

Improving lessons learned practice in Architectural Practices: Systematic conversion of lessons learned into improvement actions

By

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Declaration

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Abstract

Purpose – Architectural firms are characterized by their professional identity and knowledge-driven nature; knowledge is crucial to their success in the competitive and dynamic business environment. As knowledge management is still in its infancy in the construction industry and structured knowledge management processes have not yet been adequately deployed in the architecture discipline, this research seeks to focus on the implicit knowledge management processes and more specifically give insight into the effective communication of lessons learned from an individual project to the wider organisation through the use of graphical methods such as the Function Analysis Systems Technique (FAST diagram) that can be undertaken in professional architectural firms.

Design/methodology/approach – To establish if a FAST model can be used as a tool to capture and then communicate lessons learned. This would address the difficulty experienced in the project management of transmitting knowledge from one project to future projects of similar nature. To achieve this objective, a FAST diagram was developed from a Project Learning Roadmap developed by Carrillo *et al.* (2013) and other lessons learned process models which are based on detailed literature review in an attempt to enhance the lessons learned dissemination in South African professional architectural firms. The applicability and validity of the FAST diagram (Appendices B.13 and B.14) was verified by quantitative research methods. Based on the proposed process model, a combination of a brainstorming session and a pilot study with reflective learning approach was utilised on a selected sample population to study the opinions of professional architects on the details of these processes and the diagram. Data presentation was in text and graphic format.

Findings – Once all the data were collected and analysed, the findings were that the research has confidently proven that graphical methods and especially FAST diagrams can effectively be used to communicate lessons learned from one project to the wider organisation.

Practical implications – A clear policy/strategy governing the ways in which lessons learned should be disseminated is not prevalent among South African architectural firms.

Originality/value – Although the study applies uniquely to architectural professional services firms and may not yield an evaluation that is comparable with previous similar studies, it is hoped that the FAST Diagram developed can be applied to other types of project-based professional service organizations in order to find out whether this tool can be used in their context in terms of how they manage their organizational learning. In addition, these future studies can offer a benchmarking effect to firms striving to establish matured project management offices (PMOs) through continuous improvement processes by using lessons learned.

Limitations – Given the exploratory nature of this research, the amount of data obtained is restricted to a single architectural firm in South Africa.

Keywords - Lessons Learned, Single Loop Learning, Double Loop Learning, Learning Organisation, FAST Diagram.

Paper type – Research paper.

Dedication

This piece of research paper is dedicated to my wife, Asegedesh Beyene, and my children Elnathan, Michal and Joel who have supported me by giving hope, courage and unlimited love. Above all praise be to the Almighty God who has enabled me to complete this work against all odds.

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Many thanks to ACG Architects and my colleagues for allowing me some of their valuable production time to collect data and compile my research.

My best gratitude and enormous thanks goes to my research supervisor, Mr Ian Jay, for his professional input and guidance throughout the research process and for providing me an unfailing support in bringing my paper to this stage.

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Contents

Declaration.....	i
Abstract.....	ii
Dedication.....	iii
Acknowledgements.....	iv
Contents.....	v
List of figures.....	viii
List of tables.....	x
Nomenclature.....	xi
Chapter 1: Background to the study.....	1
1.1 Problem statement.....	2
1.2 Research question.....	3
1.3 Research proposition.....	3
1.4 Aims and objectives.....	3
1.5 Research methodology.....	4
1.6 Limitations and delimitations.....	4
1.7 Outline of the Study/ Organisation of the Report.....	4
Chapter 2: Literature Review.....	5
2.1 Importance of lessons learned.....	5
2.1.1 Lessons Learned Process.....	11
2.2 The contracting organisation context.....	17
2.2.1 The architectural practices context.....	19
2.2.2 Architectural Work Stages.....	21
2.3 Function Analysis System Technique: FAST.....	23
2.3.1 FAST Diagram.....	24

2.3.2	Logic Diagrams and FAST Trees.....	26
2.4	Concluding remarks	27
Chapter 3:	Research Methodology	29
3.1	General research strategy.....	29
3.2	Sampling.....	31
3.3	Procedural research strategy.....	32
3.4	Method of data collection	33
3.5	Brainstorming session design	38
Chapter 4:	Research Findings and Data Analysis.....	41
Chapter 5:	Conclusions and Recommendations	61
5.1	Conclusions	61
5.2	Recommendations	62
5.3	Further areas of study.....	64
References	65
Appendices.....	72
Appendix A:	Standard Architectural Work Stages.....	72
Appendix B:	Lessons Learned and FAST Diagram.....	75
Appendix C:	93
Appendix C1:	Project Closure Report for Project 'X'	93
Appendix C2:	Lessons Learned Tree Diagram for Project 'X'	108
Appendix C3:	Lessons Learned FAST Diagram for Project 'X'	118
Appendix D:	Focus Group Research help document	119
Appendix E:	Cover letter	120
Appendix F:	Confidentiality and Consent.....	121
Appendix G:	Questions for Focus Group Research.....	122

Appendix H: Individual Questions for each Participant.....	124
Appendix I: Contact summary form	127
Appendix J: Ethics Clearance	128

List of figures

Chapter Two:

Figure 2. 1: A Work in Progress: The Knowledge Management process (Kumar, 2005).	6
Figure 2. 2: The expanded 4I model of the organizational learning process and its barriers (Schilling and Kluge, 2009).	9
Figure 2. 3: Lessons learned processes (Rowe, 2008 and Rowe and Sikes, 2006a&b).....	12
Figure 2. 4: Lessons learned processes: evolve project experience into repeatable processes (Boehringer, 2009).	13
Figure 2. 5: A refined 'systemic lessons learned and captured knowledge (SLLCK) model' (Duffield and Whitty, 2012).	14
Figure 2. 6: A knowledge management vision (Goodson, 2005).	14
Figure 2. 7: Project Learning Roadmap (Carrillo <i>et al.</i> , 2013).....	16
Figure 2. 8: Single- and Double- Loop Learning (Matheson and Matheson, 1998:106).....	17
Figure 2. 9: RIBA Plan of Work (Cooper et al., 2005:21).	22
Figure 2. 10 : SAIA Architectural Work Stages (author).....	22
Figure 2. 11: Visually Displaying Higher and Lower Level Functions (Bytheway, 2007).	26

Chapter Three:

Figure 3. 1: Components of Data Analysis: Interactive Model (Miles and Huberman, 1984).	33
Figure 3. 2: Group Rules for Brainstorming (Bytheway, 2007).	39

Chapter Four:

Figure 4.1: Graph of responses to statements from Group "A" on Project Closure Report	47
Figure 4.2: Graph of responses to statements from Group "B" on Lessons Learned FAST Diagram	49
Figure 4.3: Graph of responses to statements from every individual participant.....	53

Appendix B:

Figure B. 1: Methods of selecting projects (Bytheway, 2007).	75
Figure B. 2: Questions for Method 3 (Bytheway, 2007).	75
Figure B. 3: Questions for Method 4 (Bytheway, 2007).	76
Figure B. 4: Questions for Method 5 (Bytheway, 2007).	76
Figure B. 5: Initial Functions for "Lessons Learned Process" (Author).	79
Figure B. 6: Higher Level Functions for "Lessons Learned Process" (Author).	81
Figure B. 7: List of Functions (Author).	82
Figure B. 8: Communicate Lessons Learned FAST Tree 1 (Author).....	83

Figure B. 9: Evaluation of remaining formulated Functions (Author).....	85
Figure B. 10: Communicate Lessons Learned FAST Tree 2 (Author).....	86
Figure B. 11: Communicate Lessons Learned FAST Tree 3 (Author).....	87
Figure B. 12: Communicate Lessons Learned FAST Tree 4 (Author).....	90
Figure B. 13: Basic Lessons Learned FAST Diagram (Author).....	91
Figure B. 14: Lessons Learned FAST Diagram incorporating Single-loop learning and Double-loop learning (Author).....	92

List of tables

Chapter Four:

Table 4.1: Response Rate of Participants.....	41
Table 4.2: Group Allocation and Position of Participants	42
Table 4.3: Remarks from Group “A”- Project Closure Report Group	44
Table 4.4: Remarks from Group “B”- FAST Diagram Group.....	45
Table 4.5: Remarks from individuals of Group “A” on the Project Closure Report showing their group codes	46
Table 4.6: Remarks from individuals of Group “A” on the Project Closure Report showing numerical values and percentages.	47
Table 4.7: Remarks from individuals of Group “B” on the Lessons Learned FAST Diagram showing their group codes.....	48
Table 4.8 : Remarks from individuals of Group “B” on the Lessons Learned FAST Diagram showing numerical values and percentages.	48
Table 4.9: Remarks from every individual participant.....	50
Table 4.10: Remarks from every individual participant showing numerical values and percentages.	52
Table 4.11: Raw data of remarks from every individual participant	54
Table 4.12: Descriptive Statistics of remarks from every individual participant	54
Table 4.13: Descriptive Statistics of remarks from every group.....	55

Nomenclature

2D= Two Dimensional

3D= Three Dimensional

ArchiCAD= a three dimensional modelling software used by architects

BIM = Building Information Modelling

FAST= Function Analysis System Technique

PE= Project Execution

PI= Project Initiation

PM= Project Manager

PMO= Project Management Office

PP= Project Planning

QMS= Quality Management System

SEPGs= Software Engineering Process Groups

Chapter 1: Background to the study

The author, having being involved in a number of architectural projects differing in scale and complexity for the past ten years, has learned that one of the main weaknesses of the architectural company the author works for was the lack of transferring lessons learned from individual projects to the wider organisation. Using guidelines from PMI (2013) on Close Project or Phase that provides lessons learned as the key benefit of this process (PMI, 2013:99), the author prepared a project closure template that included a lessons learned section and presented it to the management of the company. They appreciated the initiative but they had no clue how it could be used by the office. The author, then decided to test the template on a pilot project that the author is currently involved in so that it could be rolled out companywide for all projects and be used by every project leader in the office. The template was populated with information of the pilot project based on the author's experiences during the project's life cycle reflecting all the architectural work stages. After referring to literature reviews such as Rowe (2008), the author conducted a few lessons learned sessions with the core team members of the project that are still available and distributed it to those members who are no longer working with the company for their input and finally presented it to the Management Committee of the company. Due to other project commitments and priorities, it was not possible to convene the core team anymore, hence, the proposed template was given to each of them both electronically and in hardcopy to give their input individually before they convene for another group session. The team members were too busy to spend time on such an exercise where they do not see the immediate value of it and it was too cumbersome to read the document. The author then started this research to find out if there is a better way of transferring lessons learned from individual projects to the wider organisation such as through graphical methods.

Many organizations routinely identify and organize the lessons they learn on projects. But too often, these organizations then store their lessons learned in a knowledgebase that is infrequently accessed. As a result, such business-critical knowledge is rarely applied to future projects (Boehringer, 2009). Organizations can effectively improve project performance and increase project management competency by learning from both previous project successes and previous project failures (Rowe, 2008).

This paper reports on a research project that will critically review how architectural practices can systematically convert lessons learned into improvement actions. This would be achieved by using this knowledge to more effectively and efficiently implement current and future projects by both exploiting

existing ideas and opportunities and exploring new ones to be successful in changing environments. It is of concern that few contracting organizations are able to systematically convert their lessons learned into improvement actions (Chan *et al.*, 2005). Even organisations that routinely capture lessons learned fall short when it comes to analysing the lessons and then applying them to existing and future projects. 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).

Learning from feedback is vital for a contracting organization's performance improvement, nevertheless, many project monitoring systems are not well designed to provide useful feedback in order to facilitate learning from mistakes (Ruuska and Vartiainen, 2005). Contracting organizations often improve performance through detecting and correcting errors, called single-loop learning (Wong *et al.*, 2009) and yet rarely look into the causes of these errors or identify the new behaviours needed to prevent reoccurrences, known as double-loop learning (Wong *et al.*, 2009). Despite supporting the contention that the practices of single-loop learning and double-loop learning are both imperative for performance improvement, practicing single-loop learning only is not sufficient for contracting organizations to sustain performance in response to the changes of market demands (Wong *et al.*, 2012). Organizational learning is not merely a detection and correction of errors system for attaining a pre-determined performance standard (Wong *et al.*, 2012). Instead, organizational learning involves a process of unlearning which is identifying and discarding obsolete beliefs and routines (Akgün *et al.*, 2006) and organizations may not learn effectively without first unlearning irrelevant ideas from the past (Hedberg, 1981).

This paper proposes the use of graphical methods such as the Function Analysis Systems Technique (FAST diagram) used in Value Methodology (VM) studies (Sievert, 1991) which could provide a means of reinforcing the process of unlearning, double-loop learning and learning from feedback in communicating lessons from one project to the wider organisation to establish and sustain a culture of consistent project management improvement.

1.1 Problem statement

The problem to be examined in this study can be summarised as:

Lessons from individual projects are ideally captured into a repository or database but little use is made of the knowledge the lessons may provide.

1.2 Research question

The **general research question** in this study is:

Can the use of graphical methods such as the FAST diagram provide a means of communicating lessons from an individual project to the wider organisation?

The **specific research questions** in this study are:

1. How can the lessons learned from individual projects be converted into FAST models?
2. How easy is it to assimilate knowledge embedded in a FAST model?

1.3 Research proposition

The proposition from (Somers and Nelson, 2003), that shaped the data collection plan and the analytic strategies (Yin, 2009), can be summarised as follows:

The use of graphical methods such as the FAST diagram used in VM studies provide a means of communicating lessons from one project to the wider organisation.

1.4 Aims and objectives

This research project aims to:

Build on the works of Carrillo et al. (2013) and provide an insight into the effective communication of lessons learned from an individual project to the wider organisation through the use of FAST diagram.

The objectives can be summarised as:

1. To investigate the lessons learned managing activities/actions generally undertaken in architectural firms; and;
2. To develop a conceptual framework of managing the communication of lessons learned for professional architectural firms, based on the use of FAST models.

1.5 Research methodology

The research report utilises:

An explanatory study with reflective learning was utilised on a selected project to study the opinions of professional architects who are practicing in the Greater Cape Town area both on the details of the processes and the proposed FAST diagram. Through brainstorming sessions, the proposed diagram was tested on a pilot study of a project the author is working with. To enhance the validity of the brainstorming session results, a list of potential participants were assembled from within the architectural firm such as company directors, senior architects, project leaders and technologists to conduct a focus group research.

1.6 Limitations and delimitations

Limitations on the study were mainly related to time and cost factors. The direct result of the time constraint imposed on the study, is that the data analysis period was short. If a longer period was at the disposal of the author, more time could have been spent on the reduction, display, and conclusion drawing. Thus, allowing for a more thorough study. Because of the cost constraint, only one architectural firm in the Western Cape, more specifically in Cape Town, was investigated. Hence, the results are non-generalizable.

1.7 Outline of the Study/ Organisation of the Report

The first part of the paper addresses the importance of lessons learned, the contracting organisation context and the construction of a FAST Diagram and how it relates to lessons learned. This is followed by a description of a conceptual model that translates into a FAST Diagram. Next, the research method adopted is explained and justified. Finally, the limitations of the research and its conclusions are presented.

Chapter 2: Literature Review

2.1 Importance of lessons learned

Learning may be defined as the detection and correction of error (Argyris, 1976 & 2002). Learning can also be defined as a relatively permanent change in knowledge or skill resulting from experience (Weiss, 1990). The definition emphasizes the dual nature of learning as a process (perceiving and processing information, i.e. experience) and a result (modified knowledge or skill) (Dodgson, 1993). Like learning, the term organization has a dual meaning: Institutional (organization as a social system of members pursuing common goals) and instrumental (organization as a body of structures and rules that regulate human behaviour in the workplace) (Schanz, 1992).

A lesson 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: 543). It is a knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. Successes are also considered sources of lessons learned. 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). This definition thus emphasises lessons can be positive or negative and that they must have impact (Carrillo, *et al.*, 2013).

A Lessons Learned Knowledge Base is a store of historical information and lessons learned about both the outcomes of previous project selection decisions and previous project performance (PMI, 2013: 543). Lessons learned are a key element of knowledge management (Garon, 2006).

Knowledge is increasingly regarded as a survival tool in a dynamic and competitive environment (Laudon and Laudon, 2000). The basic economic resource is no longer capital, natural resources, and labour, it is and will be knowledge (Drucker, 1993). Therefore, there is a pressing need in every knowledge-intensive organization for knowledge to be well managed in order to cope with the shortcomings arising from the common uneven distribution of knowledge in these organizations (Fong and Choi, 2009).

Efficient knowledge flow is critical to enterprise performance (Nissen, 2004: 186). In spite of its inherently crucial role, knowledge is often not managed in a systematic manner, and its contribution to firm success is commonly overlooked. These firms may hold the belief that investment in knowledge processes is

unlikely to boost their business enough to generate proportionate financial returns (Fong and Choi, 2009). In many organizations critical knowledge is wasted; the knowledge exists but people do not know it exists or how to gain access to it. Often the waste occurs because the organization has no formal process for capturing and disseminating knowledge, a process called *knowledge management* (O’Dell and Grayson, 1998). Any Knowledge Management system is a “work in progress.” It is an ongoing journey, and one can lose all the benefits accrued if not managed carefully and diligently. Many Knowledge Management rollouts in the industry have failed because Knowledge Management practitioners focused on what software to use and what content to include, rather than the processes required to generate, capture, use, and maintain content (Kumar, 2005). Figure 2.1 shows Knowledge Management system as a work in progress via the four processes of Creating Knowledge, Managing Knowledge, Using Knowledge, and Purge Knowledge (Kumar, 2005).

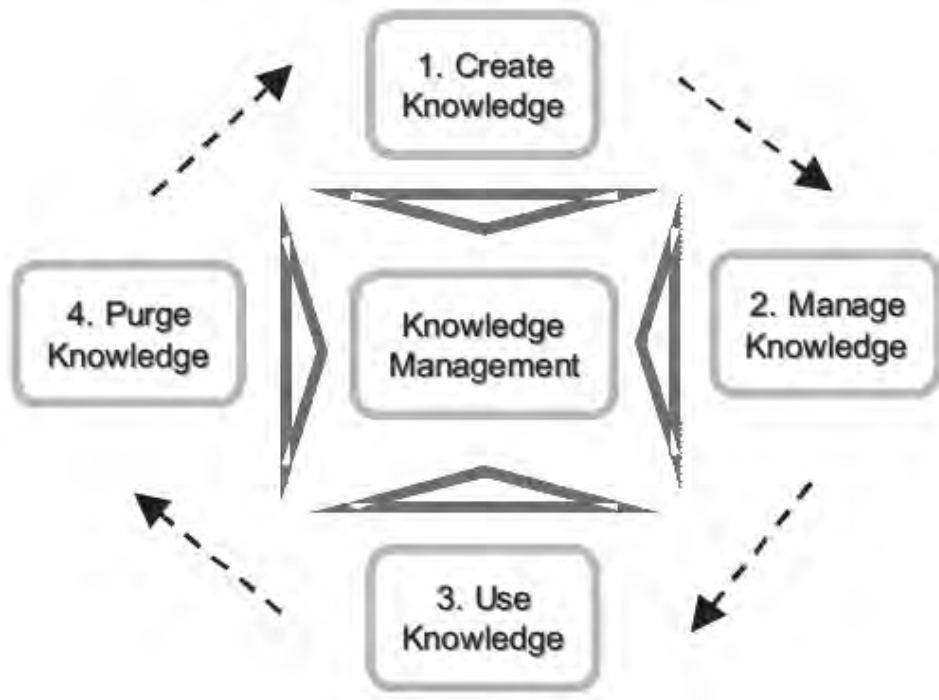


Figure 2. 1: A Work in Progress: The Knowledge Management process (Kumar, 2005).

Knowledge management is the identification, optimisation and active management of intellectual assets to create value, increase productivity and sustain competitive advantage (Webb, 1998). Hence, lessons learned are able to provide competitive advantage if used properly. They 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). In this context, *lessons learned* are the intellectual assets used to create value based on past experience. Likewise, lessons learned contribute to the organisation's learning agenda (Carrillo *et al.*, 2013). Numerous authors have discussed the need for organisational learning such as Argyris and Schön (1978), Fiol and Lyles, (1985) and Senge (1993).

Organisational Learning is an organizationally regulated collective learning process in which individual and group-based learning experiences concerning the improvement of organizational performance and/or goals are transferred into organizational routines, processes and structures, which in turn affect the future learning activities of the organization's members. Rooted in the perspective of organisational learning as a collective process of information acquisition, dissemination and storage, this definition takes three major aspects in the literature into account (Schilling and Kluge, 2009):

1. Individual and Organisational Learning are mutually dependent on each other (Popper and Lipshitz, 2000) because individuals learn as representatives of their organization, while all knowledge acquired must be retained appropriately (in the form of documents, routines, processes and structures, for instance) for it to remain available, even if an individual leaves the organization.
2. Organizations need both to exploit existing ideas and opportunities and to explore new ones to be successful in changing environments. While *exploration* is associated with the notion of learning experiences made by individuals and groups, *exploitation* is taken into account by including the aspect of transferring the experiences into organizational routines, structures and processes (March, 1991).
3. Different authors (Andreu and Ciborra, 1996; Argyris and Schön, 1996; Dodgson, 1991; Fiol and Lyles, 1985; Hawkins, 1994; Senge, 1990) distinguish between double loop or higher-level (which questions the acceptability of the goals: 'accommodation') and single-loop or lower-level learning (which includes a continuous improvement of existing behaviour and a move towards a given goal: 'assimilation'). Both kinds of learning process imply the view of Organisational Learning as a means of remedying performance related or goal-related gaps in organizations (Schilling and Kluge, 2009).

To describe and explain the barriers of Organisational Learning in a systematic manner, an appropriate model for the Organisational Learning process has to be developed. An important contribution in this respect was made by Crossan *et al.* (1999). They conceive Organisational Learning mainly as a means of strategic renewal in organizations (March, 1991); their model provides a rich, coherent framework that specifies four general processes through which organizational learning occurs. Three characteristics of the model stand out as particularly important in the development of a general model of organizational

learning: (1) it is multilevel, bringing together individual, group, and organizational levels of analysis (Lawrence *et al.*, 2005) and hence, is relatively open to different kinds of experience based changes (i.e. lower- and higher-level learning) (March, 1991); (2) the model integrates the important tension between exploration and exploitation in Organisational Learning (March, 1991); thus, it is dynamic, bridging the levels with specific mechanisms; and (3) it clearly articulates four processes- intuiting, interpreting, integrating, and institutionalizing (the "4Is")- that allow learning to feed forward to the organizational level and feed back to the individual (Lawrence *et al.*, 2005).

A further advantage of the framework lies in its extension elaborated by Lawrence *et al.* (2005). Based on the 4I framework, Lawrence *et al.* (2005) developed a political model of Organisational Learning. Power and politics are regarded as fundamental factors that shape the success or failure of such processes (Blackler and McDonald, 2000; Coopey, 1995; Easterby-Smith, 1997). The 4I model postulates four processes by which the different levels of Organisational Learning (individual, group and organization) are bi-directionally connected (Schilling and Kluge, 2009):

1. *Intuiting*: This process of developing new insights and ideas based on personal experience is located within the individual.
2. *Interpreting*: In this step, the individual explains his/her insights through words and/or actions to him/herself and – more importantly – to others.
3. *Integrating*: This step takes place at group level where a shared understanding among individuals and groups is achieved which allows for coherent, collective action within the organization.
4. *Institutionalizing*: Finally, shared understanding is implemented in systems, structures, procedures, rules and strategies, thereby becoming independent of its individual or group origins, and guides organizational action.

Lawrence *et al.* (2005) complements these four processes with four socio-political processes called influence, force, discipline and dominance (Figure 2.2). *Influence* involves a wide range of political tactics such as moral suasion, negotiation, ingratiation or persuasion. By affecting the costs and benefits that other organizational members associate with a certain idea, the creator or the champion can convince others to adapt to his/her view. The process of *force* is characterized by creating circumstances that restrict the options available to organizational members using formal authority to implement the new idea. To overcome potential resistance to institutionalizing changes, *domination* is regarded as a

particularly effective strategy. Finally, the process of *discipline* implies altering the costs and benefits associated with the actions available to organizational members (Lawrence *et al.*, 2005).

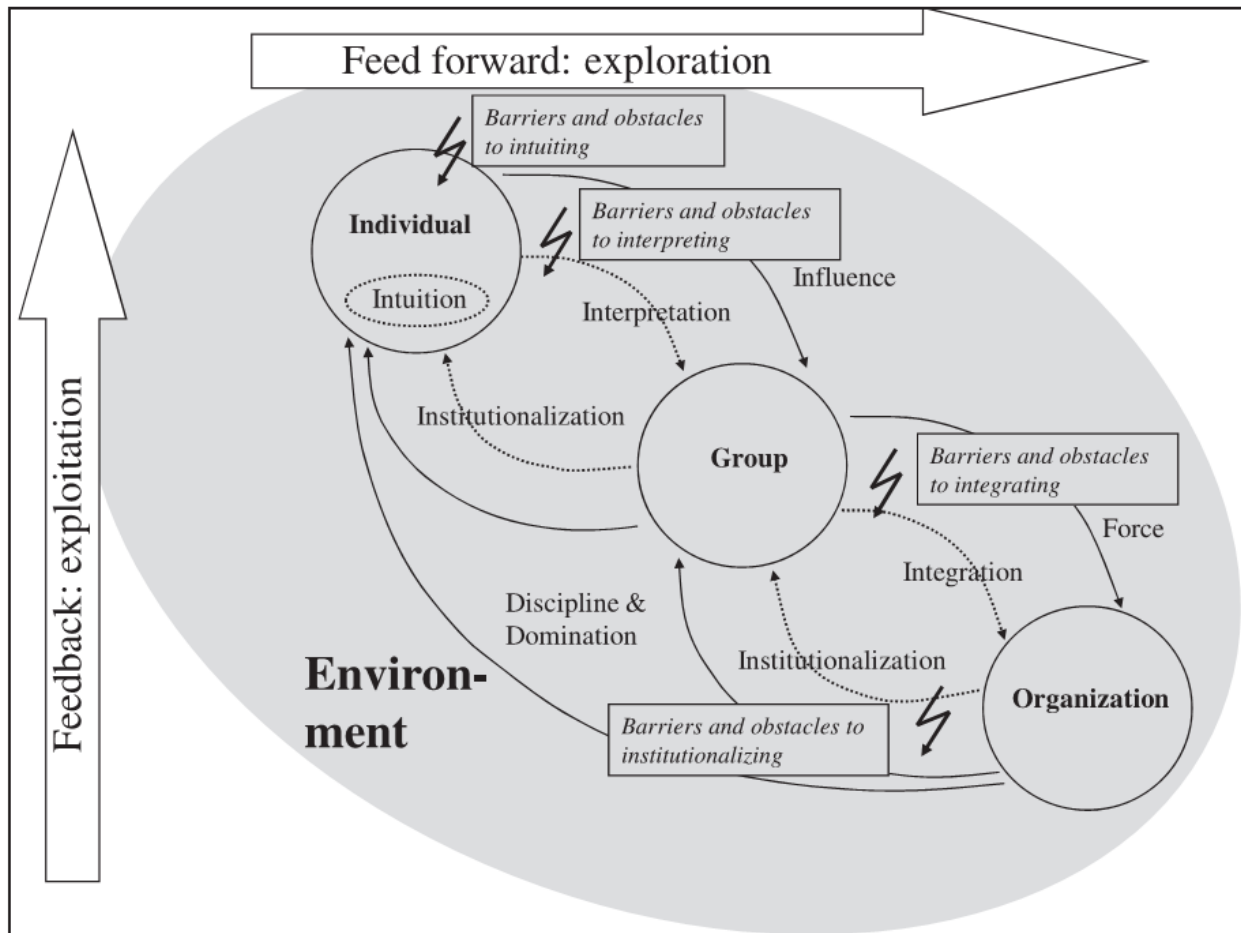


Figure 2. 2: The expanded 4I model of the organizational learning process and its barriers (Schilling and Kluge, 2009).

Lessons learned have often been seen as an unnecessary administrative burden, especially for lesser or non-media events, and there is not that “motivation” to write and use lessons learned, especially for certain areas of knowledge that are sensitive to penalties (or perception of sensitivity to penalties). The situation is worse for long projects since, in some cases, lessons learned have not been captured as they happen and have not been systematically archived (Garon, 2006). In fact, for some large government projects that have lasted longer than five to ten years, and even when considering that lessons learned are compulsory for most government projects, lessons learned have been written at the end of any given project. This was done using progress reports and the memories of the people who were still with the project at that time, making it difficult to capture all the important issues (Garon, 2006). Hence, a

continuous gathering of experiences is especially meaningful in projects with a long life cycle, where the danger exists that procedural knowledge could be forgotten due to a large time delay (Schindler and Eppler, 2003).

