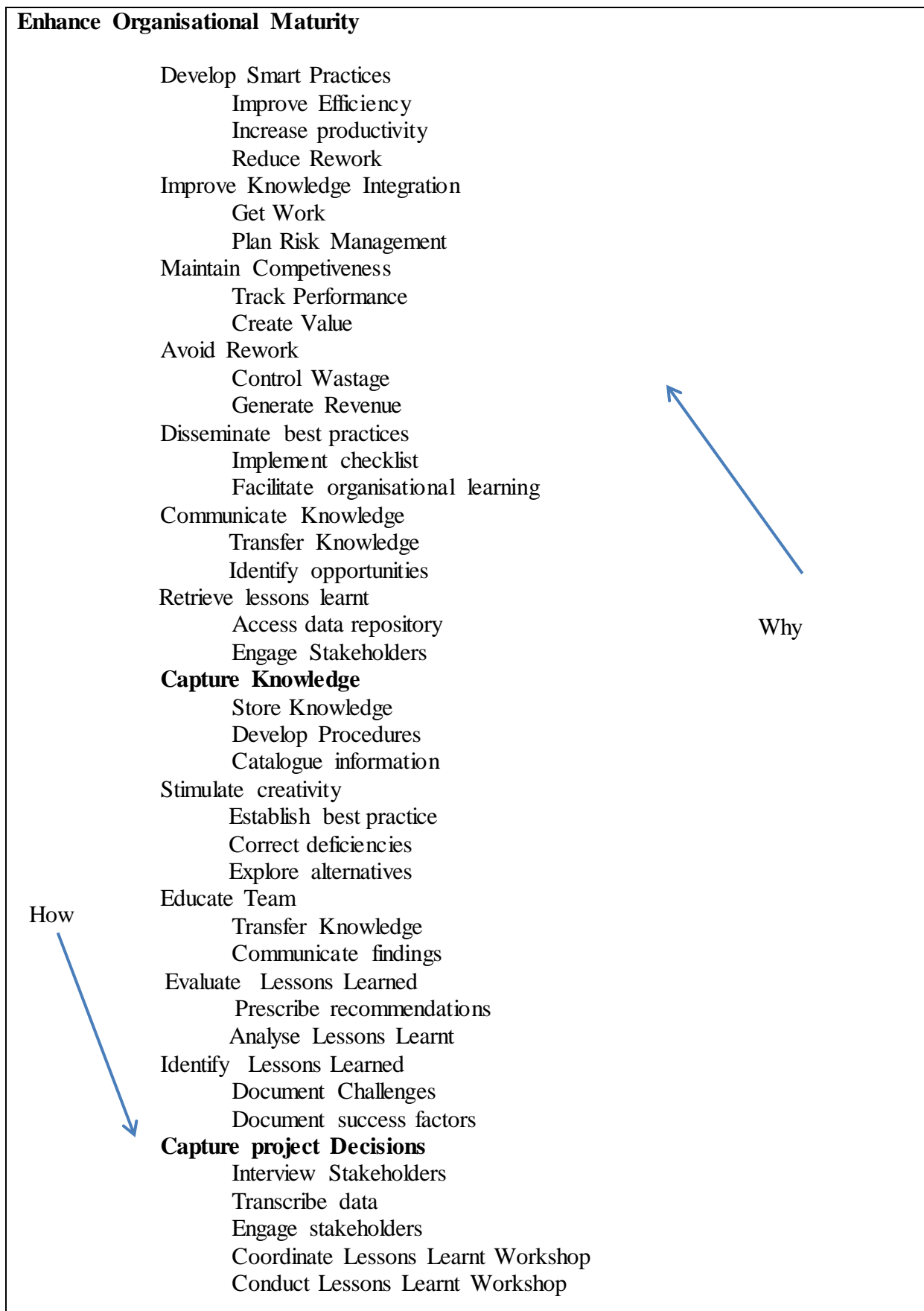
Active verb and measurable Noun Buzz words