Project lessons learned come from past and ongoing projects. They are a powerful tool to get a project's early estimates close to reality, and to provide vital ideas for problem solving during the project life-cycle. They can also be valuable inputs for corporate strategic planning, for communicating with senior management and to support continuous improvement in project management (Garon, 2006). Project learning is, thus, too important to be left to chance or to the initiative of motivated individuals (Schindler and Eppler, 2003). It is expected that for many organizations the corporate culture needs a significant paradigm shift to obtain and use lessons learned efficiently (Garon, 2006). The need for a paradigm shift is further supported by other considerations. For instance, project managers are usually overworked, and at the same time, many feel that excellence in project management comes only with experience and personal wit. Therefore they do not have or find the time to capture ongoing lessons learned, and they see that exercise as a waste of time. These Project Managers are also generally the ones who will not "find the time" to study lessons learned from the past, for the same reasons (Garon, 2006).

Even for those who do write lessons learned, many will not write honest or complete management or costing lessons learned, or will not document them sufficiently to be of significant use, for fear of disclosing problems that could have impact on one's career. This situation is made worse by an often-perceived corporate attitude of scapegoating as opposed to one of "let's learn together". Possibly compounding the problem is the fact that there seems to be no recognized standards to managing lessons learned and fostering their use (Garon, 2006).

Databases play a useful role in knowledge management, but their creation and upkeep is a problem. A knowledge database requires substantial effort and is ideally managed by a team of knowledge experts who know how to make it useful and user friendly (Nicholas and Steyn, 2008).

While developing a project plan it makes sense for the project manager to refer to earlier, similar projects (plans, procedures, successes, and failures). To be able to do this, ideally the project manager is provided with planning assistance in the form of lessons learned, best practices, suggested methodologies and templates, and even consulting advice derived from experience in past projects. Sometimes the project manager has to seek these out, and sometimes it is provided by the organization; indeed, the latter is a function of the *project management office* (PMO). Lessons learned and suggested best practices often

come from the so-called post-project summary or project post-mortem report, which is a formal retrospective report about a project created at close-out and describing what went well, what went wrong, and the lessons learned. These provide guidance in planning projects and help managers avoid reinventing the wheel and repeating past mistakes (Nicholas and Steyn, 2008).

The above considerations can be addressed by education, some internal rules, good guidelines and standards, and a compatible project approval and management system. Strong discipline will not work; the writing and use of the lessons learned depends very much on the will of the people involved to share information, and on senior management for creating the proper environment; there is a lot to do in this regard (Garon, 2006).

2.1.1 Lessons Learned Process

Organisations are becoming more project-focused with defined, even mature processes for initiating, planning, monitoring, executing, and controlling activities. These same organisations have processes for project closure, which may even include conducting a lessons learned session at the end of the project (Rowe, 2008). A guide to the Project Management Body of Knowledge includes lessons learned as one of the organizational process assets (PMI, 2013). Often organisations have a defined process of capturing lessons but do not include activities to ensure lessons are used (Rowe, 2008). Thus, unfortunately, many organizations never begin collecting lessons learned, or they abandon them after discovering that they merely checked off the activity, stuck them in a database, and never looked at them again (Boehringer, 2009).

To maximize learning from project to project, organizations should have an infrastructure in place to acquire and socialise project information which is a lessons learned process. The purpose of a lessons learned process is to define the activities required to successfully capture and apply lessons learned (Rowe, 2008 and Rowe and Sikes, 2006a&b). Different researchers have proposed different lessons learned processes and conceptual models such as those shown in Figures 2.3 to 2.7.

Rowe (2008) divides the lessons learned process into five activities and summarised them into two process groups. *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 2.3.

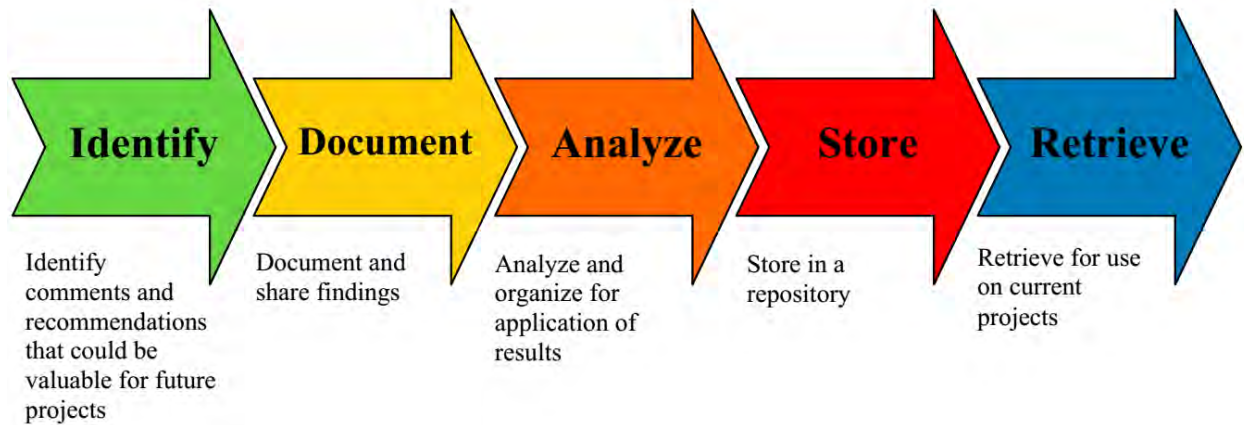


Figure 2. 3: Lessons learned processes (Rowe, 2008 and Rowe and Sikes, 2006a&b).

Boehringer (2009) introduced a process model that is part of change management as shown in Figure 2.4. It discusses the importance of establishing lessons learned sessions throughout a project's life cycle. In this process, *anecdotal statements* are gathered during lessons learned sessions and are converted *into actionable observations* and get stored in a repository categorized by project activity/ deliverable. Lessons learned observations should be culled through on quarterly basis looking for trends, then initiate process groups that will identify *best practices* (in the form of policies, processes, procedures, & standards). It is the best practices and not the lessons learned statement, which is rolled into the guidelines, processes, systems, and templates. The best practices should be driven into the process in order to make them repeatable. Otherwise, if lessons learned stay as anecdotal information, it is likely the organisation will learn the same lessons learned again and again. The process advocates how organizations can improve their practice of knowledge management by using lessons learned to mature PMOs and project teams perform better via the anecdotal statements gleaned from lessons learned sessions and the actionable observations and best practices that these insights subsequently generate. In doing so, it overviews the "Keep it simple" approach to practicing knowledge management and suggests an approach to gathering lessons learned. It summarizes how organizations can use the proposed process to manage change (Boehringer, 2009).

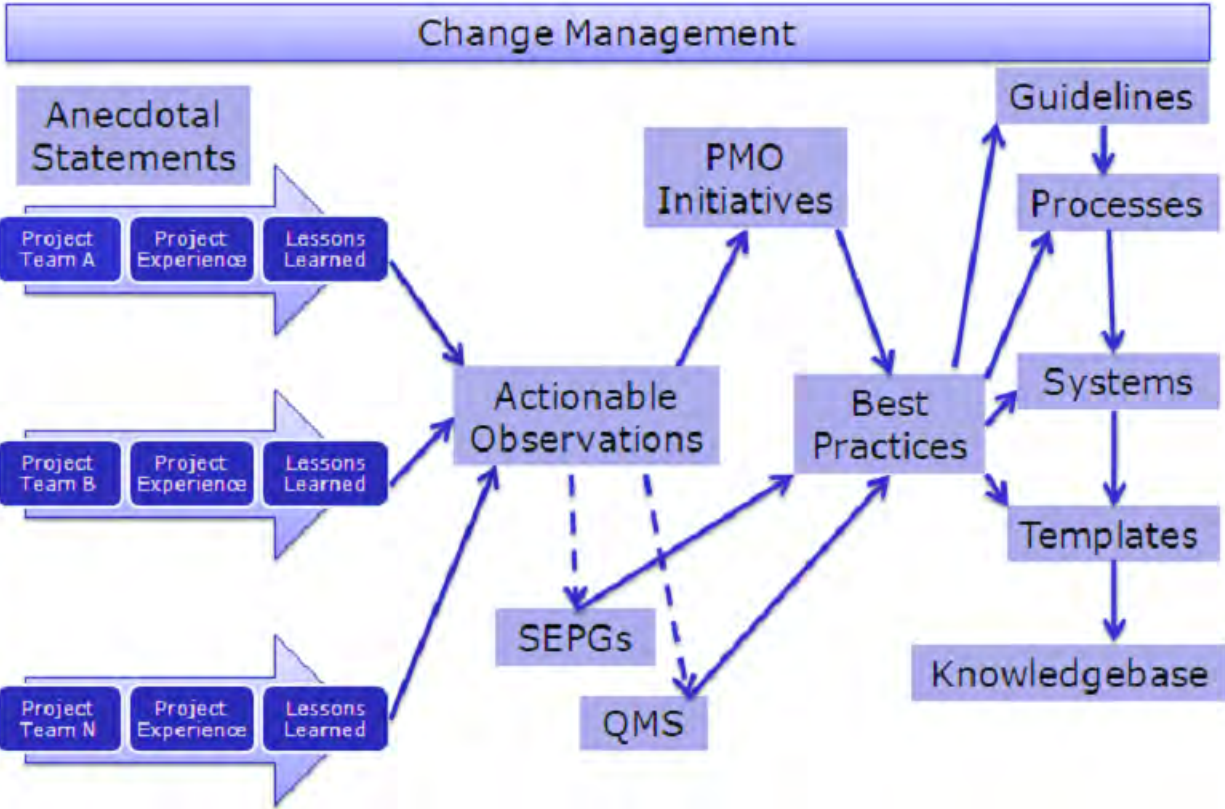


Figure 2. 4: Lessons learned processes: evolve project experience into repeatable processes (Boehringer, 2009).

A conceptual model derived from the Swiss cheese model (Reason, 1997) for safety and systemic failures, where captured knowledge from lesson learned is distributed and applied across a network of variables such as individual learning, culture, social, technology, process and infrastructure is the systemic lessons learned and captured knowledge (SLLCK (pronounced Silk)) model. This model identifies some of the facilitators and barriers to capturing knowledge from lessons learned by projects as shown in Figure 2.5. The key elements of this model are knowledge, people and systems in the context of lessons learned (Duffield and Whitty, 2012). The categorisation of these key elements is also expressed by Goodson (2005) see Figure 2.6 where process and technology are included in the systems category of the SLLCK model. Two important processes are evident in the SLLCK model; lessons learned has two distinct facets- dissemination and application as well as the fact that all systems feedback to the culture as culture has the potential to make or break the organisation depending on how it is supported by these systems.

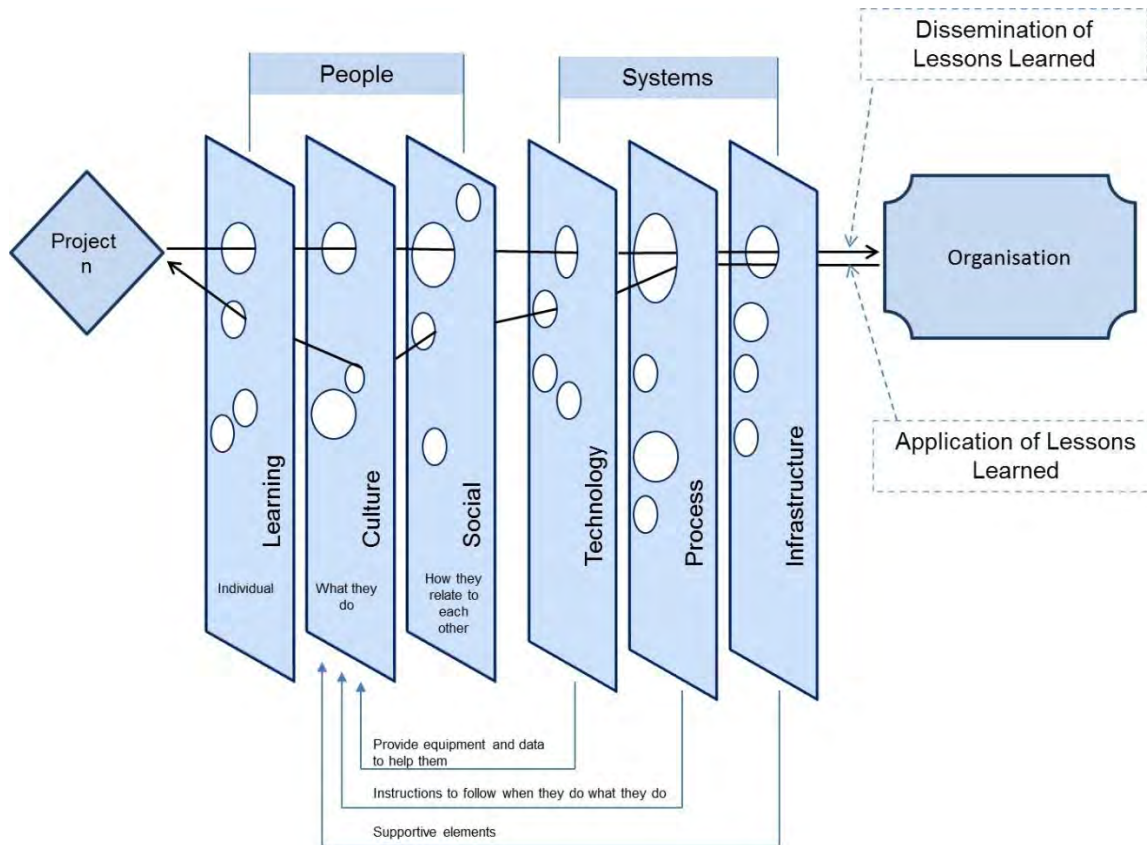


Figure 2. 5: A refined 'systemic lessons learned and captured knowledge (SLLCK) model' (Duffield and Whitty, 2012).

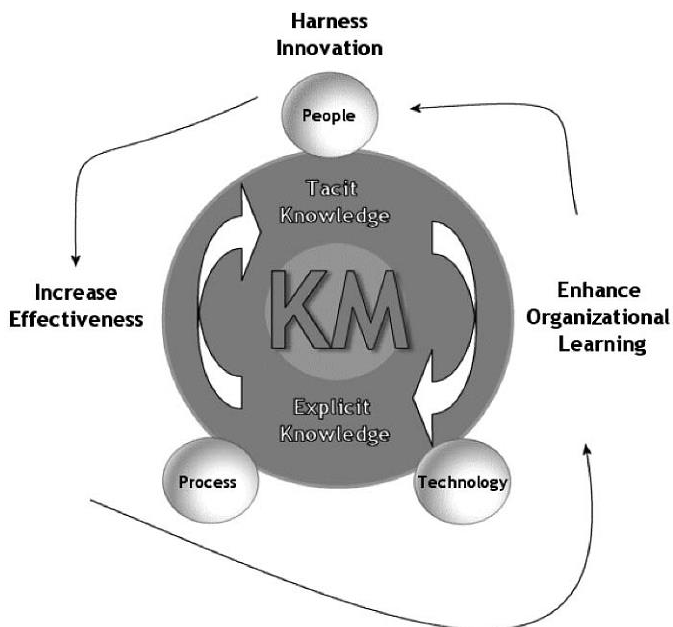


Figure 2. 6: A knowledge management vision (Goodson, 2005).

Another conceptual model was proposed by Carrillo *et al.* (2013) which was translated into a roadmap that leaders in construction organisations can use to improve their project lessons learned processes and outcomes. Companies may need to address the questions of ‘Do lessons learned address objectives at both project level and corporate levels?’ ‘Are the tools and techniques used appropriate?’ ‘Do our lessons learned processes address the problems they are designed to solve?’ The current lessons learned practices may not be geared to solve these problems, perhaps reflected in the desire for alternative tools and techniques. Rather than addressing these issues in a prescriptive manner, a Project Learning Roadmap is proposed (Fig. 2.7). The Roadmap consists of three main components as follows (Carrillo *et al.*, 2013):

1. *The Key Elements* required to bring about change in the lessons learned practices- The aim of these are to identify the high level issues the organisations need to address to improve the dissemination of lessons learned. The starting point is *Preparation* for the implementation of lessons learned. Most project planning literature advice a pre-planning phase to make any undertaking a success (Pinto and Prescott, 1990). The other five elements proposed are Needs Identification, Process and Tools Used, Content and Format of Lessons, Repository Used and Communication/Dissemination. The Key Elements also include a Review phase as proposed by both continuous improvement and learning literature. The aim of this is to ensure that the tasks undertaken address the aim of improving the collection and dissemination of lessons learned.

2. *The Actions*- which is the central part of the Project Learning Roadmap itemises the various actions that need to be undertaken to address each Key Element by leaders at both corporate and project levels within the organisation. Von Zedtwitz (2002, p.255) lamented “*most companies have not established a structured approach to learning from projects*”. These Actions, in the form of a flow chart, are aimed at ensuring there is a structured and coherent manner to address the collection and dissemination of the lessons learned. Following Von Krogh *et al.* (2012) advice, it comprises two halves as a reminder that those activities are required to address both the corporate and project teams' needs.

3. *An Implementation Guide* which provides supporting advice and information for improved processes in the form of checklists from which each organisation could choose the best approach and practical advice for their specific context and resultant needs. Where relevant, the checklists indicate whether the items are suitable for small and medium-sized organisations (SMEs) or large organisations (Carrillo *et al.*, 2013). The South African Government’s (2003) definition of SMEs is turnover less than R26 m and number of employees less than 200 (National Small Business Amendment Act, 2003).

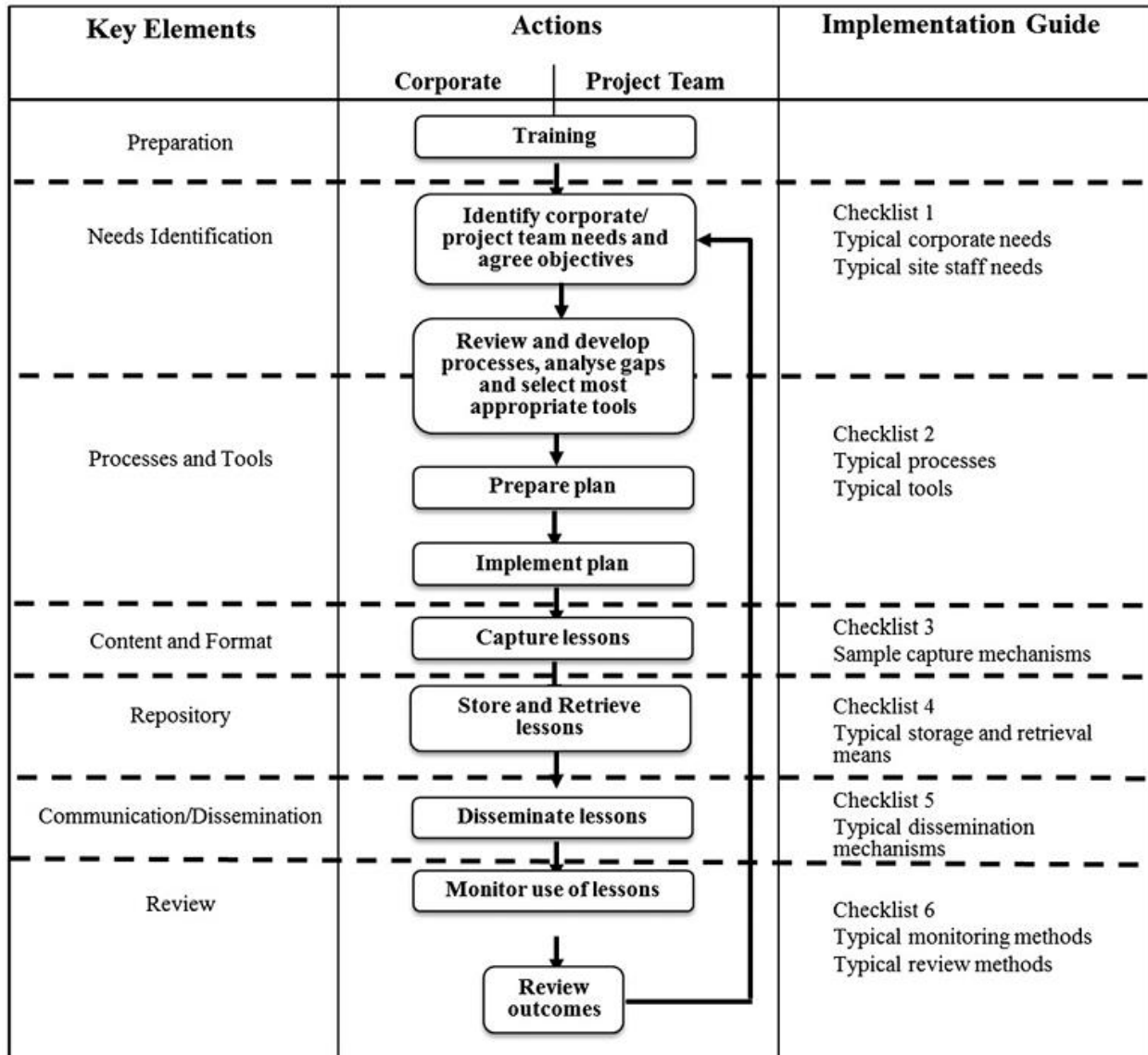


Figure 2. 7: Project Learning Roadmap (Carrillo *et al.*, 2013).

2.2 The contracting organisation context

The topic of organizational learning which was introduced by Cangelosi and Dill (1965), has received increasing interest from researchers and practitioners, especially in the last two decades (Crossan *et al.*, 1999). Contracting organization in this study refers to the organizations collaborating in a construction project. This includes, among others, the architectural, engineering and surveying consultants employed by the developers, the main contractors and the sub-contractors (Wong *et. al.*, 2012).

Learning from feedback is vital for a contracting organization's performance improvement. Nevertheless, many project monitoring systems are not well designed to provide useful feedback in order to facilitate learning from mistakes (Ruuska and Vartiainen, 2005). Even organisations that routinely capture lessons learned some times fall short when it comes to analysing the lessons and then applying them to existing and future projects. 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) which is double loop learning. Contractors typically exhibit two types of organizational learning: single-loop learning and double-loop learning (Jashapara, 2003). *Single-loop learning* refers to a detection and correction of errors without scrutinizing the organizational basic premises and norms that had led to the divergence between the expected and the actual outcomes (Argyris and Schön, 1978). Single-loop learning occurs when errors are corrected without altering the underlying governing value (Argyris, 2002). *Double-loop learning* is attained when organizations detect and correct errors by inquiring into, and modifying if necessary, their underlying norms and assumptions (Argyris and Schön, 1978). The concept of Single-loop learning and double-loop learning is further illustrated in Figure 2.8.

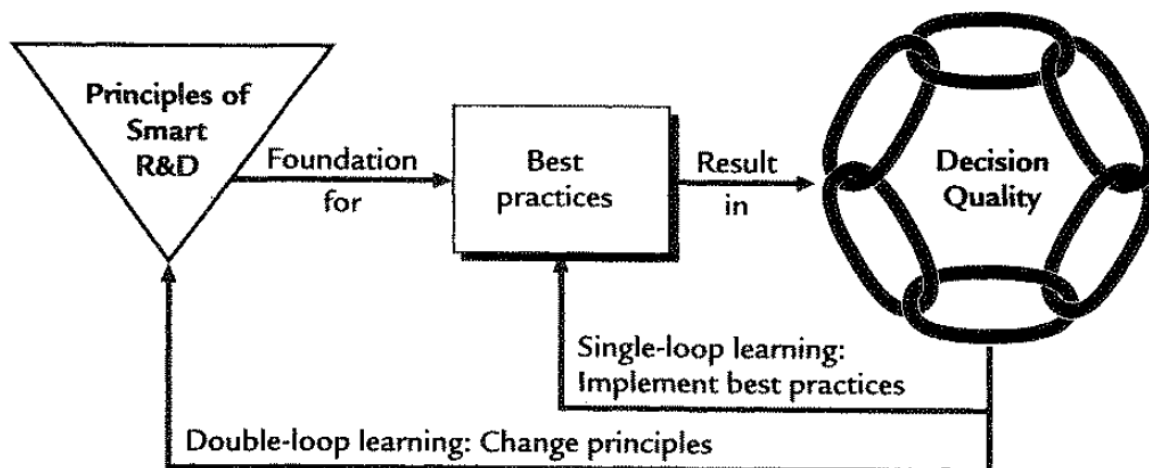


Figure 2. 8: Single- and Double- Loop Learning (Matheson and Matheson, 1998:106).

Contracting organizations often improve performance through detecting and correcting errors (i.e. practicing single-loop learning) and yet rarely look into the causes of these errors or identify the new behaviours needed to prevent reoccurrences (i.e. practicing double-loop learning). Despite supporting the contention that the practices of single-loop learning and double-loop learning are both imperative for performance improvement, practicing single-loop learning only is not sufficient for contracting organizations to sustain performance in response to the changes of market demands (Wong *et al.*, 2012).

Organizations rarely accept an operational change that does not fit their core values. Such organizations are often prone to limit themselves to acquiring knowledge that fits for achieving their pre-determined goals and pre-defined 'best performance'. Nevertheless, the organization's understanding about the client's requirements may no longer be valid when the market environment changes. Thus, if knowledge was processed under rigid sets of beliefs and core values, the possible improvement actions derived may have outlived their effectiveness to meet changing market demand (McGill and Slocum, 1993). With cumulative experience, organizations often develop a set of beliefs and routines in their operations (Akgün *et al.*, 2006). Performance change may become difficult if the required response to the environmental change clashes with their core values. As such, the rigidities of attitude formed in acquiring new knowledge hinder the organization's adaptation to changing conditions (Wong *et al.*, 2012).

The above studies found from the non-construction field collectively support the idea that organizational learning is not merely a detection and correction of errors system for attaining a pre-determined performance standard (Wong *et al.*, 2012). Instead, organizational learning involves a process of identifying and discarding obsolete beliefs and routines (Akgün *et al.*, 2006). Such processes are known as '*unlearning*' and emphasize that organizations may not learn effectively without first unlearning ideas from the past that are no longer relevant (Hedberg, 1981). It may be an uncomfortable process to unlearn those beliefs and routines that may have taken years to establish. In particular, the established beliefs and routines may have led the organizations to business success in the past and the organizations may also have invested a lot of effort in developing these routines (Akgün *et al.*, 2006; Mezas *et al.*, 2001). This reluctance may help to explain why the inability to unlearn has been highlighted as a critical weakness of many organizations (Akgün *et al.*, 2007a, b).

The barriers to effective knowledge management in a construction context have been discussed by several authors and these include lack of senior level support (Carrillo, 2004), the temporal nature of construction projects and teams leading to lack of continuity of staff and subsequent knowledge loss (Graham and Thomas, 2008), lack of standard processes between the different contracting organisations involved in

projects (Carrillo, 2004), and individuals' egos and reluctance to share knowledge due to defensive routines (Argyris, 1992). Time pressures are commonly referred to in the literature and this can sometimes be due to individuals being involved in multiple projects (Disterer, 2002; Senaratne and Sexton, 2008; Wiewiora *et al.*, 2009).

2.2.1 The architectural practices context

In today's business environments, organizations are faced with major challenges on a daily basis. For example making sense of conflicting priorities, allocating limited resources, understanding the impact of the organizations actions, comparing performance with competitors and responding to customer needs. Innovative ways are just some of the issues management has to address within the competitive environment. Balancing the effort of the organization to address these and the many other issues and challenges faced can be a daunting task, unless a systematic way is identified and followed (Nuland, 1999).

The architectural profession is an integral part of the construction industry's supply-chain, and some inefficiencies experienced by the construction industry are directly or indirectly influenced by poor management of the lessons learned processes in the architectural profession alike. The increased pressure on the construction industry to improve its practices, increased workload and demand for better quality, coupled with numerous problems facing the architectural profession, have forced architectural practices to reconsider its service delivery processes (Sidloyi, 2008). Allinson (1993:164) stated that "getting a project from A to B is dependent upon an inextricably bound union of design and management". Therefore contemporary architectural practice has a need to reconcile issues of management, design and professionalism. RIBA (2005) noted that the success of the architectural profession and its practitioners relied partly on their approach to the future as they are well placed to take advantage of future opportunities and emphasised the need to act proactively.

As stated in Gray and Hughes (2001:6) "*the rise of construction managers and then project managers as recognised disciplines in the construction process has accelerated the decline of the architects' role*". The above statement is substantiated by Cairns (1992:14) claiming that "*the architect has allowed, through lack of interest, and subsequently been forced through lack of knowledge, relinquished some of his roles in the fields of construction and project management to be assumed by others, losing control over their correct integration into the overall architectural process*". Another reason that the architect's role is being taken over by other professions is that the architects have failed to satisfy the clients due to their lack of knowledge of basic estimates and being unable to speak financial languages (Cairns, 1992).

The architectural profession is caught between accusations of gross managerial inefficiency and art-less aesthetic inadequacy (Sidloyi, 2008). It has been criticised and viewed as restrictively self-interested, economically marginal, and sometimes inexpert and frequently art-less (Allinson, 1993). What designers need to learn, and this is the most important thing, is the language of the business world. Only by learning that language can designers effectively voice the arguments for design (Gorb, 2003:2). Gorb's statement is substantiated by Allinson (1993:160) insisting that "*architects must learn the language and lessons of business*". Architects should, therefore avoid the implications that "*design is a wild card*" and that project management is "*misguided consultant-bashing by philistine*" (Allinson,1993). The architect needs to regain his role so that he can facilitate effective performance of the temporary and multi-organisational team" (Langford and Murray, 2004:23). Gorb (2003:12) further argues that designers are not there to design, but to run the business world.

Production in the architectural service provision context involves the delivery of design, management and procurement services, with associated documentation, for use before and during construction, and is therefore project-related. Project-related processes are commonly defined and outlined in procedural plans of work that are an attempt to standardise work processes around a typical project format and provide a framework from which progress can be measured and controlled (Munting and Cruywagen, 2008). The construction industry, in general, has witnessed serious efforts in the last few years through the consideration of the adoption of new procurement systems and production/manufacturing philosophies. However, process maps which can help organisations map their processes into some meaningful structure are still lacking (Aouad *et al.*, 1999). The product (building) is still the main focus in construction. In the manufacturing industry, most large organisations have process maps which can assist them in ensuring the delivery of products on time, within budget and to the right quality while capturing the best process practices. In construction, there had been some efforts to devise process maps such as the RIBA (Royal Institute of British Architects) Plan of Work in the UK (Aouad *et al.*, 1999). The British RIBA Plan of Work (RPW) shown in Figure 2.9 and the South African Institute of Architects (SAIA) Work stages shown in Figure 2.10 are widely recognised design management protocols in construction (Sidloyi, 2008).

2.2.2 Architectural Work Stages

Broadly, the practice of Architecture consists of the provision of professional services in connection with the design, construction, enlargement, conservation, restoration or alteration of a building and structure or group of buildings and group of structures (RSA, 2011a&b). These professional services include, but are not limited to, aspects of planning and land use planning, urban design, provision of preliminary studies, designs, models, drawings, specifications, technical documentation, coordination of technical documentation prepared by other built environment professionals (as appropriate and without limitation), contract administration, project managing, monitoring and quality inspections of construction (RSA, 2011a&b).

At an operational level, architectural work can be defined as the art and science of construction, comprising primarily the designing of physical interventions in the built environment- essentially buildings and their apparent open areas. This must be done in an aesthetically pleasing, socially responsible, environmentally sensitive, technologically appropriate, and professionally competent and ethical manner (RSA, 2011a&b).

The SAIA Work Stages still provides a valuable set of guidelines from which architects can develop a project and determine how their responsibilities fit into the work of others in the construction team. The Work Stages representing a logical sequence of events that should ensure that sound and timely decisions are made during the course of the project and it needs only slight adjustments depending upon the size and complexity of the project when acting as principal agent (including project management role to architectural duties) or when giving specialist services (RSA, 2011a&b).

Similarly, the RPW provides a valuable set of guidelines from which architects can develop a project and determine how their responsibilities fit into the work of others in the construction team (Cooper *et al.*, 2005:22). The RPW has 11 sequential steps representing a logical sequence of events that should ensure that sound and timely decisions are made during the course of the project. RIBA (2000) recommended that all decisions set out or implied, should be taken into account or be reviewed. RIBA (2005) suggested that the RPW needed only slight adjustments depending upon the size and complexity of the project.

Pre-design	A B
Design	C D E
Preparing to build	F G H
Construction	J K L



- | | |
|------------------------------|-----------------------------|
| Stage A: Inception | Stage B: Feasibility |
| Stage C: Outline proposals | Stage D: Scheme design |
| Stage E: Detail design | Stage F: Production info |
| Stage G: Bills of quantities | Stage H: Tender action |
| Stage J: Project planning | Stage K: Operations on site |
| Stage L: Completion | |

Figure 2. 9: RIBA Plan of Work (Cooper et al., 2005:21).

In both the RPW and the SAIA, the project progresses from inception to completion in a linear fashion, requiring the completion of one stage before proceeding to the next. This structure is, however, under attack from various authors such as Egan (1998) and Cooper *et al.* (2005). These authors argued that the construction process is not linear, architectural design process is iterative and they concluded that the RPW contributed to the problems of fragmentation and poor communication in the construction industry.

Architectural work is characterised by a sequential or staged flow of activities. In the South African context, this flow comprises 6 stages that feature prominently in project planning and apportionment of fees. They are (RSA. 2011a&b):

1. Inception
2. Concept and Viability
3. Design Development
4. Documentation and Procurement
5. Construction Contract Administration and
6. Close Out

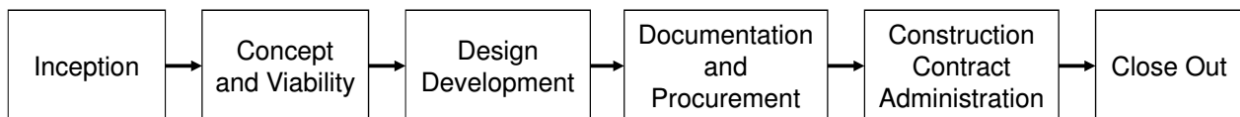


Figure 2. 10 : SAIA Architectural Work Stages (author).

It is significant that all architectural work, from the smallest and simplest, to the largest and most complex, can- and should- be managed according to this flow of work and its elemental stages. The standard architectural professional's scope of service and the architectural professional's functions and responsibilities in performing this service for each work stage along the flow of work trajectory are set out in Appendix A (RSA, 2011a&b).

2.3 Function Analysis System Technique: FAST

The field of creative problem solving is relatively new. In the cognitive science of creative problem solving, two types of contributions emerged over the last 60 years. One kind of contribution is to draw from certain basic paradigms of creative problem solving. Some notable authors and their contributions are (Bytheway, 2007):

- Genrikh Altshuller draws from a structural paradigm in which the method *TRIZ* (an acronym for the Russian term for Theory of Inventive Problem Solving) is developed.
- James L. Adams draws from a representational paradigm in the *rules of perception*.
- Edward de Bono draws a state transformation paradigm in developing *lateral thinking*.

There is another type of contribution that is just as important, which is to formalise these foundational ways of thinking into a representation and knowledge structure for the problem solving process. Charles Bytheway made such a contribution with the *Function Analysis System Technique*, commonly referred to as FAST (Bytheway, 2007).

FAST was invented during the Value Analysis (VA) and Value Engineering (VE) revolution of the 1960s. It is a rigorous method for understanding complex systems by converting the "activities" performed in a system to "functions" performed by the system for its customers. System Engineers and VA specialists use this method for product improvement, process improvement, systems design, and systems architecting. Its creation marks the completion of their formal information-gathering phase and defines the current state of a system at a high level. The basis for the 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 (Bytheway, 2007).

The value analysis management system is based on what is called function analysis. 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). Creative people look for opportunities to extend their imagination into areas where others have made assumptions or areas others have not considered or ventured into. Albert Einstein has been termed a conceptual inventor or genius. Einstein said *“Imagination is more important than knowledge”* and found that by exercising imagination, it is possible to extend imagination into unknown areas (Bytheway, 2007:1).

The fast approach breaks down function requirements into components, and it represents the logical relationships among them. Working with functions helps to break through the common psychological inertia that so commonly stifles creativity in problem solving.

The logic of functions requiring the combination of other functions is called conjunctive logic. Following FAST, there have been several discoveries of this same method that go under different names, such as function analysis, the Theory of Constraints, and the fishbone diagram (Bytheway, 2007).

2.3.1 FAST Diagram

A brief step by step methodology of creating a FAST diagram extracted from Bytheway’s (2007) book who is the creator of this technique is demonstrated subsequently in this section. The logic question involved in the FAST Creativity technique are self-stimulating. Each answer is used to formulate two new questions. Both of these questions stimulate thinking into higher levels of understanding and into other methods of performing the same task. Bytheway (2007) correlates these questions with an analogy of those questions asked by children to their parents as they grow up. Children always ask their parent “why” over and over again about everything. As soon as they get a simple answer, they would ask “why” again and again about something else. As they get older, they start to ask “how” do you do this and “how” do you do that, over and over again. It is easily understood, as they get older, they are able to completely understand the reason “why” the parents were doing something; they then wanted to know “how” to do it themselves.

This proven “Why-How Logic” is the focus of this creativity 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.

Naming Functions- Names are given to functions. The first word of the name is always an active verb and the last word of the name is always a noun. “Communicate lessons learned” is the name of a function, “communicate” being the active verb and “lessons learned” being the noun. The name given to a function describes what is to be accomplished without disclosing the method of accomplishment.

Discovering Functions- is accomplished by inserting each function name into the How Else Question and then creatively answer each question. The How Else Question reads as follows:

How else can ***this function*** be accomplished?

Discovering Basic Functions- Instead of guessing which function was the basic function, insert the function thought to be the basic function in the following question:

If I didn’t have to perform ***this function***, would I still have to perform any of the other functions listed?

The basic function is identified if the answer was no for all of the other functions listed. Not only the basic function is identified, but the function identified caused all of the other functions to come into existence.

With the basic function identified, it could be inserted into the How Else Question to search for other creative solutions. This is called the “Basic Function Determination Technique”.

Whenever any given function is selected from a list of functions that was not the basic function and then answered the question:

Why do I want to perform ***this function***?

Many times, a new higher level function also becomes the new basic function. The answer to this new Why Question causes the function inserted to come into existence. This new function is placed within a rectangle at the left of the function inserted, as shown in Figure 2.11. The next thing to ask is the question:

How is ***this function*** actually performed?

This answer could also be expressed as a single function or as several functions. These new functions are entirely dependent upon the function inserted into the How Question. Therefore, these new functions are considered to be lower level functions or dependent functions. Therefore, these new functions are considered to be lower level functions or dependent functions. These are placed to the right of the inserted function, as shown in Figure 2.11.

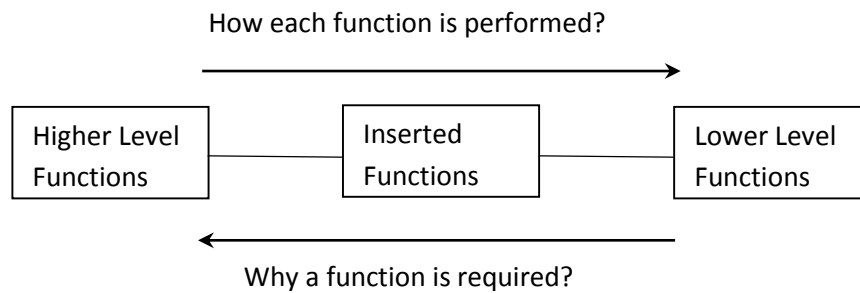


Figure 2. 11: Visually Displaying Higher and Lower Level Functions (Bytheway, 2007).

After this discovery, start to ask “why” and “how” of these new lower level functions to generate additional functions. This method of analysing functions is what is called Functional Analysis System Technique, which is better known by the acronym, FAST. The diagram used to show these relationships is called the FAST Diagram. This arrangement permits lines to be drawn between different functions, thereby showing how each function is related to other functions to the left or right of the function being considered. If you follow the line to the left of the function, it connects to the function that causes the function to “come into being.” If you follow the line to the right, it connects to those functions that describe the methods by which that function is accomplished in the present design or proposed design. 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).

2.3.2 Logic Diagrams and FAST Trees

When lots of functions are generated, the FAST Diagram method of creating a logic diagram becomes too cumbersome and too difficult to keep track of by thinking and where each function should be placed. Therefore, another method of creating a logic diagram called Functional Family Tree or in short FAST Tree is used which is also created by asking the Why-How Logic Questions, but the functions are typed into a word processing file. Each line is used to record only one function as shown in Appendix B, Figure B.12. This system allows the display to show how the logic ties the functions together and permits the diagram to expand vertically like a tree unlike a FAST Diagram which grows horizontally (Appendix B, Figure B.13) although both methods utilize the same concept (Bytheway, 2007).

2.4 Concluding remarks

If properly leveraged, lessons learned can be a primary vehicle for continuous improvement and effectively maturing a PMO (Boehringer, 2009). Few contracting organizations are able to systematically convert their lessons learned into improvement actions (Chan *et al.*, 2005). The transient nature of construction projects offers no guarantee of future dealing among team members and, consequently, contracting organizations thus often lack the necessary degree of proximity to derive learning from each other. They contended that the way of coupling organizations in construction projects can be one of the barriers of learning and thus organizational success (Love & Josephson, 2004).

Learning from feedback is vital for a contracting organization's performance improvement. Nevertheless, many project monitoring systems are not well designed to provide useful feedback in order to facilitate learning from mistakes (Ruuska and Vartiainen, 2005). Contracting organizations often improve performance through detecting and correcting errors (i.e. practicing single-loop learning) and yet rarely look into the causes of these errors or identify the new behaviours needed to prevent reoccurrences (i.e. practicing double-loop learning). Despite supporting the contention that the practices of single-loop learning and double-loop learning are both imperative for performance improvement, practicing single loop learning only is not sufficient for contracting organizations to sustain performance in response to the changes of market demands (Wong *et. al.*, 2012). Organizational learning is not merely a detection and correction of errors system for attaining a pre-determined performance standard (Wong *et. al.*, 2012). Instead, organizational learning involves a process of unlearning which is identifying and discarding obsolete beliefs and routines (Akgün *et al.*, 2006) and organizations may not learn effectively without first unlearning irrelevant ideas from the past (Hedberg, 1981).

In order for the architectural profession to regain the architects' role that has been relinquished to construction and project managers due to lack of interest, and subsequently been forced through lack of knowledge, it should be able to break the barriers of Organisational Learning in a systematic manner. To achieve this, architectural firms need to first unlearn ideas from the past that are no longer relevant and no longer valid in a changing market environment as their inability to unlearn has been highlighted their critical weakness. To sustain performance in response to the changes of market demands and as a means of strategic renewal, architectural firms should use the principles of both single-loop learning and double-loop learning to facilitate effective performance improvement of the temporary and multi-organisational team. Both systems are well designed to provide useful feedback in order to facilitate learning from mistakes at different levels as demonstrated on Appendix B, Figure B.14. Single-loop

learning or lower-level learning includes a continuous improvement of existing behaviour and a move towards a given goal. It refers to a detection and correction of errors without scrutinizing or altering the underlying governing value of the organizational basic premises and norms that had led to the divergence between the expected and the actual outcomes. Double loop or higher-level, however, questions the acceptability of the goals. It is attained when organizations detect and correct errors by inquiring into, and modifying if necessary, their underlying norms and assumptions (see Figure 2.8 and Figure B.14).

Based on the above ideals of the literature review on lessons learned and aided by the procedures of developing a FAST Diagram as suggested by Charles Bytheway (2007), a FAST Diagram for communicating lessons learned from an individual project to the wider organisation has been developed by the author as shown in Appendix B, Figure B.13. The FAST Diagram, using the Why-How Logic Questions, basically attempts to look into the root causes of project successes, failures or methods of improving future performance and this is similar to the objectives of double-loop learning which is illustrated in Appendix B, Figure B.14.

Out of the 11 steps Bytheway (2007) has suggested to be followed when developing a FAST Diagram, the eleventh step which is “Brainstorming Higher Level Functions”, will be discussed as part of the research and methodology in chapters 3 and 4. To complete the process of creating a FAST Diagram, individual effort has to be supported and enriched by the input of other groups. Hence, a team of four or five people is generally selected to participate in this activity (Bytheway, 2007).

Chapter 3: Research Methodology

The goal of scientific research is to discover laws and postulate theories that can explain natural or social phenomena, or in other words, build scientific knowledge. Given that *theories* and *observations* are the two pillars of science, scientific research operates at two levels: a theoretical level and an empirical level. The **theoretical level** is concerned with developing abstract concepts about a natural or social phenomenon and relationships between those concepts (i.e., build “theories”), while the **empirical level** is concerned with testing the theoretical concepts and relationships to see how well they reflect our observations of reality, with the goal of ultimately building better theories (Bhattacharjee, 2012).

Depending on a researcher’s training and interest, scientific inquiry may take one of two possible forms: inductive or deductive. In **inductive research**, the goal of a researcher is to infer theoretical concepts and patterns from observed data. In **deductive research**, the goal of the researcher is to test concepts and patterns known from theory using new empirical data. Hence, inductive research is also called *theory-building research*, and deductive research is *theory-testing research* (Bhattacharjee, 2012:3).

Punch (2006) stresses that the design and methods of the research report must contain clear statements concerning the generic and procedural strategy. Whether the strategy is quantitative or qualitative, the research must be described procedurally, as well as generically. Generically concerns the explanation of the strategy in general terms, i.e. identifying a suitable research method— for example, *case study*, *ethnography*, or *survey*. However, this is only part of what is required. It is furthermore essential to describe the design and method identified in the general strategy, procedurally, i.e. what are the specific steps taken to execute the general research strategy (Punch, 2006)?

3.1 General research strategy

The literature indicated two types of data, namely *quantitative* and *qualitative* data. Both types of data can be useful for *descriptive, investigative, exploratory, inductive, opening up* purposes. Moreover, they can be practically utilised for *explanatory, confirmatory, hypothesis testing* purposes. The careful measurement, generalisation of samples, experimental control, and statistical tools of good quantitative studies are valuable assets. 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).

Qualitative data are attractive. They are a source of well-grounded, rich descriptions and explanations of processes occurring in local contexts. With qualitative data one can preserve the chronological flow, assess local causality, and derive fruitful explanations. They help researchers go beyond initial preconceptions and frameworks. Finally, the findings from qualitative studies have a quality of “undeniability,” (Smith, 1983).

The most common sources of qualitative data include interviews, observations, and documents (Patton, 2002), none of which can be “crunched” easily by statistical software (Miles and Huberman, 1994). The goal of qualitative data analysis is to uncover emerging themes, patterns, concepts, insights, and understandings (Patton, 2002). Qualitative studies often use an analytic framework—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).

Qualitative methodology is not completely precise, because human beings do not always act logically or predictably. Investigators in qualitative inquiry turn to the human participants for guidance, control and direction throughout the research. Structure and order are, of course, important for the research to be scientific. The social world, however, is not orderly or systematic; therefore it is all the more important that the researcher proceeds in a well-structured and systematic way (Smith, 1983).

One of the most significant challenges for students of qualitative methods is the potentially overwhelming array of inquiry approaches in the interdisciplinary literature (Ponterotto and Grieger, 2007). Great care must be taken to find a suitable research method that will best complement a specific study without the confusion relating to the overlapping of method boundaries where a conditional approach with a basic categorization scheme is suggested. Conditions that determine when to use which method are (a) the type of research question posed, (b) the extent of control an investigator has over actual behavioural events, and (c) the degree of focus on contemporary as opposed to historical events. The five major research methods are *experiments*, *surveys*, *archival analyses*, *histories*, and *case studies*. A basic categorization scheme for the form of research questions as “who”, “what”, “where”, “how”, and “why” questions are used to determine what type of method is eminent (Yin, 2009).

Depending on the purpose of research, scientific research projects can be grouped into three types: exploratory, descriptive, and explanatory (Bhattacharjee, 2012:5-6). **Exploratory research** is often conducted in new areas of inquiry, where the goals of the research are: (1) to scope out the magnitude or extent of a particular phenomenon, problem, or behaviour, (2) to generate some initial

ideas (or “hunches”) about that phenomenon, or (3) to test the feasibility of undertaking a more extensive study regarding that phenomenon (Bhattacharjee, 2012:6).

Descriptive research is directed at making careful observations and detailed documentation of a phenomenon of interest. These observations must be based on the scientific method (i.e., must be replicable, precise, and so on.), and therefore, are more reliable than casual observations by untrained people. **Explanatory research** seeks explanations of observed phenomena, problems, or behaviours. While descriptive research examines the *what, where, and when* of a phenomenon, explanatory research seeks answers to *why* and *how* types of questions. It attempts to “connect the dots” in research, by identifying causal factors and outcomes of the target phenomenon (Bhattacharjee, 2012:6).

Given the fact that the research question relates to determining means of transferring lessons learned from individual projects to the wider organisation and that the FAST Diagram was created on the basis of the Why-How Logic Question, from Yin (2009) and Bhattacharjee (2012), it leads one to think that the type of research method to be used is of an explanatory nature. Recalling the essence of the research question at hand: how else can this function be performed or accomplished? Clearly, this is a research case of explanatory nature (“how” questions), and thus focuses this research to explain a specific phenomenon. This study will, thus, make use of an explanatory brainstorming session to verify the concept, and a pilot study or better known as focus group research with reflective learning approach as a general research strategy, as opposed to a case study approach.

3.2 Sampling

As explained in the background to the study, the author, concerned by the lack of transferring lessons learned from individual projects to the wider organisation in the architectural company the author works for, prepared a project closure template that included a lessons learned section and presented it to the management of the company. The author, further, populated the document template using information of a pilot project that the author is currently involved in based on experiences gained during the project’s life cycle reflecting all the architectural work stages. After referring to literature reviews such as Rowe (2008), the author conducted a few lessons learned sessions with the core team members of the project that are still available and distributed it to those members who are no longer working with the company for their input so that it could be rolled out companywide for all projects and be used by every project leader in the office. The team members were too busy to spend time on such an exercise where they do

not see the immediate value of it and it was too cumbersome to read the document. The document template was not well received in the office.

The author then started this research to find out if there is a better way of transferring lessons learned from individual projects to the wider organisation such as through graphical methods. Inspired by articles read on 'Lessons Learned' and after discussing the challenges of the industry with the supervisor, the author then, concluded it was better to base the research on tangible projects challenging the daily lives of architects rather than one based on data collected through Survey Monkey or other similar web based methods. The author, thus, started this research to find out if there is a better way of transferring lessons learned from individual projects to the wider organisation such as through graphical methods.

The study, thus involved an architectural company in Cape Town, South Africa where one of its largest teams is busy completing the biggest project in the office named in this research as Project 'X' to keep confidentiality of the report. The sample, however, comprises of not only project team members but also a combination of company directors, future similar project team leader and members, as well as existing and new staff members. Participants were carefully selected for relevance purposes and hence, *purpose sampling* which include company directors, senior architects, project leaders and technologists. More meaningful comparisons, contrasts and discussions can be drawn from real projects with their challenges than from having randomly selected subjects.

3.3 Procedural research strategy

Qualitative data analysis is defined as consisting of three concurrent flows of activity: data reduction, data display, and conclusion drawing/verification (Miles and Huberman, 1994). These flows together comprise the procedural research strategy of this study. The thinking is that data will be collected from a sample group, using specific data collection instrumentation, and continually sharpened, sorted, focused, discarded, and organised. The latter is implemented continually after the brainstorming session and the workshop are completed, until the final report is completed. Once the data is collected, the data will be compressed in an assembly of information that permits conclusion drawing from an organised display. Data displays range from types of matrices to graphs and charts. From the data display, conclusions can be drawn and tested (Miles and Huberman, 1994).

Qualitative data analysis is explained as an interactive model where the three types of analysis activity and the activity of data collection itself form an interactive cyclical process as shown in Figure 3.1. The procedural research strategy will be discussed on the former basis – the interrelated nature of the analysis activities is made explicit within the instrumentation utilised (Miles and Huberman, 1994). The brainstorming session design and instrumentation of the workshop on the focus group will be discussed, as well as the sample profile and the final analysis of the data collected.

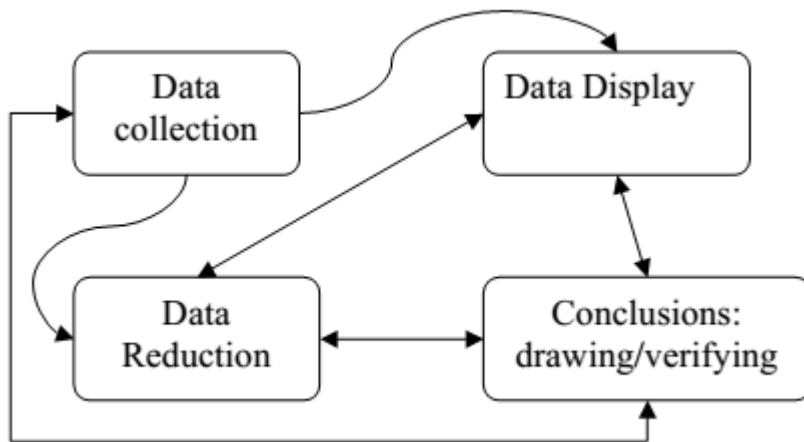


Figure 3. 1: Components of Data Analysis: Interactive Model (Miles and Huberman, 1984).

3.4 Method of data collection

Instrumentation comprises of specific methods for collecting data. These methods can focus on qualitative or quantitative organised information, and may be loosely or too tightly structured. Planning is important if there is prior knowledge about the data to be collected. If instrumentations are not structured, redundant information will be collected. Subsequently, an overload of data will compromise the efficiency and power of the analysis (Miles and Huberman, 1994).

The use of instruments that were used in prior studies is preferred, seeing that this allows for conversing across studies. There is a need for common instruments to build theory, to improve explanations or predictions, and to make recommendations about practice. A biased or uninformed researcher will ask partial questions, take selective notes, make unreliable observations, and skew information. To ensure that data is valid and reliable, validated instruments are essential for generating dependable and meaningful findings (Miles and Huberman, 1994).

One of the first decisions in any social science research is the unit **of analysis** of a scientific study. The unit of analysis refers to the person, collective, or object that is the target of the investigation. Typical unit of analysis include individuals, groups, organizations, countries, technologies, objects, and such (Bhattacharjee, 2012:9). The unit of analysis will be two groups where one group will look at the Lessons Learned FAST Diagram (Appendix C3) created initially from the same Project Closure Report for Project 'X' by first generating a Tree Diagram presented in Appendix C2 and the second group will study the Lessons Learned Report within the Project Closure Report for Project 'X' (Appendix C1) and they will be tested on their comprehension of what they have been presented with using the questions in Appendix G so that a comparison of the two groups can be performed. This test will help yield results that can be analysed in a quantitative fashion.

Although research can be exploratory, descriptive, or explanatory, most scientific research tend to be of the explanatory type in that they search for potential explanations of observed natural or social phenomena. Explanations require development of **concepts** or generalizable properties or characteristics associated with objects, events, or people. While objects such as a person, a firm, or a car are not concepts, their specific characteristics or behaviour such as a person's attitude toward immigrants, a firm's capacity for innovation, and a car's weight can be viewed as concepts (Bhattacharjee, 2012:10).

Concepts may also have progressive levels of abstraction. Some concepts such as a person's *weight* are precise and objective, while other concepts such as a person's *personality* may be more abstract and difficult to visualize. A **construct** is an abstract concept that is specifically chosen (or "created") to explain a given phenomenon. A construct may be a simple concept, such as a person's weight, or a combination of a set of related concepts such as *a person's communication skill*, which may consist of several underlying concepts such as the person's vocabulary, syntax, and spelling. The former instance (weight) is a **unidimensional construct**, while the latter (*communication skill*) is a **multi-dimensional construct** (i.e., it consists of multiple underlying concepts). The distinction between constructs and concepts are clearer in multi-dimensional constructs, where the higher order abstraction is called a construct and the lower order abstractions are called concepts. However, this distinction tends to blur in the case of unidimensional constructs (Bhattacharjee, 2012:10-11). In this case, the proposed FAST Diagram in Appendix B, Figure B.14 is the multi-dimensional construct associated with lessons learned.