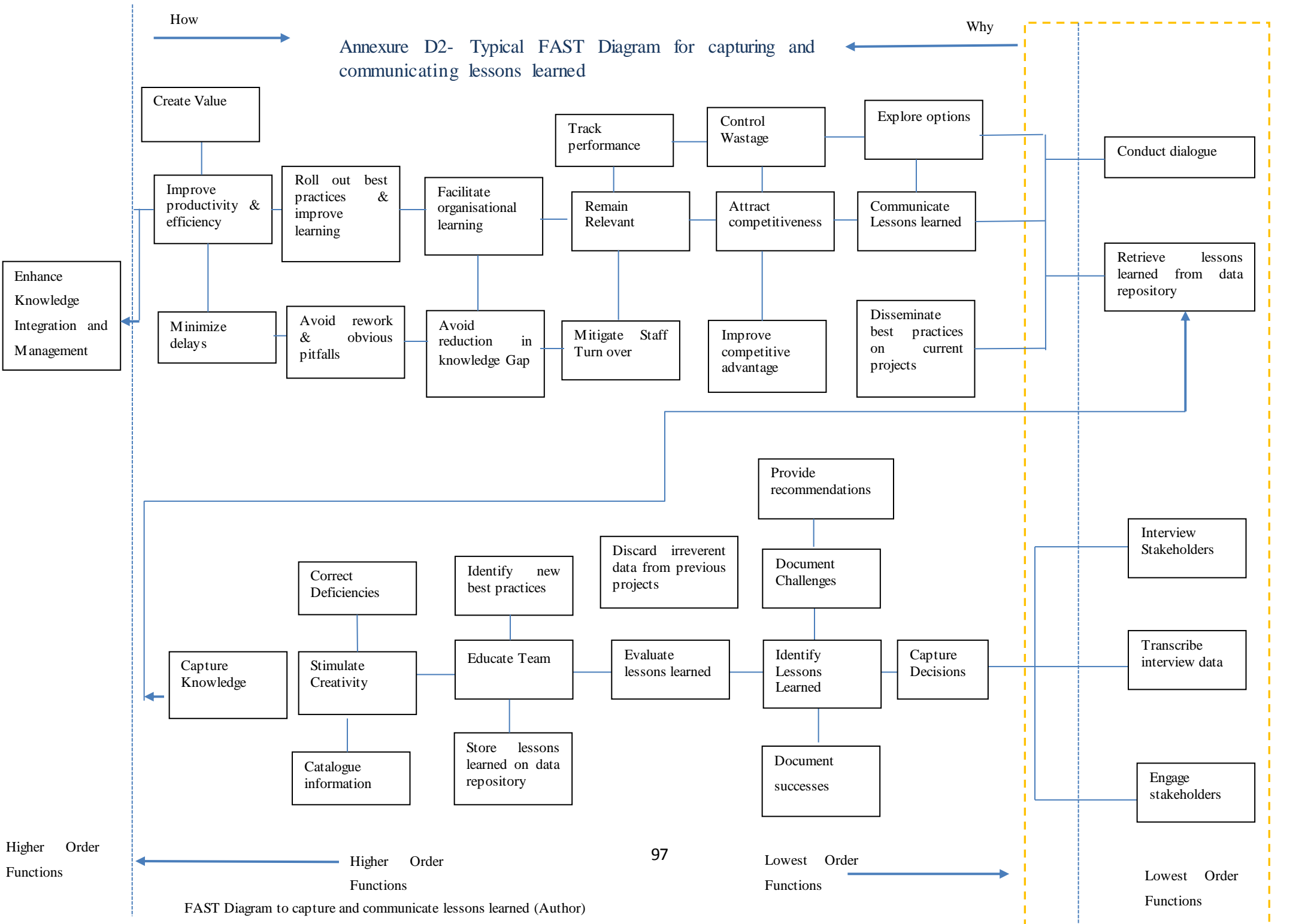
- | | |
|---|---------------------------|
| • Interview stakeholder
Track Performance | Identify Variances |
| • Conduct meeting
Prepare proposal | Correct Deficiencies |
| • Conduct Post-mortem
Process Information | Select Method |
| • Convene session
Create repository | Assure Reliability |
| • Forecast Cost
Analyse Results | Attract competitiveness |
| • Capture Data
transcribe minutes | Describe Process |
| • Store Data/Lesson learned
Control wastage | Transcribe interview data |
| • Evaluate successes
Identify Risk | Minimize delays |
| • Reduce Knowledge-Gap
Mitigate Staff-Turnover | Promote Continuity |
| • Build Partnerships
Document Successes | Document Challenges |
| • Catalogue Information
Determine conformance | Appraise Decisions |
| • Assess conformance
Review failures | Review Achievements |
| • Quantify Successes
Recommend improvements | Record lessons learnt |
| • Educate Team | |
| • Document Activity-list | |

Communicate lessons Learnt *Active verb and measurable Noun_Buzz words*

- | | |
|--|----------------------|
| • Retrieve data
Transmit data | Avoid rework |
| • Transfer Information
Distribute results | Correct Deficiencies |
| • Project Image
Justify Plan | Build confidence |