Some of the popular research designs include (Bhattacharjee, 2012:38-40):

1. **Experimental studies** are those that are intended to test cause-effect relationships (hypotheses) in a tightly controlled setting by separating the cause from the effect in time, administering the cause to one group of subjects (the “treatment group”) but not to another group (“control group”), and observing how the mean effects vary between subjects in these two groups.
2. **Field surveys** are non-experimental designs that do not control for or manipulate independent variables or treatments, but measure these variables and test their effects using statistical methods. Field surveys capture snapshots of practices, beliefs, or situations from a random sample of subjects in field settings through a survey questionnaire or less frequently, through a structured interview.
3. **Secondary data analysis** is an analysis of data that has previously been collected and tabulated by other sources.
4. **Case research** is an in-depth investigation of a problem in one or more real-life settings (case sites) over an extended period of time. Data may be collected using a combination of interviews, personal observations, and internal or external documents. Analysis tends to be qualitative in nature, but heavily contextualized and nuanced. However, interpretation of findings may depend on the observational and integrative ability of the researcher, lack of control may make it difficult to establish causality, and findings from a single case site may not be readily generalized to other case sites. Generalizability can be improved by replicating and comparing the analysis in other case sites in a **multiple case design**.
5. **Focus group research** is a type of research that involves bringing in a small group of subjects (typically 6 to 10 people) at one location, and having them discuss a phenomenon of interest for a period of 1.5 to 2 hours. The discussion is moderated and led by a trained facilitator, who sets the agenda and poses an initial set of questions for participants, makes sure that ideas and experiences of all participants are represented, and attempts to build a holistic understanding of the problem situation based on participants’ comments and experiences. Internal validity cannot be established due to lack of controls and the findings may not be generalized to other settings because of small sample size. Hence, focus groups are not generally used for explanatory or descriptive research, but are more suited for exploratory research.
6. **Action research** assumes that complex social phenomena are best understood by introducing interventions or “actions” into those phenomena and observing the effects of those actions. In this method, the researcher is usually a consultant or an organizational member embedded within

a social context such as an organization, who initiates an action such as new organizational procedures or new technologies, in response to a real problem such as declining profitability or operational bottlenecks. The researcher's choice of actions must be based on theory, which should explain why and how such actions may cause the desired change. The researcher then observes the results of that action, modifying it as necessary, while simultaneously learning from the action and generating theoretical insights about the target problem and interventions. The initial theory is validated by the extent to which the chosen action successfully solves the target problem. Simultaneous problem solving and insight generation is the central feature that distinguishes action research from all other research methods, and hence, action research is an excellent method for bridging research and practice. This method is also suited for studying unique social problems that cannot be replicated outside that context, but it is also subject to researcher bias and subjectivity, and the generalizability of findings is often restricted to the context where the study was conducted.

7. **Ethnography** is an interpretive research design inspired by anthropology that emphasizes that research phenomenon must be studied within the context of its culture. The researcher is deeply immersed in a certain culture over an extended period of time (8 months to 2 years), and during that period, engages, observes, and records the daily life of the studied culture, and theorizes about the evolution and behaviours in that culture.

Single case studies is appropriate under three circumstances (Yin, 2009). First, when it represents a *critical case* in testing a well-formulated theory). Second, when the case represents an *extreme or unique case* such as those situations in clinical psychology. The third type is the *revelatory case* where an investigator has an opportunity to observe and analyse a phenomenon previously inaccessible to scientific investigation (Yin, 2009). This study, as a single case study is more of a revelatory case than the critical or extreme cases as it aims to reveal a way of graphically communicating lessons learned which used to disappear in repositories or data bases.

Generally speaking, researchers tend to select those research designs that they are most comfortable with and feel most competent to handle, but ideally, the choice should depend on the nature of the research phenomenon being studied. In the preliminary phases of research, when the research problem is unclear and the researcher wants to scope out the nature and extent of a certain research problem, a focus group (for individual unit of analysis) or a case study (for organizational unit of analysis) is an ideal strategy for exploratory research. Looking further into the research domain, one finds that

there are no good theories to explain the phenomenon of interest and wants to build a theory to fill in the unmet gap in that area, interpretive designs such as case research or ethnography may be useful designs. If competing theories exist and the researcher wishes to test these different theories or integrate them into a larger theory, positivist designs such as experimental design, survey research, or secondary data analysis are more appropriate (Bhattacharjee, 2012:38-41).

Regardless of the specific research design chosen, the researcher should strive to collect quantitative and qualitative data using a combination of techniques such as questionnaires, interviews, observations, documents, or secondary data. For instance, even in a highly structured survey questionnaire, intended to collect quantitative data, the researcher may leave some room for a few open-ended questions to collect qualitative data that may generate unexpected insights not otherwise available from structured quantitative data alone. Likewise, while case research employ mostly face-to-face interviews to collect most qualitative data, the potential and value of collecting quantitative data should not be ignored (Bhattacharjee, 2012:38-41).

Consequently, for the purpose of this study, the collection instrument is comprised of **focus group research** as the unit of analysis is already identified to be focus groups and will be utilised to determine the management of lessons learned within architectural firms.

Given the emphasis on the use of prior instrumentation (Miles and Huberman, 1994) to ensure dependable data, the key elements to identify the high level issues organisations need to address to improve the dissemination of lessons learned will be determined, firstly, by using the FAST Diagram proposed by the author as a guiding instrument. Then, a selected group of 8 to 10 professionals drawn from within an architectural firm will participate in the brainstorming session, with the proposed FAST diagram and the thinking principles developed by Bytheway (2007) as foundation, to adopt, modify or completely change the proposed FAST model when disseminating lessons learned within the firm. The goal is to complete the process of building a FAST Diagram as the literature suggested using this information as a baseline to further develop and fine tune the FAST Diagram from the brainstorming session while educating the group on the process of creating a FAST Diagram using the Why-How Logic Question. The final diagram would also serve as a benchmark for future researchers in any field to further investigate and develop a generalised lessons learned FAST Diagram.

Secondly, the group would be split into two groups of 4 to 5 people where one group will study the Project Closure Report in Appendix C1 with special focus on the Lessons Learned part. The second group will be

given the Lessons Learned FAST Diagram (Appendix C3) created initially from the same Project Closure Report in Appendix C1 for Project 'X' by first generating a Tree Diagram presented in Appendix C2. Both groups would be given 30 minutes each as per time table set out in Appendix E to study the document and the FAST Diagram respectively. Then they will be tested on their comprehension of what they have been presented with using the questions in Appendix G so that a comparison of the two groups can be performed. This test will help yield results that can be analysed in a quantitative fashion. This way, one can determine whether *the use of graphical methods such as FAST Diagrams provide a means of communicating lessons learned from one project to the wider organisation is more effective than traditional reports.*

In summary, the work of Bytheway (2007) was used as a guideline to construct the research instrumentation for the brainstorming session. A Project Closure Report template and Lessons Learned FAST Diagram developed by the researcher as well as guidelines proposed by Bhattacharjee (2012) was used as a guideline to construct the research instrumentation for the focus group research.

3.5 Brainstorming session design

Based on the work of Bytheway (2007), the eleventh and final step of developing a FAST Diagram is brainstorming the higher level functions of the primary path functions as discussed in the literature review. This step begins by inserting the highest level function into the following How Else Question (Bytheway, 2007):

How else can ***this function*** be performed or accomplished?

As this question is answered, a participant needs to be objective about the project and list every idea that might perform the function inserted into this question. This activity is called ***brainstorming the function***. Brainstorming is very effective when applied to a function because a function tells the analyst what needs to be accomplished without identifying the method of accomplishment. A team of four or five people is generally selected to participate in this activity (Bytheway, 2007).

To ensure the principles of data triangulation, the proposed FAST Diagram was to be brainstormed by two more sessions. One session was to comprise selected participants from the partners/management and production staff (including core team members of the chosen project) to verify or modify the proposed FAST Diagram. The second session was to comprise the core team members of the chosen project to

complete the unfinished template based on the developed FAST Diagram by constantly guiding them to incorporate the six Architectural Work Stages presented in the literature review.

During the first session, all participating staff were to first be informed on the necessity of the research, the importance of lessons learned in organisational learning as well as on the basic principles of developing a FAST Diagram and on how the Why-How Logic work. This was to be followed by an open and facilitated brainstorming session with each encouraged to assume playing different roles.

The ground rules and concepts for performing brainstorming as recorded in Figure 3.2 (Bytheway, 2007), were to be reviewed before starting a brainstorming session and made visible at all times using an overhead projector.

1. Every idea or suggestion is to be recorded.
2. No criticizing of anyone else's ideas or suggestion is allowed. As a reminder of this rule everyone should be advised to write "I will not criticize!" on a full sheet of paper and then crumple the paper and put it in their pocket or keep it in one hand while the brainstorming session is taking place.
3. Divorce yourself from the present project.
4. Play different roles as you think of the function.
5. Ignore what you have experienced or learned in school.
6. Present silly or ridiculous ways of doing things.
7. Disregard standards and traditions.
8. Hitchhiking on other ideas is allowed.
9. Improvements to ideas presented are encouraged.
10. Omit anyone from your group who might be intimidating, if possible.
11. Consider how physical and life sciences would perform the function.
12. Consider primitive and mass-production methods.

Figure 3. 2: Group Rules for Brainstorming (Bytheway, 2007).

The proposed FAST Diagram was to be displayed on a large paper format (A0) and all input from the brainstorming session were to be added on it.

The first question to always ask is about the basic function:

Q: How else can **enhance Organisational Learning** be performed or accomplished?

This and other questions were to be answered by the brainstorming participating team.

Once a list of ideas and concepts has been creatively developed and documented, the next task is to creatively modify each item in the list, if at all possible, so it can successfully perform the function being investigated. Those that look promising are developed further and then evaluated to see if they can be used to develop a better concept than the concept conveyed by the completed logic diagram. In some cases, it may be desirable to develop an entirely new logic diagram to explore a new concept. Other times, alternate methods of performing a given function within an existing logic diagram may be considered or added to the diagram (Bytheway, 2007).

Chapter 4: Research Findings and Data Analysis

As already described, the data analysis is an iterative and ongoing process requiring validation and legitimation (Miles and Huberman, 1994). The analysis section commences with a brief overview of the sample participants, and a summary profile of their positions in the architectural firm. Table 4.1 summarises a participation rate of 80% who successfully completed brainstorming session of the entire group followed by focus group research by splitting them into two groups. Although this is a relatively small sample from which to generalise findings, this number does fit within the guidelines established by Eisenhardt (1989:545), who recommends a sample of between 4 and 10 for in-depth qualitative case studies, Bhattacharjee (2012:40), who suggests a sample of between 6 and 10 for in one location for focus group research as well a team of 4 or 5 as suggested by Bytheway (2007:68) for brainstorming the function.

Position of Participants	Targeted Number	Number of Participants
Partners/ Directors	2	2
Team/ Project Leaders	2	2
Team/ Project Members	2	1
Existing Staff Members	2	1
New Staff Members	2	2
Total	10	8

Table 4.1: Response Rate of Participants

The first 30 minutes were used to educate all the participants together on the importance of the research, the concept of how a FAST Diagram is created using the How-Why-Logic Question and then allowing them to give their input in modifying the proposed diagram in the form of a brainstorming session for 15 minutes. They have adopted the proposed diagram after asking a few questions on the difference between a few terms used on the diagram.

The participants were then split into two groups of four with each participant representing a position in the firm as shown on Table 4.2. Through tossing of a coin, Group A studied the Project Closure Report for Project 'X' in Appendix C1 with special focus on the Lessons Learned part. Group B was given the Lessons

Learned FAST Diagram in Appendix C3 created initially from the same Project Closure Report for Project 'X' by first generating a Tree Diagram presented in Appendix C2. The Lessons Learned FAST Diagram for Project 'X' is however, more detailed than the Project Closure Report as a result of the How-Why Logic Questions that had to be answered in order to complete the diagram meaningfully.

Group (A or B) Code	Position in organisation and Involvement in project	Age Range in years				Years of Experience			
		20-30	30-40	40-50	>50	<5	5-10	10-15	>15
A1	Partner in charge of current project				1				1
A2	Team Leader- Future similar Project			1					1
A3	Project member	1					1		
A4	New/ Junior staff	1				1			
A5	Staff member- absent		1				1		
Group A Total		2	1	1	1	1	2		2
B1	Partner				1				1
B2	Team Leader- Current Project				1				1
B3	Staff member			1					1
B4	New/ Junior staff	1				1			
B5	Project member- absent				1				1
Group B Total		1		1	3	1			4
A+B		3	1	2	4	2	2		6

Table 4.2: Group Allocation and Position of Participants

Both groups were given about 45 minutes each to study the document and the FAST Diagram respectively. Group A (the Project Closure Report group) managed to finish studying the report and jotted down some key points as a summary of their understanding. Group A, then were tested on their comprehension of what they have been presented using the pertinent group and individual questions presented in Appendices G, H and I within about 30 minutes time span.

Group B-the Lessons Learned FAST Diagram group- however, only managed to discuss half way through the contents of the diagram within the allocated time of 45 minutes. The reason for their delay was that they were caught in discussions of the logic of the processes of the architectural work stages rather than looking at the diagram as a logic of functions. The researcher has to constantly assist them refocus on trying to understand the diagram and its contents rather than the logic of the processes. The group was so interested in the contents of the diagram and they decided to continue and finish it the next day. The following day, they finalised their discussions within 30 minutes and answered the pertinent questions in a similar way as Group A did.

Summary and record of answers to group comprehension questions

Following in Table 4.3 includes a notion of the answers, each focus group managed to answer during the comprehension test given to them as presented in Appendix G regarding their understanding of the successes, weaknesses and recommendations from Project 'X'.

Remarks from Group "A" - Project Closure Report group			
Work Stage	Identify success factors in Project 'X':	Identify weakness in Project 'X':	Give recommendations for future projects:
1	<ul style="list-style-type: none"> - Use of precedent study and information from the Client used for a good kick start of the project. 	<ul style="list-style-type: none"> - Client's continuously changing requirements caused delays and was not managed effectively. 	<ul style="list-style-type: none"> - Sign standard contract document which is not subjected to interpretations. - Obtain clear Client Brief.
2	<ul style="list-style-type: none"> - Research on current design trends, the spatial diagrams generated, effective modelling of lab equipment on ArchiCAD and early preparation of written specification. 	<ul style="list-style-type: none"> - 2D/ 3D integration with MEP consultants. 	<ul style="list-style-type: none"> - If at all possible, work with consultants who use BIM software for ease of coordination of services. - Conduct proper materials research.
3	<ul style="list-style-type: none"> - Cost saving through use of light weight walls and early involvement of suppliers to specify proper materials. 	<ul style="list-style-type: none"> - Client changing requirements after design commence well in the project. 	<ul style="list-style-type: none"> - Minimize hand drawings. - Resolve services clashes early. - Designers should use 3D software. - Use Change Request forms appropriately.
4	<ul style="list-style-type: none"> - Early interaction with Council for smooth approval process. - Digital colouring of council drawings to track changes. - Effective use of Room Data Drawings. - Architects' own initiative on services reticulation coordination. 	<ul style="list-style-type: none"> - Unclear PM deadlines. - Detail Sections not completed in time for Tender and Construction lead contractor to influence construction process. 	<ul style="list-style-type: none"> - Use energy efficiency calculating software built in BIM. - Up skill staff computer literacy. - Use generic specifications.
5	<ul style="list-style-type: none"> - Room mock-ups. - Use of sample walls and finishes to control quality. 	<ul style="list-style-type: none"> - Level 5 late addition was managed poorly and seriously delayed the project which was initially well within budget and ahead of schedule. 	<ul style="list-style-type: none"> - Use advantage of 3D modelling over 2D and hand drawings such as for generating all sorts of schedules.
6	<ul style="list-style-type: none"> - Successful system in place for tracking information such as PD Server (FTP Server). - Staff interrogation of the Lessons Learned exercise. 	<ul style="list-style-type: none"> - Ensuring profitability - Controlling factors that were beyond our authority. 	<ul style="list-style-type: none"> - Staff members to stay consistent from inception to completion. - Proper project handover and archiving procedures to be followed.

Table 4.3: Remarks from Group "A" - Project Closure Report Group

Remarks from Group "B" - FAST Diagram group			
Work Stage	Identify success factors in Project 'X':	Identify weakness in Project 'X':	Give recommendations for future projects:
1	- Newly built building served as good precedent to model the research.	- Contractors not involved with fellow consultants from the start. - Brief from the Client's side was not sufficient.	- Contract with other consultants to be properly scrutinised. - Get finality on the Project Brief.
2	- Comprehensive Stage 2 report helped fix cost. - Well-developed functional diagrams.	- Insufficient brief impacted on concept design.	- Involve contractor (review procurement method). - Compile comprehensive project specification as part of Stage 2 report.
3	- BIM helped to produce very good three dimensional understanding of project 'X'.	- Insufficient brief unpacked in design development made services coordination problematic.	- Consultants must use BIM for services coordination.
4	- Council approval went smooth.	- Our own use of BIM still problematic.	- Conduct proper internal training to members on BIM.
5	- Client impressed with level of finishes at Practical Completion.	- Lack of detail resolution from Stage 4.	- Ensure greater detail resolution in Stage 4.
6	- Model kept updated to easily produce 'As Built' drawings.	- Too drawn out- financial implications.	- Ensure fee adjustment potential for extension of this stage.

Table 4.4: Remarks from Group "B" - FAST Diagram Group

From Tables 4.3 and 4.4 and an observation of the groups as they answer when populating the tables, it became clear that Group "A" - Project Closure Report group- has put more diverse comprehensive lessons than Group "B" - FAST Diagram group- due to the fact that they populated the table immediately after they read the report and they were jotting down key points as they discussed the document. Group "B", however, populated the table on the second day and they were not taking any notes to that effect. The level of interaction and passion of the discussion was more on the FAST Diagram team as was easily witnessed by the amount of time it took them to go through the contents of the diagram.

Summary and record of answers to individual objective questions

Below are tables showing summary of the degree to which each participant agrees to the objective statements posed in Appendix H regarding their understanding of the Project Closure Report and the Lessons Learned FAST Diagram generated from Project 'X'.

Remarks from individuals of Group "A"- Project Closure Report group						
Five point Likert scale, Strongly Disagree= 1; Disagree= 2; Neutral=3; Agree=4; Strongly Agree=5						
No.	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	I find it easy to understand the contents of the template (Project Closure Report).			A2	A1, A3, A4	
2	I recommend each team should read the Project Closure Report first before starting a new project of similar nature or complexity.			A3	A1	A2, A4

Table 4.5: Remarks from individuals of Group "A" on the Project Closure Report showing their group codes

From Table 4.5, it is evident that people who participated in the project from all positions found the Project Closure Report, as would be expected, easy to understand than the rest of the staff members. Surprisingly enough, non-project members, however, strongly agree that team members should read Project Closure Reports of projects before commencing on a new project of similar nature.

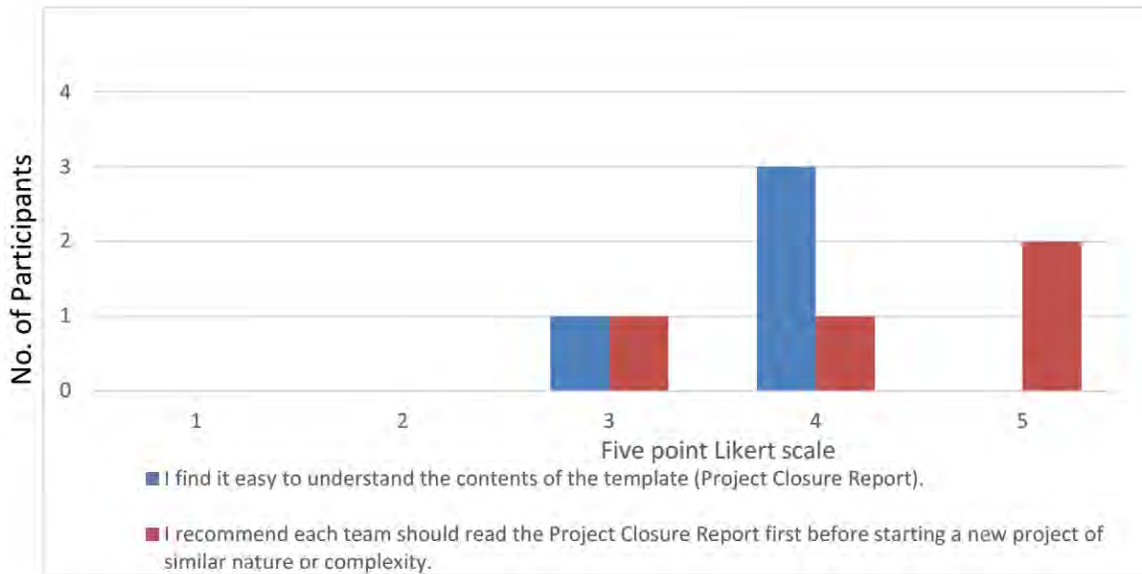
The train of thought present in the former relates to the fact that we all have cognitive frames that let us clump things rapidly. Clustering is a tactic that can be applied at many levels to qualitative data: at the level of events or acts, of individual actors, of processes, of settings/locales, of sites or cases as wholes. In all instances, there is an effort to understand a phenomenon better by grouping and then conceptualising objects that have similar patterns or characteristics (Miles and Huberman, 1994).

After the data collected from the focus group research is ordered within the conceptually clustered matrix, descriptive statistics were used to summarise the data within Microsoft Office Excel.

Statement	Unit	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I find it easy to understand the contents of the template (Project Closure Report).	#	0	0	1	3	0
	%	0	0	25	75	0
I recommend each team should read the Project Closure Report first before starting a new project of similar nature or complexity.	#	0	0	1	1	2
	%	0	0	25	25	50

Five point Likert scale, Strongly Disagree= 1; Disagree= 2; Neutral=3; Agree=4; Strongly Agree=5

Table 4.6: Remarks from individuals of Group “A” on the Project Closure Report showing numerical values and percentages.



Five point Likert scale, Strongly Disagree= 1; Disagree= 2; Neutral=3; Agree=4; Strongly Agree=5

Figure 4.1: Graph of responses to statements from Group “A” on Project Closure Report

Similarly Table 4.6 and the graph in Figure 4.1 show that 75 percent of the participants agree that the Project Closure report is easy to understand, and the same percentage also agreed that team members should read Project Closure Reports of projects before commencing on a new project of similar nature of those 50 percent strongly agree in this regard.

Remarks from individuals of Group “B”- Lessons Learned FAST Diagram group						
Five point Likert scale, Strongly Disagree= 1; Disagree= 2; Neutral=3; Agree=4; Strongly Agree=5						
No.	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	I find it easy to understand the contents of the Lessons Learned FAST Diagram for Project X.			B4	B1, B2, B3	
2	I recommend each team should review the Lessons Learned FAST Diagram first before starting a new project of similar nature or complexity.				B1, B4, B3	B2

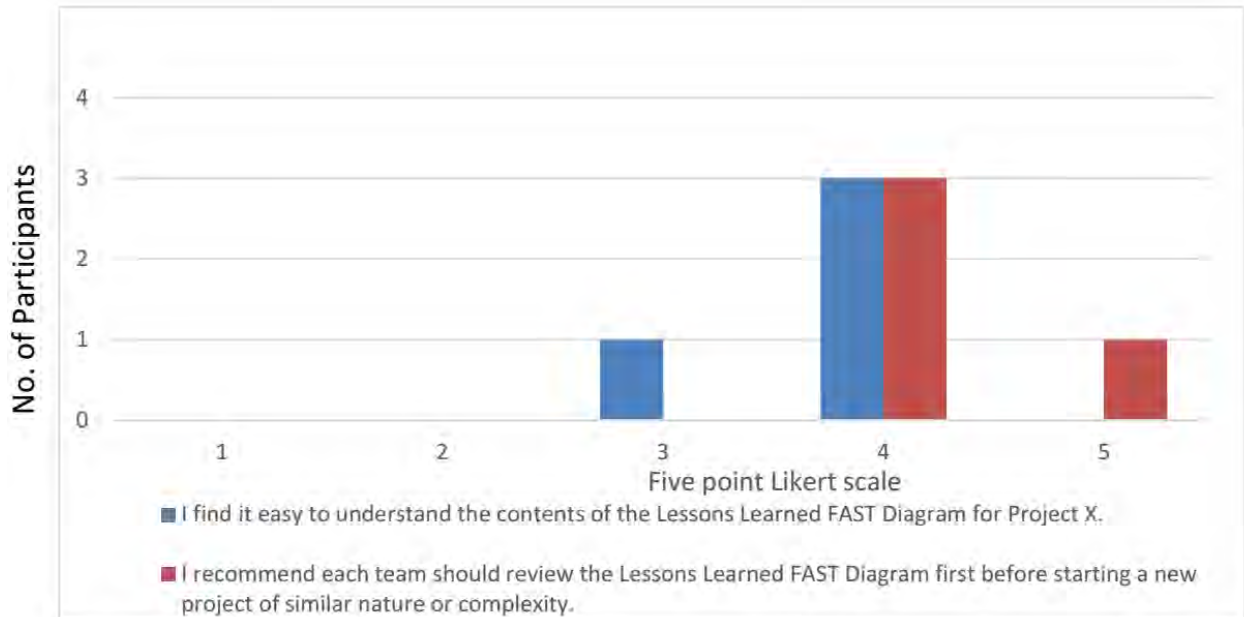
Table 4.7: Remarks from individuals of Group “B” on the Lessons Learned FAST Diagram showing their group codes

From Table 4.7, it is again clear that all participants of Group B, except the new staff member who remained undecided, agree that they found the Lessons Learned FAST Diagram easy to understand. Once again, all of them agree that team members should read Lessons Learned FAST Diagram of projects before commencing on a new project of similar nature. The current project leader strongly agree with this notion.

Statement	Unit	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I find it easy to understand the contents of the Lessons Learned FAST Diagram for Project X.	#	0	0	1	3	0
	%	0	0	25	75	0
I recommend each team should review the Lessons Learned FAST Diagram first before starting a new project of similar nature or complexity.	#	0	0	0	3	1
	%	0	0	0	75	25

Five point Likert scale, Strongly Disagree= 1; Disagree= 2; Neutral=3; Agree=4; Strongly Agree=5

Table 4.8 : Remarks from individuals of Group “B” on the Lessons Learned FAST Diagram showing numerical values and percentages.



Five point Likert scale, Strongly Disagree= 1; Disagree= 2; Neutral=3; Agree=4; Strongly Agree=5

Figure 4.2: Graph of responses to statements from Group “B” on Lessons Learned FAST Diagram

Percentage wise, Table 4.8 and the graph in Figure 4.2 show that 75 percent of the participants agree that the Lessons Learned FAST Diagram is easy to understand, while all of them agree that team members should read Lessons Learned FAST Diagrams of projects before commencing on a new project of similar nature of those 25 percent strongly agree with this statement.

Remarks from every individual participant						
Five point Likert scale, Strongly Disagree= 1; Disagree= 2; Neutral=3; Agree=4; Strongly Agree=5						
No.	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Lessons Learned report should be compiled at the end of every stage			A1, A4, B4	A2, A3, B2	B1, B3
2	Lessons Learned report should only be compiled at the end of the project as part of the Project Closure Report.		A2, B1, B2 , B3	A1, A4, A3	B4	
3	I recommend the Lessons Learned FAST Diagram than a Project Closure Report document as a means of communicating Lessons Learned from an individual Project to the wider organisation.			A2, B3, B4	A1, A3, A4, B1, B2	
4	I recommend the Project Closure Report document than a Lessons Learned FAST Diagram as a means of communicating Lessons Learned from an individual Project to the wider organisation.		B1	A1, A3, B2, B3	A2, A4	B4

Table 4.9: Remarks from every individual participant

The following observations could be drawn from Table 4.9 which includes response from all participants:

1. The partner in charge on the current project and the two new staff members remained undecided on whether Lessons Learned report should be compiled at the end of every stage or not. The two project leaders and a project member agreed with the idea and the second partner together with one staff member strongly agreed with the statement.