- *Mitigate failure*
Scope Program
 - *Allocate Resources*
Explore options
 - *Brief Stakeholders*
Convey information
 - *Issue Instructions*
Communicate decisions
 - *Win Work*
Improve effectiveness
 - *Apply Best-Practices*
Publish Newsletter
 - *Conduct Dialogue*
Communicate ideas
 - *Roll out best practices*
Motivate
- Avoid pitfalls*
 - Appoint Technocrats*
 - Describe Process*
 - Communicate designs*
 - Minimize delays*
 - Conduct Network meetings*
 - Engage Stakeholders*
 - Improve learning*

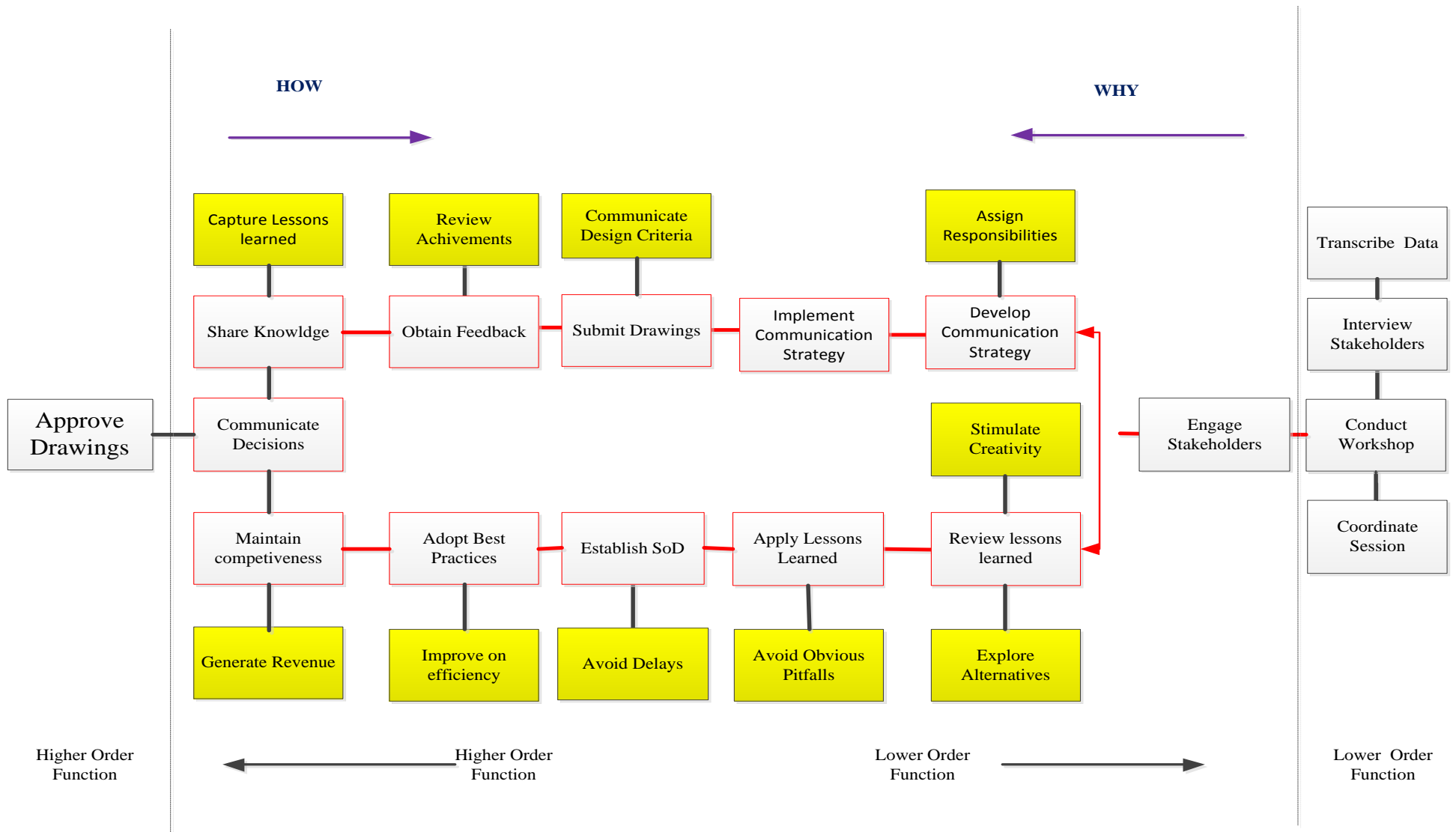




Annexure E – Lessons Learned Activity log List (Author)