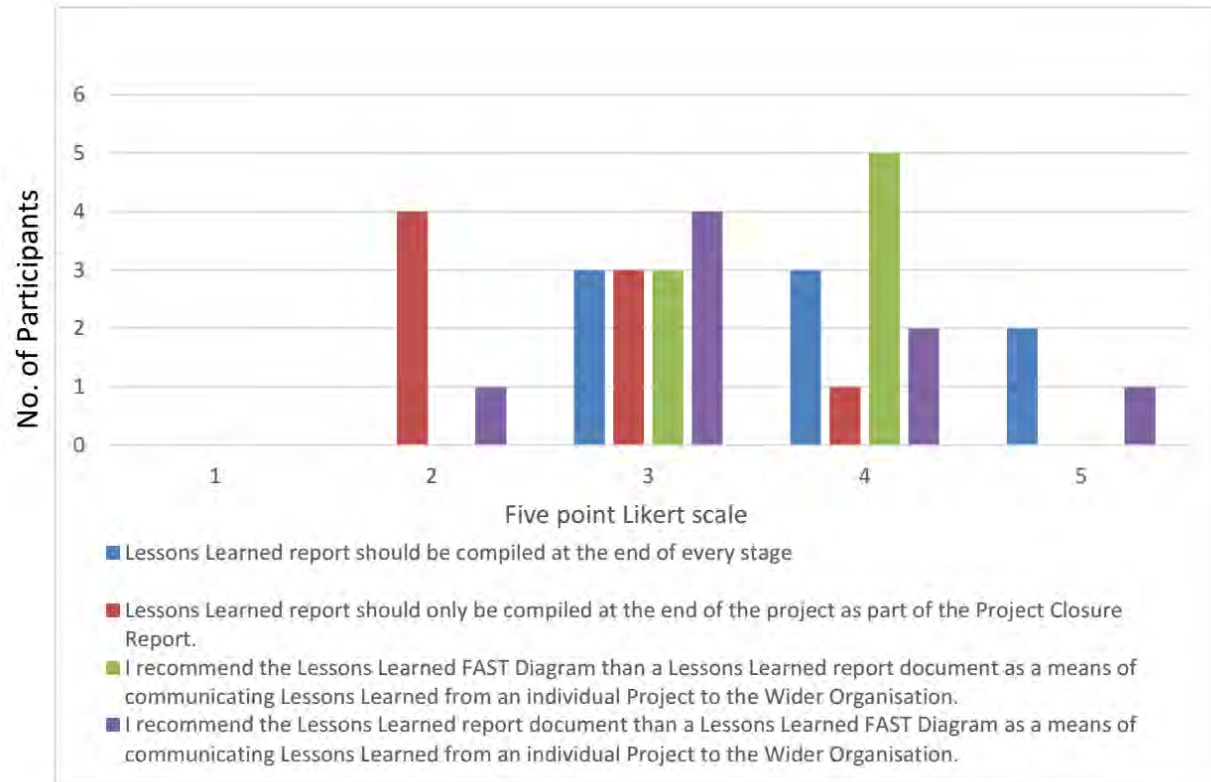
2. Defending their stance with the first statement, the two project leaders and the second partner together with the staff member who strongly agreed to statement number one all disagreed with the idea that Lessons Learned report should only be compiled at the end of the project as part of the Project Closure Report. Once again, the partner in charge and one of the new staff members maintained their neutrality. The other new staff member agreed to this statement while the project member, A3, seemed not to be understanding both opposing statements as the participant agreed with both statements, but when asked again to clarify as part of the data verification process, participant A3 decided to remain neutral.
3. With the exception of the future project leader and two relatively new staff members who remain undecided, all other participants recommended Lessons Learned FAST Diagram than a Project Closure Report document as a means of communicating Lessons Learned from an individual Project to the wider organisation.
4. Most of the participants were not sure whether to recommend the Project Closure Report document than a Lessons Learned FAST Diagram as a means of communicating Lessons Learned from an individual Project to the wider organisation. The partner who was leading the discussion of the FAST diagram disagreed with this statement and on the contrary, the new staff member who was in the same group strongly agreed with this statement.

Remarks from individuals of Group "B"- Lessons Learned FAST Diagram group

Statement	Unit	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Lessons Learned report should be compiled at the end of every stage	#	0	0	3	3	2
	%	0	0	37.5	37.5	25
Lessons Learned report should only be compiled at the end of the project as part of the Project Closure Report.	#	0	4	3	1	0
	%	0	50	37.5	12.5	0
I recommend the Lessons Learned FAST Diagram than a Lessons Learned report document as a means of communicating Lessons Learned from an individual Project to the wider organisation.	#	0	0	3	5	0
	%	0	0	37.5	62.5	0
I recommend the Lessons Learned report document than a Lessons Learned FAST Diagram as a means of communicating Lessons Learned from an individual Project to the wider organisation.	#	0	1	4	2	1
	%	0	12.5	50	25	12.5

Five point Likert scale, Strongly Disagree= 1; Disagree= 2; Neutral=3; Agree=4; Strongly Agree=5

Table 4.10: Remarks from every individual participant showing numerical values and percentages.



Five point Likert scale, Strongly Disagree= 1; Disagree= 2; Neutral=3; Agree=4; Strongly Agree=5

Figure 4.3: Graph of responses to statements from every individual participant

Table 4.10 and the graph in Figure 4.3 also show that:

1. More than 30 percent of the participants remained undecided on whether Lessons Learned report should be compiled at the end of every stage or not. The same percentage also agreed with the idea and the remaining 25 percent strongly agreed with the idea.
2. 50 percent of the participants disagreed with the idea that Lessons Learned report should only be compiled at the end of the project as part of the Project Closure Report. 25 percent remain undecided while another 25 percent agreed to this statement.
3. More than 30 percent of the participants recommended Lessons Learned FAST Diagram than a Project Closure Report document as a means of communicating Lessons Learned from an individual Project to the wider organisation. While 25 percent remained undecided.
4. Again, 50 percent of the participants were not sure to recommend the Project Closure Report document than a Lessons Learned FAST Diagram as a means of communicating Lessons Learned from an individual Project to the wider organisation. Whereas 25 percent disagreed with this statement and the rest were equally on either ends of the scale.

Five point Likert scale, Strongly Disagree= 1; Disagree= 2; Neutral=3; Agree=4; Strongly Agree=5

Participant ID	Category	Group Code	Q1. LL @ every stage	Q2. LL @ project end only	Q3. Prefer FAST Diagram	Q4. Prefer Project Closure Report
1	Group A	A1	3	3	4	3
2		A2	4	2	3	4
3		A3	4	3	4	3
4		A4	3	3	4	4
5	Group B	B1	5	2	4	2
6		B2	4	2	4	3
7		B3	5	2	3	3
8		B4	3	4	3	5

Table 4.11: Raw data of remarks from every individual participant

	Median	Mode	Range	Inter-quartile Range
Q1. LL @ every stage	4	3	2	1.75
Q2. LL @ project end only	2.5	2	2	1
Q3. Prefer FAST Diagram	4	4	1	1
Q4. Prefer Project Closure Report	3	3	3	1

Table 4.12: Descriptive Statistics of remarks from every individual participant

The measures of central location, especially the median in Table 4.12, show that the group whose responses are presented in Table 4.11 agreed to statements 1 and 3 which advocates lessons learned sessions should be conducted at the end of every work stage and the preference of FAST Diagram over the project closure report. From the measures of spread, the inter-quartile range for the three statements is 1. This shows the reliability of the responses that the group has close consensus towards the statements except to statement 1 which shows slight spread.

	Median		Mode		Range		Inter-quartile Range	
	Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B
Q1. LL @ every stage	3.5	4.5	3	5	1	2	1	1.75
Q2. LL @ project end only	3	2	3	2	1	2	0.75	1.5
Q3. Prefer FAST Diagram	4	3.5	4	4	1	1	0.75	1
Q4. Prefer Project Closure Report	3.5	3	3	3	1	3	1	2.25

Table 4.13: Descriptive Statistics of remarks from every group

Table 4.13 shows further statistical analysis between the two groups. Group B strongly agreed with statement 1 and then with statement 3 while the reverse was true with Group A. From the inter-quartile range, Group A's response are more reliable with the biggest range of only 1 while Group B's showed a bigger difference on their level of agreement to the statements with the smallest being regarding their agreement with using FAST Diagram while showing biggest differences regarding preference of the Project Closure Report.

Summary and record of answers to individual subjective questions

Below are a notion of the answers, each participant answered to the general subjective questions listed in Appendix H regarding the Project Closure Report template and the Lessons Learned FAST Diagram from Project 'X'.

1. Would you apply the Project Closure Report in your project? What else would you add to or remove from the template?

Partners:

A1 : At the beginning in detail; thereafter as a checklist or reminder.

: Add items that might be relevant to the way forward. This would depend on specific needs and objectives.

B1 : Yes.

: Stage 0- dealing with appointments and contractual arrangement with the Client and other consultants (also at what stage contractor should be brought on board).

Project Leaders:

A2 : Yes, I would.

: Add a section about items beyond our control such as bankruptcy of main contractor.

B2 : I would.

Project Members:

A3 : Yes.

: Not sure yet.

Staff Members:

B3 : Yes.

: I would add components to the work stages, so easy to comment on.

New/ Junior Staff:

A4 : Yes, with some formatting.

: Add sub-headings such positives 1. Stage 1,
1.1 materials,
1.2 Clients, and so on...

B4 : Yes.

: It benefits me as a new member of staff, it gives me an idea of what to look out for. But, I think in each project, there will be challenges and not all are necessarily the same. So in each section, there should be a brief description of how to avoid the problem by referring to the template during the entire life cycle of the project.

Previously, this architectural firm did not have any formal template for Project Closure Reports, hence, it is a new idea to all participants with all responding they would use the Project Closure Report in their projects. The second part of the question has made respondents to utter out challenges that the construction industry is facing such as how to manage scope creep, how to manage a situation when

contractors go bankrupt, how to unlearn the old tactics of contracts management that only allows contractors to get involved after tender process but rather from the beginning so that informed decisions are made during the design rather than redesigning during construction.

2. Would you consider using the Lessons Learned FAST Diagram to disseminate lessons learned within the organisation? Do you make use of any other means such as other graphical methods to disseminate lessons learned from one project to the wider organisation?

Partners:

A1 : Yes, we would as a basis for further discussion.
: Other graphical methods- yes, if necessary.

B1 : Yes.
: I do not make use of any graphical methods since I have not done it before.

Project Leaders:

A2 : Yes, I would consider using the FAST Diagram.
: I use a mind-map to link bulleted word ideas to represent a concept or idea.

B2 : I would consider using the FAST Diagram within the organization.
: No, I do not use any other method.

Project Members:

A3 : Yes.

Staff Members:

B3 : Yes, I would consider using the FAST Diagram.
: I do not make use of any other means.

New/ Junior Staff:

A4 : I would.
: In fact, it should be displayed in the organization as a constant standard to uphold.

B4 : Yes.
: FAST would give a good general overview of each project and it would be good if it is included in the staff manual so that new staff would know how to tackle their problems using the diagram as a tool.

All respondents are keen to use the Lessons Learned FAST Diagram in their projects and it was even suggested that it should be displayed in the organisation as a standard to uphold. Almost all of them have not used such diagrams before and even those who claimed they did, it was presentation diagrams and not functional diagrams.

Record of answers to individual Contact Summary questions

Below are a notion of the answers, each participant answered to the contact summary questions listed in Appendix I regarding their experiences during the focus group research contact time.

1. What were the main issues or themes that struck you most in this contact?

Partners:

- A1** : Client liaison and agreements.
- : Use of BIM software.
- : Timeous resolution of activities and specifications.
- : Coordination of services.

B1 : The use of BIM (or lack of use thereof).

Project Leaders:

A2 : Feedback is vitally important to any project's success. One can only learn from one's mistakes and successes. These should be discussed by the team at close out of each stage.

B2 : The fact that there was a clear structure that guided the process.

Project Members:

A3 : Important to highlight shortcomings of old/ current projects to avoid/ improve on new projects.

Staff Members:

B3 : This is a system to convey Lessons Learned in a more legible manner.

New/ Junior Staff:

A4 : The session sparks debate. Both the document template and the FAST Diagram got people thinking. The diagram, particularly, got a lot of the participants to interact.

B4 : Yes.

: I believe for people who worked on Project 'X', it was easy to identify what the lessons were and for me, I learnt a lot about the project's successes and weaknesses. So it was beneficial.

Broadly looking at the experience of the participants from the focus group workshop, the partners stressed the need to efficiently use available technology such as BIM. Team leaders highlighted the importance of feedback and how a properly defined structure such as the FAST Diagram could contribute in creating such a loop. The rest of the participants expressed their appreciation of the FAST Diagram in communicating lessons learned from one project to the wider organisation.

2. Summarise the fundamental objectives that were made clear during the contact session

Partners:

- A1** : Clear process needs to be agreed on and followed.
 - : Need to work together and stick to deadlines.
 - : Use of technology to save time and make decisions.
 - : Work as a team and see the project through to the end.
 - : Keep a consistent team throughout the project life cycle.
 - : Keep decision making with Client very structured.

- B1** : There is a need for ongoing assessment of project performance and capturing of where things were problematic and how they can be improved.

Project Leaders:

- A2** : Planning for future actions is vital in the success of every project. Outcomes need to be identified early and ways of achieving those outcomes need to be mapped out early in the process. The evolution of a project needs to be systematically managed and documented.

- B2** : The session and the process aimed to arrive at a tangible/ measurable end product.

Project Members:

- A3** : Get all information from participating staff on a project for successful hand over so that the project does not suffer from loss of organizational memory.

Staff Members:

- B3** : FAST Diagram is a good system to convey Lessons Learned in a more legible manner.

New/ Junior Staff:

- A4** : To determine whether the document or the FAST Diagram is a more effective way of communicating lessons learned.

- B4** : Finding the weaknesses in the project and how it got fixed so that we do not repeat the same mistakes in the next project.

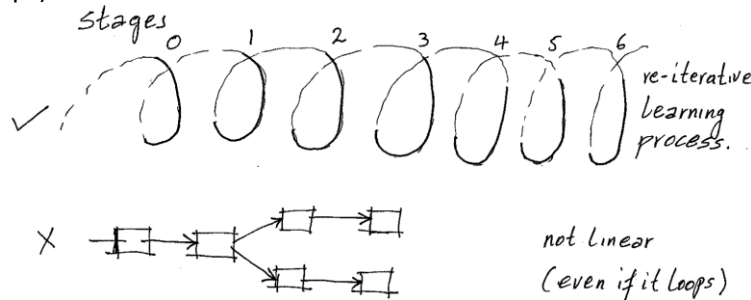
The more experienced members got the point as they focussed on what has transpired from the contact session while the juniors deviated a little and went to explain rather what the fundamental objective of the contact session was.

3. **Anything else that struck you as salient, interesting, illuminating or important in this contact?**

Partners:

A1 : The need on the consultant team to work on the same platform. In this case BIM software.
: Process of generating a Lessons Learned FAST Diagram has been completed and lessons learned are captured. How do you follow through and ensure that recommendations are implemented.
: The importance of institutional memory, administrative organization, and teamwork.

B1 : How BIM is used differently at different stages of the project. It is a re-iterative learning process and not linear (even if it loops).



Project Leaders:

A2 : Planning is everything when working as a team to reach an objective.

B2 : The whole process is so logical yet we tend to move from one project to the other without meaningful reflection.

Project Members:

A3 : Enjoyed the breakdown diagrams as they guide you step by step.

Staff Members:

B3 : FAST Diagram is a good system to convey Lessons Learned in a more legible manner.

New/ Junior Staff:

A4 : diagrams are an important factor for encouraging debate. More workshop sessions should be encouraged in the work environment.

B4 : The fact that such small things impacted the project in such a big manner.

By the end of the session, the group started to speak the language of Project Management such as organisational memory, importance of planning and feedback (single-loop and double-loop learning). The need to use BIM efficiently and the usefulness of diagrams in conveying lessons learned were once more emphasised.

Chapter 5: Conclusions and Recommendations

5.1 Conclusions

This paper proposed the FAST Diagram thinking principles as foundation, to disseminate lessons learned within an organisation through the use of graphical methods from one project to the wider organisation. To achieve this objective, a Lessons Learned FAST Diagram was developed based on literature review using the WHY-HOW Logic Questions developed by Bytheway (2007).

To test the application of the diagram on a real project, a project with an architectural firm was taken as a pilot project where the team members were lacking the motivation to compile a project closure report with a lessons learned component at the end of the project. The firm identified documenting lessons learned from each completed project and then picking up trends to adjust its strategic objectives and thus decided to use the report from this key project in the office as a pilot project and to use the outcome as a template for all other projects. Despite such objectives, the project members were reluctant to prepare such a report which they were engaged for more than three years without documenting any lessons during the project work stages.

The researcher who was a member of the project team facilitated meetings with team members, circulated draft template via email to all team members who were no longer with the company for their input and finally presented it to all team leaders and company directors. This process took several months. The researcher then developed a FAST Diagram from the project closure template, chose two representative groups of architects from different positions within the firm. After educating them on how a FAST Diagram is created and brainstorming the FAST Diagram model developed from the literature review with them, one group was given the project closure template document and the second studied the lessons learned FAST Diagram developed from it.

This research thus sought to focus on the implicit lessons learned dissemination processes being undertaken in professional architectural firms, and it became a prudent step to explore-how best practice techniques and standards can be implemented in an architectural firm at the end of each architectural work stage during the life cycle of a project (single-loop learning) and then feeding the cumulative lessons learned back to the wider organisation to change its principles (double-loop learning). This was done on a pilot project through a process of reflective learning with a focus research group. Such learning objectives are thus best achieved by displaying the lessons learned in the form of FAST Diagrams which

could be displayed at prominent spaces within the company so that they can be used as tools of interaction and knowledge sharing within the organisation.

From the level of interaction shown by the participants, their responses to both the objective and subjective questions posed to them as well as their adoption of the proposed Lessons Learned FAST Diagram, the research has confidently proven that graphical methods and especially FAST diagrams can effectively be used to communicate lessons learned from one project to the wider organisation.

5.2 Recommendations

The literature study overview in this report has conferred on the need for the systematic retention of project experiences that enables a company to compare its various projects more systematically and document its most effective problem solving mechanisms. In addition, the systematic documentation of mishaps, mistakes or potential pitfalls helps to reduce project risks. From a long term perspective, systematic project learning enables the enterprise to develop project competencies that lead to a sustainable competitive advantage (Schindler and Eppler, 2003).

Personal interaction is necessary for transferring tacit knowledge, i.e., knowledge that is difficult to put into written words or even pictures—and that often exists only in people’s heads and is sometimes hard to articulate. Much of the knowledge required to manage and conduct a project is *tacit*, which means it cannot be adequately retained or transferred via databases, documents, reports, or checklists. Tacit knowledge requires different means for capture, retention, and transfer; two are after-action reviews (AARs) and peer consulting. After-Action Reviews apply to intact teams doing somewhat repetitive projects (Nicholas and Steyn, 2008). This is similar to the statement supported by the participants that lessons learned sessions should be conducted at the end of every work stage similar to a stage-gate approach in production management.

What about project teams just starting out and where most everything about the project is new—the technology, geographic location, culture, and so on? Likely the knowledge needed exists somewhere in the organization, but the challenge is to connect the people who have the knowledge (providers) with those who need it (receivers), and then enable them to personally interact— one on one- Peer Consulting (Nicholas and Steyn, 2008). This method, however, would be better represented in the form of a FAST

Diagram safeguarding or at least minimising loss of institutional memory or organisational knowledge should knowledge providers no longer be with the organisation.

Learning, has to be managed together with the project and must be integrated into project management as standard practice (Ayas, K., 1996). The question that remains to be answered is how this can be achieved consistently. Discipline is one of the key ingredients of successful project learning. Discipline can be fostered through three ways. First, by enforcing project debriefings in all relevant project guidelines and policies. Second, by training or educating project members about the importance of systematic debriefings. And third, by encouraging project managers to lead by example and make project debriefings a strategic priority (Schindler and Eppler, 2003).

In the South African context, knowledge management is still in its infancy in the construction industry and structured knowledge management processes have not yet been adequately deployed in contracting organisations including the architectural discipline. It is often best to choose carefully, pilot and, implement a small change, rather than a large change to PMO processes. This allows the corporation to absorb and buy into the PMO processes. It is important not to be a project and process purist at the expense of changes proposed never getting adopted. It is important to always remember it is through relationships and each individual adopting a change that a PMO will move forward. Conversely, team dynamics are a powerful force that if not managed correctly, can make or break processes. When changes are successfully managed, process improvement by process improvement, organisations will mature their PMOs (Boehringer, 2009).

The management of project insights also requires significant improvements with regard to the format, process, and use of lessons learned. Various formats, process steps, and usage scenarios exist that can enable project-centred learning in a company such as the Project Closure Report template and the Lessons Learned FAST Diagram discussed in this research. Without the management's leadership, however, these methods remain ineffective (Schindler and Eppler, 2003). Most lessons learned programs fail because they simply do not generate value. It is not a matter of compiling lessons but the ability to turn them into tangible business actions by creating/ modifying procedures, policies, standards, and so on. The research process has by itself proven that bringing lessons to life is not a simple issue since time and resources are required. Some lessons may demand further attention than others. So organisations should carefully identify risk factors and plan. Organisations must not forget to measure impact as well. The most effective lessons learned programs are not those that end up registering hundreds of lessons. Efficiency is

demonstrated by the number of lessons that turn into tangible business results and FAST Diagram is an essential tool in realising that.

5.3 Further areas of study

The proposed Lessons Learned FAST Diagram would serve as a benchmark for future researchers in any field to further investigate and develop a generalised lessons learned FAST Diagram. They should either update, modify or simplify the proposed model. The model should also be tested on a number of projects to make sure it is applicable to any other given project. It needs to be validated in another architectural firm as well.

Future research should also look at the contribution of lessons learned towards achieving organisational maturity and what contribution can graphical methods such as FAST Diagrams make to achieve a desired level of organisational maturity. This can be done by finding out at what level of maturity architectural companies (local or national level) are when gauged using one of such models such as Capability Maturity Model (CMM), Organizational Project Management Maturity Model (OPM3), and so on. This can be achieved further by focussing on the following areas: (1) assess the current state of lessons learned program in architectural practices in Cape Town or South Africa in general; (2) establish a vision for the lessons learned program such using tools such as a FAST Diagram; and (3) define a process for how the organisation will reach the vision such as making it part of organisational strategic objectives to get ISO 9001 Certification.

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Appendices

Appendix A: Standard Architectural Work Stages

STAGE 1: INCEPTION

- Assist in developing a clear projects brief
- Advise on the procurement policy for the project
- Advise on rights, constraints, consent and approvals
- Advise on other consultants and services required
- Assist in defining the consultant's scope of work and services
- Determine availability of data and, drawings and plans relating to the project
- Provide necessary information within the agreed scope of project to the other consultants
- Assist in developing a project programme

STAGE 2: CONCEPT & VIABILITY

- Agree the documentation programme
- Prepare concept design based on the client's brief
- Consult with other consultants and incorporate their input
- Discuss design concept with local authorities
- Clarify and confirm the project space norms to optimise functional and operational efficiency in terms of scale and relationships of areas
- Co-ordinate design and cost interfaces with other consultants
- Select general construction materials and intended finishes
- Prepare and submit the site development plan to the local authority for approval where applicable
- Liaise, co-operate and provide necessary information to the client, and other consultants
- Review anticipated costs of the project
- Review project programme

STAGE 3: DESIGN DEVELOPMENT

- Review the documentation programme with the other consultants

- Incorporate the client's detailed requirements into building design
- Incorporate and co-ordinate the other consultants' designs into building design
- Liaise, co-operate and provide necessary information to the client, and other consultants
- Obtain detailed project specific requirements of the local authority in order to ensure understanding thereof.
- Prepare design development drawings (including draft technical details) and outline specifications
- Provide sufficient drawings and information to the quantity surveyor for the completion of detailed estimates of construction cost where applicable.
- Review the design, costing and programme with the other consultants
- Confirm the scope and complexity
- Review the design and consult with local and statutory authorities
- Develop the design, construction system, material and components
- Incorporate all services and the work of consultants.

STAGE 4: DOCUMENTATION & PROCUREMENT

- Obtain client's authority to prepare and submit drawings to local authority for approval
- Prepare specifications for the works and agree preambles with the quantity surveyor when applicable
- Co-ordinate services and prepare necessary services co-ordination drawings
- Review cost estimate with the quantity surveyor
- Provide working drawings
- Liaise, co-operate and provide necessary information to the other consultants
- Complete construction documentation and proceed to call for tenders:
- Obtain the client's authority to prepare documents to procure offers for the execution of the works
- Obtain offers for the execution of the works
- Evaluate offers and recommend on the award of the building contract
- Prepare the contract documentation (and arrange the signing of the building contract).

STAGE 5: CONSTRUCTION CONTRACT ADMINISTRATION

- Contract administration
- Hand over the site to the contractor
- Issue construction documentation
- Initiate and/ or check sub-contract design and documentation as appropriate
- Inspect the works for conformity to the contact documentation
- Administer and perform the duties and obligations assigned to the principal agent
- Receive, comment and approve interim payment valuations
- Witness and review all tests and mock-ups carried out both on and off site
- Check and approve subcontract shop drawings for design intent
- Update and issue the drawing register
- Issue contract instructions
- Review and comment on operations and maintenance manuals, guarantees, certificates and warranties
- Inspect the works and Issue the practical completion and defects lists
- Assist in obtaining statutory certificates.

STAGE 6: CLOSE OUT

- Inspect and verify rectification of defects
- Receive, comment and approve relevant payment valuations and completion certificates
- Prepare and/ or procure operations and maintenance manuals, guarantees and warranties
- Prepare and/ or procure as-built drawings and documentation
- Issue the works completion certificate

(RSA, 2011a&b).

Appendix B: Lessons Learned and FAST Diagram

In order to demonstrate how to construct a logic diagram in the form of a FAST Tree and then convert the FAST Tree into FAST Diagram, Bytheway (2007) has suggested 11 steps that should be followed and these FAST procedure are used to create a FAST Diagram for lessons learned as shown at the end of the process.

Step 1. Selecting a Project

This step is about selecting a *subject* or *project* to analyse. Bytheway (2007) presented five different methods of accomplishing this step. The five methods of selecting a project are listed in Figure B.1 and their details are given as methods in Figures B.2- B.4.

Method 1	Write down any subject, object, part, assembly, product, procedure, or process that you can describe or itemize.
Method 2	Write one, two, or three sentences about your project.
Method 3	Whenever a team is assigned to analyse a product or a piece of equipment which is normally sold to a customer, client, or consumer, answer the six questions for Method 3 (Figure B.2).
Method 4	When you do not have a clue what to select as a project, answer one or more of the 15 questions listed for Method 4 (Figure B.3). Then, within those answers, formulate one or more projects.
Method 5	Whenever a problem exists, answer the four questions for Method 5 (Figure B.4). Then, from the information contained within those answers, formulate a project.

Figure B. 1: Methods of selecting projects (Bytheway, 2007).

Q 1	What product or piece of equipment have you been assigned to analyse?
Q 2	What is the main purpose for which this product has been built or assembled?
Q 3	How can this product be made so that it is more dependable?
Q 4	How can this product be made so it is more convenient to use?
Q 5	How can this product be improved?
Q 6	How can this product be made so it is more pleasing to the five senses?

Figure B. 2: Questions for Method 3 (Bytheway, 2007).

Q 1	What wears out, breaks, or changes?
Q 2	Is anything out of proportion or too complicated?
Q 3	How are personnel affected?
Q 4	How are inventories affected?
Q 5	How are sales affected?
Q 6	What is the sequence of events or objectives?
Q 7	Is there any activity that is continually repeated?
Q 8	Is there any activity that is distasteful or messy?
Q 9	What information is needed to prevent activity repeats?
Q 10	Are special processes or operations required?
Q 11	Are special tools or equipment required?
Q 12	Is time or money lost?
Q 13	What are the requirements?
Q 14	What are the desired functions?
Q 15	What is the consequence of not solving the issues?

Figure B. 3: Questions for Method 4 (Bytheway, 2007).

Q 1	What problem shall we discuss?
Q 2	Why do you think this is a problem?
Q 3	Why do you think this a solution is needed?
Q 4	What is there about this problem that disturbs you?

Figure B. 4: Questions for Method 5 (Bytheway, 2007).

Using the questions of method five for lessons learned, the questions and possible answers for the project of lessons learned would be as follows:

1. What problem shall we discuss?
Answer: systemic conversion of lessons learned into improvement actions
2. Why do you think this is a problem?
Answer: lessons learned compiled in repositories are either never accessed or are not easily accessible causing same mistakes getting repeated over and over again in projects stagnating organisational maturity.
3. Why do you think a solution is needed?
Answer: to ensure that new projects or project phases are destined for success

4. What is there about this problem area that disturbs you?

Answer: ease of communicating the lessons learned from individual projects to the wider organisation.

Step 2. Selecting Participants

This step is the selection of one or more participants to assist in the analysis process. The choices are creating Individual Logic Diagrams, Step-By-Step Logic Diagrams, Composite Merged Diagrams, and Normal Logic Diagrams (Bytheway, 2007). Individual Logic Diagrams will be used to develop a conceptual framework of managing lessons learned for professional architectural firms using a FAST Diagram.

Step 3. Initial Functions

This step requires the statements and facts obtained when selecting and defining the project- in step 1 above- to transpose them into functions. These functions are called *initial functions* and use the naming functions and discovering functions techniques discussed above as well as from the thought provoking questions of step 1. In addition to these, Figure B.5 attempts to list initial functions from the lessons learned processes discussed in the literature review as suggested by Rowe & Sikes (2006a&b), Rowe (2008), Duffield and Whitty (2012), Boehringer (2009), Goodson (2005) as well as key ideas discussed throughout the literature review.

Lessons Learned Process and/or Project Learning Roadmap	Initial Functions
<p>1. Preparation for implementation of lessons learned</p> <ul style="list-style-type: none"> - Through training of staff members on the need for lessons learned to establish and sustain a culture of consistent project management improvement. - Refer earlier similar projects with relevant, scope specific lessons learned for the start of a new project 	<ul style="list-style-type: none"> - Assign a responsible custodian of the lessons learned knowledge base - Create value/ Instil understanding of the need amongst employees - Train users to access lessons learned

Lessons Learned Process and/or Project Learning Roadmap	Initial Functions
<ul style="list-style-type: none"> - Bring significant paradigm shift in the corporate culture 	
<p>2. Needs Identification (individual, group, organisational)</p> <ul style="list-style-type: none"> - There is no ‘one size fits all’ - review lessons learned repository during Project Initiation - Use lessons learned during Project Planning - Incorporate lessons learned in the Project Execution Plan 	<ul style="list-style-type: none"> - Ensure scalability based on organisation’s resources and culture. - formalized lessons learned into the PM process for entry
<p>3. Processes and Tools for collecting lessons learned</p> <ul style="list-style-type: none"> - Conduct LL Sessions from each project as they happen 	<ul style="list-style-type: none"> - Use agreed processes and tools for collecting lessons learned - Gather anecdotal statements
<p>4. Content and Format of lessons learned</p> <ul style="list-style-type: none"> - Identify lessons learned from comments and recommendations that could be valuable for future projects (Summary of project strengths- what went well, success factors (impact it had), project weakness- what went wrong, and Recommendations- what we need to improve (impact it would have)). - Report lessons learned - Analyse lessons learned for application of results - Convert the lessons learned from all projects into actionable observations - Cull through lessons learned observations on quarterly basis looking for trends to identify best practices (in the form of policies, processes, procedures, & standards) 	<ul style="list-style-type: none"> - Identify lessons learned - Document and share findings amongst project team members - Analyse lessons learned - Identify and discard obsolete beliefs and routines (unlearn irrelevant ideas from the past) - Exploit existing ideas and opportunities - Explore new best practices

Lessons Learned Process and/or Project Learning Roadmap	Initial Functions
<p>5. Repository used</p> <ul style="list-style-type: none"> - Store lessons learned in a repository systematically categorized by project activity/ deliverable 	<ul style="list-style-type: none"> - Store lessons learned
<p>6. Communication and Dissemination of lessons learned</p> <ul style="list-style-type: none"> - Retrieve lessons learned for use on new projects - Communicate lessons learned - Keep it simple, avoid information overload 	<ul style="list-style-type: none"> - Retrieve lessons learned - Embed lessons learned in policies, processes, procedures, & standards to make them repeatable - Roll out the best practices (not the lessons learned) to the organisation in the form of templates, guidelines and processes to make them repeatable.
<p>7. Review for Continuous improvement from feedback and company metrics</p> <ul style="list-style-type: none"> - Avoid repeating past mistakes - Mature the PMO - Avoid critical knowledge wastage, - Leverage Intellectual Assets - Promote/ harness innovation - Manage change, - Yield greatest ROI on the next project 	<ul style="list-style-type: none"> - Learn from feedback - Facilitate Continuous performance improvement - *Improve project learning - Enhance organisational learning - Increase effectiveness - sustain competitive advantage - Ensure repeatable project success

Figure B. 5: Initial Functions for “Lessons Learned Process” (Author).

Step 4. Initial Basic Functions

This step requires determining the *initial basic function* from the list of initial functions obtained in step 3 above. If the Basic Function Determination Question yields all “no” answers, then the initial basic function has been found. After the initial basic function is identified, place an asterisk (*) in front of it in the list of functions. The following Basic Function Determination Question is used to obtain the initial basic function (Bytheway, 2007):

If **this function** didn't have to be performed, would any of the other functions still have to be accomplished or perform?

Obviously the purpose of communicating lessons learned from individual projects to the wider organization is to "**improve project learning.**" Therefore, if this function is inserted into the Basic Function Determination Question, the question would be:

If we didn't have to **improve project learning**, would we still have to perform the other functions listed?

Answer: No, if we look down the list of other functions listed in Figure B.5. This is the answer we obtain for each function.

The *initial basic function* for this project becomes "**improve project learning.**"

Step 5. Develop Higher Level Functions

This step requires a diligent search for higher level functions. It is accomplished by asking questions of the initial basic function recorded during step 4. The initial basic function is inserted in the blanks where the asterisks appear in the following three questions (Bytheway, 2007):

1. Why is it necessary to _____ * _____ ?
2. What higher level function caused _____ * _____ to come into being?
3. What is really trying to be accomplished when _____ * _____ is performed?

Since "**improve project learning**" is the initial basic function, insert it into the three questions.

1. Why is it necessary to **improve project learning**?
Answer: It would avoid repeating past mistakes.
2. What higher level function caused **improve project learning** to come into being?
Answer: Enhance organisational learning.
3. What is really trying to be accomplished when **improve project learning** is performed?
Answer: Ensure repeatable project success.

After getting these answers, the next task is to glean from them additional functions. A list appears in Figure B.6, along with the initial basic function.

Enhance Organisational Learning
Avoid Repeating Past Mistakes
*Ensure Repeatable Project Success
Improve Project Learning
Communicate Lessons Learned

Figure B. 6: Higher Level Functions for “Lessons Learned Process” (Author).

Step 6. Identifying the Basic Functions

At this point in the analysis, there are at least three new higher level functions formulated during Step 5. These along with the initial basic function should be used to create the higher level functions list from which once again the one thought to be the basic function is selected and inserted in to the following Basic Function Determination Question to determine if it is indeed the new basic function:

If **this function** didn’t have to be performed, would any of the other (higher level) functions still have to be performed?

From the list of five functions in Figure B.6, select the function that appears to be the highest level. “Ensure repeatable project success” appears to be that function. Therefore, insert it on the Basic Function Determination Question, which reads as follows:

If **ensure repeatable project success** didn’t have to be performed, would any of the other functions still have to be performed?

Answer: No

Therefore, “*ensure repeatable project success*” is the new *basic function*.

As soon as the basic function has been determined, move on to Step 7(Bytheway, 2007).

Step 7. Develop Primary Path Functions

This step requires all the functions identified thus far to be listed in a word processing program to create the logic diagram, in this case, a FAST Tree is first created as shown in Figure B.7 and then converted to a

FAST Diagram at the end of the process. When a function is included in the FAST Tree from the function list created above, post a “7” near the left margin of that function. The “7” indicates that a particular function has been included during Step 7 (Bytheway, 2007).

- Sustain competitive advantage
- ~~*Ensure Repeatable Project Success~~
- Increase effectiveness
- Learn from feedback
- Facilitate Continuous performance improvement
- Enhance Organisational Learning
- Improve Project Learning
- Communicate Lessons Learned
- Roll out the best practices to the organisation in the form of templates, guidelines and processes
- Retrieve lessons learned
- Store lessons learned
- 7 Embed lessons learned in policies, processes, procedures, & standards
- 7 Explore new best practices
 - Exploit existing ideas and opportunities
 - unlearn irrelevant ideas from the past
- 7 Analyse Lessons Learned
- 7 Document and share findings
- 7 Identify Lessons Learned
- 7 Gather anecdotal statements
 - Train users
 - Assign a responsible custodian
 - Formalized into the PM process for entry

Figure B. 7: List of Functions (Author).

Since communicate lessons learned was the initial project, now select a basic function from the list of functions in Figure B.7 that allows the initial plan to be carried out. Therefore, select “enhance Organisational Learning” as the new basic function. Then develop the primary path functions shown in Figure B.8. This is accomplished by asking “why” and “how” of all new functions added. Since “Ensure Repeatable Project Success” is higher than elected to analyse, it is crossed out, as shown in Figure B.8.



Figure B. 8: Communicate Lessons Learned FAST Tree 1 (Author).

Step 8. Evaluate Remaining Formulated Functions

The first step required for this project is to list all of the functions listed in Figure B.7 that have not yet been considered in Step 7. This is accomplished by copying and pasting them after tabbing in three times for each entry and then highlight each entry only by making it bold. Next develop a function cluster of each function by asking the Why-How Questions and posting the why answers above and one tab space to the left, and posting the how answers below and one tab space to the right (Bytheway, 2007) as shown in Figure B.9.

Yield greatest ROI on the next project
Sustain competitive advantage
 — Ensure repeatable project success

Yield greatest ROI on the next project
Increase effectiveness

7 Improve project learning

Increase effectiveness

8 **Learn from feedback**

7 Communicate lessons learned

7 Improve project learning

8 **Facilitate Continuous performance improvement**

8 Learn from feedback

8 Facilitate Continuous performance improvement

9 **^ Roll out best practices to the organisation** in the form of templates, guidelines and processes

7 Communicate lessons learned

9 Roll out best practices to the organisation in the form of templates, guidelines and processes

9 **^ Retrieve lessons learned**

9 Formalize lessons learned into the PM process for entry

10 Leverage Intellectual Assets

10 **Store lessons learned** in repository

10 Systematically categorize lessons learned by project activity/ deliverable

8 Facilitate Continuous performance improvement

10 **Exploit existing ideas and opportunities**

7 **^** Communicate lessons learned

7 Explore new best practices

9 **unlearn irrelevant ideas from the past**

10 Identify and discard obsolete beliefs and routines

10 Create value/ Instil understanding of lessons learned

10 **Train users**

10 Assign a responsible custodian

7	Embed lessons learned in policies, processes, procedures, & standards
9	Assign a responsible custodian
10	Set up a PMO
10	Avoid critical knowledge wastage
9	Formalize lessons learned into the PM process for entry
10	Include lessons learned in Project Initiation, Planning, and Execution

Figure B. 9: Evaluation of remaining formulated Functions (Author).

Each cluster is checked to make sure the logic holds by asking the following question of all how functions:

Does *this how function* help *its why function*?

If the answer is yes, it indicates that the logic is correct in the how direction. If the answer is no, it indicates that the logic is not correct in the how direction. However, a “no” answer indicates that the how function is a function which supports the why function. When this occurs, a caret (^) symbol before the how function in the cluster is used to indicate that it supports the why function above it. Every supporting function has the potential to be developed into a secondary path of functions. Secondary path functions are also developed by asking the Why-How Questions, just like primary functions, and have a primary path of their own. These supporting functions are added during Step 9 (Bytheway, 2007).

Next, copy the FAST Tree developed during Step 7 and paste it at the end of the working file as shown in Figure B.10. Search the function clusters to see if any of the functions can be merged into the primary path developed in Step 7. If any can be merged, insert them in the FAST Tree and place an “8” at the left margin to indicate which functions were merged during Step 8. Do not add any supporting functions at this time until you are skilled in performing Step 9. If a function cluster is at a higher level than elected to be pursued, it informs that this function is out of the scope of this project and it should be crossed out to show that it has been considered (Bytheway, 2007).

Always remember that every function fits somewhere in a logic diagram. The task is to find out where. It is like solving a puzzle; it takes time, thought, and patience to put the diagram together (Bytheway, 2007).

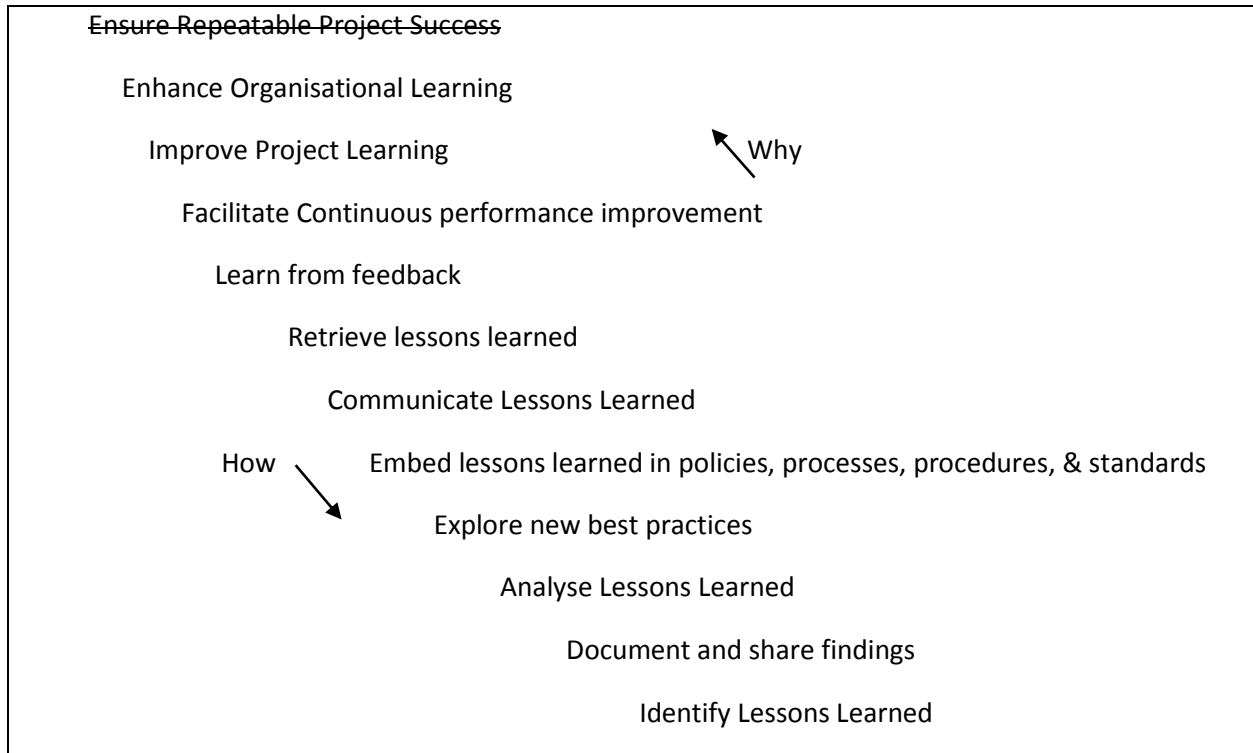


Figure B. 10: Communicate Lessons Learned FAST Tree 2 (Author).

Step 9. Using When/If Logic to Add Supporting Functions

A supporting function is a function that must be performed when and if a primary function cannot be performed without this function being performed at the same time or some time prior to the primary path function. The first task in this step is to see if any of the functions identified within the clusters in Step 8 are supporting functions of any primary path functions by scanning down the list of primary functions. These functions are sometimes identified during Step 8 by placing a caret (^) symbol in front of a function within a function cluster. However, supporting functions usually are identified by inserting each primary path function into the following question (Bytheway, 2007):

When/if **this function** is performed, what other functions must be performed?

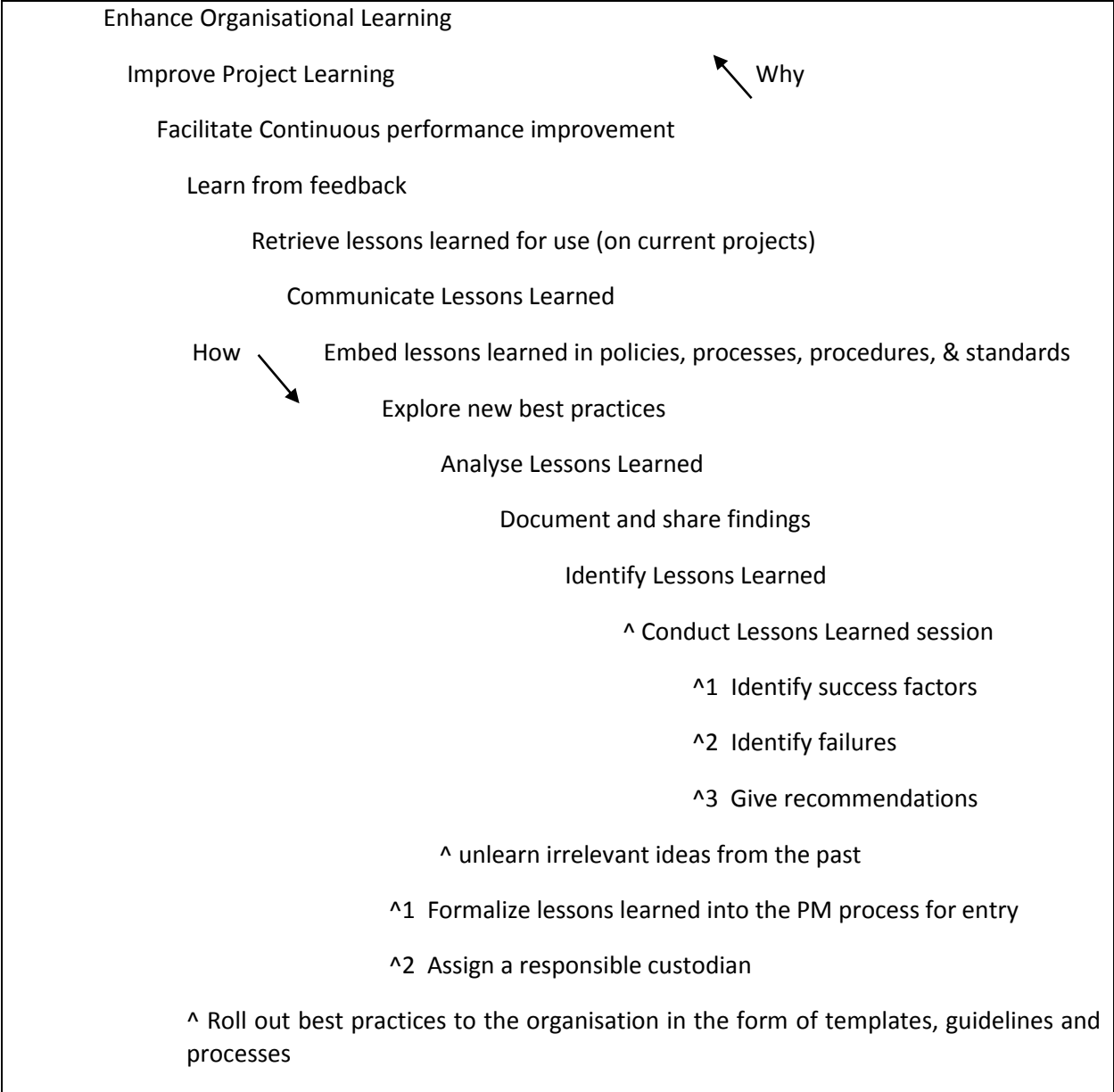


Figure B. 11: Communicate Lessons Learned FAST Tree 3 (Author).

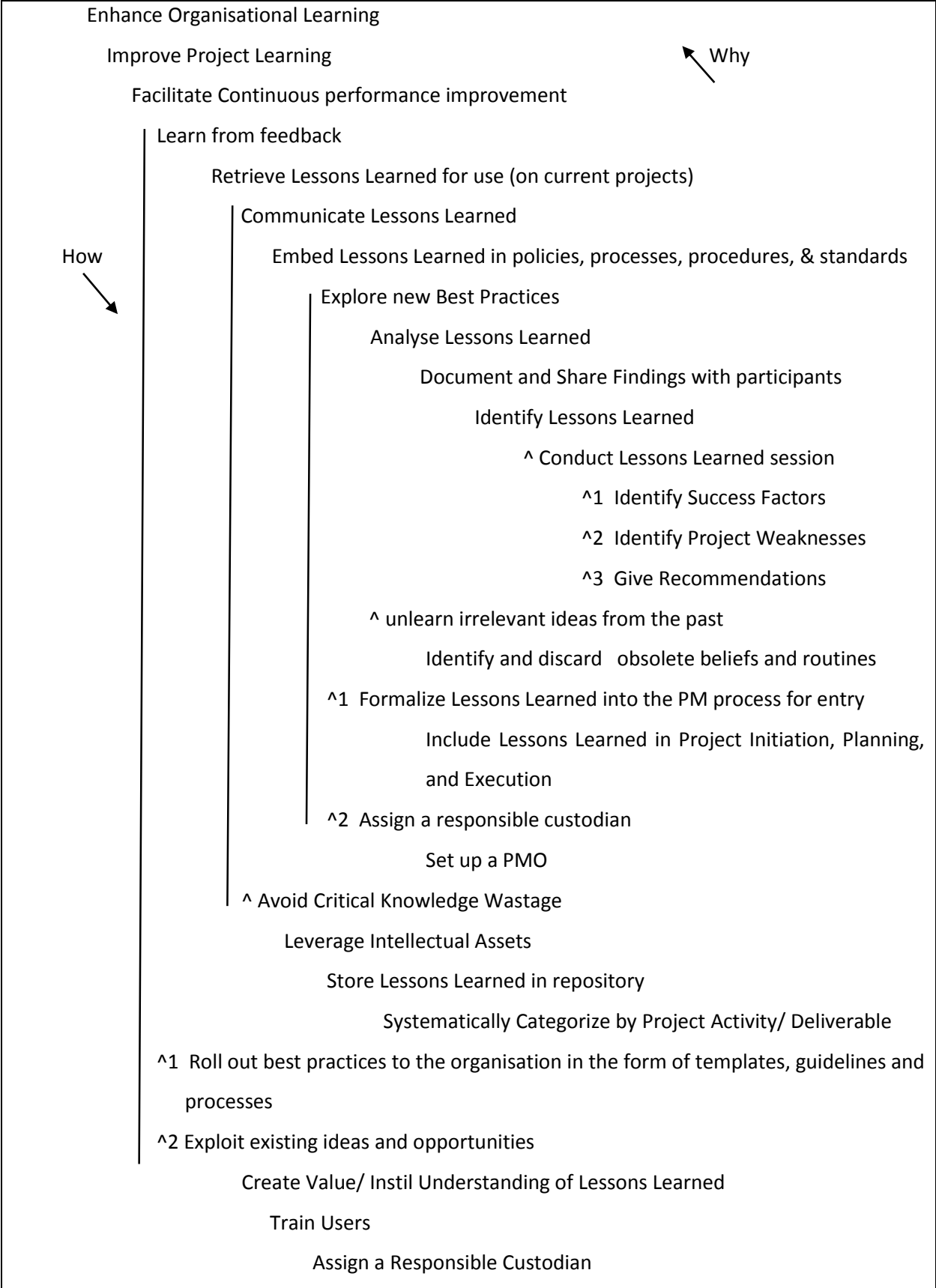
Step 10. Develop Secondary Path Functions

In this step, copy the latest logic diagram and paste it at the bottom of the working file, and use the Why-How Logic to develop the secondary path functions. After applying the Why-How Logic to all of the supporting functions while at the same time considering all the remaining function clusters, the logic diagram is expanded until it looks like FAST Tree 4 shown in Figure B.12. As functions within function clusters are merged, post a “10” near the left margin to indicate that they were merged during Step 10. If

perhaps any clusters remain that have not been merged, copy and paste them at the end of the working file. Then extend these remaining clusters by asking “why” of the highest level functions. Each time a new why function is added, ask “why” of it until it is evident where these clusters fit into the diagram. Note that a supporting function may also have a function that supports it (Bytheway, 2007).

After following these 10 steps, it can be concluded that a somehow realistic logic diagram of lessons learned has been developed. After all functions have been included, check the entire diagram to see that the logic agrees in both directions. If it does not agree, make any modifications that seem appropriate (Bytheway, 2007).

As function analysis and FAST diagramming have been adopted as an excellent way of performing an analysis, it has been determined that greater insight into projects can be obtained when the verb “provide” is avoided. For example, “provide transportation” can be changed to “transport people” or “transport cargo.” These functions are much more informative. It is also recommended that the actions performed by people or things should not be recorded as functions. Concentration should rather be on the object of performing those actions and formulating new functions for them instead. To do so requires considerably more deep thinking and greater skill on the part of the analyst (Bytheway, 2007).



Legend:

Vertical lines identify a given tab space to aid reading.

Caret (^) symbol indicates a supporting function.

A supporting function supports functions above ^ symbol.

Numbers 1, 2, and /or 3 in a vertical alignment all support the same function.

Figure B. 12: Communicate Lessons Learned FAST Tree 4 (Author).

More functions, no doubt, could be added to this logic diagram, but by limiting the functions to those shown in Figure B.12, FAST Tree 4 is converted into a FAST Diagram as shown in Figure B.13. Figure B.14 is an extension of Figure B.13 incorporating the single-loop learning and double-loop learning concepts. It is not part of the FAST Diagram constructing process proposed by Bytheway (2007), but the author's interpretation of Figure 2.8. Whenever an organised thinking is needed to be presented to a group, it is a good idea to construct a FAST Diagram so people can visually see how all the functions fit together. A FAST Diagram allows one to better see which functions may be considered when moving to the next step in this procedure (Bytheway, 2007).

Step 11. Brainstorming Higher Level Functions

Once the logic diagram has been completed, use the opportunity to take a creative look at all the functions listed in the diagram. Generally, this step is only performed on the higher level functions of the primary path functions. This step begins by inserting the highest level function into the following How Else Question (Bytheway, 2007):

How else can ***this function*** be performed or accomplished?

As this question is answered, one divorce himself from the project and list every idea that might perform the function inserted into this question. This activity is called *brainstorming the function*. Brainstorming is very effective when applied to a function because a function tells the analyst what needs to be accomplished without identifying the method of accomplishment. A team of four or five people is generally selected to participate in this activity (Bytheway, 2007). The ground rules and concepts for performing brainstorming and the questions to be answered by the brainstorming participating team are further discussed under research methodology.