LESSONS LEARNED ACTIVITY LOG LIST - Appendix							
Project Reference Number:		I03.DUR000100					
Project Name		XYZ Pump Station					
Project Manager Name:		M Mguti					
Business Unit		Industry and Buildings					
Scope Description:		Design, build, construction monitoring and handover of pump station					
Unique Identifier	Date Identified	Captured By	Category	Subject	Situation	Recommendations & Comments	Success /Failure
1	01 March 2015	John	Communication plan	Approval of drawings	the approval of drawings took longer than scheduled	Have in place a well documented communication plan that outlines the approval process of documents and the lead times allowed for. In addition the submission of marked up drawings need to be accommodated and ensure it will not fall in the critical path and thus delay the project.	Failure
2	10 March 2015	Peter	Communication plan	Approval of variations	No clear procedure on the approval of Variations.	Have in place a well documented communication plan that outlines the escalation process, the roles & responsibilities of individuals involved in that process, and a required response time. To ensure variations are approved on time to avoid delays on project	Failure
3	12 March 2015	James	Scope Management	Late additions to project	Client requested additional scope after design freeze	Have a change management process to ensure scope creep is managed effectively to avoid delays	Failure
4	12 March 2015	Richard	Scope Management	Wrong design	design document submitted was not correct	failure to engage the key stakeholders meant some areas were not fully clarified leading to wrong design concepts being captured	Failure
5	18 March 2015	Peter	Stakeholders Management	Wrong equipment specified	Flow meter specified was not compatible with other systems currently being used by client	Failure to engage all stakeholder during the requirements gathering resulted in assuming operation of equipment and specifying the incorrect equipment	Failure
6	22 March 2015	James	Project Integration Management	Power supply on site	Application of power supply from the supply authority was done on time to accommodate temporary work	The pump station has heavy machinery and as such some of the equipment will need a crane to shift the big motors and pumps into position. The load calculations were done and power supply approval was received in time before machinery could be moved in.	Success
7	24 March 2015	John	Procurement Management	Equipment delivery	the delivery of equipment was done ahead of schedule	All equipment with long lead times was procured in advanced and delivered to the contractors workshop ahead of schedule. This meant there were not delays in terms waiting for delivery of equipment	Success
8	29 March 2015	Oscar	Risk Management	Pilferage of equipment	Loss of material and equipment on site	Have proper access control systems to monitor people entering site. Have ID tags for contractors and control movement of materials on site via a documented tracking system to minimize pilferage	Failure

Annexure F – Project FAST Diagram to capture and communicate lessons learnt (Author)



FAST Diagram to capture and communicate lessons learnt (Author)

Annexure G – Evaluating criteria tool and questions

Reading a set of structured statement a participant is asked to rate, themselves on a scale of 1-5 where each rating corresponds to how likely they will perform a task described in the statement that follows:

1 = Never; 2 =Unlikely; 3 = Sometimes; 4 = Likely; 5 = Certainly;

Evaluating criteria questions

1. When starting a project, I prefer to look on previous close out reports on similar projects to obtain lesson learnt and avoid falling in similar pit.
2. If I have lessons learnt information on current project I prefer to talk about it rather than document it in a form of report
3. A formal setup in a project environment is preferable to an informal discussion to communicate lessons learnt.
4. I find it easier to comprehend lessons learnt from analysing a FAST diagram compared to a traditional project close out report
5. I find it convenient transferring and communicating lessons learnt from analysing a FAST diagram compared to a traditional project close out report
6. I like to collect and disseminate lessons learnt in the traditional way that has been used in the past without looking at the FAST diagram
7. The FAST diagram gives an overall picture of lessons learnt events that transpired during the life cycle of the project without getting into too much detail.
8. The FAST diagram outlines the co-relationship of lessons learnt events and provides enough detail to make informed decisions on future projects pitfalls

9. Pictorial or diagrammatic systems like FAST aid in capturing lessons learnt during project life cycle.

10. The ease of comprehension and cost benefits warrants the use of FAST diagram in transferring lessons learnt onto future projects.

Yes/No Questions

1. I prefer to use the traditional project close out report to capture and communicate lessons learnt on projects.
2. In utilising the FAST diagram, did you manage to identify at least 5 lessons from the project?

Open ended Question

1. Do you think diagrammatic tool like FAST have a future in capturing and communicating lessons learnt within projectized environments? Give a reason for your answer

2. Do you think utilising the FAST diagram in capturing and communicating lessons learnt stimulates creativity and stirs project teams to adopt alternative ways of performing tasks differently in the project environment. Give a reason for your answer.