Basic Lessons Learned FAST Diagram

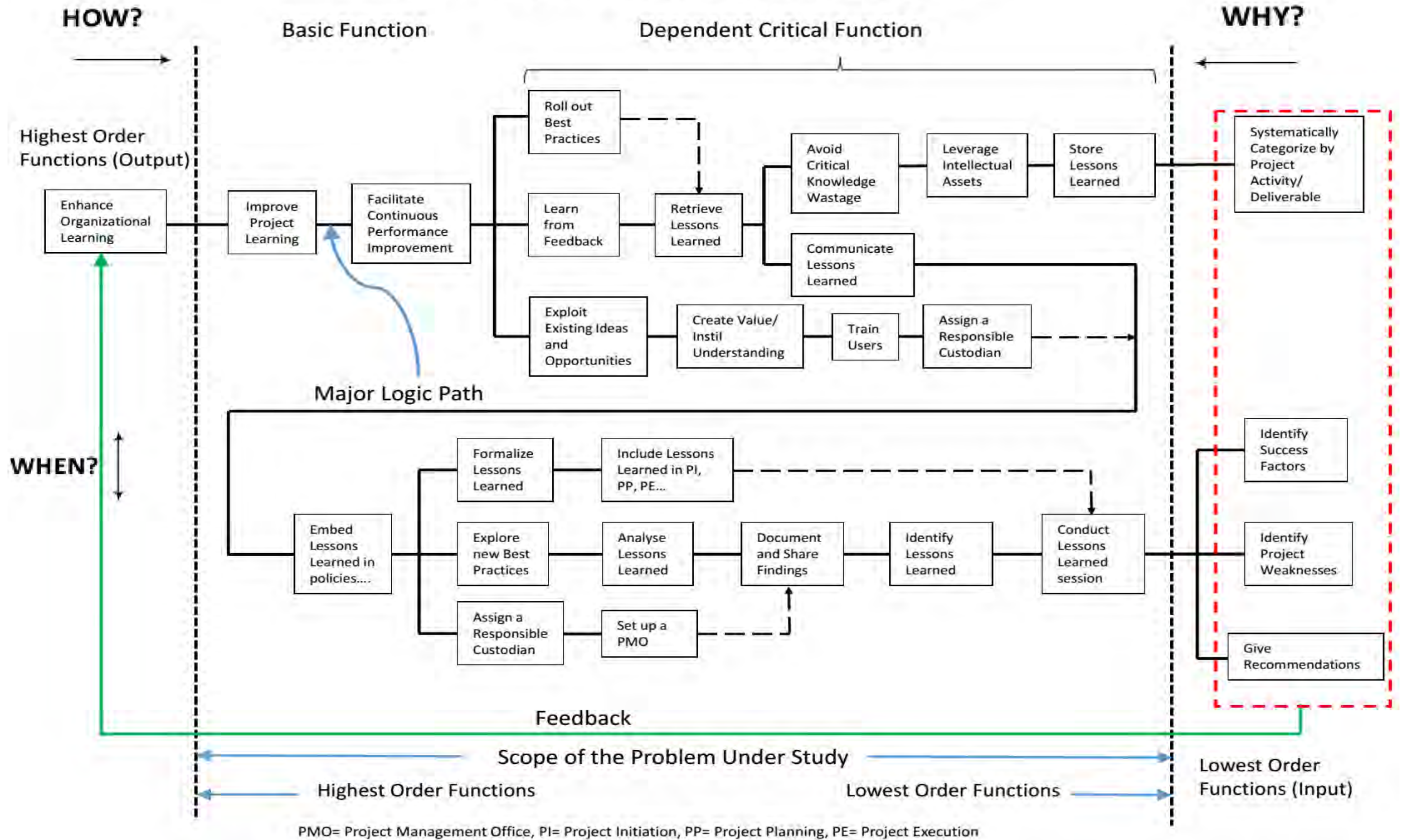


Figure B. 13: Basic Lessons Learned FAST Diagram (Author)

Lessons Learned FAST Diagram

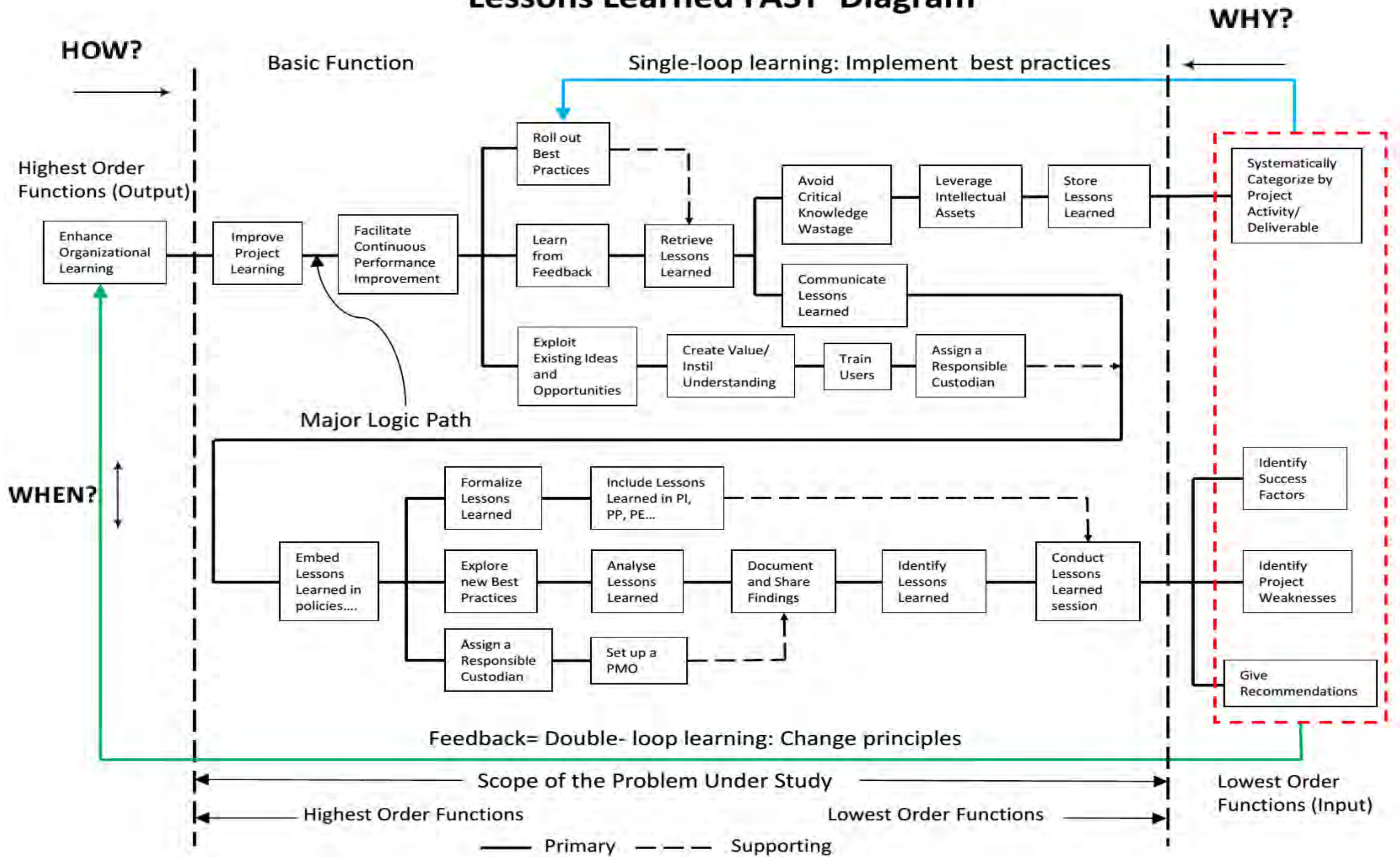


Figure B. 14: Lessons Learned FAST Diagram incorporating Single-loop learning and Double-loop learning (Author)

Appendix C:

Appendix C1: Project Closure Report for Project 'X'

Project Name: Project 'X'- New Science Building

Project No: 1104

Prepared By

Document Owner(s)	Project/Organization Role
HA	Partner in Charge
WW	Ex-Project Architect
RL	Project Architect
TB	Team Member
NB	Team Member
FS	Team Member
JY	Team Member
MRR	Ex-Team Member

Project Closure Report Version Control

Version	Date	Author	Change Description
1.0	2013.06.23	TB	First Draft for MANCO discussions
1.1	2014.01.27	TB	First Draft for Team Members opinion
1.2	2014.04.17	TB	Discussed with Team Members
1.3	2014.09.08	TB	Included Team Members comments
1.4	2014.09.18	TB	Discussed by Focus Group Research participants

TABLE OF CONTENTS

1	PROJECT CLOSURE REPORT PURPOSE	3
2	PROJECT CLOSURE REPORT GOALS	3
3	PROJECT CLOSURE REPORT SUMMARY	3
	3.1 Project Background Overview	3
	3.2 Project Objectives	4
4	PROJECT METRICS PERFORMANCE	6
	4.1 Goals and Objectives Performance	6
	4.2 Success Criteria Performance	8
	4.3 Milestone and Deliverables Performance	8
	4.4 Budget Performance	9
5	PROJECT CLOSURE TASKS	10
	5.1 Resource Management	10
	5.2 Issue Management.....	10
	5.3 Risk Management	11
	5.4 Quality Management	11
	5.5 Communication Management	12
	5.6 Customer Expectation Management	12
	5.7 Lessons Learned	12
	5.8 Post-project Tasks.....	14
6	PROJECT CLOSURE REPORT APPROVALS	15

1 PROJECT CLOSURE REPORT PURPOSE

Project Closure Report Purpose

The Project Closure Report is the final document produced for the project and is used by senior management to assess the success of the project, identify best practices for future projects, resolve all open issues, and formally close the project.

2 PROJECT CLOSURE REPORT GOALS

Project Closure Report Goals

This Project Closure Report is created to accomplish the following goals:

- Review and validate the milestones and success of the project.
- Confirm outstanding issues, risks, and recommendations.
- Outline tasks and activities required to close the project.
- Identify project highlights and best practices for future projects.

3 PROJECT CLOSURE REPORT SUMMARY

3.1 Project Background Overview

Project Background Overview

- **Site Description** - The Sciences Building is located south of the recently completed similar Science Building. The University, in its efforts to position itself as one of the leading science schools in Africa, this project is the second phase in the development of the new 'Science Precinct' on the road edge of campus.
- **Project Brief** – The project objective was to design and build a new Sciences Building for the University. The building provides: faculty offices, lecture rooms, student and research laboratories and support facilities for undergrad, graduate and doctoral students from two major departments.
- **Building Population**– This teaching and research facility was designed to accommodate 1276 students at the time of completion (July 2013) and later accommodate 2023 students (in 2020).
- **Design Criteria**– It has been a major objective of the University to use development on this edge of the campus as an opportunity to create landmark buildings which announce its presence in the 21st century. The issue of image and relationship to the newly built building was therefore a very important aspect of the design. The newly built building also represents current thinking on the planning and design of science buildings today. While there are some differences between the requirements of the built and this building, it is considered that the newly built building provides an appropriate model for the proposed new Science Building.
- **Building Area and Estimated Budget**– Based on preliminary studies, an area of approximately 7,200 Assignable Square Meters [ASM] is required for both departments. By applying the DoE's [Department of Education] 2010 cost norm for

a building of this nature, the 7,200 ASM would generate a cost of about R200 million including VAT, professional fees and a nominal amount for site works.

- **Final Building Area** - 12,800 square meters; 6 stories; 21 m (H) x 28 m (W)X 100 m (L)

3.2 Project Objectives

The general project objectives were derived from the scope statement (Project Brief) provided by the Client and documented by the architect. The key stakeholder selected is the Architects playing the role as the Project Team stakeholder responsible for the design, documentation, professional team coordination, quality control and site inspection (according to the contract: the Client-Architect Agreement) for the new Sciences Building on the Campus of the University. the Architects' objectives to this project in addition to fulfilling the project objectives should ultimately be in delivering the project within budget on time and to the full expectation of the Client's. The project objectives could fall into three categories as; procurement, functional and strategic and are summarized below:

3.2.1 Procurement Objectives

- **Budget recognition.** The initial budget for the building was R200 million. This includes VAT, professional fees and a nominal amount for site works. As compared to that of the Life Sciences building, this is an extremely tight budget;
- An additional budget exists for new and future equipment acquisitions. These would be managed by the Project Manager and the University.
- **Adhere to Project timelines.** The project is a "Fast Track Project", design started in January 2011 and the project went to site in January 2012, and should have been completed by July 2013. The project has not yet reached final completion (as of September 2014) for a number of reasons explained in the document.
- **HR recognition.** Do it right the first time and maximize profits.
- **Design and Product Quality.** Quality Product through innovation and attention to detail.

3.2.2 Functional Objectives

- Design a facility that caters for future expansion (both in student numbers and types of research), and because of high costs, there is constant pressure to maximize space and to build in flexibility and adaptability resulting in space that can be used for multiple functions. The notion of the 'generic lab' is a key issue in the modern research lab where investigating teams can work on several different projects within the same discipline, as well as future renovations. This would require as much open central spaces as possible and pushing any service cores to the edges.
- Fulfill Client expectations by developing a design that is efficient and direct reflection of the user client's needs;
- A graded security system that protects valuable equipment and intellectual property, while allowing for academic interaction and collaboration;
- Facility in general and lab workstations in particular must have access to both intranet and internet;
- Classroom and tutorial spaces must be able to accommodate various types of presentations (appropriate spatial planning and computer connectivity needed);
- Teaching and research facilities as per Room Data Sheet;
- Laboratory facilities for undergraduates (practical) and post graduate (research) students;
- Teaching and tutorial facilities;

- Student interaction should be encouraged: in informal gallery/ corridor spaces at undergraduate level, and informal meeting spaces between post graduates and researches;
- Open plan laboratories with direct access to offices and integrated pause areas (kitchenette)
- Based on the 20m height restriction and the area of 7,200 ASM, planning studies have been developed based on the undergraduate, graduate and research layouts of the newly built building. The building will consist of five floor levels, lower level for one department, two middle levels for the undergraduate of the second department labs and two upper levels for post-graduate and research activity of the second department. These latter floors and the one on the ground floor are zoned with an outer band on the south for supporting service facilities, a wide middle band for the labs flanked by write up areas and individual offices for senior staff on the north;

3.2.3 Strategic Objectives

- To establish the university as the main Science "hub" in South Africa;
- To develop a Science Precinct that will ultimately bring together Life, Chemical, Physics, Mathematical and Computer Sciences;
- The Science Precinct as a whole should create landmark buildings which announce the presence of the university on the 21st century. It should also have a coherent architectural and environmental language. The creation of such landmark buildings does not only announce the presence of the university on the 21st century but also of the designer's capability. Hence, achieving a coherent architectural and environmental language would be a strong marketing tool as well for a profitable business venture;
- The Science Building should emulate the aesthetic design principles of the newly built building. This is a good reference point for the architect to base his design on; it would serve as a precedent study;
- New Sciences Building (20m) will need to be lower than the newly built building (28m) to act as a background building to the newly built building as one drives along major road along the edge;
- The project intends to rebrand the university as an integrated university with cutting edge research facilities, and move away from the stereotype of a previously disadvantaged institution;
- Over the next 10 years (2020) it will grow to achieve its maximum capacity.
- Work very closely with the client users in unpacking and understanding the client's requirements;
- Design the building and help the client achieve its ultimate strategic objectives from a design point of view through educating the client on a stage by stage signing off of the different design stages and ensuring no surprises when the building procurement (construction) and when finally operations start;
- Develop good and effective communication channels with the Client Body so that mistakes done by the previous architectural firm which eventually lead into disputes with the client do not get repeated. Secondly, seize this opportunity to impress the Client so that:
 - Increase the chance to do the rest of the potential projects that would be built around the Science Precinct which are Physics, Mathematical and Computer Sciences;
 - Leave good footprint in the institution, and improve the company's CV with regards to designing of institutional buildings;
 - Specialize in the design of institutional buildings and hence acquire more work from other local, national and international institutions. Such institutions are a very good source of work especially during times of economic downturn.
- Promote energy efficiency and sustainability as new regulations are demanding for more 'green' consciousness;

4 PROJECT METRICS PERFORMANCE

4.1 Goals and Objectives Performance

Goals and Objectives Performance

ACG's objectives to this project should ultimately be in delivering the project within budget on time and to the full expectation of the Client's requirements and thus should also fall into the three categories listed below:

4.1.1 Procurement Objectives

- **Budget recognition.** Architects have worked closely with the QS to adhere to the extremely tight budget;
- **Adhere to Project timelines.** The project was delayed due to the addition of Level 5, indecisions by the Client around the Entrance and finally due to Client interference regarding Practical Completion list accomplishments. Practical Completion date has been delayed by 6 months and the overall project by more than 18 months.
- Quality Product through innovation and attention to detail has been achieved;
- **HR recognition-** although "do it right the first time" policy was adhered to profits maximization was not achieved.
- The designed facility caters for future expansion (both in student numbers and types of research), and hence will help to reduce the high costs, that cause constant pressure to maximize space and to build in flexibility and adaptability resulting in space that can be used for multiple functions. The notion of the 'generic lab' is a key issue in the modern research lab where investigating teams can work on several different projects within the same discipline, as well as future renovations. This was achieved by providing as much open central spaces as possible and pushing any service cores to the edges;

4.1.2 Procurement Objectives

- Architects have worked very closely with the Client to fulfill expectations by developing a design that is efficient and direct reflection of the user client's needs,
- The building has been designed to be a teaching and research facility, that will initially accommodate 1276 students, and later accommodate 2023 students (in 2020);
- The functional spaces have been designed and built according to the original brief with the exception of little increased height due to the addition of Level 5 and hence the increased ASM.
- A graded security systems that protects valuable equipment and intellectual property, while allowing for academic interaction and collaboration has been achieved;
- A free for all Wi-Fi internet access has been provided to all facilities.
- Classroom and tutorial spaces must be able to accommodate various types of presentations (appropriate spatial planning and computer connectivity needed);
- Comprehensive Room Data Sheet prepared for each teaching and research room type;
- Student interaction should be encouraged: in informal gallery/ corridor spaces at undergraduate level, and informal meeting spaces between post graduates and researches;
- Open plan laboratories with direct access to offices and integrated pause areas (kitchenette)

4.2 Success Criteria Performance

Success Criteria Performance
<ul style="list-style-type: none">• Were all criteria achieved? To what level of success?<ul style="list-style-type: none">➢ All criteria were achieved and the building is built according to the brief with Client approving progress every step of the way.• If some criteria were not achieved, what were the reasons? Is achievement anticipated at a later date?<ul style="list-style-type: none">➢ Due to the Employer's interference in quality related issues such as waterproofing materials used and ways of achieving Practical Completion and the subsequent delays there off;➢ Due to the liquidation of the main construction company that was completing the building construction and the fact that a new contractor is appointed to complete the rest of the works to bring the building to completion;➢ Due to lack of transparency from the Project manager and being delinquent in delivering data for fit out of computers and IT, furniture and equipment fit out (including flat screens, document projectors, and audio visual teaching aids). This caused delays in completing final joinery and fully understanding the brief of some rooms reliant on this equipment.<p>For these and other reasons, neither the Employer nor the professional team were happy; the relationship somehow became tense. Hence, the strategic objective to seize this opportunity to impress the Client so that:</p><ul style="list-style-type: none">➢ Increase the chance to do the rest of the potential projects that would be built around the Science Precinct which are Physics, Mathematical and Computer Sciences;➢ Leave good footprint in the institution, and improve the company's CV with regards to designing of institutional buildings;➢ Specialize in the design of institutional buildings and hence acquire more work from other local, national and international institutions. Such institutions are a very good source of work especially during times of economic downturn, do not seem to be achieved.• Who is responsible for measuring continued progress?<ul style="list-style-type: none">➢ Partner in Charge

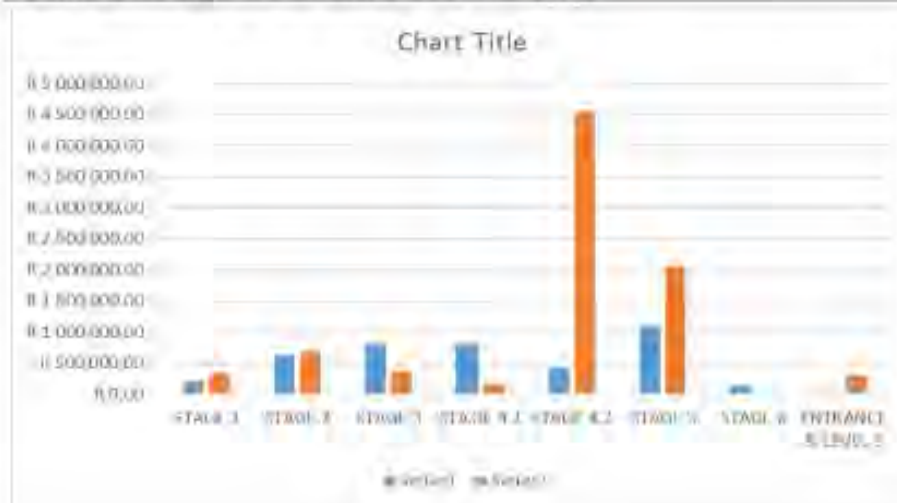
4.3 Milestone and Deliverables Performance

Milestones and Deliverables Performance
<ul style="list-style-type: none">• Were all deliverables achieved with high quality and customer acceptance?<ul style="list-style-type: none">➢ The project went to site in January 2012, and was expected to be completed by July 2013, the completion date has been delayed by more than a year and a half thus far and the Architects are forced to complete the project at a loss.• If not, what were the reasons?<ul style="list-style-type: none">➢ Due to excessive change requests from the Employer during design and interference towards achieving Practical Completion.• Is achievement anticipated at a later date?<ul style="list-style-type: none">➢ Practical Completion is finally achieved and Final Completion is expected by end of 2014 via the newly appointed contractor.

4.4 Budget Performance

Budget Performance							
Project Budget Overview:							
PROJECT NAME		Project 'X' - New Science Building					
PROJECT CODE		1104					
PRODUCTION BUDGET		50%					
STAGE	%	PROJECTED PRODUCTION BUDGET	ACTUAL PRODUCTION BUDGET	VARIANCE	% VARIANCE	COMMENTS	% Completion
STAGE 1	5	R 204 457.40	R 328 262.23	+R 123 804.83	161%	overspend	100%
STAGE 2	15	R 613 372.21	R 677 516.19	+R 64 143.98	110%	overspend	100%
STAGE 3	20	R 817 829.62	R 361 125.45	R 456 704.17	44%		100%
STAGE 4.1	20	R 817 829.62	R 164 740.75	R 653 088.87	20%		100%
STAGE 4.2	10	R 408 914.81	R 4 540 976.96	+R 4 132 062.16	1110%	overspend	100%
STAGE 5	27	R 1 104 069.98	R 2 049 856.62	+R 945 786.64	186%	overspend	54%
STAGE 6	3	R 122 674.44	R 9 641.84	R 113 032.60	8%	*	98%
ENTRANCE & LEVEL 5	0	R 0.00	R 298 759.17	+R 298 759.17			95%
TOTAL		R 4 089 148.08	R 8 430 879.21	+R 4 341 731.14	206%		

*budget for this stage has been absorbed into other stages.



5 PROJECT CLOSURE TASKS

5.1 Resource Management

Resource Management

- **What resource needs changed during the project?**
 - First Project Architect had to leave and go outside the continent due to unavoidable circumstances with all the project information and the new Project Architect had to learn to take the lead in his place.
 - A technical experience staff member has to step in to assist with detailing and inspections
 - The architect in charge of Room Data drawings and a point of contact with the end user has to slowly pull out to lead the company's new branch office in her home country. A team member who was focused on door schedules has to take on more responsibilities from her and then on completion defects lists coordination.
 - The technician who was in charge of consultant drawings coordination has to hand most coordination to the new Project Architect but keep council and As Built coordination efforts.
- **Outline the steps to be taken in shifting project resources to other projects.**
 - Ensure smooth transition between member staff in terms of project knowledge transfer.
 - Regular team meetings help keep everyone informed about the project and hence ease handover.
- **Explain how project knowledge (IP) from project team members will be captured and retained for future projects.**
 - Discuss these with staff members through Fri-pro and Lessons Learned discussions.
 - Make the document part of Project Start up where project teams should review the document before commencing on a new project.

5.2 Issue Management

Issue Management

- **Will each issue be resolved?**
 - Distinguishing between Practical and Works Completion Lists
 - Waterproofing material used questioned by Client.
- **Who will continue to report on each issue's progress?**
 - Project Architect

5.3 Risk Management

Risk Management
<p>Project Risks Mitigated:</p> <ul style="list-style-type: none">• Were actions taken to lessen the impact?<ul style="list-style-type: none">➢ The necessity of this procedure can be evaluated at the end of each phase or once a month. Any additional information that might have come to light can be added into the knowledge base database. This will ensure that every member is learning as the capturing process progresses contributing to the development of a 'live' risk register system for the company that would be used for the anticipated projects to come. Additionally, the risk register would be updated at the completion of every project. Such a system would contribute to the overall maturity of the company. Reports can be quickly made to check on the progress and completed items.➢ No risks were formally identified and mitigated but the following risks were informally mitigated:<ul style="list-style-type: none">▪ The departure of the Project Architect and the subsequent loss of unwritten historical information by smoothly transferring duties to existing team members,▪ The challenge of convincing the Employer that the Fortune Reflect waterproofing membrane used on all flat roofs was indeed to the best interest of the project. All documentation, manufacturer's and installers guarantees and warranties have been issued to the Employer.➢ The employer's concern regarding the water proofing membrane used is yet not concluded. <p>Outstanding Project Risks:</p> <ul style="list-style-type: none">• Who will continue to keep an eye on it?<ul style="list-style-type: none">➢ Project Architect• Is a mitigation plan in place?<ul style="list-style-type: none">➢ No

5.4 Quality Management

Quality Management
<ul style="list-style-type: none">➢ Quality Assurance Reports were prepared and issued during each Technical Meeting to be actioned by the Contractor.➢ Other quality management processes are the Practical Completion, Works Completion and Final Completion Lists that the contractor should act upon to get his certificates.

5.5 Communication Management

Communication Management

- Emails and telephone were the main modes of communication and drawings were exchanged via PD Service (EFT server).
- **How effective was the process?**
 - All were effective especially the use of PD Service has also helped as a record of issue slips, with no need to print all drawings but only those needed. Everyone was on the same page at all times but an email notification has to be sent every time you post drawings to PD Service.
- **What changes were made during the project?**
 - Due to the amount of emails coming each day, priority was given to those from Employer, Contractor and the Project Manager. When we send emails we have to do a follow up call to make sure that our messages are delivered, understood and acted upon.
 - Those that were agreed via phone calls had to be confirmed via a written confirmation email.
 - It was requested that email titles have to be clear for future search on mimecast such as for legal reasons.

5.6 Customer Expectation Management

Customer Expectation Management

- The architects dedicated an experienced architect full time to work very closely with the client users in unpacking and understanding the client's requirements;
- Designed the building to help the client achieve its ultimate strategic, objectives from a design point of view through educating the client on a stage by stage signing off of the different design stages and ensuring no surprises during the building procurement (construction) and when finally operations start;
- **Did these expectations vary during the course of the project? If so, how?**
 - The expectations didn't change at all, if there was it was a positive one.

5.7 Lessons Learned

Lessons Learned

- **Which activities and processes worked well?**
 - which phase of the project
 - **Stages 2-5:** Do redlining on A3s for resolving global problems with design, missing drawing information, etc. Use highlighters when acting upon redlined drawings. Print on A1/A0 for final fine-tuning of drawings (but at least a week before say Council Submission).
 - what contributed to the success
 - **Stage 1:** The Architects went beyond the norm to go and extract the needs and requirements of the end users. The newly built building which was a given precedent and the information obtained from the Client were helpful for a positive kick start.
 - **Stage 2:** The research done from university library books, the diagrams generated by the architectural team regarding space relationships and

movement pattern of people, goods and chemical waste as well as the libraries of laboratory objects created on ArchiCAD to accurately depict the virtual spaces. Draft written specifications submitted to the QS as part the Stage Two Client Report were effective in controlling project cost and reducing design visions early in the design process

- **Stage 3:** the replacement of most internal walls with light gauge framed partition walls was a great advantage for reducing the thickness of slabs from Coffer to normal slab without beams and hence great cost saving, flexibility to the spaces and relieving the pressure on the pile footings. Early involvement of the supplier has also helped the project to have fully detailed specifications of the partitioning system and related ceiling systems.
 - **Stage 4.1:**
 - This, from the start, went very well as the entire professional team has met with council members representing their respective departments. A clear, rich picture was communicated regarding design intent, structural system, rational fire and reticulation of services. This good understanding of the intent and effective communication with the authorities has greatly helped for the smooth approval and inspection by the Building Inspector when the construction was done.
 - Use of colour on ArchiCAD helped to trace changes easily, saved manual colouring but a lot of colour printing, feasible only if the Employer pays for printing.
 - **Stage 4.2:** The meticulous coordination processes with all professional consultants has greatly helped in creating state of the art reticulation of services clearly visible and aesthetically pleasing reticulation and layering of services where there is no ceiling in most spaces. The tedious, mostly parametric but extremely effective Room Data Drawings were instrumental in achieving such a standard.
 - **Stage 5:** The setting up of mock-up rooms, walls with sample finishes were also effective.
- Things that did not work well
- which phase of the project
 - **Stage 1:** The excessive contact time with the client was not well organized, some heads of departments and end user representatives were changing and processes had to be repeated and reworked. This has wasted the architects a lot of time and hence money.
 - **Stage 2:** MEP (Mechanical, Electrical, and Plumbing) initially used primitive way of drawing, this has forced the architects to redraw all MEP lines. BIM exchange with Structural Engineer was not used to the benefit of the project.
 - **Stage 3:** Some researchers were continuously changing their brief causing lots of re-working. MEP was drawing in 2D and the architects were forced to model all ducts to determine ceiling heights and to avoid clashing of services.
 - **Stage 4.1:** Not getting a clear date of submission from the Project Manager caused unnecessary rush and wasted colour printing of unchecked drawings.
 - **Stage 4.2:** Wall sections not finished in time for Tender failed to make it during construction as well.
 - **Stage 5:** Addition of Level 5 after construction has commenced has caused a serious time delay and impacted the completion of the project which was ahead of schedule by almost a month at that time and it is still incomplete more than a year later of its anticipated completion date.

- recommendation to avoid future repeat with action owners if applicable
 - The architects should avoid working with consultants who use 2D packages but those who use Level 2 BIM software to aid in coordination work which takes substantial time of working back and forth as well as to help with using built-in energy efficiency software. The biggest saving on this is early detection of services/ structural clashes than on site rectification which would be costly- Partners to decide on this.
- **Which could have been improved (things that could have been done differently), and how?**
 - Window and Shopfront drawings were done in 2D and were unable to keep up with the changes to the design. They were dependent on Shop Drawing approvals and this has affected getting sign off from the Employer as well as rectifying the 'Council' and 'As Built' drawings.
 - Hand drafted documents and schedules could not keep up with revisions during the project and caused incongruences in information provided to the contractor.
 - Project designers would have been more efficient had they been 3D modeling their solutions on ArchiCAD
- **Lessons Learned**
 - The architects should sign contracts to industry norm standards only such as the JBCC, NEC, and FIDIC etc. but not to Employer modified documents which are subject to interpretations.
 - The architects should have a formal "Change Request" form that is part of a project brief that has to be clearly communicated to all stakeholders that any scope change that has a time and/or cost impact to the architects has to be signed and endorsed by the Employer or the Project Manager.
 - Proper research should be done by project team members before specifying any new materials that do not have SABS approval or an Agrément South Africa certificate.
 - The architects should avoid working with consultants who use 2D packages but those who use Level 2 BIM software to aid in coordination work which takes substantial time of working back and forth as well as to help with using built-in energy efficiency software.
 - A team members' debate is needed to comment on whether details should have been hand drawn or on CAD. At what stage we were supposed to cut the link between 2D and 3D on the model, etc.
 - Production staff should be computer literate on Microsoft Windows, Microsoft Office and CAD as a minimum to improve efficiency and cohesion among production team members.
 - Foreign trained Lead Project Architects should be registered with SACAP
 - The architects should utilize an effective, robust written specification method which is linked to technical documents to reduce errors, omissions and redundancies in information conveyed to the contractor and provide a sound defense and control of quality of construction.

5.8 Post-project Tasks

Post-project Tasks

- **What actions are not yet completed? Who is responsible for them?**
- **Which success criteria are not yet met? Which deliverables are not yet achieved?**
- **Which training requirements are still outstanding?**
- **This information can be summarized from details in the preceding sections.]**
 - Practical Completion impasse resolution, Works Completion and Final

Compilation Lists- Project Architect.

- Convincing the Employer to accept the Fortune Reflect waterproofing and the methods of installing it used- Partner in charge.
- 'As Built' drawings: both PDF and DWG of all Plans, Elevations, Sections, and Schedules as well as archived files of all the ArchiCAD 3D documents of the project. Updated A3 Progress Set properly labeled- Senior Technician. Refer to 'the Architects' 'AS BUILT' Information Handling Policy' in the MANCO Drive under Templates.

6 PROJECT CLOSURE REPORT APPROVALS

Prepared By TB
(Senior Architectural Technologist)

Approved By HA
(Architect- Partner in charge)

RL
(Project Leader)

Approval Date 18-09-2014

Appendix C2: Lessons Learned Tree Diagram for Project 'X'

Learn lessons from completed projects- Stage 0 (Precedent Study)

Learn strengths and weaknesses of the just finished LSB

Obtain experiences of Building Manager, End Users and the Project Manager

Study drawing information, specification and ideas used

Learn lessons from Stage 1 (Inception)

Avoid time delays and budget overruns

Develop a clear project brief

Go beyond norm to extract end user requirements

Use layered system of information gathering

Create an excel spreadsheet of every required space

Capture information as they get revealed from every source

Deal with designated End User representatives

Manage Scope Creep

Stick to the brief at all times

Prepare Change Request Form

Ensure all Change Requests are signed by the Client/ PM

Avoid signing contracts subjected to interpretations

Agree to standard contracts (JBCC, NEC and so on.)

Close Stage 1 before proceeding to Stage 2

Get Client Sign off on the developed Project Brief

Prepare Stage 1 closure and lessons learned report

Conduct lessons learned session

Identify success factors

Identify weaknesses

Give recommendations

Learn lessons from Stage 2 (Concept and Viability)

Do proper research for current trends and concepts

Get university libraries membership

Do space and movement analysis diagrams

Generate space relationship diagrams

Use space planning software such as Affinity linked with ArchiCAD

Generate movement pattern of people

Generate movement of goods and chemical waste

Depict virtual spaces accurately

Understand dynamics of each equipment and the rooms it would be housed in

Model every lab equipment in 3D

Control project cost and design visions

Reconcile draft project specifications with QS's

Avoid too many design iterations while on limited budget

Avoid costly materials experimentation while on limited budget

Involve a Building contractor at advisory level

Get feedback of design concept from design committee/ staff

Educate Client on what to expect with limited budget

Define and obtain formal approval of building security

Involve Civils early to formally define parking lots and vehicle access

Allow budget for building maintenance

Include bird control and window cleaning in the planning

Avoid redrawing of consultants services

Avoid working with consultants who use 2D CAD software

Request to work with consultants who use Level 2 BIM software

Exchange model information with all consultants

Hold consultants accountable to their responsibilities

Oppose replacement of experienced consultants' team with juniors

Appoint consultants with higher level of professionalism and competency

Remove MEP's mentality that AR will give up and accept their mess finally

Ensure MEP do not leave coordination to the architect

Work closely with MEP in areas with exposed ceilings

Ensure MEP adhere to void space allocated to them

Ensure MEP size ducts early than depend on installers

Minimize costly on site rectification of services clashes

Advocate all consultants' drawing coordination be BIM based

Convince Project Manager for architect to model all services

Motivate a separate architect's budget for BIM coordination

Close Stage 2 before proceeding to Stage 3

Get Client Sign off on all diagrams and concept drawings

Prepare Stage 2 closure and lessons learned report

Conduct lessons learned session

Identify success factors

Identify weaknesses

Give recommendations

Learn lessons from Stage 3 (Design Development)

Manage construction cost within budget

Get wall and ceiling details resolved fully

Involve material suppliers from the start

Reduce loading on Pile Footings

Reduce thickness of slab

Use normal slab instead of coffers

Replace internal brick walls with light gauge framed partition walls

Conduct Value Engineering exercise with all consultants

Shrink building size to minimum

Reduce areas requested from every end user

Downgrade material specs such as louver types

Do Sun study analysis to exactly identify areas of need

Manage risks related with Fast Track nature of project

Minimise items with provisional sums

Generate all schedules from BIM

Use standard specification systems such as NBS or Autospec

Avoid issuing incomplete drawings to site

Ensure flexibility of spaces for future internal reconfigurations

Push service cores to the building perimeter

Use demountable partition walls

Implement concept of the 'Generic Lab'

Ensure aesthetic appearance of services on exposed ceilings

Avoid use of internal beams for smooth run of services

Closely monitor services coordination with consultants

Use BIM to detect clashing of services and with structures

Close Stage 3 before proceeding to Stage 4

Get Client Sign off on all drawings and specifications produced

Prepare Stage 3 closure and lessons learned report

Conduct lessons learned session

Identify success factors

Identify weaknesses

Give recommendations

Learn lessons from Stage 4 (Documentation and Procurement)

Ensure smooth council approval process

Arrange pre-scrutiny meeting of all consultants with council

Do energy efficiency calculations during stage 3

Give ample time for checking drawings, filling forms and printing

Use BIM (Building Information Modelling) to project's advantage

Colour council drawings on BIM model to save time

Do all schedules on BIM model for ease of tracking changes

Generate Equipment Schedule from model

Generate Door, Window and Shop front Schedules from model

Generate Sanitary ware Schedule from model

Determine façade shading from BIM climatic analysis

Do energy efficiency calculations from BIM model

Generate Room Data Drawings from BIM model

Use library parts for future projects

Ensure state-of-the-art services reticulation

Undergo meticulous drawings coordination with consultants

Make effective use of Room Data drawings

Minimize delays and crashing risks caused due to large BIM file size

Separate 3D Model and Layout Files

Create separate but linked Room Data 3D model

Keep each storey of Room Data as separate linked model

Make use of modules for repetitive library parts

Make changes to modules or library parts only once if used multiple times

Use the full potential of BIM to project's advantage

Decide when to break link between 2D drawing and 3D model

Use 3D model for 3D visualisation, coordination and tracing changes

Use 3D model to churn out pressuring Client presentations very quickly

Factor in initial time delays when 3D modelling

Keep 3D model updated to benefit when doing 'As Built' drawings

Minimize hand drafted documents which appeared unprofessional

Use opportunity to enrich office's technical drawing standards

Manage integration difficulty with CAD generated technical drawings

Use 2D with virtual link to 3D for details

Issue details and wall sections in good time

Make use of standard details from technical library

Ensure team members can work on the project from any remote location

Put proper internet infrastructure for remote team working

Set up remote team working using company's domain over the internet

Close Stage 4 before proceeding to Stage 5

Get Client Sign off on all drawings and specifications produced

Prepare Stage 4 closure and lessons learned report

Conduct lessons learned session

Identify success factors

Identify weaknesses

Give recommendations

Learn lessons from Stage 5 (Construction Contract Administration)

Set finishes and workmanship quality standard before construction commences

Set up mock up for typical rooms and services reticulations

Set up typical brickwork quality and wall finishes samples

Keep mock up samples till completion of project

Manage late design changes with time and cost implications

Get Change Request forms signed by employer and PM when required

Manage scope creep appropriately

Evaluate impact of adding extra floor after construction has well commenced

Evaluate impact on regulations such as fire

Evaluate impact on company's human resources needs

Treat such major changes as separate projects

Keep track record of delays and communicate impact to client immediately

Warn PM when Client takes too long to make decisions dragging project progress

Set deadline for Client decision making dates via the PM

Manage Schedule Programme

Warn PM that Client delaying decisions would undermine quality and coordination

Avoid putting pressure on consultants and Contractor to make up lost time

Manage unnecessary Client interfering on professionals' work

Educate client on impact of dragging progress and programme

Manage delay in Practical Completion Date

Manage impact of contract cancelation by Contractor

Manage impact of new contractor appointed to finish the work.

Put sound Quality Assurance measures in place

Get all drawings checked by senior staff before issuing

Red line on A3s to resolve global problems

Use A0/A1 for fine tuning to office standards

Use highlighters to trace down redlined comments

Get senior staff to set the standard of quality on site for juniors

Follow ISO 9001 Quality Assurance guidelines

Get ISO 9001 certification office wide

Avoid legal risks to the project

Ensure Project Architects are registered with SACAP

Avoid use of foreign approved materials

Use SABS or Agrément South Africa approved products

Avoid errors, omissions and redundancy of information

Link BIM model to standard specification systems

Up skill ArchiCAD skills and efficiency of Production Staff members

Use FTP site to extract drawing issue register than DRPRO

Avoid hand drafted documents and schedules

Encourage Project Designers to use BIM software

Close Stage 5 before proceeding to Stage 6

Get Client Sign off on all drawings and specifications produced

Prepare Stage 5 closure and lessons learned report

Conduct lessons learned session

Identify success factors

Identify weaknesses

Give recommendations

Learn lessons from Stage 6 (Close Out)

Issue "As Built" drawings to Client with disclaimer

Issue all pertinent Certificates to Contractor

Save PDF and DWG drawings of project in repository

Close Stage 6 before proceeding to close the project

Close all outstanding project tasks

Prepare Stage 6 closure and lessons learned report

Conduct lessons learned session

Identify success factors

Celebrate council's appreciation of adherence to building standards

Keep Building Inspector updated at all times

Celebrate Client's satisfaction during Practical Completion period

Identify weaknesses

Seriously study why ACG made financial loss on a key project

Review efficiency of budget tracking methods used

Identify factors that led to internal cost overruns

Identify why issues were not mitigated in a timely manner

Give recommendations

Avoid every possible time and budget wastage

Avoid award winning mentality on every project

Create corporate identity through design

Get early input from design team

Ensure reshuffling of staff resources easy

Avoid loss of institutional memory

Mitigate risk of entire project knowledge residing with one person

Document lessons learned at end of every stage

Minimise possibility of key personnel leaving during the project life cycle

Introduce staff retention policy

Produce Project Closure Report at the end of every project

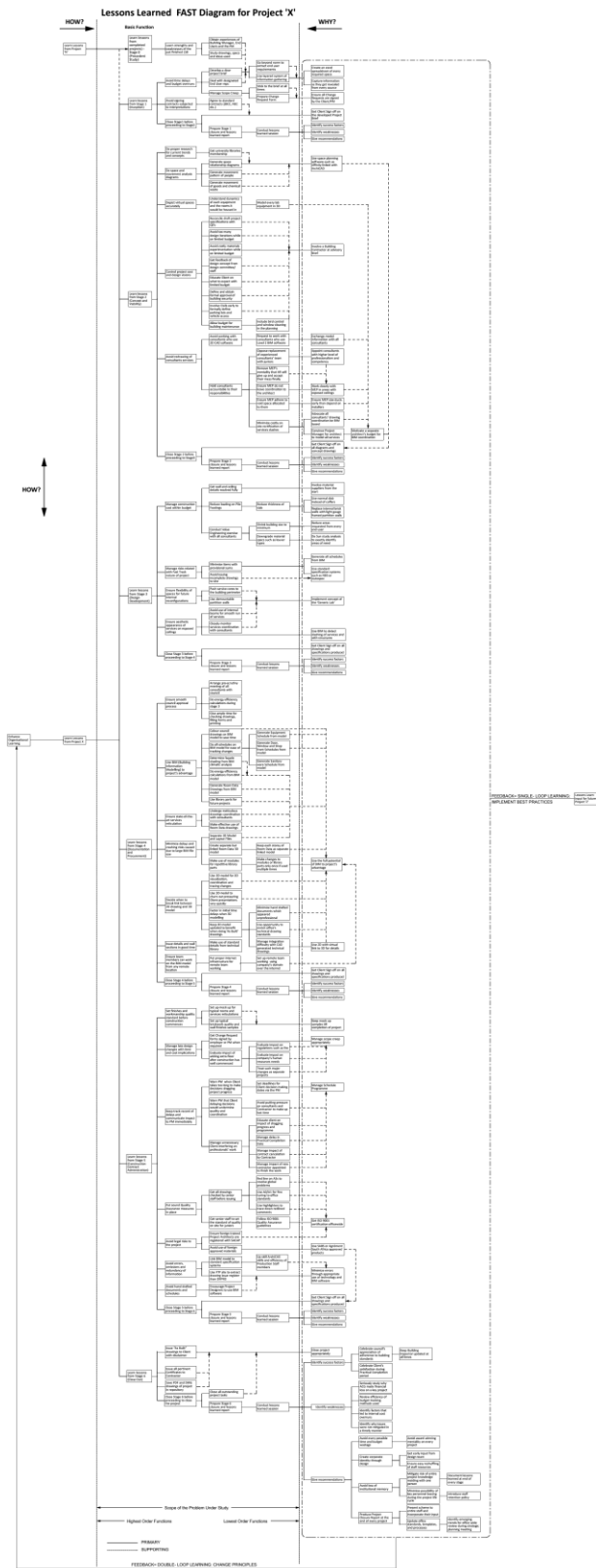
Present scheme to entire staff and incorporate their input

Update office standards, templates, and processes

Identify emerging trends for office wide review during strategic planning meeting

Appendix C. 2: Lessons Learned Tree Diagram for Project 'X' (Author)

Appendix C3: Lessons Learned FAST Diagram for Project 'X'



Appendix C. 3: Lessons Learned FAST Diagram for Project 'X' (Author)

Appendix D: Focus Group Research help document

Dear participant

Thank you for participating in the brainstorming session and the focus group research workshop! Your participation in this study is of much value to the principle researcher.

By your participation in the above two sessions, you will help the principle researcher achieve the following goals:

- 1. Lessons Learned FAST Diagram:** the principle researcher has proposed a FAST Diagram (*Functional Analysis System Technique*) as a means of communicating lessons learned from an individual project to the wider organisation. He will educate you and the group on how it was created using the Why-How Logic Question. Through your active participation during the brainstorming session, you are expected to adopt, modify or completely change the proposed FAST Diagram. The final diagram would serve as a benchmark for future researchers in any field to further investigate and develop a generalised lessons learned FAST model.
- 2. Lessons Learned FAST Diagram vs. Project Closure Report:** During this second session which is focus group research workshop, two groups of 4 to 5 people will be formed where one group will study a Project Closure Report compiled for Project 'X' (the biggest and key project in the office from 2011 to 2013) with special focus on the Lessons Learned part. The second group will be given a Lessons Learned FAST Diagram created from the same Project Closure Report. Both groups will be given 30 minutes each to study the document and the FAST Diagram respectively. Then they will be tested on their comprehension of what they have been presented with using questions prepared by the principle researcher so that a comparison of the two groups can be performed. This test will help yield results that can be analysed in a quantitative fashion. This way, one can determine whether the use of graphical methods such as FAST Diagrams provide a means of communicating lessons learned from one project to the wider organisation is effective or not.

The two groups are categorised as follows:

Group A Code	Position in organisation	Group B Code	Position in organisation
A1	Partner in charge of current project	B1	Partner
A2	Team Leader- Future similar Project	B2	Team Leader- Current Project
A3	Project member	B3	Project member
A4	Staff member	B4	Staff member
A5	New/ Junior staff	B5	New/ Junior staff

Appendix E: Cover letter

Dear participant,

Thank you for responding to my request to participate in this study. Your participation is of high significance relative to the success of this study.

Please refer to the Consent and Confidentiality form, for further information on the study. Before you commence with participating in the brainstorming session as well as the focus group research, please make sure that you have read the latter form carefully, in order to understand the motivation for the study and the benefits your participation will bring about.

This email contains the following documents:

1. Consent and Confidentiality form
2. Focus Group Research help document

If you do participate, the entire process will take two (2) hours of your time at the most. In order to ensure that this study is completed on time, I will appreciate it if you can meet the following date and time slots:

Presentation by Principle Researcher:	Time: 15h30- 15h45, Date: 25 September 2014
Brainstorming Session:	Time: 15h45- 16h15, Date: 25 September 2014
Focus Group Research Session:	Time: 16h15- 17h00, Date: 25 September 2014
Answering Individual Questions Session:	Time: 17h00- 17h30, Date: 25 September 2014

If you feel that you will not be able to meet these dates, please contact me, and I will reschedule a similar time for Friday 19 September due to time constraint.

I am looking forward to your cooperation in this regard.

Your inputs are most valuable.

Kind regards,

Tekle Beraki

Principle researcher

Appendix F: Confidentiality and Consent

Dear participant,

The aim of this study is to determine how the lessons learned from individual projects can be converted into organisational knowledge and how these lessons could contribute to more successful future projects. Data will be collected during a workshop with a selected focus group within this participating architectural firm. Nine (9) other architects/ technologists from this office will also be asked to participate in the study. The ten participants will form two groups with each group consisting one of the Partners, members of the project under study, a team leader, a relatively new staff member and members of the next similar project where the lessons are expected to be conveyed to.

Participation in this study is voluntary – please feel free to reject the opportunity to partake, if you so desire. If you do participate and wish to withdraw at any time during your participation, you are encouraged to feel comfortable when doing so. The data collected from the focus group research workshop, will be treated confidentially, the source of which will only be known to the principle researcher. To emphasise the anonymity of your participation, you will be referred to as Group “A” or “B” and as participant “A1 to A5 or B1 to B5” in the research report as shown in Appendix D. A copy of the final report will be provided to you for your scrutiny should you wish to. If you do participate in this study, the following benefits for the study will be realized:

- Insight into what is currently being done to capture; retain and transfer lessons learned by others;
- Insight into the full lessons learned FAST Diagram creation process that a learning organisation can utilize to develop one of its own.
- Information regarding the use of graphical methods such as the FAST Diagram to disseminate lessons learned from one project to the wider organisation with a practical example of one of the key projects just being completed in the office;

Should you require any information throughout or during the sessions, please feel free to contact or prompt the principle researcher. It is the aim of the principle researcher to conduct the study carefully and thoughtfully, ensuring that the data capturing, display, and analysis processes are completed in a way such that there is no risk involved for the participating individual or organisation. If the participant so wishes, a confidentiality agreement if specified by the participant organisation, will be signed by the principle researcher.

I, Teklehaimanot Tewelde Beraki, undertake to safeguard the data collected, by treating it as confidential, and by referring only to the organisation as “the Architects”, the project as Project ‘X’ and the participant as “participant A or B”.

I, _____ (print name), am fully aware of the aim, motivation, and purpose of this study and _____ (disagree/agree), to participate in this study.

THUS DONE AND SIGNED AT _____ ON THIS THE _____ DAY OF _____ 2014.

PARTICIPANT: _____

PRINCIPLE RESEARCHER: _____

Email: tekl.tewe@gmail.com

Mobile: 083 259 3615

Appendix G: Questions for Focus Group Research

Questions for Group "A" - Project Closure Report Group: You have read the Lessons Learned report for Project X for the past 45 minutes, now fill as much information as you can in the table below within the next 15 minutes:

Work Stage	Identify success factors in Project X:	Identify weakness in Project X:	Give recommendations future projects:
1			
2			
3			
4			
5			
6			

Questions for Group “B” - FAST Diagram Group: You have studied the Lessons Learned FAST Diagram for Project X for the past 45 minutes, now fill as much information as you can in the table below within the next 15 minutes:

Work Stage	Identify success factors in Project X:	Identify weakness in Project X:	Give recommendations future projects:
1			
2			
3			
4			
5			
6			

Appendix H: Individual Questions for each Participant

Date	25 September 2014
Time	15:30 to 17:30
Place	Office Main Board Room
Participant	

Questions for every participant: You were introduced to the Lessons Learned report and the FAST Diagram generated from it for Project 'X', now please answer the questions below within the next 30 minutes:

A. Objective Questions

To be answered by each member of **Group A** – Project Closure Report group:

No.	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	I find it easy to understand the contents of the template (Project Closure Report).	1	2	3	4	5
2	I recommend each team should read the Project Closure Report first before starting a new project of similar nature or complexity.	1	2	3	4	5

To be answered by each member of **Group B**- Lessons Learned FAST Diagram group:

No.	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	I find it easy to understand the contents of the Lessons Learned FAST Diagram for Project X.	1	2	3	4	5
2	I recommend each team should review the Lessons Learned FAST Diagram first before starting a new project of similar nature or complexity.	1	2	3	4	5

To be answered by *every participant*

No.	Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	Lessons Learned report should be compiled at the end of every stage	1	2	3	4	5
2	Lessons Learned report should only be compiled at the end of the project as part of the Project Closure Report.	1	2	3	4	5
3	I recommend the Lessons Learned FAST Diagram than a Project Closure Report document as a means of communicating Lessons Learned from an individual Project to the wider organisation.	1	2	3	4	5
4	I recommend the Project Closure Report document than a Lessons Learned FAST Diagram as a means of communicating Lessons Learned from an individual Project to the wider organisation.	1	2	3	4	5

B. Hypothetical alternatives- subjective questions

3. Would you apply the lessons learned template in your project? What else would you add to or remove from the template?

4. Would you consider using the FAST diagram to disseminate lessons learned within the organisation? Do you make use of any other means such as other graphical methods to disseminate lessons learned from one project to the wider organisation?

Appendix I: Contact summary form

Date	25 September 2014
Time	15:30 to 17:30
Place	Office Main Board Room
Participant	

1. **What were the main issues or themes that struck you most in this contact?**

2. **Summarise the fundamental objectives that were made clear during the contact session**

3. **Anything else that struck you as salient, interesting, illuminating or important in this contact?**

Appendix J: Ethics Clearance

EBE Faculty: Assessment of Ethics in Research Projects

Any person planning to undertake research in the Faculty of Engineering and the Built Environment at the University of Cape Town is required to complete this form before collecting or analysing data. For more info regarding the procedure of completing the form please log onto <http://www.ebe.uct.ac.za/research/ethics/>.

When completed it should be submitted to the supervisor (where applicable) and from there to the Head of Department. If any of the questions below have been answered YES, and the applicant is NOT a fourth year student, the Head should forward this form for approval by the Faculty EIR committee: submit to Ms Zulpha Geyer (Zulpha.Geyer@uct.ac.za; Chem Eng Building, Ph 021 650 4791).

Students must include a copy of the completed form with the thesis when it is submitted for examination.

Name of Principal Researcher/Student: **Teklehaimanot Tewelde Beraki**
 Department: **Construction Economics and Management**

If a Student: Degree: **Masters** Supervisor: **Ian Jay**

If a Research Contract indicate source of funding/sponsorship: **N/A**

Research Project Title: **Improving lessons learned practice in Architectural Practices: Systematic conversion of lessons learned into improvement actions**

Overview of ethics issues in your research project:

Question 1: Is there a possibility that your research could cause harm to a third party (i.e. a person not involved in your project)?	YES	NO
Question 2: Is your research making use of human subjects as sources of data? If your answer is YES, please complete Addendum 2.	YES	NO
Question 3: Does your research involve the participation of or provision of services to communities? If your answer is YES, please complete Addendum 3.	YES	NO
Question 4: If your research is sponsored, is there any potential for conflicts of interest? If your answer is YES, please complete Addendum 4.	YES	NO

If you have answered YES to any of the above questions, please append a copy of your research proposal, as well as any interview schedules or questionnaires (Addendum 1) and please complete further addenda as appropriate.

I hereby undertake to carry out my research in such a way that

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

Signed by:

	Full name and signature	Date
Principal Researcher/Student:	Teklehaimanot Tewelde Beraki signature removed	22-09-2014

This application is approved by:

Supervisor (if applicable):		
HOD (or delegated nominee): Final authority for all assessments with NO to all questions and for all undergraduate research.		
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.	G. Sithole signature removed	25-09-2014

EBE Faculty: Assessment of Ethics in Research Projects

Any person planning to undertake research in the Faculty of Engineering and the Built Environment at the University of Cape Town is required to complete this form before collecting or analysing data. For more info regarding the procedure of completing the form please log onto <http://www.ebe.uct.ac.za/research/ethics/>.

When completed it should be submitted to the supervisor (where applicable) and from there to the Head of Department. If any of the questions below have been answered YES, and the applicant is NOT a fourth year student, the Head should forward this form for approval by the Faculty EIR committee: submit to Ms Zulpha Geyer (Zulpha.Geyer@uct.ac.za; Chem Eng Building, Ph 021 650 4791).

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Name of Principal Researcher/Student: **Teklehaimanot Tewelde Beraki**
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Overview of ethics issues in your research project:

Question 1: Is there a possibility that your research could cause harm to a third party (i.e. a person not involved in your project)?	YES	NO
Question 2: Is your research making use of human subjects as sources of data? If your answer is YES, please complete Addendum 2.	YES	NO
Question 3: Does your research involve the participation of or provision of services to communities? If your answer is YES, please complete Addendum 3.	YES	NO
Question 4: If your research is sponsored, is there any potential for conflicts of interest? If your answer is YES, please complete Addendum 4.	YES	NO

If you have answered YES to any of the above questions, please append a copy of your research proposal, as well as any interview schedules or questionnaires (Addendum 1) and please complete further addenda as appropriate.

I hereby undertake to carry out my research in such a way that

- there is no apparent legal objection to the nature or the method of research; and
- the research will not compromise staff or students or the other responsibilities of the University;
- the stated objective will be achieved, and the findings will have a high degree of validity;
- limitations and alternative interpretations will be considered;
- the findings could be subject to peer review and publicly available; and
- I will comply with the conventions of copyright and avoid any practice that would constitute plagiarism.

Signed by:

	Full name and signature	Date
Principal Researcher/Student:	Teklehaimanot Tewelde Beraki signature removed	22-09-2014

This application is approved by:

Supervisor (if applicable):	<i>E I JAY</i> signature removed	<i>23 09 2014</i>
HOD (or delegated nominee): Final authority for all assessments with NO to all questions and for all undergraduate research.		
Chair : Faculty EIR Committee For applicants other than undergraduate students who have answered YES to any of the above questions.		

ADDENDUM 1:

Please append a copy of the research proposal here, as well as any interview schedules or questionnaires:

Please see attached **Research Proposal** as well as the questions prepared for the focus group research in **Appendices G, H and I** all in **PDF format**.

ADDENDUM 2: To be completed if you answered YES to Question 2:

It is assumed that you have read the UCT Code for Research involving Human Subjects (available at <http://web.uct.ac.za/depts/educate/download/uctcodeforresearchinvolvinghumansubjects.pdf>) in order to be able to answer the questions in this addendum.

2.1 Does the research discriminate against participation by individuals, or differentiate between participants, on the grounds of gender, race or ethnic group, age range, religion, income, handicap, illness or any similar classification?	YES	NO
2.2 Does the research require the participation of socially or physically vulnerable people (children, aged, disabled, and so on) or legally restricted groups?	YES	NO
2.3 Will you not be able to secure the informed consent of all participants in the research? (In the case of children, will you not be able to obtain the consent of their guardians or parents?)	YES	NO
2.4 Will any confidential data be collected or will identifiable records of individuals be kept?	YES	NO
2.5 In reporting on this research is there any possibility that you will not be able to keep the identities of the individuals involved anonymous?	YES	NO
2.6 Are there any foreseeable risks of physical, psychological or social harm to participants that might occur in the course of the research?	YES	NO
2.7 Does the research include making payments or giving gifts to any participants?	YES	NO

If you have answered YES to any of these questions, please describe below how you plan to address these issues:

Although there is **no YES** answer to the above questions, the following extra precautions have been taken into account:

1. No mention of the organisation is made other than it is an architectural firm as per the title of the research and it is mentioned as **'the Architect'** as shown in **Appendix C1**;
2. The project used for this pilot study is named as **Project 'X'** as shown in **Appendices C1, C2 and C3**;
3. The two groups participating in the focus group research are named as **Group "A"** and **Group "B"** and the individual participants as participant **"A1 to A5 or B1 to B5"** as shown in **Appendices D, E and F**;
4. Please also refer to the **Confidentiality and Consent** forms already signed by all the participants and myself which forms part of **Appendix F**.

ADDENDUM 3: To be completed if you answered YES to Question 3:

3.1 Is the community expected to make decisions for, during or based on the research?	YES	NO
3.2 At the end of the research will any economic or social process be terminated or left unsupported, or equipment or facilities used in the research be recovered from the participants or community?	YES	NO
3.3 Will any service be provided at a level below the generally accepted standards?	YES	NO

If you have answered YES to any of these questions, please describe below how you plan to address these issues:

ADDENDUM 4: To be completed if you answered YES to Question 4

4.1 Is there any existing or potential conflict of interest between a research sponsor, academic supervisor, other researchers or participants?	YES	NO
4.2 Will information that reveals the identity of participants be supplied to a research sponsor, other than with the permission of the individuals?	YES	NO
4.3 Does the proposed research potentially conflict with the research of any other individual or group within the University?	YES	NO

If you have answered YES to any of these questions, please describe below how you plan to address these issues: