ORGANISATIONAL LEARNING IN CONSTRUCTION: A FRAMEWORK FROM THE PROCESS IMPROVEMENT PERSPECTIVE

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Declaration

The thesis builds on research conducted as part of the EPSRC funded SPICE project, a two year research programme that finished in 2005. The author was a research student on the project and was responsible for developing and testing the model through a series of case studies. The author was also involved in the EPSRC funded KIM research project which also investigated organisational knowledge and information management.

Dedicated to my beloved **family**

for their unconditional **love** & **patience**

Abstract

The construction industry, one of the significant sectors of most regional and national economies, is being continuously urged to improve its performance at project and organisational level. The urgent need to improve the processes of construction projects and organisations has been highlighted in a number of industry reports. In this regard, organisational learning has been considered as essential to facilitate process improvement, innovation and sustaining the competitiveness of construction organisations, and also of the sector as a whole.

Although there are a number of initiatives to facilitate organisational learning in construction contexts, literature reveals that the organisations are still finding it difficult to identify ways to effectively facilitate learning to improve their processes and performance. Therefore, this research aims to bridge the gap by developing a framework to facilitate organisational learning in construction contexts. In doing so, the process improvement perspective has been taken into consideration. Given the constructive nature of the research, design science was used as the overarching methodology. Within this overall approach, case studies were used to inform, develop and validate the research process and the outcomes. An extensive literature review, document analysis, workshops, participant observations are the key techniques used to achieve the research aim.

The main outcome of this research is the framework to facilitate organisational learning within construction context. The research further highlighted the complex adaptive nature of the construction contexts and processes, and it has been incorporated into the Procurer, Provider and User (PPU) framework. In addition, the integration of the role of process maturity and time dependent meta roles of stakeholders in the context of complex construction projects, to facilitate learning and improvement, is one the significant contributions to the body of knowledge. The developed framework could be adopted by any organisations, which are contracting, consultancy, client's organisations and/or regulatory bodies when they seek to improve their processes while facilitating organisational learning. It is recommended that industry practitioners / strategic level decision makers take consider their time and stake dependent meta-role and the resultant information flows as a basis for evaluating and updating their current organisational processes.

Keywords: Organisational Learning, Complex Adaptive Organisations, Process Improvement Framework, Construction Industry

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Abbreviations

BPI	Business Process Improvement
CIB	Construction Industry Board
CMM	Capability Maturity Model
CMMI	Capability Maturity Model Integration
CRISP	Construction Research and Innovation Strategy Panel
DETR	Department of the Environment, Transport and Regions
DSR	Design Science Research
EPSRC	Engineering and Physical Science Research Council
GDP	Gross Domestic Product
GNP	Gross National Product
GVA	Gross Value Addition
ICT	Information Communication Technology
IES	Institute for Employment studies
IPRA	International Public Relation Association
KIM	Knowledge Information Management
KM	Knowledge Management
LIFT	Local Improvement Finance Trust
NAO	National Audit Office

OGC	Office of Government Commerce
OL	Organisational Learning
OLS	Optimal Learning Spaces
PFI	Project Finance Initiative
PIT	Process Improvement Team
PMBOK	Project Management Body of Knowledge
POE	Post Occupancy Evaluation
PPP	Public Private Partnership
PPU	Procurers Providers and Users
RAE	Royal Academy of Engineering
SECI	Socialisation, Externalisation, Combination and Internationalisation
SEI	Software Engineering Institute
SPICE	Structured Process Improvement for Construction Enterprises
TPS	Toyota Production System
TQM	Total Quality Management
UK	United Kingdom
USA	United States of America

Chapter One

1. INTRODUCTION

This introduction chapter provides an overview of the doctoral research aimed at facilitating learning in construction organisations. Firstly, the background and the rationale of the research are explained. In doing so, literature pertaining to organisational learning, knowledge management and process improvement aspects relating to the construction industry context is presented, thereby, establishing the current state of knowledge, and the existing gaps in knowledge. Subsequently, this chapter elucidates the research aim, objectives, overview of the adopted research methods and the research process, scope of this research and the delimitations. Finally, this chapter underlines the contribution of this research to the body of knowledge and the value of undertaking this research study. A guide to this thesis is also included at the end of this chapter.

1.1 Background and rationale

The construction industry is important due to a number of reasons. Amongst them are, the significant contribution that the construction industry makes to the economy, environment and to the overall sustainability agenda. Horta and Camanho (2014, p.974) state;

> *"Construction as a key sector of the national economy and of the global economy has also witnessed major structural changes, such as globalization, technological evolution and increased regulation, which contributed to a considerable increase in competition among construction companies"* (Horta and Camanho, 2014, p.974).

Construction is a major contributor to UK Gross Domestic Product (directly 8.5% in 2008, rising to 10% overall when the entire value chain is considered) and a driver of historical GDP growth (National Construction Statistics, 2013). Its' contribution to GNP (Gross National Product) globally is approximately 10% (Hillebranbdt, 2000) and the contribution to the GVA (Gross Value Addition) was approximately 6% in 2012 (Rhodes, 2013). The same GVA percentage was maintained during the year 2014 (Department of Business, Innovation and Skills, 2014). Moreover, Harvey and Ashworth (1997) highlighted that the industry also represents over half of Britain's fixed capital investment and contributes 6.6% to the employment in 2013 (Rhodes, 2013).

1.1.1 Need for industry improvement

Performance of the construction industry in terms of its ability to meet cost, time and quality targets have been often called into question. Latham (1994) and Egan (1998) reports have been at the forefront of these calls. Having quoted the findings of the British Property Federations survey (1997) on major UK clients, Egan (1998) pointed out

> *"more than a third of major clients are dissatisfied with contractors' performance in keeping to the quoted price and time, resolving defects, and delivering a final product of the required quality …..and….more than a third of major clients are dissatisfied with the consultants' performance in coordinating teams, in design and innovation, in providing a speedy and reliable service and in providing value for money"* (Egan, 1998, p8).

This statement strongly emphasised the urgent need for improving the performance of construction products and services towards delivering better value for clients' investments.

On one hand, the construction industry is widely perceived as been slow to innovate and has lagged behind many manufacturing industries in the implementation of management and technology innovations (Veshosky, 1998; Reichstein, Salter and Gann, 2005). On the other hand, there is growing pressure for organisational, operational, structural, and cultural transformation within the industry to survive in the competitive markets (McGeorge and Palmer, 1997). Kale and Arditi (1999) noted that industry characteristics such as the fragmented nature of the industry, structure and organisation of construction processes, easy entry to the construction business, post-demand production, one-off nature of projects, high uncertainty and risk, high capital intensiveness of the constructed facilities, temporary nature and duration of exchange relationships, impose great challenges on the companies operating in it. Moreover, Fernández-Solís (2008, p.2) identifies construction industry as a

> *"human system but it is the complex nature of the industry that makes it behave as an adaptive system, thus its transformation in time is captured by the panarchy metaphor" Fernández-Solís (2008, p.2).*

However, with the increase of uncertainty and turbulence in the construction business environment (Lansley, 1987), construction contractors are being urged to learn new ways of working in order to compete in present business environment (The Royal Academy of Engineering, 1996).

1.1.2 Need for process improvement in construction

Latham (1994) and Egan (1998) called for changes through the introduction of effective business processes within construction in order to meet the challenges of an evolving business environment. Supportively, the International Public Relation Association (IPRA) and the University of Westminister's report (1998) for the Construction Industry Board also provided further impetus for the need for a learning culture that should facilitate effective business process improvement within the construction industry (Kululanga, 1999). Moreover, Working Futures 2004-2014 report (2006) highlighted that the construction's share of total output is expected to continue its slow decline over 2004-2014, as output growth is forecast to be around 1.5% per annum (Wilson, Homenidue and Dickerson, 2006). Having observed the pattern of construction industry during the period of 1965-1996, Anheim (2003) identified that the industry was forming lower productivity (1.7% of growth rate) when compared to the other sectors of the economy. Moreover, Foster-Mcgregor *et al.* (2013) explain the productivity and efficiency gaps in construction industry. Therefore, there is an essential need to improve the construction industry performance in terms of customer satisfaction, productivity, quality, and efficiency.

1.1.3 Importance of learning in construction organisations

The complexities of the design and construction processes have been highlighted as a major factor behind the industry's failure to realise significant improvements over the last 60 years. The fragmented nature of the industry and the separation of disciplines have prevented some degree of tangible change. There have been

increasing calls for construction to improve its processes and learn from the past (Egan, 2002; Ofori, 2008) and also learn from the mistakes (Dainty, Cheng and Moore, 2003) to improve production operations and customer satisfaction. Researchers in the field of the built environment have highlighted the importance of learning and process improvement in construction (Boyd and Robson, 1996) and also recognised the positive effect of organisational learning towards Business Process Improvement (BPI). Supportively, Chinowsky, Molenaar and Realph (2007) highlighted the importance of construction and engineering organisations to evolve into learning organisations with continuous knowledge and business process improvements. Jashapara (1995) advocated researchers to explore the antecedents of learning issues for the construction industry to facilitate business process improvement, and the seminal studies of Buckler (1998), Vakola and Rezgui (2000), and Vakola (2000) also expressed the same opinion. It is also worth noting that construction research has also progressed on the role of organisational learning in promoting innovation (Buckler, 1998; Winch, 1998; Vakola, 2000; Vakola and Rezgui, 2000; Barlow, 2000). Attention has also been paid to learning that takes place within partnering context (Barlow and Jashapara, 1998; Franco, Cushman and Rosenhead, 2004) and also within strategic alliances (Holt, Love and Li, 2000). Chan *et al* (2004) explained organisational learning as a key to the survival of construction organisations.

Kululanga (1999) stated that lack of antecedents associated with organisational learning could result in a situation where construction contractors may not effectively create and imbibe knowledge in their internal and external business

environments. Having identified the gap, he developed a mechanism to evaluate forms of organisational learning for construction contractors' which will help construction directors' to manage and improve their businesses. However, a lack of methodology for measuring the learning capability of a company has been one of the problems for implementing organisational learning within companies and those mechanisms need to go beyond the traditional financial performance indicators. Behm and Schneller (2013) have indicated the importance of organisational learning in order to improve the safety performance in construction, by putting the lessons learnt into good use. Carrillo, Ruikar and Fuller (2013) also support the idea that the lessons learnt practices in the construction contractor organisations should be improved, while Tennant and Fernie (2013) state that learning within supply chain management is strongly linked positively to enhancing the competitive advantage.

However, the project based nature of the construction industry has been identified as a barrier to foster learning in construction. Arguably, Chan *et al.* (2004) explained that the project based nature of the industry is causing problems in embracing organisational learning. Having explored the organisational learning practices in the Indonesian construction industry, Tan and Tjandra (2002) argued that due to the project based nature of the industry, project teams tend to focus on short term results and move on to the next project without the opportunity for reflection, thus resulting in discontinuities in the knowledge flows and learning. This idea is supported by Eriksson (2013) too. Moreover, Tan and Tjandra (2002) stated that it is only recently that the importance of a learning culture has been

recognised in this project based industry. Supportively, Anheim (2003) noted the project based nature as one of posing obstacles for the construction organisations to learn from their operations, stating that the view that each new project as a separate assignment reduces the insight into transferring the lessons learnt from the previous projects.

It is worthy to note that there are positive aspects of the project based nature of construction too (Anheim, 2003). Having studied the building contractors working methods and how team work affects the potential for learning, Anheim (2003) concluded that complex projects with relatively autonomous project teams promote learning. This argument is in line with that of Nonaka and Takeuchi (1995) who emphasised the need for sufficiently stimulating tasks as a pre-requisite for learning. More importantly, Anheim (2003) stated that if construction projects are viewed as complex scenarios containing large number of different problems, they could also be considered as potential learning scenarios. The Post Occupancy Evaluations (POEs) are seen as a way of learning and informing the future design improvement (Zeisel, 1981; Zimmerman and Martin, 2001; Meir *et al,* 2009). However, Way and Bordass, (2005) consider the POE stage and the process as one of the most neglected stages in construction.

Although the concepts related to learning within organisational contexts have been presented in literature over the last six decades, it became widely recognised in the management contexts in the 1990s, especially within practitioner led scenarios. Knowledge management has also developed into a popular phrase within the field of management. As such many researchers have used the current

models of organisational learning and knowledge management as forms of representations of learning within organisations, while practitioners tend to use them as tools to promote and make effective use of learning in companies. The Institute for Employment Studies (IES) identified fostering organisational learning as one of the challenges facing management in major UK employing organisations (Harish and Carter, 2002).

Large amounts of literature identify organisational learning as essential for the success and survival of organisations. De Geus (1997) stated that the only source of competitive advantage is an organisation's ability to learn. Baldwin, Danielson and Wiggenhorn (1997) noted that what seems to distinguish surviving and adopting organisations from the rest is their ability to learn. Also Nonaka (1991) argued that competitive advantage, innovation and effectiveness are the primary products of nurturing a culture of learning within a company. Barrow (1993) and Hill (1996) highlighted that organisational learning and continuous improvement principles are inextricably linked, such that organisational learning should be the most compelling reason for undertaking any continuous improvement schemes. Toyota Way, which advocates the use of Toyota Production System (TPS) based on lean production, considers learning and continuous improvement amongst the fourteen (14) Toyota Way principles (Liker, 2004). The Balance Scorecard (Kaplan and Norton, 1996), a popular framework for strategic performance measurement, considers the building of the necessary infrastructure in organisations to facilitate learning and growth, as a core element of its framework. Sarshar *et al,* (2000) argued that a systematic management of construction processes is one of the

good methods of increasing predictability and delivering increased customer value. However, the industry has no standard mechanism to assess process improvements and the need is highlighted.

Given the fact that construction is significantly a project based industry, the way in which projects are viewed, is worth noting. In this regard, the deficiencies of the popular understanding of project management such as that of PMBOK (Project Management Body of Knowledge) has been highlighted (Koskela and Howell, 2002). As such, they have indicated that a theory of project management should address three aspects namely, design and the making of systems employed in designing and making; control of those systems in order to realise the production intended; and the improvement of those systems. This provides further evidence that learning and improvement is an integral and essential aspect of successful project management.

1.1.4 Complex adaptive nature of construction context

The need to recognise the complex nature of the construction industry relationships has been highlighted by Gibb *et al* (2014). Therefore, a shift in thinking of how to visualise organisations and projects may result in challenging some of the established thinking in organisational learning and knowledge management. As such, the study of organisation learning has been subjected to criticism by observant researchers. Dahlgaard (2004) recognises the need to consider the different perspectives as interacting and interrelated in the dynamic process of learning. From the perspective of metaphysics of change, it is 'change' which is natural and primary and 'organisation' is seen as secondary, and an

artificially-imposed attempt to arrest and stabilise what is essentially a ceaselessly fluxing reality indifferent to causes (Chia, 1999). Moreover, Tsoukas and Chia (2002) noted that the traditional approaches to organisational change have been dominated by the assumptions of prevailing stability, routine, and order. As a result, organisational change has been reified and treated as exceptional rather than natural.

The perspective of complex responsive processes of relating (Stacey, 2001; Cooke-Davis *et al*, 2007), explain the dynamic and organic nature of the project and organisational environments.

> *"Project arrangements and settings can be seen as a particular kind of a pattern of interactions between people" (Cooke-Davis et al, 2007, p 58).*

Therefore, they highlighted that the project contexts which were traditionally seen as systemic, with a dual relationship. *"…on the one hand, formative unfolding of the envisaged design towards some pre-given motivation such as a project goal, and on the other hand, rationalist individual choice of action"* (Cooke-Davis *et al*, 2007, p 58), will now be considered as *"continually iterated, self-organising process of relating, and if strategic direction and future goals are continually emerging"* (Cooke-Davis *et al*, 2007, p 58).

1.2 Research Problem / gap in knowledge

Section 1.1 of this chapter explained the importance of 'organisational learning' for construction organisations, and recognised the necessity for broadening the understanding of 'organisational learning' within the construction context. Literature reveals 'learning' in two viewpoints. Learning can be considered as a natural process taking place in humans and other living beings. In such instances, the purpose of learning may not necessarily be aimed at seeking improvements of the contexts. On the other hand, learning is considered as an essential requisite for improvement, as evidenced in Section 1.1. Therefore, within this research study, 'learning' is considered from the process improvement perspective. Although many research addressing organisational learning and knowledge management exist, the absence of an in-depth consideration of organisational learning for process improvement within the complex adaptive construction context is lacking. Therefore, there is a need for a framework to facilitate "learning in organisations" in construction, through the process improvement perspective.

1.3 Aim and Objectives

The aim of this research is *'to develop a framework to facilitate organisational learning in construction specifically to achieve process improvement'*. In order to achieve the broader aim, the following objectives have been formulated.

1. to study the principal concepts of organisational learning and practices;

2. to explain the role of process improvement perspective in facilitating organisational learning;

3. to explore the contextual issues associated with organisational learning and process improvement within construction industry context;

4. to develop a framework to facilitate organisational learning in construction organisations; and

5. to validate the framework and identify the implications for theory and practice.

1.4 Methodological steps

Research methodology is a way of systematically solving the research problem. In a way it is a science of studying how research is done scientifically (Kothari, 2004). Moreover it refers to the overall approach to a problem which could be put into practice in a research process, from the theoretical underpinning to the collection and analysis of data (Remenyi *et al.*, 1998; Collis and Hussey, 2003). The study was guided by the 'constructivist knowledge claim' and categorised under the constructive research category. The dominant purpose was in the tradition of Design Science (van Aken, 2004) research. However, some aspects of descriptive and explanatory research traditions were adopted in achieving the first three objectives. The study requires an understanding of organisational learning, process improvement and the complex adaptive nature of the construction contexts. A multi-method approach was adopted to collect and analyse data comprising literature review, document analysis, case study, participant observations, and a questionnaire survey followed by focus group workshops (see Figure 1-2). Having collected the required data, a desk study was used to develop

and integrate the key themes in to the framework. Finally the developed framework was tested and improved through a focus group workshop.

As a response to the call for process improvement in construction, the Structured Process Improvement for Construction Enterprise (SPICE) research project was initiated in 1998. The project developed a stepwise process improvement framework for the construction industry, utilising experience from the software industry, and in particular the use of the Capability Maturity Model (CMM), which has resulted in significant productivity improvements in the software industry. The SPICE III was a two year EPSRC (Engineering and Physical Sciences Research Council) funded research project in collaboration with a consortium of academics and industry was initiated in 2002. SPICE III focused specifically on creating the process capability to facilitate good practice sharing in construction organisations. The author joined the project in 2002 as a researcher and was responsible for SPICE III model development and testing through questionnaire survey, case studies and focused group workshops. An overview of SPICE research project and a detailed elaboration on SPICE III research project are provided in Chapter 3 and Chapter 4. The data exchange between SPICE III and this doctoral research is illustrated in Figure 1-1.
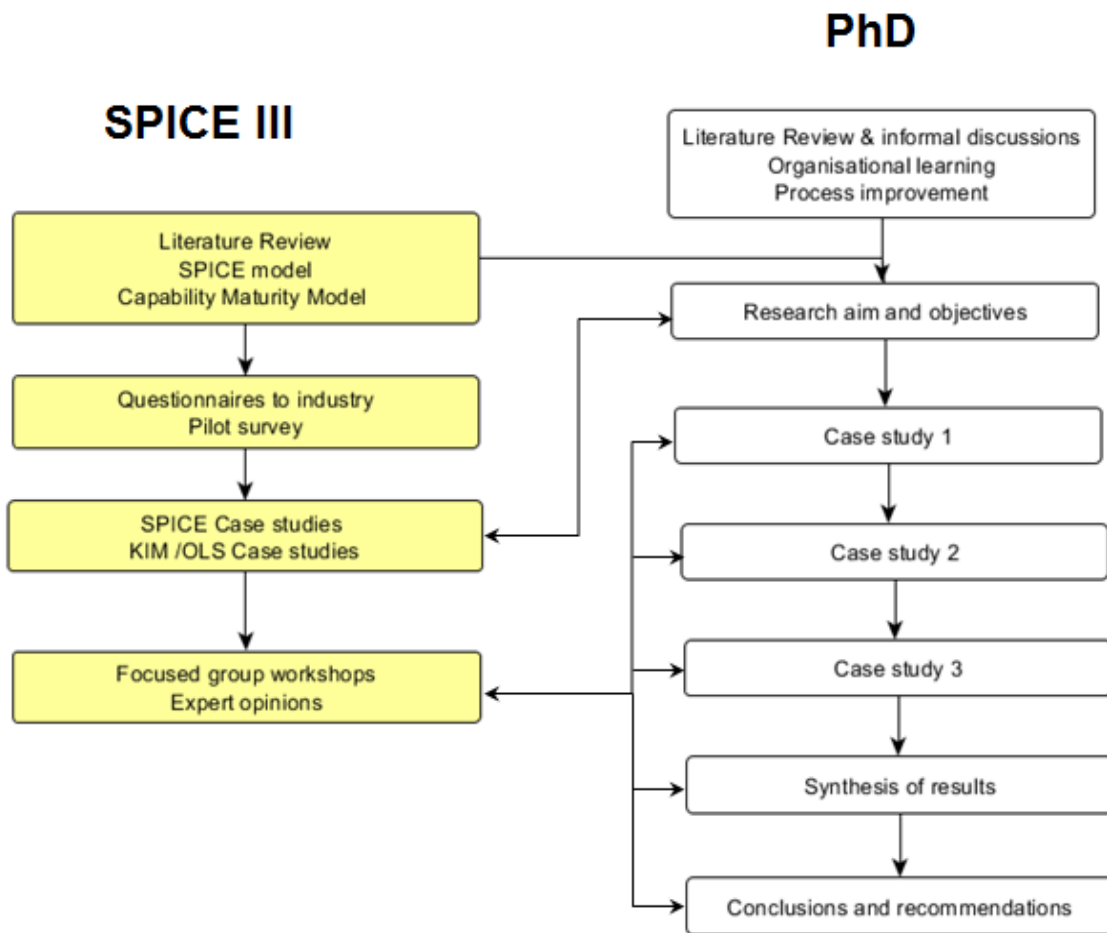
Figure 1-1: Data exchange between the PhD and SPICE III research project

The adopted research process within this investigation is illustrated in Figure 1-2.
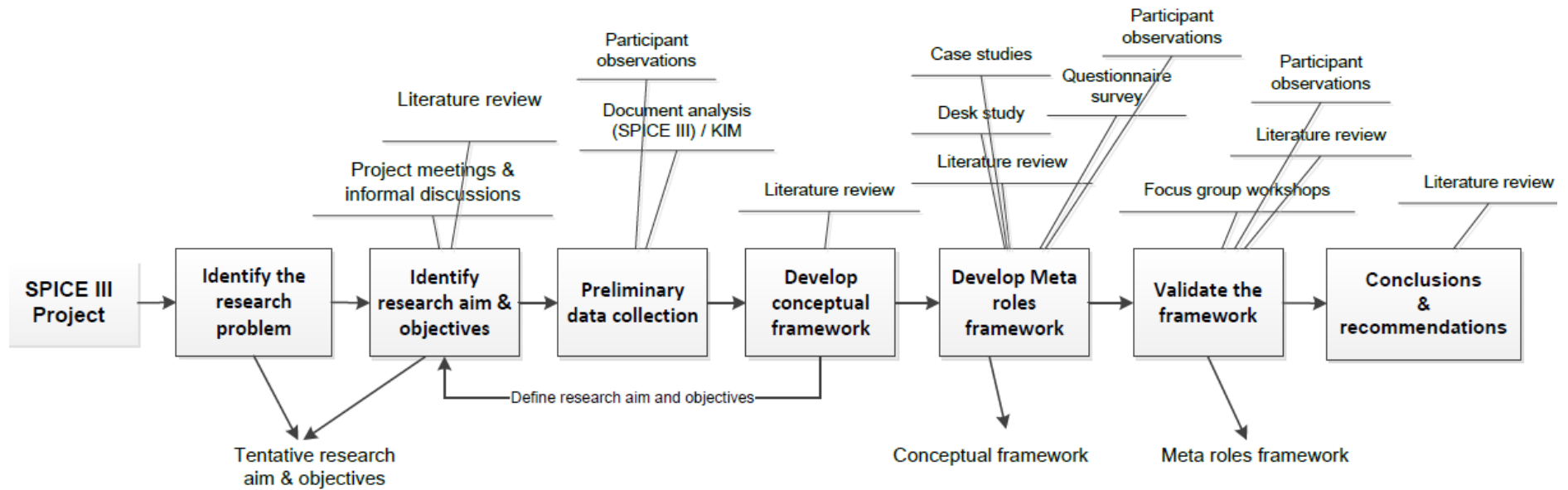
Figure 1-2: Adopted research process

Table 1-1 outlines the adopted research methods within this scientific enquiry. Moreover, Chapter 4 (see Table 4-5) clearly elaborates the reasons for selecting those research methods and rationale for rejecting other appropriate methods.

Table 1-1: Summary of the adopted research methods

Research objectives	Adopted Research Methods							
	Literature review	Informal discussions	Document analysis	Case study	Questionnaire survey	Desk study	Participant observations	Focus group workshop
1. to study the principal concepts of organisational learning and practices	√	√						
2. to explain the role of process improvement perspective in facilitating organisational learning;	√	√	√				√	
3. to explore the contextual issues associated with organisational learning and process improvement within construction industry context;	√		√	√	√			√
4. to develop a framework to facilitate organisational learning in construction organisations;	√	√	√	√	√	√	√	√
5. to validate the framework and identify the implications for theory and practice.	√						√	√

1.5 Scope and delimitation

The study was focused on organisational learning capabilities of construction organisations in the UK. The study was delimited to process improvement aspects in construction organisations. Three critical case studies were undertaken to develop and validate the proposed framework. A further discussion on research limitations is provided in the final chapter.

1.6 Contribution to knowledge

The contribution to the body of knowledge from this study is threefold.

Firstly, the research developed a Procurer, Provider and User (PPU) framework to facilitate organisational learning in order to facilitate process improvement within construction organisations. The developed framework identifies the meta-roles of project stakeholders, and the information flows (in and out). Absence of such a framework in current literature makes this research outcome an original contribution to knowledge. Secondly, this framework further enhances the applicability of the Capability Maturity Model and SPICE process maturity framework by providing a basis for developing process improvement actions. Thirdly, the overall research approach adopted was the Design Science approach, which is quite a unique feature of this research investigation. Further information about the contribution to knowledge is discussed in Chapter 6.

1.7 Structure of the thesis

This thesis comprises six chapters.

Chapter One: Introduction

This chapter presents the introduction to the thesis. It explains the background and rationale, the gap in the current knowledge, research aim and objectives, scope and delimitations, and an overview of adopted research methods.

Chapter Two: Organisational learning

This literature review chapter reveals the current principles, development and practices of organisational learning. The first part of the chapter elaborates the key concepts related to organisational learning. Then it explains the notions of learning organisation, knowledge management and organisational knowledge and their relationships to organisational learning. This chapter concludes by emphasising the current state of learning in construction organisations.

Chapter Three: Process improvement perspective

This chapter elucidates the theoretical underpinning of process improvement perspective and the complex adaptive nature of construction. It discusses the current approaches to process improvement and its underpinning theories and philosophies. Moreover, the chapter investigates the nature of the construction within which the applications are practised, and recognises the key factors which needs to be considered when facilitating learning in construction organisations. Chapter summarises with a conceptual framework which was used as a preliminary guide to establish the process improvement framework.

Chapter Four: Research Methodology

This chapter elaborates the adopted research methodology for this research enquiry. First part of the chapter overviews the overall research approach (i.e. Design Science approach) while providing pertinent justifications for selecting particular approach for this study. Then the chapter explains the adopted research methods and techniques, justifications for selecting those methods and rationale for rejecting other alternative methods within this research investigation.

Chapter Five: Framework development and validation

The first part of Chapter 5 explains the data collection and analysis processes used within this study in order to achieve the research objectives. The second section explains the results of the work undertaken and develops a framework for organisational learning in construction in specific to the process improvement perspective. The priority was given to explain the development and validation of proposed framework throughout its conceptual to developed stages.

Chapter Six: Conclusions and recommendations

This final chapter covers three sections. The first section explains the conclusions of this research endeavour. The priority was given to explain how the research objectives were achieved within the specified research boundaries and the credibility of the results. In the second section, the contributions to the body of knowledge are envisaged. This section is followed by the discussion on the limitations of the research validity, reliability, rigour and bias. In the last section, recommendations for further research are provided.

Chapter Two

2. ORGANISATIONAL LEARNING

2.1 Introduction to chapter two

The aim of this chapter is to provide a holistic overview of organisational learning and it's applicability for the construction organisations. The chapter details the generic literature related to organisational learning and knowledge management in order to understand the concepts, principles and their relevance to the area of research. The chapter then reviews literature pertaining to organisational learning and knowledge management with specific reference to the construction context. The chapter concludes by highlighting the essential need for a renewed understanding of learning in construction organisations in order to improve their performance.

2.2 Historical overview of learning in organisations

Organisational learning is considered as one of core underlying concepts in the field of management. It has been presented in the literature for decades however only become widely recognised within management literature in the 1990s. Easterby-Smith and Araujo (1999) quoting the survey of Crossan and Guatto's (1996) noted that as many academic contributions in this area were published in 1993 than in the whole of 1980s. However the interest in the subject certainly did

exist long before. Easterby-Smith and Lyles (2003) acknowledged the contributions made by Dewey (1916), Hayek (1945), Polanyi (1959), and Penrose (1959) as some of the significant early philosophical works. In an attempt to trace back the development of the term and the meaning of the "learning", Dahlgaard (2004) pointed out that ancient Chinese ideogram may be one of the oldest conceptualisations of the term.

It refers to a two key elements, namely;

- *to study i.e. acquisition and accumulation of knowledge (cognitive and intellectual learning); and*

- *to practise repeatedly i.e. continuous / endless (physical) practice.*

Dahlgaard (2004)

There are number of definitions available to describe the term 'learning'. The Oxford concise dictionary (2011) defines learning as knowledge obtained by study. Buchanan and Huczynski (1997) considered learning as the process of acquiring knowledge through experience which leads to an enduring change in behaviour. Moreover, Rollinson, Broadfield and Edwards (1998) introduced learning as an experimental process which results in an individual displaying relatively permanent changes in underlying values of behaviour, so that the individual is able to adapt to a changing environment. However the concept of learning is understood from various perspectives and mainly developed in the psychological field over a long evolutionary history and its application at organisational level was primarily conditioned as the collectivity of individual training, training and development (Wang and Ahmed, 2003).

The recent literature suggests that 'learning' occurs in a cognitive context of what has been learnt before and in an environmental context it is defined by the location, time and specific features of the tasks in hand (Balsam, 2014). Even though learning starts with individuals, individual learning does not necessarily lead to organisational learning. Supportively, Cyert and March (1963) were instrumental in pioneering the notion that organisations are capable of learning in ways which are independent of the individuals within it. Cangelosi and Dill (1965) also strengthened Cyret and March's argument. Therefore, it was recognised the necessity for a more holistic view for the concept of organisational learning (Ikehara, 1999).

The year 1991 saw the emergence of another wave of significant contributions to the field of organisational learning through the studies of Huber (1991), March (1991), and Simon (1991). By this time the theorists have made a significant change in the way organisational learning was viewed at. Although they still belonged to the neo-rationalist domain, emphasising that it is desirable to maximise the efficient use of knowledge in organisations. Easterby-Smith and Lyles (2003) pointed out that whilst March and Simon (1958) argued based on neo-rationalist stance, Argyris and Schon (1978) challenged it with the view that human behaviour within organisations frequently does not follow lines of economic rationality. Having said that, they recognised the existence of substantial barriers and challenges such as human/people issues, in pursing their objectives.

The idea of organisational learning emerged in the effort to developed organisations that are more responsive and flexible to change (Tan and Tjandra, 2002). Kululanga, Edum-Fotwe and McCaffer (2001) argued that the concept of organisational learning as the progress from a doing to a thinking workforce, from a reactive to proactive readiness to change, from loss to gain of competitive advantage and from status quo to continuous improvement. With reference to the studies of Argyris and Schon (1998), learning occurs under two conditions. When there is a match or a mismatch between intentions and outcomes of intended actions in organisations. They further explained if there is a mismatch the actions are corrected until there is a match between actions and intended outcomes. More importantly, the notion of 'single-loop' and 'double-loop' learning (Argyris and Schon, 1978, 1998) and 'triple loop' (Wang and Ahmed, 2003) identified as the next significant development in the field. Having said that it was realised the development of market based organisational learning cannot be far removed from that of organisational learning.
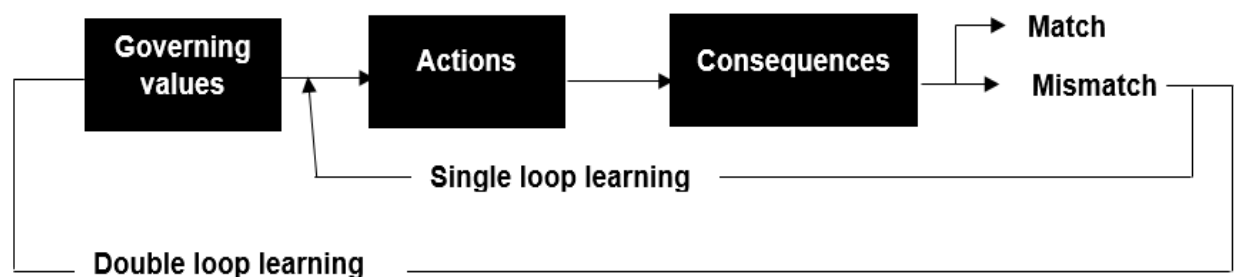
Figure 2-1: Single and double loop learning

Source: (adapted from Argyris and Schon, 1998)

Apart from those considerations, Morgan (2004) developed a model to explain the working conceptualisation of market based organisational learning, which is characterised by six main elements (See Figure 2.2).
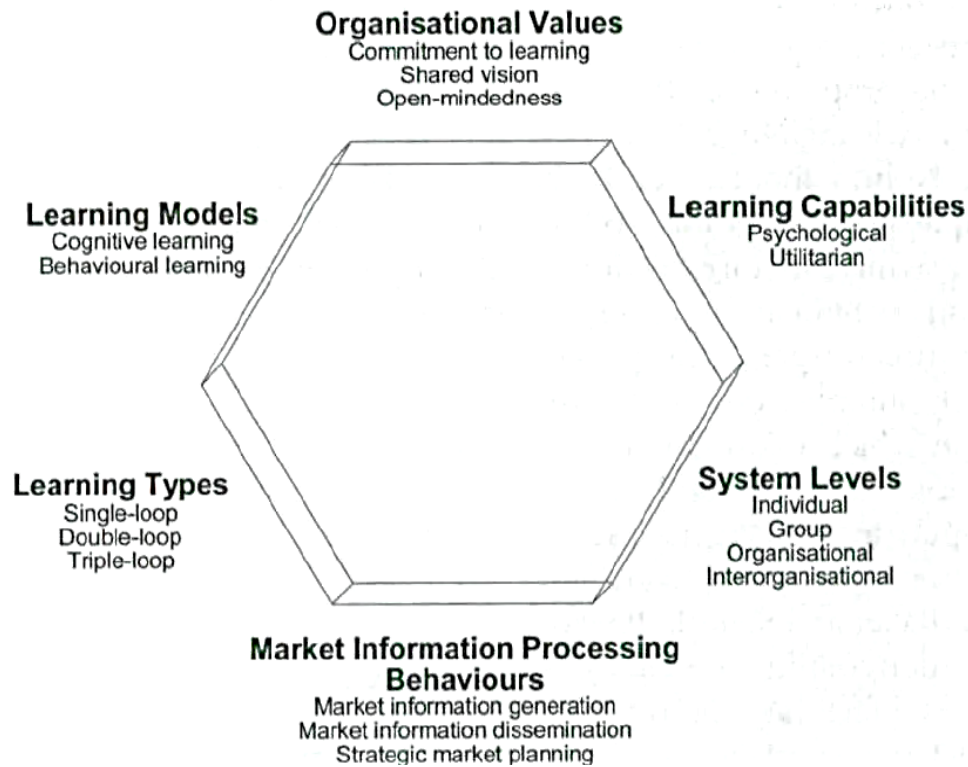
Figure 2-2: Working conceptualisation of market based organisational learning

Source: (Morgan 2004, p.81)

Morgan (2004) explained the meanings of those elements as follows.

- Organisational value is the value that the organisation holds towards market base learning and the propensity for a learning culture to exit;

- Learning capabilities are the development of learning capabilities in cognitive terms;

- System levels are considered as the extent and capacity that individuals have to learn;

- Market information processing behaviour is merely the gathering information and making intelligence from information is a first principle;

- Learning types are to detection of errors in product market; and

- Learning models are to learning for the sake of broadening the knowledge base of the organisations and to store in the organisation memory.

The above model covers the key specific areas of organisational learning that required to be considered when there is a business to be survived in a competitive business environment. Easterby-Smith and Araujo (1999) identified two developments that have been significant in the growth of the field of organisational learning. First, it has attracted the attention of scholars from disparate disciplines. Business strategists have realised that the ability of one organisation to learn faster and better than its competitors may indeed carry the key to long-term success (Collis, 1994; Grant, 1996). Economists also have taken a similar path, arguing that firms learn by doing as well as the formal training processes (Stiglitz, 1997). Moreover, sociologists echoed the role that learning in organisational learning can play in the internal dynamics and politics of organisational life (Coopey, 1995). The second major development in the field is the fact that many companies and consultants identifying and promoting its commercial significance (Easterby-Smith and Araujo, 1999). In this regard the studies of Pedler, Boydell and Burgoyne (1989), Senge (1990), and Field and Ford (1995) are significant due to the fact that they focused on making practical interventions in organisations to

help them become learning organisations. Much of the efforts of these theorists have been identifying templates or ideal forms, which real organisations could emulate.

Having revealed the key literature on organisational learning one of the main observations was the frequent use of the terms organisational learning and learning organisation, whilst some authors used the two terms interchangeably. Burgoyne (1999) admitted that confusion still exist about the clarity of the concept. In this regard the observations made by Easterby-Smith and Araujo (1999) are noteworthy. They differentiated that the two concepts (i.e. organisational learning and learning organisation) have developed in two divergent tracks. Simply, the literature on organisational learning concentrated on the detached observation and analysis of the process involved in individual and collective learning inside organisations, whereas learning organisation literature has an action orientation, and is geared towards using specific diagnostic tools which can help to identify, promote and evaluate the quality of learning process inside organisations.

Dewey (1916) viewed organisational form the "individual learning" perspective, and hence expressed reservations regarding the ability to transfer what is learnt through social interaction, from one person to another. The distinction between tacit and explicit knowledge by Polanyi (1959), paved the way for increased attention on the concept of organisational knowledge. This concept leads to the divergence of research themes namely explicit and tacit knowledge management. Tacit knowledge is the kind of knowledge that cannot be articulated and codified,

whereas explicit knowledge is easy to codify (Drejer, Christensen and Ulhøi, 2004). Therefore different strategies for handling knowledge and for learning are highly needed for tacit and explicit knowledge.

Knowledge management (KM) has also developed into a popular phrase within the field of management. As such many researchers have used the current models of organisational learning and knowledge management as forms of representations of learning within organisations, while practitioners tend to use them as tools to promote and make effective use of learning in organisations. However, a paradigm shift in thinking of how visualise organisations may result in challenging some of the established thinking on organisational learning and knowledge management. The concepts: 'knowledge management' and 'organisational knowledge' also given high priority within the management literature. Therefore the four key terms, 'organisational learning', 'learning organisation', 'organisational knowledge' and 'knowledge management', need more elaboration. They are closely knitted but yet have established as distinct areas for both research and practice. Dahlgaard (2004) stated a deep understanding of the terminology and history of the theory and the philosophy is necessary to understand and advance practices for learning organisations. The next sections of the chapter will explain the terminologies with regards to their conceptual evolution.

2.3 Organisational learning

Organisational learning is the capacity of a process within an organisation to maintain or improve performance based on experience (Kale and Arditi, 1999). March (1991) noted that organisational learning not only consist of gaining competence in certain activities, routines, technologies or goals, but also involves a process which is characterised by search for an exploration of alternative routines, technologies and goals based on realisation that certain competencies can no longer meet the previously set targets. In general, organisational learning can be viewed as a social system whose members have learned conscious, communal processes for continually.

The key characteristics are;

- *generating, retaining and leveraging individual and collective learning to improve the performance of the organisational system in ways important to all stakeholders; and*

- *monitoring and improving performance*

(Drew and Smith, 1995)

The paradox of organisational learning is that it is not merely individual learning though organisations learn through the experiences and actions of individuals (Argris and Schon, 1978). Kim (1993) stated that organisational learning is more than the learning of individual employees. Individuals build cognitive maps of their work contexts and it is only when these maps are made explicit and shared that individual learning is transferred to the organisational level. The process of

interpreting the nature of a problem or work situation enables an individual to develop a cognitive map of that domain.

Nonaka (1994) proposed that cognition arises from a spiral of knowledge creation in which tacit knowledge is converted to explicit knowledge at an individual level and subsequently at group and organisational levels. Having analysed the commonalties of definitions on organisational learning, adaptive behaviour focuses on improvement and achieving better state of knowledge. In most of the definitions the subject of organisational learning is the entire organisation. But most of them also pay considerable attention to the role of individual learning and its impact to the learning of the organisation as a whole.

A significant development is the shift from changing organisations standard operating procedures and rules (Cyert and March, 1963) to more emphasis on creating a culture conducive to promote learning (Pedler, 1997). In terms of incentives that trigger organisational learning, a shift from defining learning as a reaction to slack resources (Cyert and March, 1963) to excellence in quality (Weick and Roberts, 1993) could be observed.

Moreover, Lopez, Peon and Ordas (2005) identified organisational learning as a dynamic process of creation, acquisition and integration of knowledge aimed at the development of resources and capabilities that contribute to organisational performance. Having reviewed more than hundreds of websites on knowledge management, Quintas, Lefrere and Jones (1997) revealed the following heterogeneous range of interests, perspectives and issues:

> *"economics, intellectual capital, engineering approaches (flexible manufacturing systems), aspects of computing and knowledge media, organisation studies (informed by anthropology, sociology etc.), epistemology (including learning, situated cognition and cognitive psychology), other aspects of classification and definition informed by artificial intelligence, human resource issues etc"* *(McAdam and McCreedy, 1999, p.91).*

With reference to Bushe (2009, p.21) organisational learning happens *"when two or more people inquire into their patterns of organising (how they work together) and produce knowledge that leads to a positive change in their patterns of interaction"*. Through an extensive literature review Wang and Ahmed (2003) identified six focus areas, concepts and practices of organisational learning, which illustrate in the Table 2.1. They highly emphasised that there is a significant impact from individual learning, organisation systems and processes, organisation culture, knowledge management practices adopted in particular organisation, continuous improvement and innovation towards the organisational learning.

Table 2-1: Focus areas of organisational learning

Focus	Concepts of Organisational Learning (OL)	Practices
Individual learning	OL occurs when individuals within an organisation experience a challenging situation and inquire into it on the organisation's behalf (Argyris and Schon, 1998).	Staff training and development
Process or system	OL is the process whereby organisations understand and manage their experiences (Glynn, Milliken and Lant, 1992).	Improvement of information processing and problem solving capability
Culture or metaphor	A learning organisation should be viewed as a metaphor rather than a separate structure, whose employees learn conscious communal processes for continually generating, retaining and leveraging individual and collective learning to improve performance of the organisational system (Drew and Smith, 1995).	Creation and maintenance of learning culture: collaborative team working, employee empowerment and involvement, etc.
Knowledge management	OL is the changes in the organisation's state of knowledge (Lyles, 1998). It involves knowledge acquisition, dissemination, refinement, creation and implementation: the ability to acquire diverse information and to share common understanding so that this knowledge can be exploited (Fiol, 1994) and the ability to develop insights, knowledge and to associate among past and future activities (Fiol and Lyles, 1985).	Facilitation of interaction and strengthening of knowledge base
Continuous improvement	A learning organisation should consciously and intentionally devote to the facilitation of individual learning in order to continuously transform the entire organisation and its context (Pedler, Burgoyne and Boydell, 1991).	The adoption of TQM practices
Innovation and creativity	In a dynamic business context, OL is the process by which the organisation constantly reviews existing product, process and system, identify strategic position, apply various modes of learning, and achieve sustained competitive advantage.	Facilitation of triple-loop learning and knowledge creation; focus on creative quality and value innovation.

Source: (Adapted from Wang and Ahmed 2003, p. 13)

Having considered the generic aspects of organisational learning it was recognised the importance of identifying the nature, key characteristics and existing models for organisational learning as this research tunnelled towards the 'organisational learning' in construction.

2.3.1 Technical perspective

Literature reveals that organisational learning can be categorised as taking either a technical view or a social view, according to their perspective on it (Easterby-Smith and Araujo, 1999). The technical view assumes that organisational learning is about effective processing, interpretation of and response to information both inside and outside the organisation. Huber (1991) is one of the key researchers who supported this view. Having cited Huber's work on the importance of information for organisational learning Davenport (1993), identified a distinct but related information management processes that support organisational learning activities.

Among the other researchers on this view, the work of Argyris and Schon (1978) is noteworthy. As noted before, the key distinction made between the single, double and triple loop learning is a major contribution made by them. They introduced single loop learning as the detection and correction of errors within a given set of variables, while double loop learning involves changing the governing variables themselves. Almost a two decade later, Argyris (1996) noted that this distinction has become popular among both managers and theorists alike, largely because of its ability to correspond to the forms of organisational change, i.e. single loop learning representing the incremental change and double loop learning

representing radical change. The idea that learning as a process could go through stages of improvement lead to the notion of triple loop learning (Argyris, 1996).

Triple-loop learning is accompanied by organisational ambition, wisdom and courage, and involves knowledge creation. Moreover, the process incorporates a higher degree of creative input and organisational unlearning, and it is an interactive and iterative process (Wang and Ahmed, 2003). Accordingly an organisation that continuously look for innovative and effective ways of promoting learning are said to be in a stage of triple loop learning. Notions such as "learning to learn" and "learning from others" are associated with this.

2.3.2 Social perspective

The social view of organisational learning is the way people make sense of their experiences at work (Easterby-Smith and Araujo, 1999). These experiences may derive from explicit sources such as financial information or they may be derived from tacit sources such as the feel that a skilled worker has, or through intuition. The ideas of organisational learning as social construction (Brown and Deguid, 1991; Orr, 1996), a political process (Senge, 1990; Schein, 1996; Coopey, 1994), and as a cultural artefact (Lave and Wenger, 1991) are also worth taking note of. In advocating the idea of organisational learning as a social construction, Brown and Deguid (1991) stated that formal instructions about how to do jobs are always inadequate, and therefore looks at the way new employees learn the unwritten information about how to perform effectively. Informal exchanges between the experienced and the less experienced people and the use of anecdotes and stories are some of the ways of achieving this (Orr, 1990).

With reference to use of organisational learning as a political process, Senge (1990) identified political activity as a major constraint on the establishment of learning organisation, whilst the other authors prefer to focus on the need for dialogue amongst different occupational cultures rather than to acknowledge the political nature of organisational life (Schein, 1996). In this regard Coopey (1994) noted that as politics are a natural feature of any social system, idea of eliminating organisational politics is naive and idealistic. Therefore, he emphasised the need for the development of organisational conceptions that embrace political process within them. The notion of learning as a cultural artefact sees learning as something that take place not within the heads of individuals, but in the interaction between people. It is reflected in the way people behave when working with others, and these patterns of behaviour are normally learnt by newcomers to the community through a process of socialisation (Lave and Wenger, 1991).

2.3.3 Models of organisational learning

The belief that normative processes lead to enhanced learning capability is a common feature among writers of organisational learning (Easterby-Smith and Araujo, 1999). The number of researchers proposed different models in order to explain the nature of organisation learning. Some agrees with linear models with a series of hierarchical stages, whilst others propose cyclical models. For example, integrated models (Kim, 1993), two-dimensional model of Carre and Pearn in (1992), three dimentional models of Swieringa and Wierdsma (1992) and the eight-dimensional of Torbet (1994). Although a number of learning stages differ they all have some common features. In all those models, each level is conceptually different from others, organisational processes can be classified as

belonging uniquely to one or other of these levels and successive levels are increasingly desirable for organisations wishing to increase their learning capacity. Literature suggests theoretical and applied models for organisational learning. Theoretical models are focused on how organisational learning has been explained using models instead of flows. Applied models explain how organisation learning might be conceptualised and how they have been developed as measures of organisation learning in global contexts (Tarrini, 2004).

2.3.3.1 Theoretical models for organisational learning

The most popular theoretical model explained in the literature is Observe, Assess, Design, Implement – Shared Mental Model (OADI – SMM) developed by Kim (1993). As it name appears this model is combined with two big components, which are OADI and SMM (see Figure 2.3).
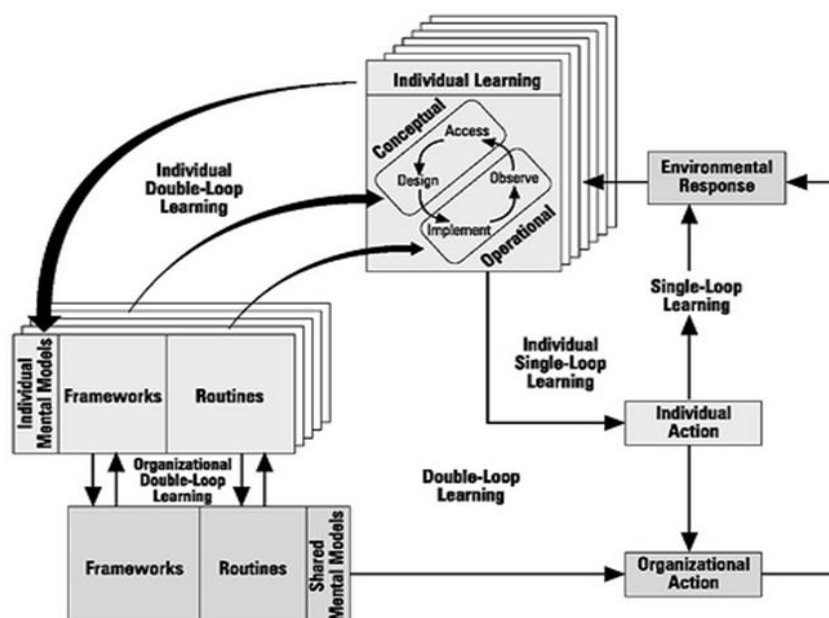
Figure 2-3: OADI - SMM Model

Source: (Kim, 1993)

"The cycles of individual learning affect learning at the organisational level through their influence on the organization's shared mental models. An organisation can learn only through its members, but it is not dependent on any specific member. Individuals, however, can learn without the organisation (Kim, 1993). The same model is referred as an integrated model in the literature. In fact this model attempts to explain the basis of organisational learning thus it is considered as a theoretical model and there is no evidence that the model is derived through empirical findings. It has incorporated 'single-loop' and 'double-loop' (Argyris and Schon 1998) concepts. However this model is lacking the human behaviour/action as an outcome of organisational learning (Tarrini, 2004). Moreover, the model does not describe how group effect impact in organisational learning (Kim, 1993). Enhancement of organisational learning as a continuous process is the key idea behind cyclical models. The improvements are helped by a series of stages involving the generation of information, interpretation of information and development of actions on the basis of these interpretations (Kolb, Rubin and MacIntyre, 1984; Garvin, 1993; Dixon, 1994).

Two dimensional model (see Figure 2.4) by Carre and Pearn (1992), explains when the structure and culture of the organisation enhances, supports and sustains the learning of all employees. The learning organisation can be measured on dimensions (environment and people), resulting in one of four quadrants, which are 'stagnated organisation', 'frustrated organisation', 'frustrating organisation' and 'leaning organisation'.
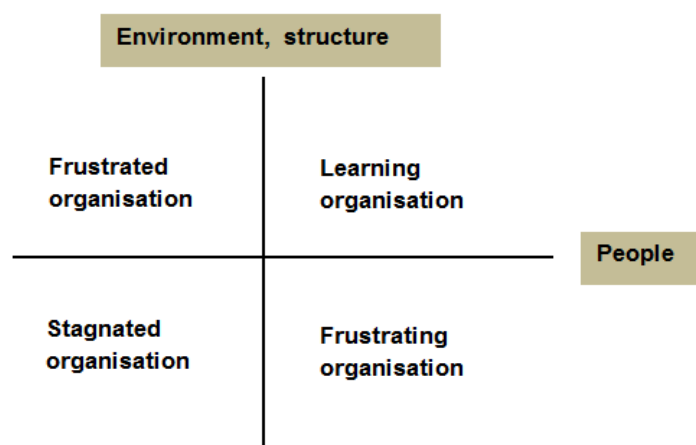
Figure 2-4: Two dimensional model

Source: (Carre and Pearn, 1992),

The 'stagnated organisations' use the past experience for the future solutions and 'frustrated organisations' think they are doing right things however their employees are reluctant to adapt into new working practices. 'Frustrating organisations' fail to understand the employees' skills and capabilities on new learning, which provides little flexibility and opportunity for self-learning. 'Learning organisations' have clear vision on their future and also they understand their individuals/ group capabilities for adapting in to their challenges. However Carre and Pearn (1992) did not present any empirical evidence as to how their model was delivered. Their model has no validation data and no case study evidence in the literature.

2.3.3.2 Applied models for organisational learning

Energy flow model (E-Flow) for organisation learning introduced by Pedler (1997) defined 'learning organisations' as a dynamic entity, which facilitates the learning of all its members and consciously transforms itself and its context. Their studies further introduced eleven (11) key characteristics of learning organisations in order

to identify techniques and instruments of processes of managing, directing, learning and participating. These characteristic are 'learning approach to strategy', 'participative policy making', 'information', 'formative accounting and control', 'internal exchange', 'reward flexibility', 'enabling structure', 'boundary workers as an environmental scanner', 'inter- company learning', 'learning' and 'self-development opportunities' for all the organisation members (Pedler, Burgoyne and Boydell, 1991). Having integrated those characteristics into four main domains (policy, operations, action, ideas) they have developed the E-Flow model (see Figure 2-5), which follows series of double-loop flows of energy and 'energy' represents from information, resources, etc. This model explains what the learning organisations looks like and how competencies for organisational learning interact. However this model also not explain behavioural perspective on organisational learning and the 11 characteristics are the mechanism which requires number of competencies to support them (Tarrini, 2004).
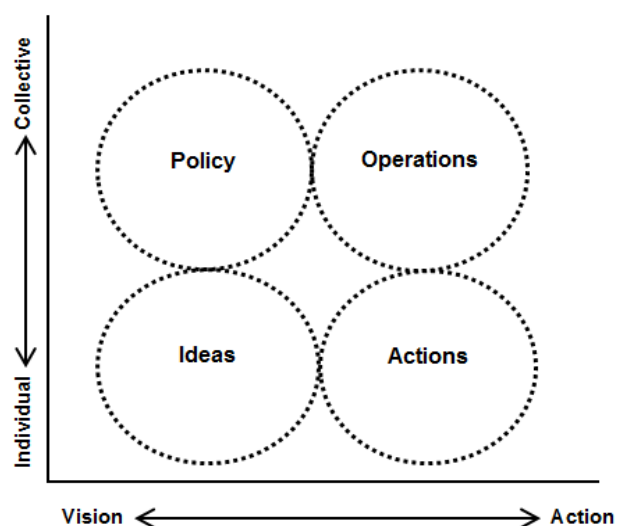
Figure 2-5: Energy flow model

Source: (Pedler, Burgoyne and Boydell, 1991)

In addition to above models Pearn, Roderick and Mulrooney (1995) introduced INVEST model, which was based on six factors for organisational learning. These factors are **I**nspired learners, **N**urturing culture, **V**ision of the future, **E**nhanced learning, **S**upportive management and **T**ransforming structures. The application of this model can be seen in many of world-wide organisations (eg. IBM, Kodak, Natwest Bank).   This model attempted to cover many of the aspects of organisational learning which other models didn't attempt to. However the interrelationship between those six factors has not been revealed.
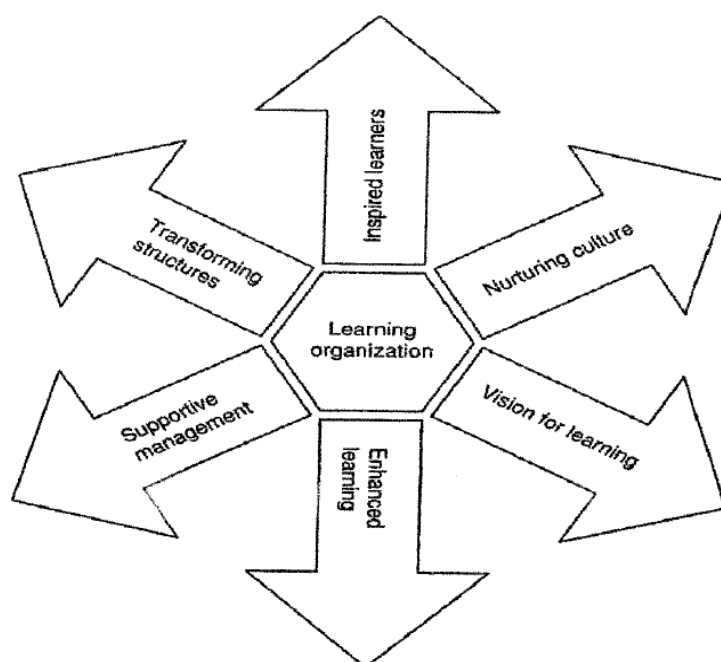
Figure 2-6: INVEST Model

Source: (Pearn, Roderick and Mulrooney, 1995)

Having studied the nature of theoretical and applied models for organisational learning, it is clear that human factor as a key to sustain in the competitive

environment. The next section briefly explains the influential factors for organisational learning.

2.3.4 Influential factors for organisational learning

From the review of the current literature key factors were identified as being influential in facilitating organisational learning. They could be categorised as external and internal to the organisation. The internal factors include organisational activities (Miner, 1991; Cohen and Bacdayan, 1994), organisational design (Mohrman, Cohen and Mohrman, 1995), organisational culture (Schien, 1996), leadership (Stata, 1989), employee turnover (Mobley, 1982), group dynamics (Martin, 2001), and knowledge repository management (Easterby-Smith, Snell and Gherardi, 1998). The external factors include government role in supporting the learning processes (Lundvall and Johnson, 1994), institutional set-up of the economy (Lundvall and Johnson, 1994), role of played by the supply chain, uncertainty of the external environment, technology (Levin, 1993), and characteristics of the industry (Vakola and Rezgui, 2000).

2.3.5 Importance and criticisms on organisational learning

Literature suggests organisational learning as an essential consideration for the success and survival of organisations. Due to the change nature of work, organisations consider learning as a critical variable than it used to be (Thomas, 2006). De Geus (1997) stated that the only source of competitive advantage is an organisation's ability to learn. Moreover Baldwin, Danielson and Wiggenhorn (1997) noted that what seems to distinguish surviving and adopting organisations from the rest is their ability to learn. Also Nonaka (1991) argued that competitive

advantage, innovation and effectiveness are the primary products of nurturing a culture of learning within a company. Supportively, Barrow (1993) and Hill (1996) highlighted that organisational learning and continuous improvement principles are inextricably linked such that organisational learning should be the most compelling reason for undertaking any continuous improvement schemes. The Institute for Employment studies (IES) also identified fostering organisational learning as one of the challenges facing management in major UK employing organisations (Harish and Carter, 2002). The literature reflects the generic nature of organisational learning and it is vital to study those characteristics in specific to construction organisations. However, the study of organisation learning has also been subjected to criticism by observant researchers. Prange (1999) identified key criticisms of the current state of knowledge in relation to organisational learning. It

- *lacks theoretical integration, and research is being done on a non-cumulative way;*

- *does not provide 'useful' knowledge for practitioners; and*

- *mostly used in metaphorical and / or analogous sense.*

(Prange, 1999)

Garrick and Rhodes (1998) in their discussion on the use of deconstruction as an approach to organisational learning research observes the focus of organisational learning in research and practice as

> *"…..the ways organisational learning tends to be understood in contemporary contexts which are characterised by uncertainty, unpredictability and insatiable market appetite to develop 'knowledge workers' who will give an organisation a competitive edge" (Garrick and Rhodes, 1998, p1).*

They expressed scepticism about existing theoretical frameworks for promoting organisational learning, especially in terms the value of organisational learning in how it relates to the power structures that are being challenged and changed (Garrick and Rhodes, 1998).

The above review explained the key considerations of 'organisational learning' and its merits and demerits. In this realm, this study is curious to identify how organisational learning could be considered within construction businesses. Before coming in to the specific point it is quite important to understand the other key terms such are learning organisations, knowledge management and organisational knowledge as they are closely associated with organisational learning.

2.4 Learning organisation

"The fifth discipline" by Senge (1990) brought the term learning organisation into the limelight. Moreover, Easterby-Smith and Lyles (2003) acknowledged the initial contribution that that Garratt (1987), Pedler, Boydell and Burgoyne (1989) and Pedler (1995) made towards learning organisations. Senge (1990) provided the tool that the companies and consultants were interested at that time, by presenting a model, merging the technical and social aspects associated with learning. Although made in the USA, the notion became more popular in Europe and lead to the later developments relating to action learning (Revans, 1980).

According to the belief of Easterby-Smith and Araujo (1999) on learning organisation, the concept could also be divided according to the technical and

social views. The technical variant of learning organisation advocates intervention based on measurement in which the use of "learning curve" is popular. Adler (1993) illustrated that the use of measurement as the focus of intervention naturally leads to the use of information systems for the collection of relevant data. With regard to social view of the learning organisation the concept of "dialogue" as a means of improving the quality of communication between people and the concepts related to systems dynamics are noteworthy (Senge, 1990; Issacs, 1993; Edmonson, 1996). Moreover, Senge (1990) identified five key themes associated with learning, which are;

- *System thinking – understanding the whole rather than the fractional parts of organisational thinking and behaviour;*

- *Personal mastery – a readiness to continually renew personal learning and relate this to organisational work;*

- *Shared vision – related to conviction, commitment and clarity of intent that generates a need for learning and the collective will to learn;*

- *Mental models – that assist managers to challenge their own assumptions and views of the "current reality"; and*

- *Team learning – to encourage work groups to engage in dialogue.*

(Senge, 1990)

Highlighting the importance of individuals in organisational learning Senge (1990) stated that "Organisations learn only through individuals who learn. Individual learning does not guarantee organisational learning. However, without individual learning there is no organisational learning occurs" (Senge, 1990, p 139).

2.5 Knowledge management and organisational knowledge

The emergence of knowledge–based organisations and increased importance of knowledge as the key to competitive advantage poses new and interesting challenges for the current businesses. Researchers pointed out that due to the emphasis of information and communication technologies on work, ICT have been closely associated with knowledge management initiatives (Hayes and Walsham, 2003; Hayes, 2001; Zuboff, 1996).

Vera and Crossan (2003) stated that knowledge management as defined by many suggests as "managed learning" and is assumed to have a positive impact on performance ['explicit control and management of knowledge within an organisation aimed at achieving the company's objectives (Van der Spek and Spijkervet, 1997, p.43), *"the formal management of knowledge facilitating creation, access, and reuse of knowledge, typically using advanced technology"* (O'Leary, 1998, p.43), *"the process of creating, capturing, and using knowledge to enhance organisational performance"* (Bassi, 1999, p 424)]. Although the term "knowledge management" is relatively new when compared with the previous topics, especially organisational learning and organisational knowledge, it has gone through a rapid rise to popularity and interest. The emergence of ICT as a key strategic enabler for organisational excellence also heavily contributed to this. As such many early knowledge management researches attempted to provide technical solutions. However, of late the importance social and other non-technical aspects have been recognised and attempts are being made for a more accommodating approach.

Easterby-Smith and Lyles (2003) identified the distinction between organisational knowledge and knowledge management. Organisational knowledge adopts a philosophical slant in trying to understand and conceptualise the nature of knowledge that is contained within organisations. Hence many of the discussions relate around distinctions between individual and organisational knowledge, or between tacit and explicit knowledge. Knowledge management is generally associated with using technological means as to disseminate and leverage knowledge to in order to enhance organisational performance. However, of late with the realisation of the limitations of pure technological solutions to tackle tacit knowledge in organisations, knowledge management practices are increasingly paying attention to non-technological means too. Moreover, organisational knowledge existed as a concept within the economics community for a long time, which is evident through the studies of Hayek (1945) and Penrose (1959) (Easterby-Smith and Lyles, 2003). Also noted is the foundation contribution made by Nelson and Winter (1982), highlighting the importance of "tacit knowing" both in terms of individual and organisational levels. Nonaka and Takeuchi (1995) brought forward the most influential contribution work in this regard through the notion of knowledge creation through transformations of tacit and explicit knowledge.

Dahlgaard (2004) observed that Nonaka and Takeuchi's (1995) knowledge creation model attempts to bring together individual, social, cognition and practice, of learning. They considered knowledge as dynamic and evolving, thereby giving more emphasis on interaction and situational aspects. Some theorists have

recognised the concepts of learning and knowledge as multi-faceted phenomena (Blackler, 1995; Nonaka and Takeuchi, 1995), and as such they require a comprehensive approach rather than a narrow and one sided approach.

Knowledge workers are defined as people who enrich given information and who learn from information communicated (Hayman and Elliman, 2000). The emphasis here is on employees who are educated to a higher level (Hayes and Walsham, 2003). However, this definition is somewhat questionable as the case studies of this research reveal the need for collective learning, knowledge production and reuse by employees of all levels of the organisation, especially those organisations in the construction industry.

Hayes and Welsham (2003) observe academic literature presenting two perspectives that underpin knowledge management namely content (Scarbrough and Burrell, 1997; Tsoukas, 1996). Having cited Nonaka and Takeuchi's work (1994), Galliers and Newell, (2000) stated that the 'content' perspective defines knowledge as being a predictive truth as it prescribes what to do, and as being viewed as being able to be codified and stored in knowledge repositories, which allows for knowledge to be shared, built upon and retained (Wasco and Faraj, 2005). Having summarised the works of Bohm, (1994), Pan and Scarbrough, (1999) and Shin, Holden and Schmidt (2001), Hayes and Welsham (2003) explained that from the content perspective, knowledge is viewed as an economic asset that allows for predictive growth to be codified, stored and exchanged between individuals within an organisation. This position needs to be further

examined as this research entails researching construction organisation contexts, which are both intra-organisational and inter-organisational due to the complex project based nature of the industry.

2.5.1 Knowledge management in a complex dynamic settings

Knowledge is an essential and critical function needed in order to obtain and facilitate competitive advantage in organisations (Goulding and Lou, 2013). In this regards the topic 'knowledge management' has been subjected to a similar critique and as such different stages of its evolution can be observed. Snowden (2002) considered three stages of evolution in understanding in relation to the topic of knowledge management. The first age, prior to 1995, sees knowledge being managed, where the focus is on the appropriate structuring and the flow of information to decision makers and the computerisation of major business applications leading to a technology enabled revolution dominated by the perceived efficiencies of process reengineering. However towards the mid-late 90s disillusionment crept in. Snowden (2002) further considered the failure to recognise the value of knowledge gained through experience, through traditional forms of knowledge transfer such as apprentice schemes and the collective nature of knowledge as some of the key reasons for it.

The study of Nonaka and Takeuchi (1995), which became popular with their SECI (Socialisation, Externalisation, Combination and Internalisation) model, was considered as the dominant view of knowledge management during the second stage (Snowden, 2002). The model focused on the movement of knowledge

between tacit and explicit states thorough the four processes of socialisation, externalisation, combination and internalisation. In this regard he noted "this concept is not totally new, and in fact its roots can be tracked to Polanyi (1974). In fact, Polanyi identified tacit and explicit as different but inseparable aspects of knowledge, the de facto use of the SECI model was dualistic, rather than dialectical" (Snowden, 2002, p.101). Moreover, Snowden (2002) stated that Nonaka and Takeuchi (1995) were only seeking to contrast a claimed Japanese tradition of "Oneness" with a rational, analytical and Cartesian western tradition. Their work derived in the main from the study of innovation in manufacturing processes where tacit knowledge is rendered explicit to the degree necessary to enable that process to take place; it did not follow that all of the knowledge in the designers' heads and conversations had, should or could have been made explicit. In partial contrast, early knowledge programmes attempted to disembody all knowledge from its possessors to make it an organisational asset. Nonaka (1994) attempted to restate more holistic and dialectical view of tacit and explicit knowledge when he republished the model utilising the Japanese word Ba, which is a "shared space for emerging relationships" (Nonaka and Konno, 1998), however by this time the simple two by two of the SECI model was too well established in business plans, software brochures and the structured methods of consultants to be restored to its original intend.

The basic concepts underpinning knowledge management are now being challenged (Stacy, 2001; Snowden, 2002). Knowledge is not a "thing", or a system, but an ephemeral, active process of relating. If one take this view then no

one, let alone a corporation, can own knowledge. Knowledge itself cannot be stored, nor can intellectual capital be measured, and certainly neither of them can be managed (Stacy, 2001). Snowden (2002) explained that in the third generation the focus extends beyond managing knowledge as a "thing" to also managing knowledge as a flow. To do this it is needed to focus more on context and narrative, than on content. The question of the manageability of knowledge is not just an academic one. Organisations have increasingly discovered that the tacit and explicit distinction tends to focus on the container, rather than the thing contained (Snowden, 2002). On his view three heuristics illustrate the change in thinking required to manage knowledge:

1. Knowledge can only be volunteered; it cannot be conscripted.

2. We can always know more than we can tell, and we will always tell more than we can write down.

3. We only know what we know when we need to know it.

> *"Human knowledge is deeply contextual, it is triggered by circumstance. In understanding what people know we have to recreate the context of their knowing if we are to ask a meaningful question or enable knowledge use? To ask someone what he or she knows is to ask a meaningless question in a meaningless context, but such approaches are at the heart of mainstream consultancy method"*
>
> *(Snowden, 2002, p.102)*

The three heuristics noted above is partially supported Stacy's view of knowledge as an "active process of relating" (Stacy, 2001). However Snowden (2002) identified that, there is no need to abandon second generation practice, but must be aware of its limitations. It is possible to encompass both Stacy (2001) and

Nonaka (1994) if adopts paradox. Snowden (2002) pointed out those philosophers have long seen paradox as a means of creating new knowledge and understanding. Physicists breaking out of the Newtonian era had to accept that electrons are paradoxically both waves and particles: if you look for waves you see waves, if you look for particles you see particles. Properly understood knowledge is paradoxically both a thing and a flow; in the second age it looked for things and in consequence found things, in the third age it looked for both in different ways and embraces the consequent paradox. Snowden (2002) also explored the importance of context and content within this discussion. With regard to context, the dimension of abstraction and the dimension of culture are of significance. He further noted that the mechanisms of learning are very different to those for teaching. "In the case of teaching there is little ambiguity between teacher and taught, in learning such ambiguity is often a precondition of innovation" (Snowden, 2002, p103).

The debates and discussions about learning is also closely associated with the topic of change management, especially within organisational contexts.

> *"If you pay more attention to how people learn, you will be capable of more effective change management. Learning and technology change management reinforce one another. "……… Learning is the keystone for dealing with the higher number of failed change efforts, the rapid rate of change in the information technology, and the need for new organisational constructs" (Levine, 1999, p1).*

 Learning is also seen from two other perspectives, namely "cognitive" and "behavioural". And also learning as a change of the content of the "known" forms the basis for cognitive perspective whilst learning as a process of change, transformation and development in the "outcomes", are the basis for behavioural

perspective (Dewey, 1929; Weick, 1979; Fiol and Lyles, 1985; Huczynski and Buchanan, 1985). However, Dahlgaard (2004) recognised the need to consider the different perspectives as interacting and interrelated in the dynamic process of learning.

However, Tsoukas and Chia (2002) noted that the traditional approaches to organisational change have been dominated by the assumptions prevailing stability, routine, and order. As a result, organisational change has been reified and treated as exceptional rather than natural. Change, they argue, is the reweaving of actors' webs of beliefs and habits of action to accommodate new experiences obtained through interactions. In so far as this is an ongoing process that is to the extent the actors try to make sense of and act coherently in the world change is inherent in human action, and organisations are sites of continuously involving human action. In this view organisation is a secondary accomplishment, in a double sense. Firstly, organisation is the attempt to order the intrinsic flux of human action, to channel it towards certain ends by generalising and institutionalising particular cognitive representations. Secondly, organisation is a pattern that is constituted, shaped and emerging from change. Organisation aims at stemming change, but, in the process of doing so, it is generated by it (Tsoukas and Chia, 2002, p.567). From the perspective of metaphysics of change, it is change which is natural and primary and 'organisation' is seen as secondary and an artificially-imposed attempt to arrest and stabilise what is essentially a ceaselessly fluxing reality indifferent to our causes (Chia, 1999).

2.6 Conceptualising the notions

In conceptualising the notions expressed so far Vera and Crosan's (2003) indicating of the relationship between knowledge, knowing and learning is noteworthy. They stated that knowledge can be obtained through mind (learning by reflection, anticipatory learning) and through the body (learning by doing, experimental learning). Knowledge is accumulated in our minds (know what, declarative knowledge) and also in our bodies (know how, procedural knowledge). Knowing is practice and it is something that we do. Knowing is not knowledge used in action, but knowledge that is part of action (Cook and Brown, 1999).

Learning is change in knowledge and change in knowing, which also is termed as changes in cognition and changes in behaviour. Vera and Crossan (2003) have also made a significant contribution in terms of explaining the boundaries of each of the four key terms discussed above. They pointed out both organisational learning and organisational knowledge as two overlapping fields of research, however there are topics that are dealt exclusively within their domains. The Figure 2-7, illustrates the conceptual positioning of major four streams (organisational learning, learning organisation, knowledge management and organisational knowledge) related to learning in organisations. The dotted lines denotes the common ground of research covered. The topics outside belong to the respective research areas as shown in the boxes.
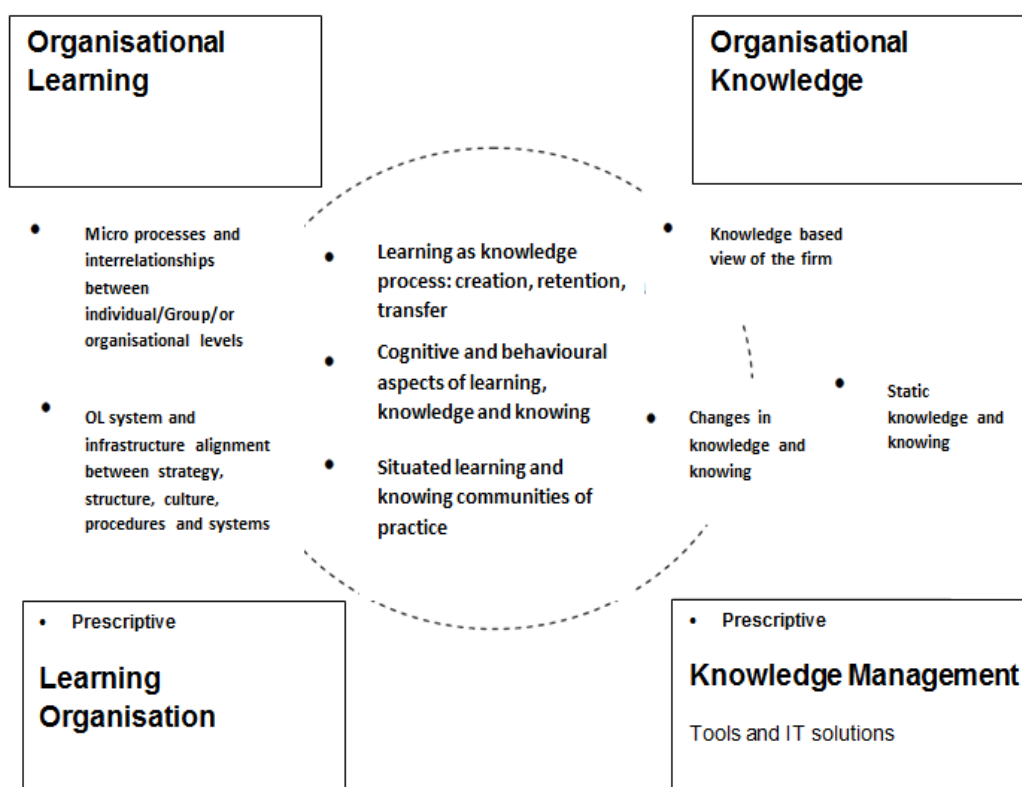
Figure 2-7: A Conceptual positioning of major focus streams related to learning in organisations

Source: (Adapted from Vera and Crossan, 2003)

Surveying across the research efforts in the area of learning, Dahlgaard (2004) noted an attempt to separate individual, group/team, and organisational (firm) as different levels of learning. Nevertheless, it is common to observe that most leading researchers in organisational learning and learning organisation (Stata, 1989; Senge, 1990; Garvin, 1993; Hodgetts, Luthans, and Lee, 1994) seem to indicate that individuals play a pivotal role in fostering learning at an organisational level. If that is the position, how can we distinguish them as representative of organisational learning? The following is an attempt to seek clarification in this regard. Moreover Elkjaer (2003) stated that learning theory in much of the literature on organisational learning and the learning organisation has its roots in

the individual oriented psychology. The theories which consider the "individual" as the key to learning also possess the strong emphasis on the change in cognition as a vital part of organisational learning. The fact that organisations comprise of individuals seems to provide strong support in this respect. In this perspective, enhancing information processing and decision making in organisations is seen as something that is done by the individuals' learning and the processes that can be enhanced by individuals learning. Individuals' learning outcomes can then, by way of individuals acting on behalf of an organisation, be crystallised in organisational routines and values and hence become organisational learning. The notion that individuals possess mental models that represent an abstracted form of their actions is a key element in this school of thought. Therefore the popular theories that emanates from this position enhancement of these mental models within individuals for better processing of information and to better decision-making in organisations. This focus brings leads to individual learning being strongly associated with the cognitive learning paradigm.

Cognitive learning theory is privileged abstract and general verbal and conceptualised knowledge over and above the thinking that derives from practice (Nicolini and Meznar, 1995; Lave, 1988). The study of Senge (1990) stands testimony to this respect. He advocates the use of systems thinking to develop learning organisations. This means that Senge (1990) identified the organisation as an abstract entity or a system, which then the members of the organisation must learn, so that they can relate to it and understand it. As such the process of abstraction is considered as a necessary condition for learning in individual /

cognitive learning paradigm. Another striking feature of organisational learning concepts that are derived from individual learning theory is the fact that learning being regarded as a specific activity, which needs to be initiated, motivated and stimulated. For example learning takes place when there is a problem to be solved (Argyris and Schon, 1978).

The immense focus on the relationships to / roots of individual learning, as the basis for formulating the concepts of the popular organisational learning and learning organisation has come under much criticism (Cook and Yanow, 1993; Gherardi, Nicolini, and Odella, 1998). Most of the organisational learning literature (Argyris and Schon, 1978; Senge, 1990), consider individuals as agents of the organisations acting on behalf of the organisation, which creates a separation between the organisation and the individual. Dahlgaard (2004) highlighted the need to pay attention to a counterpart group of theorists who pay attention to "collective learning" as promoting organisational learning. Social learning theories can be considered as an alternative view to of conceptualisation of organisational learning. It has emerged as a result of the criticism of the individual learning bias of organisational learning theory. Moreover, Lave (1988) summarised the following as key issues of concern in the above respect.

- If learning is indicated by the change in cognitive structures (or mental models), how is it possible to learn on the basis of actions that may or may not be verbally representative as specific mental models, but instead may be emerging through taking action?

- If learning is a specific activity that is delimited to certain initiated events such as problem solving, how does one account for what is not learning?

- If it is possible to separate the individual from the organisation, how does one account for the fact that people can be knowledgeable in one situation, and not in another comparable situation?

The social context, relational, inter-actional, situational and historical perspectives (Lave and Wenger, 1991; Strauss, 1993; Brown and Duguid, 1996) are key components that the theorist has taken into account in this regard. Dahlgaard (2004) highlighted the concepts such as "communities of practice" (Brown and Duguid, 1991, 1996), "learning in practice", "participation" as some of the representative concepts. They explained the adaptation of "social learning" as a more suitable way of fostering learning as opposed to focusing purely on individual cognitive theory. On the other hand, Cook and Brown (1999) presented the alternative view of the individual – organisation relationship by commenting that individuals at one and the same time should be regarded as products of their social and cultural history, and producing situations that mirror them. They stated that individuals interact with selves, others, artefacts, and contexts, just as that products and producers of situations. As such this situated view of learning would move learning away from the individual mind to the social sphere of interaction, activity and practice. As such within the view of organisational learning from a

social learning perspective, learning is not regarded as a specific, delimited and intentional activity.

Learning is considered as part of natural human activity. This position is similar to the stance shown by Nicolini and Meznar (1995) and (Gherardi, Nicolini and Odella, 1998). Nicolini and Meznar (1995) explained that learning cannot be avoided; it is not a choice for or against learning, but it is an integral part of normal day to day organisational life and work. Gherardi, Nicolini and Odella (1998) investigated the view that learning is a process that takes place among and through other people. In other words, learning is not restricted to taking place inside individual's minds, but as processes of participation and interaction. Elkjaer (2003) explained that whilst individual learning theories aims the content of learning to help the learner get to know the organisational practices, the social learning theory aims the content of learning to help the learner to become a practitioner. Expressed in a different way, social learning theory is a way of being and becoming part of the social worlds that comprise an organisation, and in which the central issue of learning is to become a practitioner (Brown and Duguid, 1991; Richter, 1998).

2.7 Organisational learning in the context of construction industry

A growing attention towards the aspect of learning in construction organisations is identified. Many researchers have highlighted the importance of learning and process improvement in construction organisations (Boyd and Robson, 1996). The recent research explored different facades of organisational learning in specific to construction organisations. The literature reveals *"elements of learning organisations"* (Love et al., 2004), "learning behaviour and approaches" (Knauseder, Josephson, and Styhre, 2007), *"learning mechanisms and techniques"* (Kululanga et al., 1999; Chinowsky, Molenaar and Realph, 2007), "effects of organisational learning and unlearning on the performance of organisations" (Wong and Lam, 2012), *"training and learning of individuals as enablers of organisational learning"* (Alwani-Starr, 1997), *"drivers for construction sustainability"* (Opoku and Fortune, 2011), "lack of organisational learning and lack of legitimacy" (Kale and Arditi, 1999) as key considerations in organisational learning. It is also worth noting that construction research has also progressed on the role of organisational learning in promoting innovation (Vakola, 2000; Vakola and Rezgui, 2000; Buckler, 1998; Winch,1998; Barlow, 2000). Attention has also been paid to learning that takes place within partnering context (Barlow and Jashapara, 1998; Franco, Cushman and Rosenhead, 2004) and also within strategic alliances (Holt, Love and Li, 2000). Although a majority of research cited are either UK or European based, far east countries have also paid their attention in this regard (Tan and Tjandra, 2002; Walker and Johannes, 2003; Ofori, 2002).

Kululanga, Edum-Fotwe and McCaffer (2001) argued that construction organisations should proactively promote organisational policies, procedures and practices that explore knowledge creation to sustainable learning agenda. Moreover, the findings of Kululanga's research (1999) showed that both the average gross profit and turnover per employee increased with the construction contractors' learning. He also performed a gap analysis of the strong and weak areas of learning practices adopted by the UK construction contractors. The research emphasised that large and medium scale contractors focused more on individual learning dimensions and less on vision learning i.e. undertaking internally organised improvement efforts. This supports the findings of Alwani-Starr (1997) who stated that the aspects of organisational learning in the UK construction industry have normally focused on training and learning of individual employees, whereas the antecedents normally associated with organisational learning has received little attention. Anheim (2003) also concluded that to a large extent learning in a construction project takes place at the level of individuals, but noted that a certain amount of learning also occurs among sub-groups that exist within projects.

Moreover, the engagement in project reviews and the application of lessons learnt facilitates a mechanism for organisational learning (Kululanga and Kuotcha, 2008). The importance of team learning is highlighted by Senge (1990). From the construction industry perspective, Anheim (2003) supports this by stating that most training and development work in organisations in present day organisations is conducted in teams. He further stated that for team learning to function, an

environment that facilitates free exchange of opinion is essential. Project based nature of the industry has been cited as a barrier to foster learning in construction. This argument is in line with that of Nonaka and Takeuchi (1995) who emphasised the need for sufficiently stimulating tasks as a pre-requisite for learning. In contrary, Anheim (2003) identified a positive aspect of the project based nature of construction.

Having studied the building contractors working methods and how team work affects the potential for learning, he concluded that complex projects with relatively autonomous project teams promote learning. Anheim (2003) agreed that the project based nature as posing obstacles for the construction organisations to learn from their operations stating that the view that each new project as a separate assignment reduces the insight into transferring the lessons learnt from previous projects. He further argued that if construction projects are viewed as complex scenarios containing large number of different problems, they could also be considered as potential learning scenarios. Recent literature suggests that in practice lessons learned processes rarely happen, and when it does it is concerned with lessons identification rather than organisational learning (Duffield and Whitty, 2014).

Having reviewed the available literature on organisational learning it was identified the importance of considering organisational learning within construction context. Therefore this research tunnelled through to explore organisational learning and its challenges in particular to construction organisations. In this realm the process

improvement is identified as a central consideration for facilitating organisational learning. The next chapter elaborates the concepts, practices and theories behind process improvement in organisations.

2.8 Chapter summary

The chapter identified the importance of organisational learning towards the development of today's business enterprises including those in construction. It also observed that theory development has taken place in two main areas namely, organisational learning and learning organisation. While the former is more descriptive, the latter is more prescriptive. Organisational learning was also identified as a subject area that has links to many other topics related to organisational improvement covering both explicit and tacit dimensions. A growing attention in the construction sector towards researching into organisational learning was observed. Business process improvement, innovation and partnering contexts are some of the areas that have been studied. Many have highlighted the bias towards individual learning, but this needs to be verified through conduct of fresh research. Although the project based nature of the industry has been cited as an obstacle for learning to take place, a shift in paradigm could see the use of projects as learning opportunities. The findings from this chapter would help in theory unification with regard to the concepts of learning and knowledge, and allows a better conceptualisation in terms of learning complex construction contexts. The next chapter is focused on the process improvement perspective and the contextual issues that require attention in developing the framework to facilitate learning in construction.

Chapter Three

3. PROCESS IMPROVEMENT PERSPECTIVE

3.1 Introduction to chapter three

Process Improvement is considered as one of the proactive and on-going practices for identifying, analysing and improving the processes within an organisation for optimising its productivity. This literature review chapter describes the theoretical underpinning of the process improvement perspective, the development of SPICE (Structured Process Improvement for Construction Enterprises) Level 3 maturity model for construction process improvement, and the construction context related factors which require consideration. The first part of the chapter explains the process philosophy, approaches, tools and techniques for process improvements, and underpinning concepts. It will then highlight the connection between the processes and learning, with specific focus on organisational contexts. The chapter also highlight the need to take the process improvement perspective as the core standpoint in engaging with the body of knowledge on learning, in order to facilitate the development of a framework which facilitates learning within complex construction contexts.

3.2 Process philosophy

The term 'Process Philosophy' is based on the premise that being is dynamic and that the dynamic nature of being should be the primary focus of any comprehensive philosophical account of reality and the place within it (Stanford University, 2012). It is an old philosophical tradition that emphasises becoming and changing over static being. According to the Internet Encyclopaedia of Philosophy (2013), the process philosophy is characterised by an attempt to reconcile the diverse intuitions found in human experience (such as religious, scientific, and aesthetic) into a coherent holistic scheme. Moreover it seeks a return to a neo-classical realism that avoids subjectivism. This reconciliation of the intuitions of objectivity and subjectivity, with a concern for scientific findings, produces the explicitly metaphysical speculation that the world, at its most fundamental level, is made up of momentary events of experience rather than enduring material substances. Process philosophy speculates that these momentary events, called "actual occasions" or "actual entities," are essentially self-determining, experiential, and internally related to each other. Therefore understanding process philosophy in specific to particular scientific investigation is important.

Having identified the nature of process philosophy it is important to identify what '*does process mean'* and '*how important it is,* in organisational contexts and the '*key characteristics'* of it. There are several definitions presented in the literature to define a 'process', however none seems to be standard and well-established. When revealing the mainstream management literature, defining processes seems

to be a constant struggle. Jeong *et al* (2004) noted that the term is interpreted differently depending on the sector, function and the market in which they are operating on. So much so, that Ould (1995) explained that rather than discussing the exact definition of a process, it is essential to discuss its critical features. The following features were identified as key characteristics of a process.

- *it involves activity. People or equipment do things;*

- *generally involves more than one person or piece of equipment;*

- *it is about groups, it concerns collaborative activity;*

- *it has a goal. It is intended to achieve something and produce some results;*

Moreover it was identified the following requirement for process.

- *Since a process must be shared among groups, it needs to be defined;*

- *The definition and knowledge of the process must be passed to those who will perform it. Hence there is a requirement for process learning;*

- *The knowledge of the process should drive and align the behaviour and activities of those who perform it;*

- *The process leads to process results, which are the results of performing the process.*

Bal (1998) stated that a process can be looked at from various perspectives depending on the kind of information required. In his view this may take the form of what is going to be done, who and how it is going to be done, when it will be done, who will take the decision etc. Therefore, Bal (1998) identified that a process has

functional, behavioural, organisational, informational, and resource based content,

and provides the following explanations of the various perspectives.

Table 3-1: Perspectives of process

Perspective	Explanation
Functional view	Functional view represents what activity or element of the process is being performed. It represents the act or activity that is being done by the actors or the employees.
Behavioural view	Behavioural view relates to when the process is being performed, and how it is being done. The activity or process as a whole could be going through a feedback loop or an iterative process etc
Organisational view	Organisational view represents who is performing the process. The mechanism through which there is interaction or transfer of content.
Informational view	Informational view represents the information details or entities that are being manipulated by the process. These can be data or product entity details. The informational view considers both the data involved and their relationships.

Source: (Adopted from Bal, 1998)

Having analysed the available definitions for 'process', the following definitions were considered within this study as they are closely related to define organisational processes;

'A course of action, proceeding, especially a series of operations in manufacturing, printing, photography, etc.' (Oxford Concise Dictionary, 2011).

'A sequence of steps performed for a given purpose. More simply stated, process is what you do. The process integrates people, tools and procedures together' (Software Engineering Institute – Capability Maturity Model, 2014).

'Any activity or group of activities that takes an input adds value to it and provides output to an internal or external customer. Processes use an organisation's resources to provide definitive results' (Harrington, 1991).

The above definitions highlight the importance of managing processes within organisations to run their business in long term and further to improve the 'value' of their businesses. The concept of process improvement, which developed in the quality movement, requires first that the existing process be stabilised. It then becomes predictable, and its capabilities become accessible to analysis and improvement. Simply, process improvement refers to making a process more effective, efficient, or transparent. The literature states that 34 continuous process improvements occur when the cycle of stabilizing, assessing, and improving a given process becomes institutionalised (Davenport and Short, 1990).

3.3 Capability maturity model for software

Continuous process improvement is one of the significant considerations of any organisations to survive in the competitive markets. Therefore there was a real need to develop a tool/framework to evaluate organisational processes which will help organisation to understand their process and evaluate the process efficiency. As a result Capability Maturity Model (CMM) was first introduced by the Software

Engineering Institute (SEI) to improve the software process capability while reducing redundancy, cost and complexity. The key purposes of CMM are to:

- identify strengths and weaknesses in the organisation (Assessments teams)

- identify the risks of selecting among different contractors for awarding business and to monitor contracts (Evaluation teams)

- understand the activities necessary to plan and implement a software process improvement program for organisation (Managers and technical staff)

- to assist to define and improve the software process in organisation (Process improvement groups)

The CMM model structured to identify maturity levels, key processes, common features and key practices of individual or collective processes (see Figure 3.1). The model introduced five (5) maturity levels (see Figure 3.2) of best engineering and management practices based on data collected from various industries. Each of that maturity level provides a robust base for continuous process improvement.
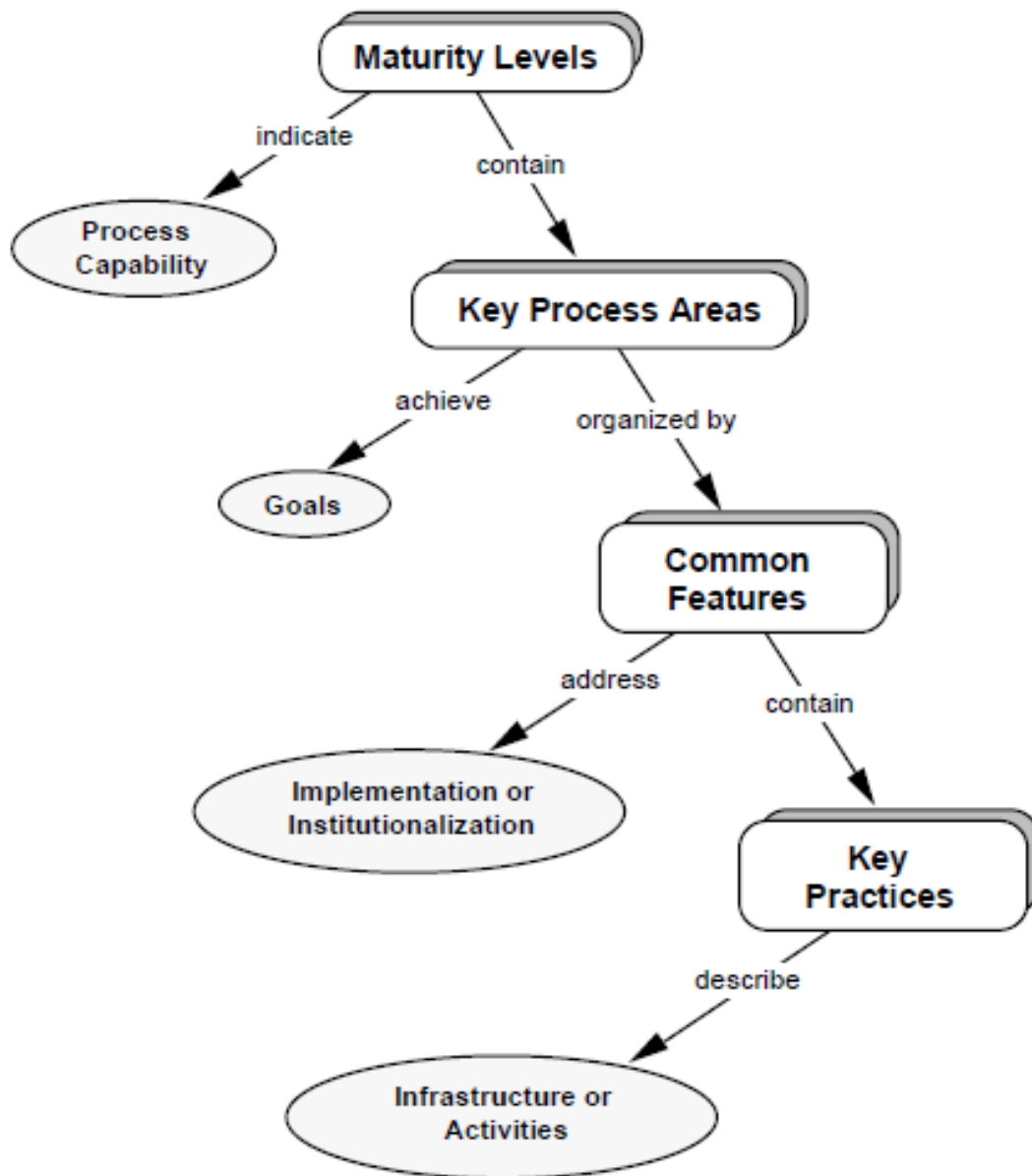
Figure 3-1: The CMM Structure

Source: (Software Engineering Institute, 2014)

Five (5) most significant maturity levels were identified in the CMM structure. They are;
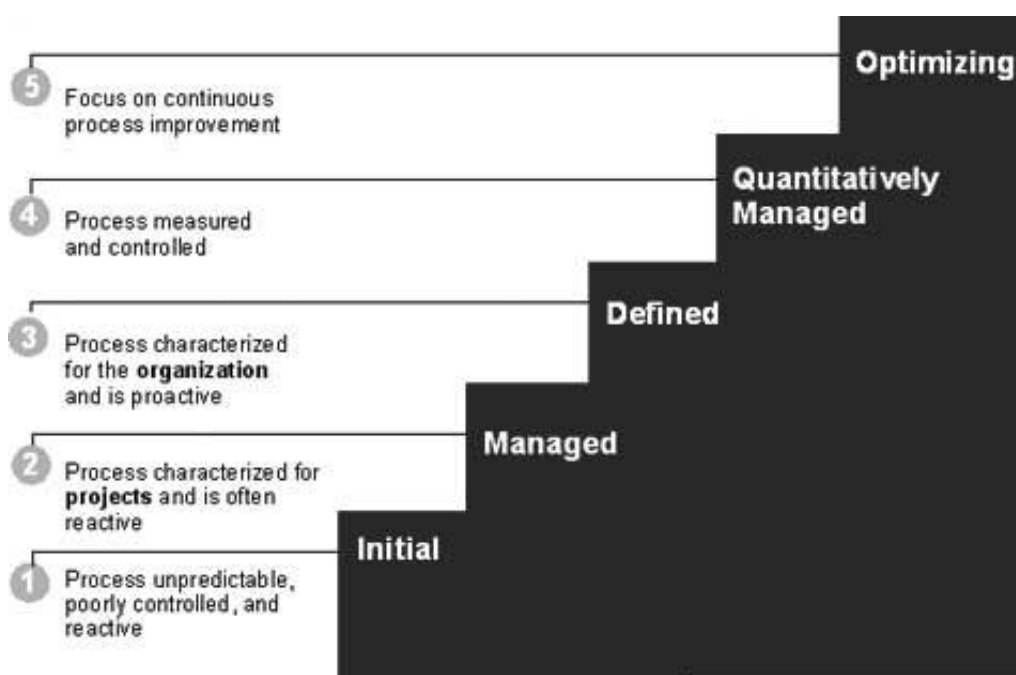
Figure 3-2: Characteristics of the maturity levels

Source: (Software Engineering Institute, 2014)

LEVEL 1 - Initial level: Preliminary or starting level for use of a new or known but undocumented repeat processes are considered within this level. The process is disorganised, inconsistent, and supportive services/infrastructure required to be developed massively.

LEVEL 2 - Development level: The process is under development and also documented sufficiently. Therefore repeating the same steps can be tried. The processes are established and infrastructure (technology, training, funds etc.) is developed to support the process.

LEVEL 3 – Defined level: At this stage the process is well defined and considered as a standard business process. Policies and procedures are well established and facilities are well defined, integrated and communicated properly.

LEVEL 4 – Managed level: The process is quantitatively measured and managed. Policies and procedures are well accepted as a part of organisation culture. Well managed (in terms of time, cost, and quality) processes.

LEVEL 5 – Optimised level: The final level of the maturity level. Key aim is to focus on continuous process improvements and lessons learnt. Policies and procedures are reviewed continuously and improve where appropriate. Optimise infrastructure to facilitate smooth processes. Customer feedback also highly considered when updating and improving the processes.

Having identified the loopholes of CMM (e.g. lack of consideration of human factors) it was suggested to revise the existing model and introduce the new model named 'Capability Maturity Model Integration' (CMMI) which guides the process improvement across a project, or an entire organisation.

3.4 Approaches for construction processes improvement

An organisation that conducts process improvement focuses on proactive problem resolution in order to avoid the inefficiencies of processes. Process improvement helps an organisation to:

- view process value through the eyes of the customer;

- define, manage, and measure a process in order to regularly evaluate it using data-driven information;

- break down process silos by contributing to an understanding of how processes interact and impact one another and customers; and

- reduce unnecessary costs.

The focus on processes in the construction industry has been in the limelight for a sometime. However, a pivotal moment was the release of the Egan report in 1998. In this report, Sir John Egan recommended the process focus as a key approach for the performance improvement in the construction industry. Research and industry programmes were launched as a result. As noted, Egan (1998) was not the only instance where the need to improve processes was called for. In a typical organisation environment, "process" is considered as a pivotal point in the long term survival of a business. It mainly integrated with inputs, outputs, controls and resources (entities). However, those entities also further associated with sub entities. Therefore, process is identified as a complex array of activity, which required to be managed properly. The following figures illustrate a typical organisational process and its entities.
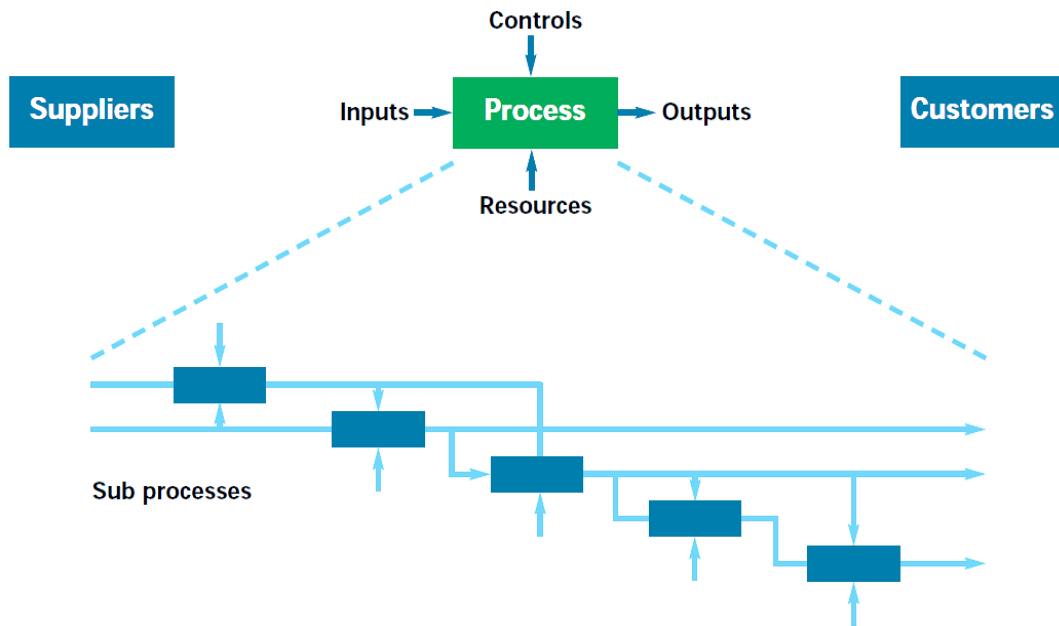
Figure 3-3: Typical process in an organisation

Source: (Department of Trade and Industry, 2012)
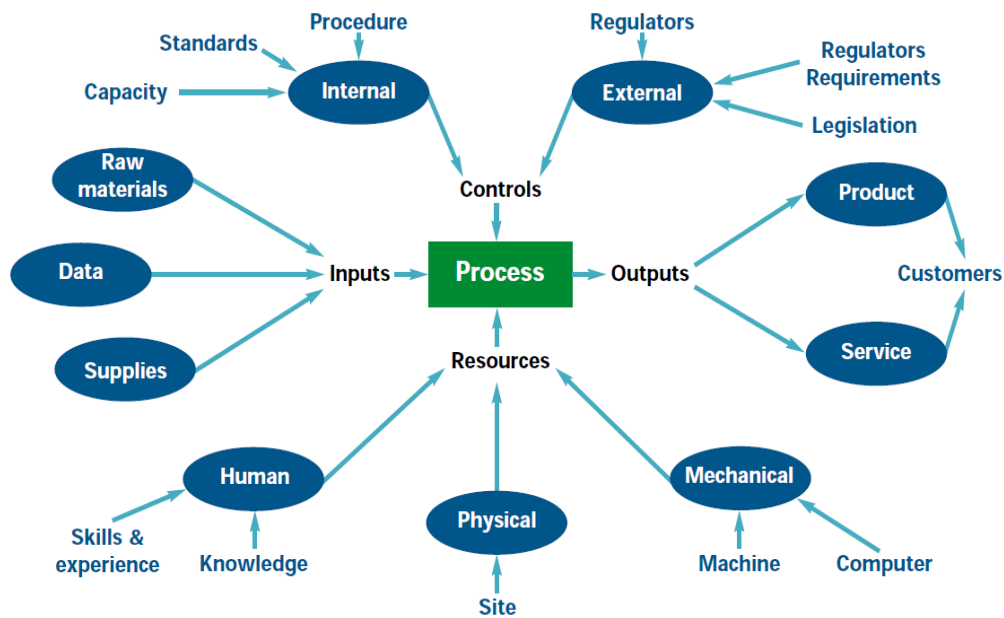
Figure 3-4: Organisational processes and its entities

Source: (Department of Trade and Industry, 2012)

Having identified the complexity of process and the heterogeneous nature of construction the process improvement is considered as one of the significant considerations in construction businesses. The approaches like 'Six Sigma' (Kwak and Anbari, 2006), 'Lean Construction' (Ballard and Howell, 1994), 'Re-engineering' (Hammer and Champy, 2006), Total Quality Management (TQM), Design of Experiments, and Process Excellence are frequently utilised as good techniques for process improvement in construction.

The Six Sigma focuses on near elimination of defects from any process, product or service and it follows a top-down approach. The Lean approach also focuses on the process and aims to reduce waste through breaking from the conversion process model, and reconceiving production processes (Ballard and Howell, 1994). Moreover, Constructing Excellence (2004) explains that Lean considers the flow of the beginning to end actions and all the interactions between them as a process value chain or the "value stream". Those steps are classified from the customer's point of view meaning that the value of each action in the stream is determined by whether it adds value from the customer perspective as "value adding" or does not add value from the customer perspective as "non-value adding". In fact, lean applies practical solutions to practical problems that can exist in any flow of work. Practical solutions are sometimes obvious fixes that can be quickly implemented. Simply, re-engineering refers to reinventing the process to gets its work done. Similarly, the Chartered Quality Institute (2014) explains TQM as a way of thinking about goals, organisations, processes and people to ensure that the right things are done right first time. Having studied the approaches

available for process improvement it can be concluded that almost all the process are trying to eliminate waste by slightly different ways. However it is important to understand which approach might fit for purpose before it integrates with the business process.

3.5 SPICE approach to improve construction processes

Structured Process Improvement of Construction Enterprises (SPICE) research project commenced in 1998 at University of Salford, UK, as a response to the calls from the critics of the construction industry, noted by Sir John Egan (1998) and Sir Michael Latham (1994). They pointed out that there is an essential need for the construction organisations to focus on and improve their processes (Latham, 1994; Egan, 1998). SPICE research project was an attempt to explore the applicability of Capability Maturity Model (CMM) in specific to the context of construction industry. This chapter elaborates the potential scope of the SPICE model, especially the SPICE Level 3 process maturity framework to contribute to the government's call for achieving public sector efficiencies. The priority was given to discuss the relevant aspects of the organisational context within which the proposed process improvement model operates.

The SPICE approach offers a method to continuously improve business processes in a step-wise manner. It is a continuous process improvement model developed through a DETR (Department of the Environment, Transport and Regions) funded project. The model developed at the University of Salford provided a structured approach to help construction organisations to improve their management

processes in a structured manner. The first iteration of the SPICE project, which is referred as the 'Introduction to SPICE' published by Construct IT (2000), it presented a robust instrument to assess process maturity at an individual project level. This is also called SPICE level 2. The second iteration of the SPICE project, funded by EPSRC (Engineering and Physical Science Research Council), investigated key issues in process improvement at an organisational level (called Level 3). As a requirement to attain SPICE Level 3 process capability maturity, construction organisations are required to create an effective management infrastructure to support organisational learning and change processes. Several key issues pertinent to building and developing a management infrastructure for process improvement were highlighted (Jeong *et al,* 2004):

- The organisational level process improvement requires far greater efforts than the collection of individual project level process improvement;

- Implementing organisational level process improvement is not just a linear mapping exercise, nor transmitting process information through ICT tools;

- Organisational level process improvement should be driven by business strategy, which enables managers and employees alike to identify and prioritise critical issues;

- The success of organisational level process improvement hinges on the individual and organisational capabilities to create, transfer and exploit knowledge to the organisation's advantage;

- Organisational level process improvement requires developing and integrating internal and external knowledge-based across all levels of the organisation and across its supply chain; and

- Interaction between technology, people, and processes are significant to successfully developing an enabling environment for good practice sharing.

A combination of literature review and synthesis and empirical research, development and testing, four key processes namely, process definition, process customisation, process training, and process improvement resourcing, were deemed critical to building an organisational management infrastructure within construction companies to facilitate process improvement through good practice sharing. SPICE research has borrowed many basic concepts from CMM (Capability Maturity Model) and customised them into a construction specific model. SPICE is aimed at addressing the improvement of management processes within construction organisations with emphasis on processes associated with tendering, design and construction. The use of Capability Maturity Model has

indicated that companies can create a general culture of process improvement by initially emphasising the core processes of product development.

3.5.1 Process capability and maturity

Over the past two decades, a number of management thinkers (Ghoshal and Bartlett, 1994; Patton, 1998) have stressed the unique factors that can provide an organisation with a source of competitive advantage, that distinguish it from competitor organisations and that explain why it does certain things well. The terms such as core competence or corporate competence, were brought to the forefront. As such, rather than competence being viewed solely as the property of an individual, it becomes a social and collective phenomenon embedded in an organisation's processes, systems, relationships and routines. In the view of these thinkers, organisational capabilities are far more decisive in securing competitive advantage than the ability to manage physical assets or produce isolated moments of strategic brilliance. One reason cited is that it is easier for a competitor to copy a strategic decision than to duplicate a fine tuned highly effective day-to-day business process (Sayles, 1994).

The approach adopted by the SPICE research considers the issue of capability by identifying the current process capability of organisations. Process capability is a forward-looking view of an organisation's operational processes (Paulk *et al.*, 1995; Zahran, 1998). The intention is to predict the outcome of a process before that process has taken place. When a process is stable, its results will have predictable means and be within predictable ranges about the means.

Process maturity indicates the extent to which an organisation is able to define, manage, measure and control a specific process. Higher process maturity is an indication that an organisation has potential to improve its capability, and demonstrates the richness of its processes. Process maturity also suggests that processes will be applied consistently in projects throughout the organisation. The SPICE model helps organisations to understand their level of process capability, in terms of their process maturity. In general, mature organisations have a high level of process capability, while immature organisations have a low level of process capability.

3.5.2 Immature vs mature organisations

SPICE approach also considers the difference between immature and mature organisations. In an immature organisation, construction processes are generally improvised by employees and project managers during the project (Jeong *et al*, 2004). Even if a particular construction process has been specified, there is no confidence that it will be rigorously followed or enforced. An immature organisation is forced to react to events and managers or decision makers of similar capacity, frequently have to engage in firefighting. This is due to the reactive approach to addressing problems. In an immature organisation, there is no method for judging the quality of the product or for solving product or process problems. Quality assurance is often suspended or eliminated when projects fall behind schedule. Therefore in an immature organisation, it is difficult to predict the quality of the product. Activities intended to enhance quality, such as project reviews, are often given insufficient attention. Quality assurance checks and documentation are often

left until project completion, where defects are identified as snags. At this point, the problems are often more costly to rectify and lead to conflict within the project team. However, even in undisciplined and immature organisations, individual projects sometimes produce excellent results. When such projects succeed, it is generally thanks to the efforts of a highly dedicated team or individual, rather than systematic and proven methods (Jeong *et al,* 2004)

A mature construction organisation on the other hand, possesses an organisation-wide ability to manage design, construction and maintenance activities (Jeong et al, 2004). The processes are communicated accurately to existing staff and new employees, and activities are carried out according to planned processes. The processes fit each situation well and are consistent with the way the work gets done. Roles and responsibilities are clear throughout the project and across the organisation. In mature organisations, managers monitor the quality of the product as well as client satisfaction. There is an objective basis for judging product quality and analysing problems with the product and process. The organisational culture includes time for reflection. In general, disciplined processes are consistently followed because all the participants understand the value of doing so, and the infrastructure exists to support the processes. In a mature organisation, construction processes are well understood, usually thanks to practice, enforcement, documentation and training. After implementation, the processes are continually monitored and improved by their users. It is important to note that the actual performance of the project may not reflect the full process capability of the organisation. In some cases, the environment and outside factors can constrain

the capability of the project. External constraints which can influence process capability include economic recessions, new supply chain relationships, and acquisitions and mergers. Mature organisations, such as those at Levels 2 and 3 of the SPICE framework, are able to respond to these external factors (Jeong et al, 2004).

3.5.3 Stepwise improvements in organisational maturity

The SPICE model advocates continuous process improvement based on many small and evolutionary stages. It divides these evolutionary steps into five maturity levels, which lay successive foundations for continuous process improvement (Jeong et al, 2004). These maturity levels form a scale for measuring the capability of a construction organisation's individual processes, and its overall process capability. Each level of maturity consists of a set of key processes. When an organisation is successfully applying each key process, it can stabilise an important part of the construction process and make it predictable. The five levels provide guidelines on how to prioritise efforts at process improvement.
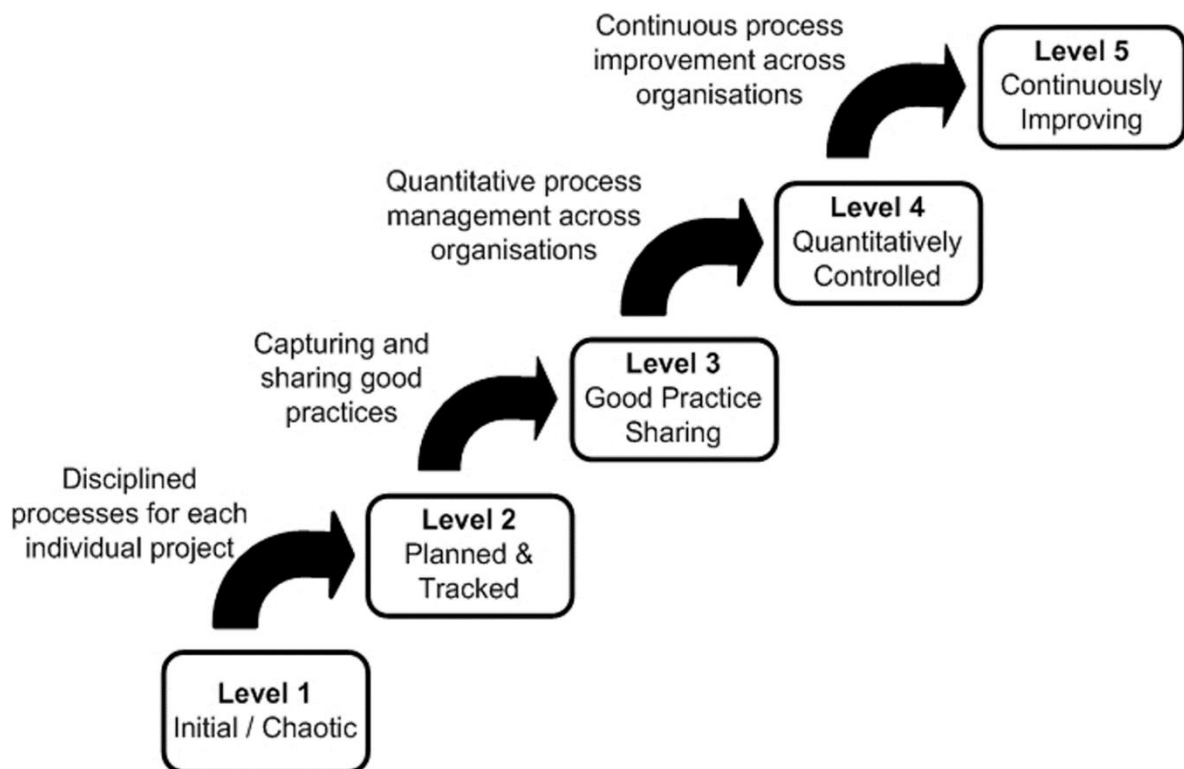
Figure 3-5: The SPICE process improvement framework

Source: (Construct IT, 2000)

At each Level, SPICE model specifies a number of "key processes". By following the steps in the model, an organisation can achieve effective and continuous improvement based on evolutionary steps (Jeong *et al*, 2004). An organisation can only be at one level of the model at any one time. If an organisation is at Level 1, but implements some of the key processes of Level 3 or 4, it is still considered as a Level 1 organisation. The SPICE model highlights that an organisation has little to gain by addressing issues at a higher level if all the key processes at the current level have not been implemented (Jeong et al, 2004). The following sub-sections will discuss the key purpose and considerations of each level.

3.5.3.1 Level 1 – Initial/Chaotic

At the Level 1 the organisation has little focus on process, and project visibility and predictability are poor (Jeong *et al*, 2004). Good practices of projects are local, and are not repeated or "institutionalised" across the company. Ineffective planning and co-ordination undermine good practices. Organisations make commitments that staff or the supply chain cannot meet, which can lead to a series of problems. In problematic situations, projects typically abandon planned procedures; instead, individuals do whatever activities it takes to get the job done, with little regard for the effects on other people. In the context of construction, time and cost schedules are often under tight control. Hence the problematic situation often leads to compromises on quality (Jeong *et al*, 2004), thereby leading to poor performance. At Level 1, the success of a project depends entirely on having an exceptional manager and a competent team. When these managers leave, their stabilising influences leave with them. The construction process capability of a Level 1 organisation is unpredictable, because the process is constantly changed or modified as the work progresses. Performance depends on the capabilities of the individuals, rather than that of the organisation (Siriwardena *et al,* 2005).

3.5.3.2 Level 2 – Planned and Tracked

At Level 2, there is a degree of project predictability. The organisations have established policies and procedures for managing the major project-based processes. This allows organisations to repeat the successful practices of earlier projects (Jeong *et al,* 2004: Siriwardena *et al*, 2005). Effective process planning is introduced before a project starts. During the project execution, activities are

evaluated and improved. An effective process can be described as one that is practised, documented, enforced, trained, evaluated and able to improve.

An organisation at this level make realistic commitment to clients and the supply chain, based on the results obtained from previous projects and on the requirements of the current project. Managers track quality and functionality on site as well as time and costs. Problems in meeting commitments are identified as they arise (Jeong *et al,* 2004). The integrity of the project's brief and requirements are maintained throughout the project. Standards are defined and organisations ensure that they are closely followed. They also engage the sub-contractors and the supply chain to establish strong relationships.

At this stage, processes for good project management are planned, tracked and enforced on every project. Each project within the organisation is predictable. However, the management processes across the different projects may differ. Each team devises and enforces their processes (Jeong *et al*, 2004).

3.5.3.3 Level 3 – Good Practice Sharing

A well-defined process includes standard descriptions and models for performing the work, mechanisms to verify that the work has been done correctly (such as peer reviews) and completion criteria, that provide a good insight into progress (Jeong *et al*, 2004). In other words, there is organisational visibility of projects. Because the process is well defined, management has good insight into progress. Quality and functionality of all projects are well tracked.

Level 3 is the stage where an organisation develops the capability to capture and share good practices, across the organisation rather than on a localised or at project basis. SPICE model advocates that an organisation does not have the capability to capture and share good practices, until it reaches Level 3. Attempts to do so will be risky and are likely to prove unsuccessful. The processes for all activities are documented and integrated into the organisation (Siriwardena et al, 2005). All projects use an approved, tailored version of the organisation's standard process. Consequently, organisations develop the capability to capture and share good practices.

3.5.3.4 Level 4 – Quantitatively Controlled

The process discipline established throughout the organisation at Level 3 lays the foundations for objective measurement of the product and processes at Level 4. Jeong *et al* (2004) observes that consequently, projects are able to reduce variations in process performance, so that they fall within acceptable boundaries. Meaningful variations can be distinguished from random variations. The risks involved in moving up the learning curve - as a result of taking on new categories of projects, or new procurement and supply chain arrangements - can be managed. The organisation will have a programme that measures productivity and quality for important construction process activities across all projects. This programme forms an objective basis for measuring the product, the process, the degree of customer satisfaction, and the level of harmony across the supply chain.

At this Level, organisations have the capability to set quality goals for (i) the product, (ii) the process, and (iii) the supply chain relationships. Productivity and

quality are measured for important construction process activities across all projects as part of an organisational measurement program. This also indicates some degree of commitment for improvement from the centre (of the organisation). This forms an objective basis for measuring the product, the process, and the degree of customer satisfaction (Jeong *et al*, 2004).

3.5.3.5 Level 5 – Continuously Improving

The entire supply chain is focused on continuous process improvement in Level 5. The organisations can identify weaknesses and strengths of processes before any problems emerge, and can do so in a collaborative manner. Data on the effectiveness of the processes is used to perform cost benefit analysis of any new technologies and proposed changes in the organisation's processes. This increased level of understanding allows organisations to consider large-scale changes to their processes. (Jeong *et al,* 2004) Innovations that exploit good practice in business management are identified and adopted throughout the organisation. Project teams across the supply chain analyse defects to determine their causes. Construction processes are evaluated to prevent known types of defects from recurring, and lessons learned are communicated to other projects.

By Level 5, an organisation can use the data on the effectiveness of processes to identify strengths and weaknesses in a pro-active manner. This enables the organisation to continuously improve its processes.

3.5.4 Key Processes

Each SPICE Level, with the exception of Level 1, includes key processes that identify where an organisation must focus to improve processes. SPICE Level 2 key processes are brief and scope of work management, project planning, project tracking and monitoring, subcontract management, project change management, health and safety management, risk management, and project team coordination. For an organisation to achieve Level 2 of maturity, all projects must perform all these key processes adequately. This forms the basis for progression to Level 3.

3.5.5 Process Enablers

SPICE approach makes the distinction between incomplete processes and disciplined processes, listing a number of key management features for a complete and coherent process. Process enablers focus on results that can be expected from a key process. This is a forward-looking approach, which indicates process capability before a process takes place. They provide critical features that a key process must possess in order to yield successful results (Jeong *et al,* 2004). By ensuring that all the process enablers are in place, it improves the performance and predictability of key processes. Process enablers are common across all the key processes.

3.6 SPICE Level 3 process maturity framework

3.6.1 Process improvement in organisational level

As construction projects often have a relatively limited life span, with a multi-organisational environment to undertake unique and novel products, it is extremely difficult when they attempt to improve processes by leveraging knowledge and lessons learnt from, within, and between projects, to the organisation. In order to successfully deliver a unique, novel, and transient project, it would be beneficial if the project team can make decisions and make adjustments on processes at a local level (Jeong *et al,* 2004). However, if too strong an emphasis is placed on defining processes at each project, process improvement at an organisational level would suffer. It could lead to improvising processes each time, thus re-inventing the wheel each time. Process improvement beyond individual projects is thus a logical and necessary step forward to improve organisational performance by capturing good practices and leveraging expertise of all employees.

In order to develop rich and substantial organisational process capability, it is necessary to go beyond a boundary of a firm (Siriwardena *et al*, 2005). As the construction industry is highly fragmented, it is essential to integrate the knowledge of various project stakeholders across both upstream and downstream value chains. As these stakeholders have different interests and competencies in processes, it is necessary to prevent opportunistic and adversarial behaviours from impeding collective learning and change. In this context, it is called for more proactive integration efforts among construction supply chain. This may be achieved through strong leadership to create a collaborative climate by forming

strategic networks in the construction communities for fostering reciprocal knowledge and good practice sharing.

SPICE Level 3 organisation builds upon the achievements of Level 2. At this level an organisation has the capability of capturing and sharing good practices on an organisational scale. The aim of SPICE Level 3 is defined as establishing management infrastructure to facilitate process improvement at an organisational scale (Jeong et al, 2004). Moreover, the organisation has the capability to capture and share good practices and knowledge across projects, at an organisational scale. A Level 3 organisation focuses on creating a process improvement infrastructure for capturing and sharing good practices across the whole organisation (Paulk *et al*, 1995; Zahran, 1998). Following figure illustrates how Level 3 differs from the previous Levels as to process execution and improvement. Project teams use these good practices and tailor them to define their unique project processes. Employees in any part of the organisation can easily refer to its well-defined set of good practice processes.
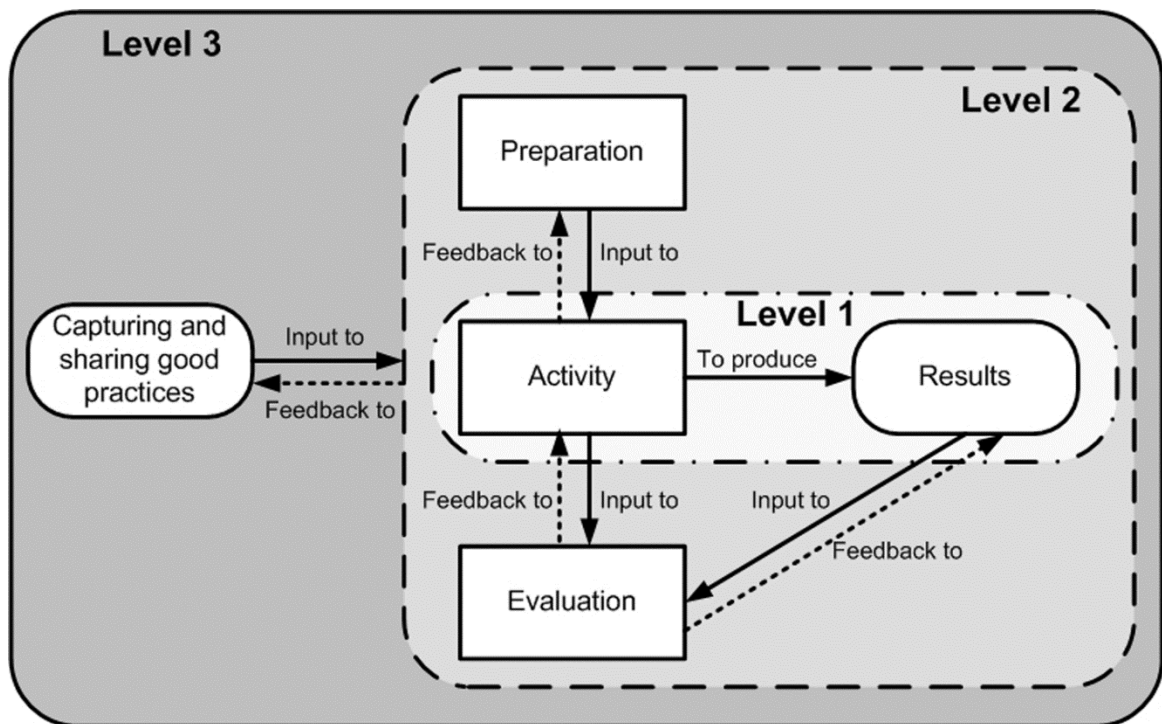
Figure 3-6: Transition from Level 1 and Level 2 to Level 3

Source: (Construct IT, 2000)

In order to demonstrate a Level 3 maturity level, organisations need to show organisational process capability that they can integrate and institutionalise learning from individuals and projects, which can be subsequently used at an organisational scale. SPICE Level 3 process maturity assessment can highlight strengths and weaknesses of organisational process capability, and lays a foundation for openly discussing and thereby building consensus on organisation specific strategies to bridge the gap between a current state and a desirable and feasible state.

3.6.2 SPICE Level 3 key processes

Although establishing an organisational infrastructure for process improvement at an organisational scale entails a diverse array of factors and processes, the SPICE Level 3 team has attempted to untangle complexity involved in organisation-wide process improvement and to present a concise set of key processes that have most direct and important bearings on implementing and achieving Level 3 process maturity (Jeong *et al*, 2004). Siriwardena *et al* (2005) and Jeong *et al* (2004) define each key process as explained below.

3.6.2.1 Process definition

This key process is to establish and develop a well-defined set of organisation-wide good practice processes. Building upon from the achievements and lessons learnt from Level 2, this key process is to ensure that lessons learnt and good practices at a project Level are continuously and periodically captured.

3.6.2.2 Process customisation

This key process is aimed at achieving the implementation aspect of the common understanding of good practice processes across the organisation. Based on the organisation-wide good practice processes, each team will use them as guidelines (rather than rigid procedures) for developing more project-specific processes considering specific project characteristics (e.g. procurement route, supply chain, location, project team structure, project strategy, and resource requirements).

3.6.2.3 Process training

This key process is to ensure that the individuals and groups possess appropriate and relevant knowledge and skills required not only to fulfil processes at hand but also to absorb new knowledge necessary to develop further organisational competencies. It entails identifying the current and future gaps of individual, group and organisational competencies and addressing the identified needs successfully.

3.6.2.4 Process improvement resourcing

This key process refers to providing required organisational resources and time for facilitating process improvement and subsequent organisational change. Detailed requirements and solutions for 'process improvement resourcing' will vary depending on each organisation or team's circumstances and internal climate; however, process improvement initiatives will benefit from senior management sponsorship, which will ensure that resources are directed to critical areas and at an appropriate level.

3.6.3 SPICE process enablers

SPICE approach identifies five process enablers that are prerequisite for a process to be complete and coherent. This is a forward-looking approach, which indicates process capability before a process takes place. They suggest that, in order for a process to yield successful results, it must possess such features as detailed in the SPICE process enablers. Thus, all key processes in each Level are

tested against these common process enablers. Siriwardena *et al* (2004) and Jeong *et al* (2004) explain them as follows.

3.6.3.1 Commitment

Commitment refers to establishing policies that are shared by the whole organisation. Some processes need sponsors or leaders in the organisation. Commitment ensures that leadership positions are created and filled, and that the relevant organisational policy statements exist.

3.6.3.2 Ability

Ability is having sufficient resources (physical and/or virtual) and time, an appropriate organisational structure, and formal/informal training in place. It is also necessary to have appropriate mechanisms to enlist collaboration and involvement of employees.

3.6.3.3 Activity

They typically involve establishing plans and procedures, performing the work, tracking it, and taking corrective action as necessary.

3.6.3.4 Evaluation

During the early stages of maturity, this will mean efforts by the team to improve existing processes. The focus here is on the project team's internal improvements.

3.6.3.5 Verification

Adopting such verification checks as a process enabler emphasises the need for independent quality assurance. The focus is on external verification of processes. This enabler can be usefully utilised as a learning point that it helps organisations identify possible root causes of their success/failure and devise feasible solutions.

The following figure shows a schematic diagram to illustrate how these Level 3 key processes are linked to each other and to process enablers within the SPICE Level 3 assessment scheme.
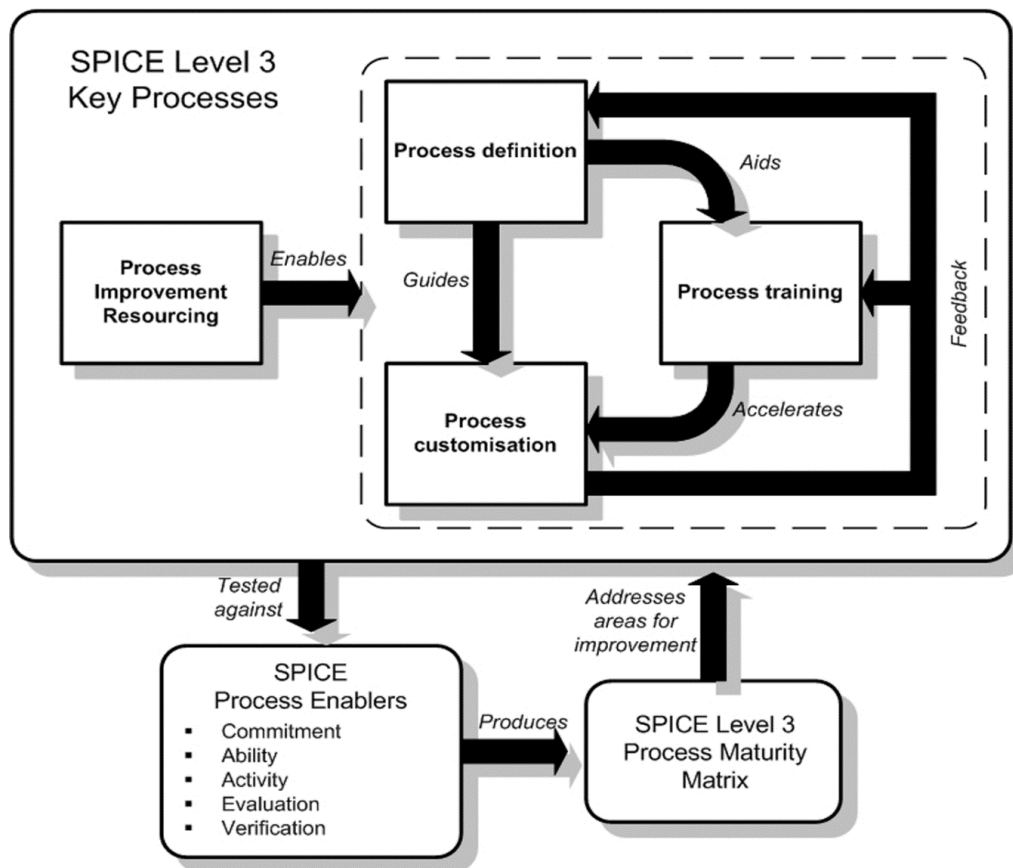
Figure 3-7: Positioning Level 3 Key Processes within SPICE Level 3

Source: (Construct IT, 2000)

The SPICE model argues that, at Level 3, key processes should be integrated and interacts with each other. For example, establishing and developing organisation-wide good practice processes ('Process Definition') will aid the organisation to prioritise issues pertinent to employee learning and development ('Process Training'). The established and developed organisational good practice processes would help the organisation have common understanding of the processes and their contexts so that they can tailor those good practice processes to meet the specific needs of individual construction project ('Process Customisation'). The tailoring process will be also accelerated along with the increased competency and skill levels of employees through process training. The activities within these three key processes will be sustained and enabled when there are appropriate organisational resources and supports to foster process improvement and organisational change ('Process Improvement Resourcing').

In order to satisfy the process maturity level advocated by SPICE Level 3, the key processes need to be backed up by the process enablers that are key features of disciplined processes: commitment, ability, activity, evaluation, and verification. Once the SPICE Level 3 key processes are tested against these five process enablers, the SPICE Level 3 process maturity matrix can be produced to help organisations identify gaps and initiate organisational change. The process maturity matrix shows graphically the strengths of the organisation in terms of process capability and which areas need to be further improved. A sample process maturity matrix is shown in Figure below. The dark colour cells reflect the areas

that required further improvements and white colour cells give the areas that are satisfied.
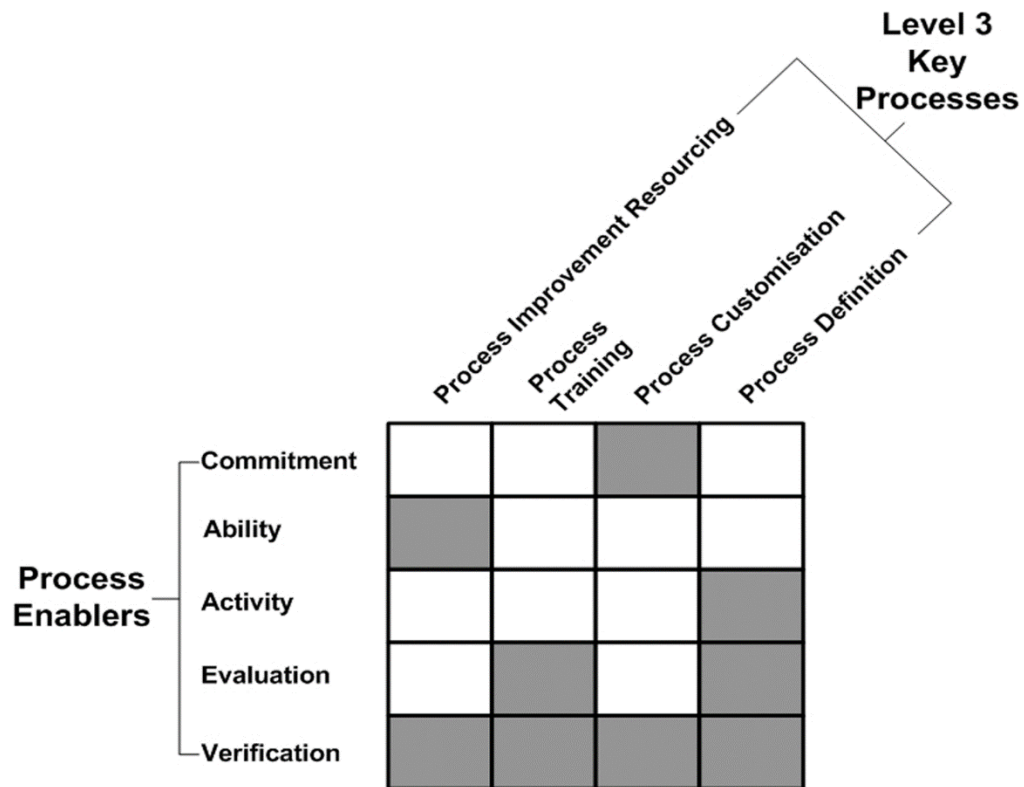
Figure 3-8: SPICE Level 3 process maturity matrix

Source: (Construct IT, 2000)

Above explains how SPICE Level 3 maturity model can be used to improve construction processes. The next section identifies 'procurement' as one of core processes of construction businesses and the key consideration to improve the procurement process. The facts that highlighted in the report called Gershon review (1999) are considered within the context of construction.

3.7 Process improvement in construction procurement

The "Modernising Procurement" report published in 1999 highlights the importance of procurement as key criteria for the management of public sector operations (Siriwardena et al, 2006). The report stated that *"it is vital to get the necessary goods and services at the right quality, at the right price and at the right time"* (National Audit Office 1999, p.2). It is also noted that improving the efficiency and cost effectiveness of government procurement is an important part of the modernising Government agenda. In 1998, the government commissioned two separate but complementary reviews on the subject of government procurement (Office of Government Commerce, 1999). The first of these reviews was undertaken by Sir Peter Gershon, to review civil procurement in central government in the light of the government's objectives on efficiency, modernisation and competitiveness in the short and medium term. The second was by Sir Malcolm Bates, which examined the progress made by the government in the delivery of. Both reviews proposed significant organisational change (NAO, 1999). The report by the Comptroller and Auditor General titled "Modernising Procurement" which was published in 1999 also indicated the government's intention to achieve public sector efficiencies, especially within its procurement function. Sir Peter Gershon's independent review of public sector efficiency titled "Releasing resources to the frontline", published by the Treasury in July 2004 was one of the latest publications of in this regard (Siriwardena *et al*, 2006).

The Gershon Review of 1999 also reviewed the whole process of acquisition from third parties by Government, including goods, services and large capital projects (OGC, 1999; Siriwardena et al, 2006). Having recognised that the term 'procurement' has many different interpretations, Gershon (1999) considered 'procurement' as the whole process of acquisition from third parties (including the logistical aspects) and covers goods, services and construction projects. This process spans the whole life cycle from initial concept and definition of business needs through to the end of the useful life of an asset or end of a services contract. Both conventionally funded and more innovative types (e.g. PFI/PPP) of funded projects are included. In an attempt to highlight the importance of including built environment assets within this context, Gershon quotes

> *"The process is not limited to the purchasing function in departments and is inherently multi-functional especially in large, complex and / or novel procurements"* (Siriwardena et al, 2006 cited in Gershon, 1999, p1).

Gershon also recognised that construction is a key component of public procurement.

> *"..the public sector is one of the biggest purchases of goods and services in the economy. In 2003-2004, the public sector spent over £100 billion purchasing for example utilities, ICT systems and services, as well as professional services, temporary labour, construction, social housing, social care, and environmental services;"* (Gershon, 2004, p 9).

In order to determine the efficiency and effectiveness of the current procurement process, Gershon (1999) considered seven (7) aspects, namely Policy, Organisation and Structure, Process, Measurement, People, Supply Base and Implementation. Those were considered in following sub sections (Siriwardena *et*

al, 2006) to highlight what improvements are required in construction procurement process.

3.7.1 Policy

Gershon (1999) identified a number of weaknesses in Government procurement. These cover organisation, process, people and skills, measurement and the contribution of the "centre" of Government. The proposals for dealing with these weaknesses called for the creation of a central procurement organisation called the Office of Government Commerce (OGC). The aim was to provide a greater sense of direction in procurement and push best practice in the public sector. Gershon (1999) recommended that OGC should establish a common strategic framework within which all departments should conduct their procurement activity. The framework would cover a standard procurement process, common performance measures, key standards, common systems and key values (Siriwardena *et al*, 2006).

3.7.2 Organisation and Structure

The review found widespread recognition that there is a need for a central body to ensure consistency of strategy, promotion of best practice and appropriate aggregation. Fragmentation and insufficient coordination between those central organisations with a significant role in procurement mean that, at present, the centre lacks the means to drive through changes in Government procurement (OGC, 1999; Siriwardena *et al,* 2006). There is no single person or body accountable for the deployment of resources involved in central procurement

activities and it considers that these resources are being utilised in a sub-optimal manner in terms of ensuring the best overall procurement performance by Government. The fragmentation and lack of co-ordination result in the centre having an unnecessarily limited 'value add' and not being able to act as a strong catalyst in improving overall Government procurement. A single 'one-stop shop' procurement central organisation should be created by combining as many of the resources of the above central activities as is possible (Gershon, 1999, p. 5-6).

3.7.3 Process

Another weakness identified in Gershon (1999) was the absence of a common process across Government for the management of large, complex or novel projects. Noted in Siriwardena *et al* (2006), there is no well-defined, common 'cradle to grave' process for managing procurements which are large, complex, novel, or some combination of these criteria. This puts important acquisitions of goods, services, or construction projects - funded either conventionally or by other means such as PFI - within, or across, Departments at unnecessary risk as there is no common mechanism for strategically controlling such procurements throughout their life cycle (Gershon, 1999, p 7). Moreover, Siriwardena *et al*, (2006) observed that Gershon (1999) recommended that OGC should define a common process taking into account best practice in the private sector and relevant experience from Government. A well-defined, common process for the strategic management of large, complex or novel (or some combination of these criteria) procurements should be implemented based on the following principles:

- *projects have distinct phases in their life-cycle;*

- *the 'gates' between these phases can be characterised by sets of deliverables (e.g. requirements specification, procurement plan, project management plan, risk management plan);*

- *deliverables should be assessed by people with relevant expertise who are independent of the project; and*

- *important 'gates' (typically 3 in the life cycle) can only be passed as a result of successful reviews chaired by senior people who have no vested interest in the outcome of the review (Gershon, 1999, p 8).*

Gershon also suggested that the detailed definition of this process, including the required deliverables at each gate, should be led by the OGC who will take into account external best practice and the experience gained from both recent successes and failures in Government procurement of large, complex, or novel projects. Highlighting the potential benefits of the above approach, Gershon (1999) stated;

> "such a process will *help to ensure a more consistent and enhanced level of performance on project orientated procurements, thereby saving money and boosting efficiency; catalyse widespread use of best practice, as this will increasingly be documented in the definition of the deliverables provide a foundation for procurements which support joined up Government initiatives*" Gershon (1999, p8).

Moreover he noted the importance of incorporating the supply chain management within the overall process framework. The OGC should develop a common process for the management of the supplier base, with top priority being given to those suppliers who are involved in the provision of goods and services which are critical to the successful operation of Government. Such a process must be firmly based on measurable data. It should also define the role of the OGC in the management of the overall relationship with suppliers and the role of Departments

in managing individual project based relationships with suppliers (Gershon, 1999, p 8).

3.7.4 Measurement

Good common measurement systems are an essential component of any effective procurement system (OGC, 1999). The Review identified that there are no cross-Government systems for recording what is purchased, the associated prices and sources of supply; analysing the true costs of procurement transactions; rating the capability and performance of suppliers; or targeting and measuring year on year value for money improvements. Gershon (1999) considered this is an area of great concern. The complete absence of any such systems is the finding that provided the greatest concern during the course of review. The absence of a common system for rating the capability and performance of suppliers' results both in unnecessary duplication of effort in Government and the supply base, and contributes to the overall sub-optimal management of suppliers. The weakness in measurement means that Government lacks an essential tool for strategic procurement activities and inhibits informed decision making (OGC, 1999). Gershon recommended that the OGC should work with Departments to produce a common system for rating the capability and performance of suppliers. He explained wherever possible capability measurement should be based on recognised external benchmarks (i.e. Business Excellence Model). Performance ratings should be based on objective measurement of recent track record on Government contracts where these exist (Gershon, 1999, p11; Siriwardena *et al*, 2006).

3.7.5 People

Gershon (1999) further recognised the importance of redefining the knowledge skill requirements within the public sector in order to achieve the proposed efficiencies. Although there are some very talented and capable people within the Government Procurement Service that is now being established, the overall levels of skill, capability and seniority need to be raised significantly (Gershon, 1999, p12). He recommended that a strong planning function to be implemented within the OGC so that procurement skills required supporting new Government policies and initiatives.

Several sources have indicated that the Gershon reviews and recommendations have specific relevance to the local government institutions too. Achieving greater efficiencies across the whole of the public sector is essential to support the Government's continuous drive for improved public service delivery (Siriwardena et al, 2006). Local government has a key role to play in this ambitious agenda (Sylvester, 2004). Future for Local Government: Developing a ten – Year Vision (Office of the Deputy Prime Minister, 2004) identified "service delivery and the performance framework" as one of the four main areas of attention in achieving the above vision (Leach and Pratchett, 2005). In this regard, finding ways of continuously improving organisations is seen as a challenge (Leach and Pratchett, 2005). They also consider Sir Peter Gershon's latest public sector efficiency review as a key external influence to the local government agenda. Sir Peter Gershon's independent review of public sector efficiency, published by the Treasury in July 2004 in advance of its three year spending review, has of all

external influences, potentially the most significant impact on local government (Leach and Pratchett, 2005, p 327).

3.7.6 Towards the process improvement through SPICE

The public sector forms a major component of the construction industry. Construction organisations are increasingly challenged to improve performance. This has been further highlighted by the public sector efficiency reviews and such as Gerhon (1999), and Gershon (2004) as discussed in the previous section. SPICE research, especially the development of SPICE level 3, recognised process improvement at an organisational level as a multi-faceted problem, involving a range of stakeholders. Taking into account many organisational process management aspects, it was identified four key processes at level 3 that have important bearings on efforts to establish and develop an organisational management infrastructure for process improvement. The four key processes are: process definition, process training, process customisation, and process improvement resourcing. Consequently those four key processes need to satisfy five process enablers: commitment, ability, activity, evaluation, and verification.

Having considered the above mentioned public sector efficiency focus, in can be contended that the use of Capability Maturity Models in Construction, especially SPICE, can contribute towards achieving procurement improvements. Gershon report strongly supports the use of common best practice processes (Jones, 2004) by observing the best practice principles, which will involve developing standards, training staff and better coordination. This issue is at the heart of SPICE Level 3,

since its main aim was to develop organisational wide good practice sharing framework. In SPICE Level 3 key processes, the "Process Definition" recommends a similar approach.

Gershon (2004) stated that efficiency in the public sector involves making the best use of the resources available for the provision of public services. It is common knowledge that the public sector procurement, especially with regard to built environment assets and services consist of a wide scope and variety. Hence the common best practices identified at a broader regulatory level, requires being tailored to suit and also to make best use of the local conditions. In this regard SPICE Level 3 key process "Process Customisation" advocates a related concept. Gershon's call for improving the skill and knowledge of frontline professionals to seek improvement efficiencies and engage in novel procurement approaches can draw similarities with the SPICE Level 3 key processes "Process Training". The overall organisational commitment to engage in the quest to seek efficiencies bears comparisons with the principles advocated within "Process Improvement Resourcing". Together with the SPICE process enablers, it is believed that, the SPICE framework, especially SPICE Level 3 has the potential to act as both an assessment and improvement tool, within the broader objective of reshaping the public sector built environment stakeholders to achieve greater efficiencies. As such further exploration in this regard is seen as a worthwhile exercise. Having analysed the key element of Grashon's report and its applicability in construction procurement process the next section explains the product-service paradigm and its influence towards the process improvements.

3.8 Product – service paradigm

Engineering companies are perceived to be going through a paradigm shift, from providing products to total service business models (Siriwardena *et al*, 2008). This paradigm shift, often referred to as product–service, requires the shift in focus from designing and selling physical products, to sell a system of products and services, which are jointly capable of fulfilling specific client demands. Complex engineering projects include large scale defence infrastructure (e.g. aircraft carriers), aircrafts, large scale construction infrastructure projects, software development etc. This does not, however, preclude the idea that product service paradigm is equally significant for engineering endeavours of a lesser scale (e.g. customised housing). As Leiringer and Green (2006) noted that although in the construction sector, the development of the PFI (Private Finance Initiative) market has had a significant impact on how many companies win work, the extent to which construction operating companies have become more service-oriented is debatable.

Product service paradigm presents a different approach to the manner in which engineering systems are considered (Siriwardena *et al*, 2008). It puts the user at the heart of the system. This means that the satisfactory servicing of user requirements is a key priority, and in most cases dictates performance measurement. For example, Maloney (2002) stated that there is no natural demand for the construction product; the demand for the constructed product is derived from the intended use of the facility. This entails that design, production, operation / use, maintenance / refurbishment, are no longer separate activities, but are part of a seamlessly integrated, multi-agent, multi-cyclical, long term supra

system. Therefore the focus on whole life cycle of the product's ability to provide sustained services is an essential requisite. It requires new business, operational and information system models that extend many years into the future. A shift from product to product service presents many challenges from several perspectives, as outlined (Siriwardena *et al,* 2008) in the following sub sections.

3.8.1 Product development

Designing for product-service is extremely challenging. One of the main issues that needs to be addressed is 'how do we know what users of the facility need in several decades?'. As the user needs are strongly influenced by what happens in the broader external environment, predicting such future requirements become further challenging. Designing systems to co-evolve with the changing circumstances may be an avenue worth exploring in this regard. Need to support globally distributed design, production and use are also key considerations.

3.8.2 Information management

Siriwardena *et al* (2008) noted that the through-life aspect of product service paradigm means that information will be continuously generated. McMahon (2006) observes two issues that require attention. Firstly, how to ensure that the information created and the knowledge gained during the design and subsequent operation of the product are recorded and organised in such a way that they are accessible through the whole life of the product, and of most value in product support and in further design work. This could mean that approaches to avoid information overload, and continued harnessing of the power of information

technology developments, needs to be considered. Secondly, to ensure that the organisations adopt the most appropriate strategies to maximise their performance in the new business approach (Siriwardena *et al,* 2008).

3.8.3 Procurement

The success of through-life support depends heavily on the integration of a network of organisations such as specialised component suppliers, subcontractors and service providers. This network of organisations, the context and the environment within which it operate will change with time (e.g. staff turnover, technology changes such as hardware and software, user needs, market and social changes etc.). It is vital that procurement and contractual arrangements move towards providing integrated solutions rather than pursuing bounded interests.

Leiringer and Green (2006) observe that the move from product delivery to also providing additional services can hardly be considered a paradigm shift. They contend that firms in a whole host of sectors would claim to have been operating in this way for a long time. However, they noted that the trend for product manufacturers to add various forms of services to their offerings is clear. There are many reasons why a firm would want to undertake a transition towards this end. Such a change could be mobilised as a means of securing future business, or it could be initiated by a change in public procurement strategy.

3.8.4 Product-service in the built environment

Blyth (2000) noted that the relationship between organisations and buildings is dynamic and continuously changing. The predominant approach to building procurement has tended to assume that a building project is a self-contained event. Moreover the Construction Research and Innovation Strategy Panel (CRISP) (1999) explained how buildings are part of a far bigger 'organisational project' and subject to rapid change. They identified

- adaptability and flexibility are not necessarily 'explicit' priorities during the briefing, design and construction of buildings; they often seem to be implicit;

- the definition of a 'flexible' building depends on the organisation using it, therefore it is difficult to brand buildings as flexible or inflexible;

- it is more important to test whether a building can respond to a variety of different demands rather than worry about trying to predict what those demands might be;

Siriwardena *et al* (2008) noted that in contrary, Blyth (2000) stated that the CRISP study did not reveal a particular pattern of change in the one building considered, but it did reveal how operational constraints can undermine flexibility strategies built into buildings;

- The operational constraints of an organisation need to be clearly articulated in the brief since they can easily conflict with physical building systems, therefore compromising the 'flexible' elements of a building;

- The study revealed that different stakeholders had different interests in adaptability and flexibility. It seems to matter most to those who manage buildings because they have to grapple with everyday management problems. Users probably notice it when things go wrong and designers only when they are asked to investigate a failure;

- Decisions affecting adaptability and flexibility are taken by different people during the briefing, design and construction process. Unless these are coordinated, the result maybe a less adaptable and flexible building than anticipated;

- Maintenance of key client and design team personnel from when a building is designed and built to its adaptation several years later provides valuable continuity. For example, the cost of controlling infection in the environment may not be an explicit operational cost;

- Hidden building operating costs may distort perceived costs of running buildings;

- The procurement process is a vital link in achieving a coordinated strategy for matching user needs and building responses. Anecdotally, clients of PFI projects perceive that they are expected to pay a 'high price' or a 'penalty' to PFI contractors if they want to make changes. This suggests that clients are finding it difficult to transfer a major area of risk.

The CRISP study also reveals the importance of adaptability and flexibility, and noted that there is more work to be done to gain an understanding about how it impacts on organisations and buildings. As noted by Siriwardena *et al* (2008), it offered four specific further research directions;

- Longitudinal studies of buildings to reveal how the politics of decision-making in an organisation affect decisions about buildings, and consequently how the building responds to changing organisational needs;

- Research into the cost and benefits of adaptability and flexibility by tracking how a range of buildings has responded over time and how the occupiers have changed;

- Comparative studies of a number of buildings into how they have responded to organisational change to identify common themes;

- A study of the speed of organisational change during the development of a building project from early briefing to handover to identify the effects on decision-making about the new building.

3.8.4.1 Stakeholders

Product – Service approach to the built environment (i.e. buildings, public and private infrastructure and other associated services) requires significant attention being paid to the involvement of stakeholders and their roles, over time. The presence of many stakeholders in the planning, design, construction and operation of the built environment is well documented. They range from national to local government agencies, designers, builders and facility managers to end users. Increasing focus on partnering and private financed initiatives for procuring public infrastructure such as healthcare, education and transport, has to a certain extent resulted in increased upfront mapping of the stakeholder engagement (Siriwardena et al, 2008). Following figure is such an abstract attempt to indicate one such high level stakeholder involvement (LIFT - Local Improvement Finance Trust) in the UK healthcare sector.
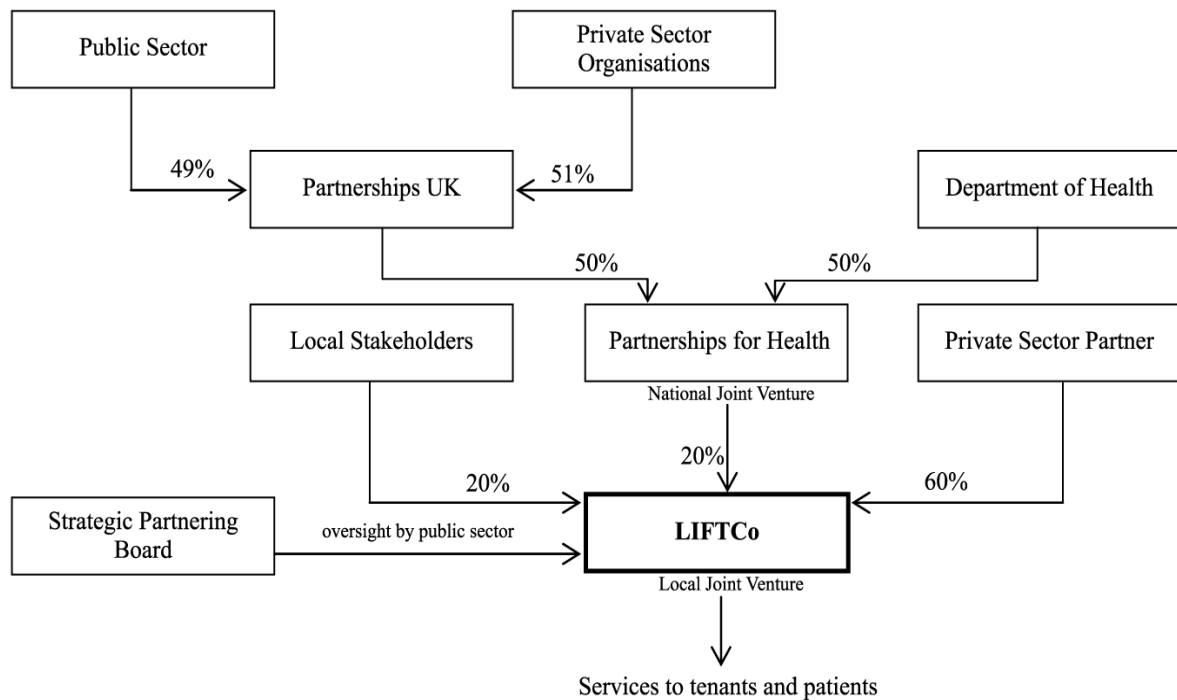
Figure 3-9: Ownership arrangement of LIFT companies

Source: (Holmes, Capper and Hudson, 2006)

Moreover, Siriwardena *et al* (2007) explained that although PPP/PFI context provides a case for product-service in the built environment, the origins and the diffusion has not followed with the same intention. Government avoiding the use of public money to provide public services, and privatisation seems have been the driving forces for these schemes. The lack of emphasis on life cycle considerations, especially the maintenance / refurbishment aspects, and adaptability and flexibility within the PFI literature indicates the need for further research on the readiness of PPP/PFI schemes to act as the built environment's response to the product-service challenge.

3.8.4.2 Life cycle issues

Buildings and infrastructure are built to last for a considerably longer period of time. Having quoted architect Chris Alexander, Brand (1994, p 194) noted

> *"A building's foundation and frame should be capable of living 300 years. That's beyond the economic lifetime of any of the players"*
> *Brand (1994, p 194).*

Koskela *et al* (2007) highlighted several approaches namely; life cycle assessment, product-service systems, product-life cycle management, systems engineering, integrated solutions, public private partnerships, design studies and concurrent engineering, which claim to emphasise the life cycle considerations in engineering contexts. In a systematic comparison of the mentioned approaches, it was concluded that major focus tends to be directed towards the front-end of the life cycle, especially to redesign and design decisions, which conventionally are considered of crucial importance, especially from a life cycle view point, with relative less attention on the subsequent use, maintaining, refurbishment and disposal. Multiple life cycles can be observed within built products over time (Siriwardena *et al*, 2008). They include component life cycles, space and functional life cycles, physical life cycles and legacy life cycles. Table below provides an explanation these terms.

Table 3-2: Multiple life cycles of the built environment

Type of life cycle	Description	Examples
Component life cycle	Refers to the life span of various components in buildings	Lifts, electrical equipment, doors, windows
Space / functional life cycle	Refers to the life span of a particular space in a building. When the intended use of the buildings changes, these spaces will attain different names	Warehouse / storage spaces in buildings changing to office space over time
Physical life cycle	Refers to the safe technical life of the building	Buildings above this period are considered not safe and are generally demolished
Legacy life cycle	New buildings are built with many in existing sites, but carries the same names, and are its associated history	Demolition and re-building of primary schools in UK Demolition and re-building of sports stadiums such as Wembley stadium in London

Source: Siriwardena *et al* (2008)

It could therefore be contented that conceptualising product-service for the built environment requires the consideration of changing roles of its stakeholders over time and the whole life cycle issues, tied together by information and incentive flows that facilitate continuous product and service delivery improvements.

3.8.4.3 Through-Life Management

Buildings and infrastructure facilities are results of the derived demand various services. Koskela, Siriwardena and Rooke (2008) noted that hospitals are built in order to provide healthcare facilities and roads are built as a response to the demand for transport. Therefore, a significant amount of construction projects are part of a much larger scheme, aimed at long term service delivery. Success of such long term performance can be significantly attributed to through-life management of the facility.

> *Through life management refers to the management of artefacts, often large and complex, such as buildings, plants, ships, airplanes through their life time. It is thus basically referring to designing and producing those artefacts, as well as to producing services through those artefacts, and finally to the deconstruction (or disposal otherwise) of those artefacts. Of course the central idea is to see all those stages as one unit of analysis and as one integral object of management. (Koskela, Siriwardena, and Rooke, 2008, p 71)*

Koskela, Siriwardena, and Rooke (2008) defined through-life management as an approach, where

- each stage, activity and decision, the impacts on later stages, activities and decisions are taken into account for the sake of through life optimum regarding cost, value and material flows;

- unavoidable uncertainty is appropriately counteracted;

- relevant real asset capitals are preserved and increased;

- production system design and control are geared towards elimination of waste and increase of value;

- value and cost are conceived of as flow phenomena – continuously generated throughout the life-cycle of the artefact, rather than being one-off transactional phenomena;

- continuous improvement (and innovation) regarding cost and value is pursued;

Furthermore Koskela, Siriwardena, and Rooke (2008) pointed out that there are two challenges, in the achievement of through life management, namely;

- Creating the appropriate incentives and settings through integration;

- Creating the appropriate system designs, operational methods and practices as well as methods and practices geared towards learning and improvement.

3.9 Summary

Construction organisations are increasingly challenged to improve performance. Process improvement at an organisational level is a multi-faceted problem, and involves a range of stakeholders. This chapter highlighted the role of Capability Maturity Model (CMM) and the SPICE (Structured Process Improvement of Construction Enterprises) research in the context of process improvement.

SPICE was developed in response to this call to aid construction organisations to improve process capability in a structured manner. Taking into account many organisational process management aspects, it was identified four key processes

at Level 3 that have important bearings on efforts to establish and develop an organisational management infrastructure for process improvement. The four key processes are: process definition, process training, process customisation, and process improvement resourcing. In addition, in order to achieve SPICE Level 3 maturity level, it was argued that these four key processes need to satisfy five process enablers: commitment, ability, activity, evaluation, and verification. As indicated in Jeong *et al*, 2004; Siriwardena *et al*, 2005; and Jeong *et al*, 2006), the principal aim of SPICE level 3 is to enable good practice sharing. In other words, the success of SPICE level 3 is heavily dependent on the ability to foster organisational learning. This aspect highlights the key role of SPICE 3 research within the context of this PhD research. However, the chapter also pointed out several other factors should be taken into consideration when developing a framework to facilitate organisational learning in construction from the process improvement perspective. The perceived shift from product to product-service is likely to present several challenges to the firms and stakeholders of the built environment. Aspects such as product development, information management and procurement need to take into account the changing roles of the stakeholders over time. Consideration of through-life issues also adds further complexity. Therefore, a framework to facilitate organisational learning needs to encapsulate the complex relationships and meta-roles, at organisational/project level.

Chapter Four

4. RESEARCH METHODOLOGY

4.1 Introduction to chapter four

This chapter describes the theoretical and practical perspectives of the research methodology that was used to solve the research problem stated in the chapter one. Theoretical position is reflected through the 'research philosophy', which focuses on the ontological and epistemological positions of the study. Practical perspective is reflected through research approach and methods. The study exploited the Design Science approach and multiple methods were used to collect, analyse and interpret the data. Furthermore, attention was given to justify the selected data collection and analysis methods while elaborating the reasons for rejecting other appropriate methods. The validity and reliability of research is also considered at the end of the chapter.

4.2 Research methodology

Although the importance of research methodology has been emphasised as an essential aspect of good research, defining research methodology does not appear to be a straight forward task. Authors of research methodology texts have used terms such as research strategy, research design (Easterby-Smith, Thorp

and Lowe 1991; Yin, 1994; Crotty, 1998), mainly to describe the considerations that need to be taken into account in conducting research, as well as the processes that should be followed. According to (Remenyi *et al.,* 1998, Collis and Hussey, 2003), research methodology refers to the overall approach to a problem which could be put into practice in a research process, from the theoretical underpinning to the collection and analysis of data. Gasson (2002) identified following key steps to determine the cycle of research.

- Understanding the "problem situation" objectively and determining appropriate situations in which phenomena relevant to the research problem can be observed;

- Engaging in those situations intersubjective with actors who regularly participate in such situations, to obsessively collect data on all phenomena;

- Disengaging from the situation at relevant points, to analyse the data, to question which phenomena are significant, then reengaging if data saturation has not been achieved. Disengagement also requires regular, objective questioning of the value-systems and assumptions that bring to interpretation of the situation; and

- Disengaging from the situation, to present the subjective as objective and to interpret the situation for others.

(Gasson, 2002)

It should be noted that if the purpose of a research effort is to make an original contribution to knowledge, the rigour of the process adopted to make claims for such knowledge should be at the heart of the said research effort. Although it is difficult to find an agreed definition of the term knowledge, Plato's claim that knowledge is "justified true belief" (Chappell, 2013) is popular especially amongst those advocating Western philosophy. As such, Baggini and Southwell (2012) state that knowledge is true belief plus a rational account to show that the belief is true. Therefore, research methodology can be considered as an attempt to make the research road-map explicit as much as possible. Literature explains the term 'research methodology' as a science of understanding how research can be done scientifically. Therefore, it is necessary to study the underpinning theories and methods to be adopted to undertake the particular investigation. Theory can be easily explained through the philosophical stances of the research. Having studied the various research philosophies explained in social science research, the Section 4.3 used explains the generic philosophical paradigms and then justifies the most appropriate philosophical stance for this investigation.

4.3 Research Philosophy

Research philosophy is usually reflected through several core assumptions concerning ontology, epistemology, human nature and methodology (Holden and Lynch, 2004). Ontology considers *'the philosophy of reality'* and epistemology explains *'how we come to know that reality'* (Krauss, 2005). Developing a philosophical perspective requires that the researcher make several core assumptions concerning two dimensions: the nature of society and the nature of

science (Burrell and Morgan, 1979). Moreover, Partington (2002) explains that philosophy is primarily concerned with rigorously establishing, regulating, and improving the methods of knowledge creation in all fields of intellectual endeavour. In philosophical inquiry, the facts, the theory, the alternatives and the ideas are brought together and weighed against each other in creation of knowledge to create and legitimise knowledge. Therefore, the researcher needs to be careful and articulate his/her research, especially the interrelationship between ontological, epistemological and methodological levels of inquiry (Proctor, 1998 p.76). Easterby-Smith, Thorpe and Lowe (2002) discuss the importance of research philosophy in scientific investigations.

There is a consensus within the discipline that management research does not operate within a single agreed ontological or epistemological paradigm (Tranfield and Starkey, 1998). The relationship between theory and empirical research is still controversial because 'certain social scientists assumed that the first need is to carry out intensive empirical work to prepare the ground for a decent social scientific theory, while others asserted that empirical research without prior, comprehensive theoretical reflection would at best yield meaningless and at worst erroneous results' (Joas and Knobl, 2009). Therefore the relationship between theory and practice is notable in scientific investigation as because many theories are underpinned by practice and many practices originate from theories. Usually, the selection of research strategy and the methods for research activities in the construction industry is inter-related with those philosophical stances (Saunders, Lewis and Thornhill, 2009).

4.3.1 Positivist and phenomenological paradigms

Having considered the epistemological debate on 'how to best conduct a research' there are two schools of thought, positivism and phenomenology. These perspectives are based on different assumptions about the world and how science should be conducted (Khun, 1996). The paradigm of positivism deals with a hypothetico-deductive approach and quantitative methods are usually adopted to collect and analyse data (Tashakkori and Teddlie, 1998; Easterby-Smith, Thorp and Lowe, 2002; Silverman, 2005) and produces an appropriate result in order to achieve research aims and objectives. Blakstad (2001) explains that the positivistic approach might not be practical when there is a lack of theory from which the hypothesis can be deducted. On the other hand, phenomenological paradigm considers phenomena. It becomes an exploration, via personal experiences, of prevailing cultural understandings (Knobe and Nichols, 2013). A phenomenological approach to research is at the core of interpretivism or in other words social constructivism. It allows researcher to consciously make the implicit explicit and also questions the very axioms of existence. Figure 4.2 illustrates a use of these two philosophical paradigms in a typical research enquiry and Table 4.1 identifies the key characteristics of each philosophical paradigm in more detailed manner.

Research Question
|
Theory
|
Philosophical Perspective

Positivism
Single, objective reality

Phenomenology
Multiple realities

Research Purpose

Test, verify, describe
(discrete variables)

Explain, interpret,
describe (phenomenon)

Research Design

Experimental, quasi
experimental, descriptive

Qualitative case study,
Ethnography, Grounded theory

Research Methods

Controlled intervention,
sequential clinical trials,
survey

Observation, interview,
documentary analysis

Research Data

Quantitative
Statistical analysis

Qualitative constant
comparative

Confirmed or reviewed theory

Figure 4-1: Alternative philosophical approaches to research

Source: (Shepard *et al.*, 1993)

Table 4-1: Characteristics of Positivist and Phenomenological paradigms

	Positivist paradigm	Phenomenological paradigm / Interpretivist paradigm
Ontology	Objective reality and social world exist independent of humans and it can be discovered Human action is intentional and rational Conflict and contradiction are not endemic to social relations and must be corrected	Reality is subjective and is constructed by actors and lived through a shared understanding which can be interpreted and not discovered. Meaning and intentionality are of paramount importance for they constitute behaviors.
Epistemology	Researcher is neutral Based on verification and falsification (theory testing). Search for universal laws and principles. Use of strict categorization and tight coupling among explanation, prediction and control.	Researcher is not neutral but involved in the phenomenon. Social processes cannot be captured by hypothetical deductions. Primacy of experience. Description of events from the participants' perspectives.
Methodology	Quantitative – Primarily experimental, quasi experimental	Hermeneutical/ Often qualitative and/or quantitative
The observer	Must be independent	Is part of what is being observed
Human interests	Should be irrelevant	Are the main drivers of science
Explanations	Must demonstrate causality	Increase general understanding of the situation
Research progress through	Hypothesis and deductions	Gathering rich data from which ideas are induced
Concepts	Need to be operationalised so that they can be measured	Should incorporate stakeholder perspectives
Units of analysis	Should be reduced to simplest terms	May include the complexity of 'whole' situations
Generalisation through	Statistical probability	Theoretical abstractions
Sampling requires	Large numbers selected randomly	Small numbers of cases chosen for specific reasons

Source: (Adapted from Galliers, 1991; Easterby-Smith, Thorp, and Lowe, 2002; Lincoln and Guba, 2013)

The philosophical orientation of positivism is the process whereby evidence rooted in objective reality and gathered directly or indirectly through the human senses is used as a basis for generating knowledge (Shepard *et al.* 1993 cited Pilot and Hungler 1991). Within the positivism paradigm, reality can be answered through testing one or many testable hypotheses which of course can be used to test the existing theories. Simply, the paradigm of phenomenology (interpretivism / social Constructivism) accepts no neutral grounds for knowledge, since all observation is value and theory-laden (Johnson and Duberley, 2000). This philosophy is commonly exploited in theory building and also appreciates social engagement (ideas, beliefs etc.). In this research philosophy, the researcher does not only interact with environment but also seek to make sense of it through their interpretation of events and the meaning that they draw from these. The section 4.3.2 explains the most appropriate philosophical position for this investigation.

4.3.2 Adopted research philosophy and justification

As noted in Figure 4-1 almost all research start with an unsolved research question, that will be expecting a reasonable answer and/or further testing (falsified or verified) at the end of the study. Therefore it is important to understand the correct research question and its behaviour to position the study in the correct philosophical stances. The area to be researched pointed out within this investigation was originated from two large research projects called SPICE III, which was aiming to identify process capability to facilitate good practice sharing in construction organisations and KIM (Knowledge Information Management).

Having studied the existing literature on the main theme (organisation process capabilities) the researcher observed that the lack of organisational learning towards process improvement in construction organisations as a significant gap in the current literature. Therefore the research question was formed to develop a framework to facilitate organisational learning in construction specifically to process improvement'.   Having understood different facades of the research question (e.g human engagement in organisational learning, adaptive nature of organisations/processes etc.) the study is directed more towards to study of social phenomena. Therefore, this study is placed in phenomenological philosophical paradigm based on hermeneutical Pre-understanding-Understanding spiral (Odman, 1985) which will be explained in Section 4.3.3. Schwandt (2007) defined Hermeneutics as, 'where the act of interpreting an utterance, text, or action is defined as a kind of exegesis (a clarification and subsequent explication of meaning that at first appears strange and puzzling), we imagine it to be a kind of critical analysis or explanation using the method of the hermeneutic circle' (Schwandt, 2007). Three case studies were used to study organisational learning (from the process improvement perspective) in construction context. The researcher was actively engaged with the participant observations, informal discussions, and focus group workshops with the project partners to acquire the data for this investigation. Therefore, positivism paradigm was rejected as it does not clearly fit with the elements of this research investigation.

4.3.3 The learning spiral

The learning spiral considers that no knowledge is possible without presuppositions (Susman and Evered, 1978). This research investigation (from problem identification to the generation of likely solutions) also adopted the principles of 'learning spiral' (see Figure 4.2). Pre-understanding is the initial stage, which was used to understand the research question correctly. The author's intuition and informal discussion were carried out at the pre-understanding stage. Having clarified the unclear issues at the pre-understanding stage the study moves to the next stage (i.e. understanding stage). This iterative process happened several times until the study received the satisfied results. This approach follows the notion of foundationalism (Baggini and Southwell, 2012).
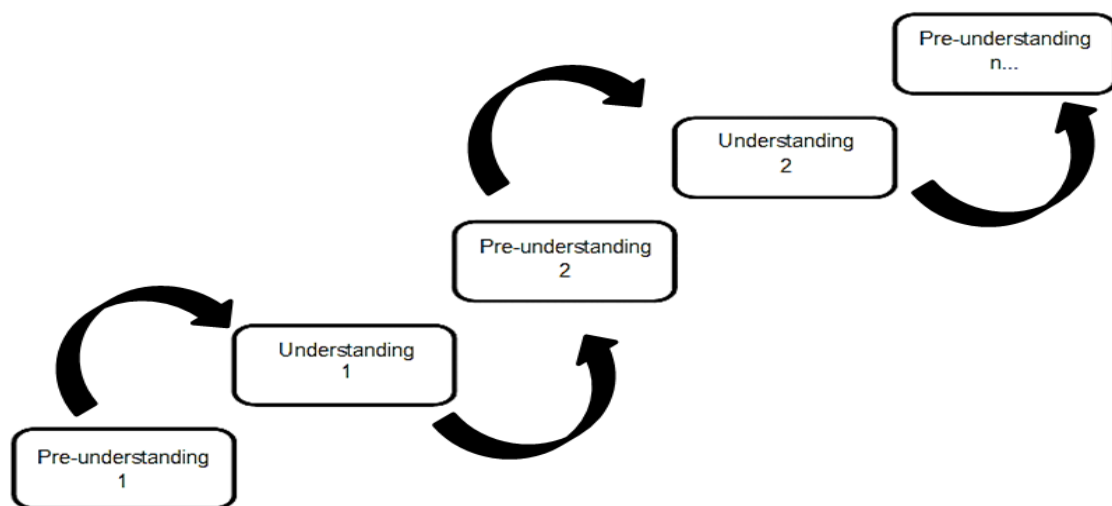
Figure 4-2: The hermeneutic learning spiral

Source: (Adapted from Odman, 1985 in Kagioglou *et al*, 2000)

Section 4.4 explains the adopted research approach for this study.

4.4 Research approach – Design Science

The selection of which research approach to use in any research enquiry depends on what the research question is and from which philosophical perspective one chooses to study that question (Shepard *et al*, 1993; Remenyi *et al*., 1998). Having positioned this study in 'Phenomenological philosophical paradigm' the researcher investigated the nature of research question in detail to identify the most appropriate research approach for this investigation. Simon (1996) stated that a natural science is a body of knowledge about some class of things - objects or phenomenon - in the world (nature or society) that describes and explains how they behave and interact with each other. A science of the artificial (also known as design science), on the other hand, is a body of knowledge about artificial (man-made) objects and phenomena designed to meet certain desired goals. In order to enable the developmental aspect of this research, a design science (van Aken, 2004; 2005), approach is used as the overall research approach for this investigation.

Koskela (2008 cited in Simon 1969) stated;

> *"a science of the artificial is closely akin to a science of engineering; it is concerned with how things ought to be, in order to attain goals and to function. The core of that science would be provided by a science of design, a body of intellectually tough, analytic, partially formalizable, partially empirical, teachable doctrine about the design process"* *(Koskela, 2008, p 54).*

He further noted that Aristotle made a similar, sophisticated call for a science of production a long time before Simon brought his work in 1969. Drawing heavily

from Kuhn (1996; first published in 1962) and Lakatos (1978), Vaishnavi and Kuechler (2004) state that research can be very generally defined as an activity that contributes to the understanding of a phenomenon, and in the case of design research, all or part of the phenomenon may be created as opposed to naturally occurring. Järvinen (2004) explained that

> *"if the research question contains any of the following words, one might be doing design science research: design, build, change, improve, develop, enhance, maintain, extend, correct, adjust, introduce. However, to be different from ordinary designing, building, changing etc., the research task need to address important and unique problems, or solve problems in a more effective way, and provide contributions to the knowledge"*
>
> *(Koskela, 2008, p 58 cited in Hevner et al, 2004).*

Moreover, Vaishnavi and Kuechler (2004) quoting March and Smith (1995) state that constructs, models, methods and instantiations are general outputs of design science research. From the work of Rossi and Sein (2003) and Purao (2002), Vaishnavi and Kuechler (2004) also add better theories (or theory building), as another outcome of design research. The table below summarises the outputs that can be obtained from a design science research effort.

Table 4-2: The outputs of design research

Output	Description
Constructs	The conceptual vocabulary of a domain
Models	A set of propositions or statements expressing relationships between constructs
Methods	A set of steps used to perform a task – how – to knowledge
Instantiations	The operationalisation of constructs, models and methods
Better theories	Artefact construction as analogous to experimental natural science

Source: (Vaishnavi and Kuechler, 2004)

With reference to Lukka (2003) design science is a research procedure for producing innovative constructions intended to solve problems faced in the real world, and, thereby make a contribution to the theory of the discipline in which it is applied. From a knowledge creation perspective, design science research is capable of developing scientific knowledge to support the design of interventions or artefacts. Design science is not concerned with action itself, but with knowledge to be used in designing solutions, to be followed by design-based action (van Aken, 2004). "Constructive research" is another term used to identify design science. The term "constructive" emphasises the developmental nature of research, as opposed to descriptive and/or explanatory research. Preference for design science research stems firstly from the problem-solving nature of the intended research, and secondly due to the prescriptive nature of the outcome of the research.

Lukka (2003) identified the following attributes of Design Science approach:

- Focuses on real-world problems felt relevant to be solved in practice;

- Produces an innovative construction meant to solve the initial real-world problem;

- Includes an attempt for implementing the developed construction and thereby a test for its practical applicability;

- Implies a very close involvement and co-operation between the researcher and practitioners in a team-like manner, in which experiential learning is expected to take place;

- Is explicitly linked to prior theoretical knowledge, and

- Pays particular attention to reflecting the empirical findings back to theory.

4.4.1 Design science research cycle

Design Science research process includes a number of steps. The exact number and the terminology vary. Nevertheless, it can be safely argued that problem awareness, analysis, design of the solution, and evaluation of the solution are core aspects of a design science research process. Following model explains the key stages of design science research cycle.
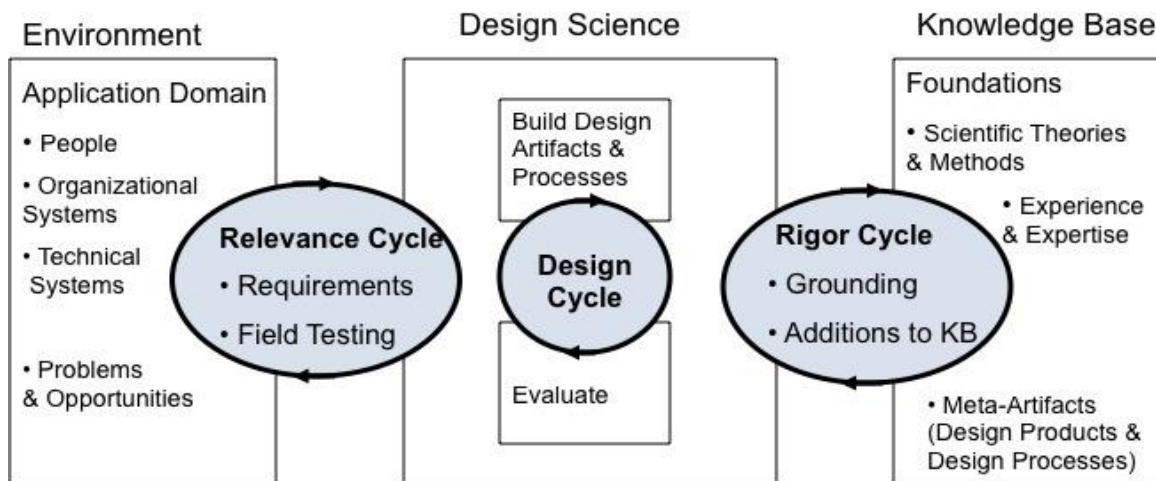
Figure 4-3: Design science research cycle

Source: (Hevner, 2007)

The key reasons for adopting design science approach within this investigation are;

- Design Science Research produces a critical part of the evidence to be used in the field of management and could be easily adopted in the area of organisational learning

- This evidence is not to be used as a set of instructions or fixed protocols, but as input to the creative and innovative process of designing structures, processes or interventions (van Aken, 2004).

- Research-informed designing is the core activity in a complex process of changing the actual into the preferred (van Aken, 2004): Organisational learning involves acting, rather than (only) decision-making, on the basis of evidence.

The Section 4.5 explains the adopted research design and process.

4.5 Research design and process

Research design is 'the logical sequence that connects the empirical data to a study's initial research questions and, ultimately, to its conclusions' (Yin, 2009, p.26). The design involves a series of rational decision-making choices, which ultimately lead to improving the scientific rigour (Sekaran, 2003). Human cognition and empiricism seem the most important facets in research design as they interact with theory and practice. On the other hand, the research process concerns the *'conceptual organisation'* of the overall research, ideas to express *'needed understanding'*, *'conceptual bridges'* from what is already known, *'cognitive structures'* to guide data gathering and *'interpretations'* to present the data (Stake, 1995, Robson, 2002, Sekaran, 2003, Lanksher and Knobel, 2004, Neuman, 2011). The fundamental issues for designing a research endeavour, and therefore underpinning the selection of suitable methods (qualitative, quantitative, mixed and multi), concern the research question and the problem contexts. The research question lays the foundation for any scientific research while encouraging the researcher to undertake it within the boundaries of time, cost and quality. The literature reveals three types of research design: quantitative, qualitative and mixed method designs (Creswell, 2009).

Quantitative research design shows how the variables are seen and organised with respect to each other (Punch, 1998), although they are explanatory in nature, predetermined and number-driven (Mason, 2002). By contrast, qualitative design elicits the illumination, understanding and extrapolation of a particular phenomenon (Hoepfl, 1997) and is exploratory in nature, fluid and flexible, data-

driven and context-sensitive (Mason, 2002). A typical mixed method design considers the aspects of both quantitative and qualitative designs together.

A preliminary literature review is often used to identify the research problem and further to determine the research objectives. Generally, much research begins with a specific purpose/s that is surrounded by broader contextual phenomena. From these broader contexts, a workable research question needs to be identified and well defined to provide an achievable target within the given boundaries. Corbin and Strauss (2008, p.12) critically argue that 'the research question should dictate the methodological approach that is used to conduct the research'. Well-defined research questions are able to identify what is to be measured or explored, while ensuring the rigour (the reliability and validity) of the research. Having considered the research aim and the underpinning objectives of this investigation, qualitative approach was adopted to collect the appropriate data.

4.5.1 Case study design

Having studied the nature of proposed research question, which is 'organisational learning in construction' a case study design was selected to study the phenomenon. The existing theories can be categorised into three groups: theories that are in accordance with the research findings, in contrast with the research findings or neutral (provide no framework or grounding) to the research findings (Eisenhardt, 1989). Case studies can be exploited to build new theories and/or test and retest existing theories that are well developed in foundation (Yin, 2003). Thus, theory plays an important role in case study research.

Case study design is appropriate where it is necessary to study a real-life situation in real time (in a limited space and time) with immediate impact and relevance (Johns, 2008). Moreover, case study design can be used to gather and analyse data about one or a small number of samples as a way of studying a broader phenomenon. Generally, the case is bound by time and activity, and a variety of data collection methods (interviews, document and record analysis, and observations) are usually exploited to collect detailed information over a sustained period of time (Stake, 1995).

A distinctive feature of the case study is the use of multiple sources of evidence to examine the case holistically (Tan, 2002). Hence, case studies inherit different strengths and weaknesses (Gillham, 2000). Yin (2009) explains the logic of case study design in two different aspects. Point (a) below considers the scope of the case study and point (b) explains the technical characteristics and data collection and analysis strategies encompassed in case study design.

a) A case study is an empirical inquiry which:

- investigates a contemporary phenomenon in depth and within its real-life contexts: especially when

- the boundaries between the phenomenon and the context are not clearly evident.

b) The case study inquiry:

- copes with technically distinctive situations in which there will be many more variables of interest than data points and, as one result:

- relies on multiple sources of evidence, with data needing to converge in a triangulating fashion and, as another result:

- benefits from the prior development of theoretical propositions to guide data collection and analysis.

Yin (2003) further stated that many social scientists deeply believe that the best use of case studies can be obtained in exploratory research rather than descriptive or explanatory investigations. Walsham (1995) proposed that the most appropriate method for conducting empirical research in the interpretative tradition is the in-depth case study; however, such studies are not necessarily qualitative (Stake, 1995). The case study's main strength is its ability to provide a real situation in which practice can be studied and contact can be made with real participants who can contribute to the research with their practical knowledge (Blakstad, 2001; Simons, 2009).

Case study design is an ideal method/design for particularisation (Stake, 1995). Notably, the data gathered is more qualitative than quantitative (Sekaran, 2003). Its poor ability with regards to generalisation seems to be the key limitation of case study research (Stake, 1995). Eisenhardt (1989) argues that binding the emergent theory with existing literature strengthens the internal validity, generalisability (external validity) and theoretical level of theory building from case study research. The generic characteristics of case study research (Punch, 1998), types of case studies (Yin, 2003) and their central components (Yin, 2009) are discussed in the literature.

Table 4-3: Characteristics of case study research

Each case has boundaries that must be identified at an early stage of the research.
Each case will be a case of something in which the researcher is interested. Hence, the unit of analysis must be defined at the outset in order to clarify the research strategy.
Case studies seek to preserve the wholeness and integrity of the case. However, in order to achieve some focus, a limited research problem must be established geared towards the specific features of the case.

Source: (Punch 1998 p.153)

There are four types of case study design and Yin (2003) discusses the characteristics of each type and their rationales, as noted in the Table 4-4.

Table 4-4: Types of case study design

	Characteristics	**Rationale**
Type 1	One case, holistic, one unit of analysis, case and unit of analysis are indistinguishable.	Critical case Unique case Typical case Revelatory case Longitudinal case
Type 2	One case, embedded units of analysis, not holistic but still context dependent, case and unit of analysis are distinguishable.	Extensive analysis More focused analysis
Type 3	More cases, holistic, case and unit of analysis are indistinguishable.	More robust findings Replication logic (literal/theoretical) External validity
Type 4	More cases, embedded unit of analysis, not holistic yet context dependent, case and unit of analysis are distinguishable.	More robust findings Replication logic (literal/theoretical) External validity Extensive analysis Focused analysis

Source: (Yin, 2003)

Within the boundaries of this investigation, a multiple Type 4 case study design was adopted to understand the process improvement in construction organisations. Three (3) cases were studied.

Case A: Airport and Aviation sector organisation – This case used to identify the organisational processes improvement infrastructure, and the extent to which it facilitated organisational learning from a private sector commercial perspective

Case B: Highways sector organisation – This case also identify the organisational processes improvement infrastructure, and the extent to which it facilitated organisational learning from public and private sector perspective

Case C: School building programme conducted by a major local authority in the UK – Case C was used to identify the organisational processes improvement infrastructure, and the extent to which it facilitated organisational learning, from a public sector perspective

Having identified the nature of above three cases the Type 4 design (see Table 4-4) provides more opportunities for extensive investigations and also help to achieve robust findings. The unit of analysis is a significant factor in case studies, as it determines what or who is to be analysed. This study focused on into organisational process improvement, thus, organisational process improvement, was considered as the unit of analysis. The detailed information on each case is explained in Chapter 5.

The central components of case study design are discussed in the literature (Yin, 2009).

- Case study questions – 'how' and 'why'

- Case study (theoretical) propositions – pointing attention, limiting scope and suggesting possible links between phenomena

- Case study units of analysis – main units must be at the same level as the study questions and typically comparable to those previously studied

- Logic linking the data to the propositions – matching pieces of information to rival patterns that can be derived from the propositions

- Criteria for interpreting the findings – iteration between propositions and data, matching sufficiently contrasting rival patterns to data; there is no precise way of setting the criteria

In a way, the case study can be considered to be an 'all-encompassing method' that covers the logic of research design, data collection techniques and approaches to data analysis (Tan, 2002; Yin, 2009). It is important that it must use some empirical methods and present some empirical data. The adopted data collection methods and rational for rejecting other available methods are discussed in following sections.

4.5.2 Data collection methods

Literature explains multiple types of data collection methods that can be adopted in any research enquiry. However, for data collection to be a part of a research design, it needs to fulfil two key objectives (Lankshear and Knobel, 2004). First, it

must be conducted by aiming towards a particular problem, and next it needs to support some kind of explanation or interpretation instead of simply providing information. Thus, proper tools/instruments need to be exploited for extracting the relevant data to provide robust information. Research can be espoused by undertaking either a mono-method or a multi-method approach for collecting data. Several authors (Tashakkori and Teddlie, 1998; Creswell, 2003; Saunders, Lewis and Thornhill, 2003; Bryman, 2008) pointed out the key strengths of the multi-method approach over the mono-method approach. The multi-method approach may provide more confidence in the research and it enables triangulation or the use of different data collection methods within one study, ensuring that the data is clear, valid and reliable (Saunders Lewis and Thornhill, 2003). To complete the set research objectives noted in the Chapter 1 the study exploited the different data collection methods (see Figure 1-2: Research process adopted within this research enquiry).

4.5.2.1 Literature review

A comprehensive literature review was undertaken throughout the study. Firstly, the literature review was used to identify the seminal studies previously undertaken in organisational learning and then to set the foundation for this investigation. Secondly, the literature review was exploited to narrow down the research problem, refine the objectives and explore suitable research methods for undertaking this study. Thirdly, the literature review was used to compare the research findings with the existing body of knowledge, which provides robust conclusions at the end. The peer reviewed journal articles, books, conference

papers, web-sites were used to study the organisational learning in general and also more specific to construction context.

4.5.2.2 Informal discussions

Together with the literature review, several informal discussions were undertaken with the SPICE, KIM (Knowledge Information Management) and OLS (Optimal Learning Spaces) research teams and their collaborative partners throughout this research endeavour. Their suggestions and criticisms reinforced and facilitated the robust grounding of this study. Notably, informal discussions were used to select the turning points for this study in two specific instances. At the very first stage, informal discussions were used to fine-tune the research aim (i.e. organisational learning in specific to process improvement perspective) and objectives and then to refine the clarity and usability of the developed PPU (Procurer, Provider, User) framework.

4.5.2.3 Documentary data

Documentary data is a source of rich data in any research undertaking. The key sources of documentary data for this study were the information of three cases (Case A, B and C) studied within this investigation and the Government Policy reports.

4.5.2.4 Participant observations

Participant observation is one of popular methods for collecting data in fieldwork in variety of disciplines (Kawulich, 2005). Simply, it is the process enabling

researchers to learn about the activities of the people under study in the natural setting through observing and participating in those activities. It provides the context for development of sampling guidelines and interview guides (DeWalt and DeWalt, 2002). Moreover, this method provides researcher to check for nonverbal expression of feelings, determine who interacts with whom, grasp how participants communicate with each other, and check for how much time is spent on various activities (Schmuck, 1997).

Within this study, the researcher was actively involved in four observations. First, observation was undertaken at the preliminary data collection stage to understand the process and how the research objectives could be refined according to the selected cases. Other three observations were undertaken at the development and validation stages of the PPU framework. The aim was to study the organisation processes and their implications towards the organisational learning.

4.5.2.5 Desk study

As depicted by name, Desk Study is a research technique which is mainly acquired by sitting at a desk (Management Study Guide, 2013). The technique basically involved in collecting data from existing resources hence it is often considered a low cost technique as compared to field research. A desk study was used in this research at the end to assemble the findings of each objective and then to develop the PPU framework for evaluating the process improvement in construction organisations. In addition to the findings of each objective, the researcher's instinct and the previous literature on framework development

provided a pertinent platform for undertaking the desk study. Desk research is very effective and can be conducted in starting phase of market research as it is quite quick and cheap and most of the basic information could be easily fetched which can be used as benchmark in the research process (Management Study Guide, 2013).

4.5.2.6 Workshop/focus group

Focus groups are ideal for exploring people's experiences, opinions, perspectives, wishes and concerns (Kitzinger and Barbour, 2010). A frequent application of the workshop method can be seen in the process of data collection. The main purpose of organising workshops within this study was to collect and verify the findings obtained from the case studies and to validate the PPU framework. Altogether three (3) workshops were arranged with the industry partners for the SPICE III and KIM/OLS research project. Having used the design science approach within this investigation the pre-learning / learning approach was highlighted. The first two workshops were arranged to collect and verify the results obtained from the case studies. Then the final workshop was undertaken with the same project partners to verify the usability of the developed PPU framework. The final workshop generated a large amount of data. This data was recorded using a tape recorder and transcribed immediately after the workshop. However, the transcription process consumed a lot of time due to attempting to recognise individual voices.

4.5.2.7 Questionnaire survey

A structured questionnaire, which was developed by the SPICE III project (see Appendix 1), was used to identify the managers perspectives on organisational process improvement. The survey was undertaken among the three levels of managers (senior, middle and operative levels) who were actively participated in the first two focus group workshops, which were based on Case A and Case B. However this questionnaire was not circulated among the managers of Case C mainly because that there is a significant difference in Case C and other two cases. Twenty six (26) managers (5 senior, 9 middle level and 12 operative) were invited to complete the survey and 23 did so. Their level of experience and the result of questionnaire analysis are explained in Chapter 5.

When compares to other data collection methods, questionnaire survey method is inexpensive, user friendly, and less time-consuming. Errors in survey research design can occur in the areas of respondent selection, survey questions and administration (Neuman, 2011). Generalisation in survey findings is a critical issue in scientific research because many surveys end with low response rates. Therefore, proper attention must be paid throughout the survey.

4.5.3 Justification for adopted research methods

Table 4-5 clearly explains the justifications for adopted research methods and rational for rejecting other alternative methods.

Table 4-5: Justifications for selected methods

Research objectives	Data sources and methods used	Justification for selected methods and rejection of other alternative methods
1. to study the principal concepts of organisational learning and practices;	• Literature review • Informal discussions	• The first objective was aimed to identify the current gap in the knowledge. Therefore an extensive literature review was undertaken at the beginning of the study to understand the theories and practices that support organisational learning. The literature from different disciplines (software industry, manufacturing industry etc.) were analysed and articulated them to use in construction industry. Informal discussions were carried out among the SPICE project team to fine-tune the research question that was initially established through the literature review. The methods like structured/semi-structured interviews would be suitable to gather rich data however it was not adopted at this preliminary stage as because the researcher didn't have a clear understanding about the nature and complexity of the research problem and its boundaries.

Research objectives	Data sources and methods used	Justification for selected methods and rejection of other alternative methods
2. to explain the role of process improvement perspective in facilitating organisational learning;	- Literature review - Informal discussions - Document analysis - Participant observations	To accomplish the 2nd objective of this research the literature review was tunnelled towards the process improvement perspective. The main reason was that the researcher was funded through EPSRC (SPICE III) project, which aimed on organisational process maturity. Therefore the study was designed towards process improvement perspective rather exploring the other facades of organisational learning (i.e. socio-economic perspectives etc.). The second objective also supported through a detailed literature review and informal discussions. Moreover, 3 cases were studied to identify the nature of organisation, their processes. Participant observations were continued to understand the overall research process and improve the clarity of objectives to achieve the optimum use of the available data. The interviews would be the other most appropriate method to understand the organisation culture and processes however it was not adopted at this stage as documentary evidences were sufficient to understand the organisation and their allied activities.

Research objectives	Data sources and methods used	Justification for selected methods and rejection of other alternative methods
3. to explore the contextual issues associated with organisational learning and process improvement within construction industry context;	• Literature review • Document analysis • Case study • Focus group workshops • Questionnaire survey	• The project documents (Case A, B and C, internal reports and minutes of the meetings) and literature review were used to clarify the contextual issues associated with organisational learning. The selected cases represent three different construction organisations (Airport and Aviation, Highway Agency and School building). Therefore the case study method is the most suitable method to analyse each case in detail and then cross cases. Moreover questionnaire survey was undertaken in two workshops among senior, middle and operative level managers to understand their perspectives and contextual issues related process improvement. Questionnaire survey was selected to obtain large data and also to observe any patterns. • The 3rd objective was more focused to identify contextual issues related to organisational learning/process improvement. Therefore large sample was targeted and other methods such as interviews were rejected due to time and cost limitations.

Research objectives	Data sources and methods used	Justification for selected methods and rejection of other alternative methods
4. to develop a framework to facilitate organisational learning in construction organisations;	• Literature review • Informal discussions • Document analysis • Case study • Desk study • Questionnaire survey • Participant observation	• The literature review was used to develop the conceptual framework and informal discussions were carried out to categorise and rank those contextual issues that were derived from each case study. Case study findings and the outcome obtained through the questionnaire survey were used to understand the organisational entities, how they facilitate learning within the organisation and further to define roles and responsibilities of stakeholders. Desk study was used to integrate those findings and develop the framework. • The data were gathered continuously through multiple methods to accomplish Objective 4. No interviews were undertaken as participant observation was very much helpful to understand the issues and clarify them where appropriate.

Research objectives	Data sources and methods used	Justification for selected methods and rejection of other alternative methods
5. to validate the framework and identify the implications for theory and practice.	• Literature review • Participant observation • Focus group workshop	• The empirical evidence from the previous four objectives was logically assembled together in a desk study. In addition, the researcher's intuition, the literature review was used to develop a logical and readable format for the framework. The strength of the focus group workshop approach in assessing the usability of the conceptual framework is that it offers the possibility to look at many different facets of the system at the same time. The conceptual framework considers contextual issues related to organisational learning and process improvement. Three focus group workshops were organised during framework development and validating stages with the organisational managers. The main reason for selecting focus group workshop method to validate the framework was the experience of team members, their engagement throughout the process of data collection and their interest towards organisational learning and process improvement. Focus

groups can be easily combined with qualitative and quantitative methods, for example to develop a questionnaire or refine the key issues. Having studied the qualities of focus group workshops/interviews, the study used workshops to fine-tune and validate the developed framework.

- Having studied the contextual issues related to organisational learning and process improvement, this framework establishes the key roles and responsibilities of parties (procurer, provider and user) who are involved in procurement process. Case studies were rejected because of the difficulties with generalisation. Thus, focus group workshop was undertaken to validate the developed PPU framework. The validation process is explained in Chapter 6.

4.5.4 Data sampling strategies

Data sampling plays a vital role in the credibility of the overall results of research. However, it is not practical to gather data from the whole population; thus an 'accessible population' is used in many studies to represent the whole population (Tashakkori and Teddlie, 1998). Sampling involves deciding which technique to adopt to capture a representative group (Kelly *et al.* 2003). The literature reveals two main forms of sampling method: probability sampling and non-probability sampling. Probability sampling allows for statistical methods, eliminates population parameters and bias and must have random selection of units and that non-probability sampling is used in exploratory research, so the population parameters are not of interest and can be used when the adequacy of a sample is unknown (Germain, 1997). The difference between these two methods depends on the form of sample selection. In random sampling, the sample is selected randomly; in non-probability sampling, the sample is not selected objectively (Fink, 2006). However, this study exploited a purposive sampling method, meaning the data was collected purposely to achieve specific objectives. However, the method has bias and can create errors (Teddlie and Tashakkori, 2009).

4.5.4.1 Case study sampling

As previously noted, a purposive sampling method was adopted in this study for sampling the case study. Silverman (2005) explained that purposive sampling allows one to choose a case because it illustrates the features or processes in which we are interested. In contrary, Vogt (2005) argued that it is an unwise procedure because

the researcher knows in advance what the relevant characteristics are and therefore runs the risk of introducing unknown bias. The purpose of the case studies within this research investigation was to understand the organisational processes and further to provide process improvement framework for construction organisations.

4.5.5 Data analysis methods

The collected data can be placed in the categories of quantitative and qualitative data. Hence, the most appropriate data analysis methods were used in both cases to create a vivid narrative. Quantitative data analysis is about how the measurements of variables are analysed (Punch, 1998) and qualitative data analysis is a process of resolving data into its constituent components, in order to reveal its characteristic elements and structure (Dey, 1993). The qualitative analysis referred to in this study was mainly based on the focus group workshop transcripts, documentary data, and participant observation notes used in the case study design. Miles and Huberman (1994) introduced data reduction, data display and drawing conclusions as the basic steps of qualitative data analysis. This study also followed the same sequence for analysing the qualitative data. The collected data was filtered through the reduction process. First, the data was grouped into big ideas/themes and then it was narrowed down to specific codes. The data was represented through diagrams and graphs. However, Yin (2009) identifies the difficulty in analysing case study evidence as one of the limitations in case study design. Moreover, the findings from questionnaire survey (managers' perspectives on organisational learning and process improvement) were analysed through Excel and explained in chapter 5.

Literature revealed that the analytic focus in case studies is on the overall pattern of variables within a case, looking at the parts in relationship to the whole and then, if there are multiple cases, looking across them (Kohn, 1997). The data gathered from each case study were used to analyse the contextual issues related to organisational process improvement and their level of existence (see Table 5-3). Moreover each case and cross case analyses were undertaken to identify organisational 'strengths' and required 'further improvements' (see sections 5.3.1.1 – 5.3.1.3).

4.5.6 Validity and reliability

Neuman (2011) cites reliability and validity as ideas that help to establish the 'credibility' of findings. Reliability aims towards the consistency or replication of research findings in similar conditions, while validity evaluates the truthfulness of findings (Fink, 2006). The latter can be demonstrated in three ways: the validity of selected measures or 'construct validity', 'internal validity' and 'external validity'. Most often, validity is associated with the 'operationalisation' of concepts, which is commonly used in quantitative research (Mason, 2002). Although reliability and validity are treated separately in quantitative studies, these terms are not viewed separately in qualitative research. Instead, terminology that encompasses both, such as credibility, transferability, trustworthiness or dependability, and confirmability are used (Hoepfl, 1997; Riege, 2003). Internal validity is used for establishing causal relationships and external validity deals with the generalisation of findings (Neuman, 2011). Generalisability aims towards making general conclusions based on the research findings, rather than them being particular to the research context. Moreover, Miles and Huberman (1994) noted key questions that need to be asked in

the domains of reliability, internal validity and external validity as illustrates in the Table 4-6.

Table 4-6: Key considerations of validity and reliability

Component	Reliability	Internal validity	External validity
Research question	Clear? Matches with the research design?	Meaningful?	Defines the scope and delimitations?
Role of the researcher	Described explicitly?		
Data	Across the suggested full range?	Rich? Well linked to the emerging theory? Any negative evidence? Rival explanations?	True representative sample? Any threats to generalisability?
Research paradigms	Clearly specified?		
Participants	Any comparable data collection protocol?		
Checks	Coding? Quality/bias?	Uncertainty?	
Research findings and conclusions	Meaningful parallelism across the data sources?	Did triangulation provide uniting conclusions? Internally coherent? Replicated in other parts of the research? Considered accurate by original informants?	Consistent? Connected to prior theory? Applicable? Narrative sequence? Could fruitfully be tested further?

Source: (Miles and Huberman, 1994)

Yin (2003) proposed two types of generalisation: i.e. statistical generalisations and analytic generalisations. Statistical generalisation is established by an inference made about a population on the basis of empirical data collected about a sample and that the analytic generalisation is employed as a framework with which to collate the empirical results of the case study (Yin, 2003). Supportively, Kohn (1997) noted that in the case study method, the researcher does not use statistical generalisation, but rather, generalises to theory.

This study exploited analytical generalisation in the case studies. The key method adopted to analyse multiple case studies was 'replication'. Kohn (1997) explained that the primary focus of the analysis is on the overall pattern of results and the extent to which the observed pattern of variables matches a predicted one.

Further attention was paid to explain the validity and reliability issues particular to case study research, as this investigation was fundamentally supported by three main cases. Construct validity, internal validity and reliability tests were undertaken to check the confirmability, credibility and dependability/trustworthiness of the findings. Construct validity was tested through multiple sources of evidence (i.e. case study information, participant observations etc.). The method 'triangulation' was used to test the internal validity of this study. 'Triangulation' is a popular technique for testing the credibility of findings in qualitative research. On the other hand, it is identified as a very powerful technique to gain insights and results, assisting in making inferences and drawing conclusions. Simply, triangulation is a 'means of cross-checking the relevance and significance of issues or testing out arguments and perspectives from different angles to generate and strengthen evidence in support of key claims'

(Simons, 2009 p.129). In a way, it is a 'validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study' (Creswell and Miller, 2000 p.126). Case - cross case analysis (explained in chapter 5) and the use of multiple research methods to collect data assures the internal coherence of findings.

This study exploited the method of triangulation to find the credibility (the internal validity) of the results. This method can be used to approach the research question from different angles (Mason, 2002). In one way, it is a strong method; however, the whole process takes considerably much more time than a single method. The literature suggests that the rationale of multi-method research is underpinned by the principle of triangulation, which implies that researchers should seek to ensure that they are not over reliant on a single research method and should instead employ more than one measurement procedure when investigating a research problem (Bryman, 2008). More specifically, this study used multiple methods to cross-check the internal validity of the findings. The case studies exploited within this research enquiry was obtained from different data sources.

4.6 Summary

The chapter explained the research methodology that was adopted in this scientific enquiry. The main aim was to understand the organisational learning in construction in particular to process improvement perspectives. The research philosophy was placed on the hermeneutic learning spiral and case study research approach. The design science approach was adopted and multi techniques such as literature

review, informal discussions, document analysis, participant observations, questionnaire survey and focus group workshops were used to develop and validate the Procurer-Provider-User (PPU) framework. Further attention was given to justify the adopted research methods and reasons for rejecting other appropriate methods within this research enquiry. Validity and reliability tests were undertaken to check the confirmability, credibility and dependability/trustworthiness of the findings. Construct validity was tested through multiple sources of evidence (i.e. case study information, participant observations etc.) and the 'triangulation' method was used to test the internal validity of this study.

Chapter Five

5. DEVELOPMENT AND VALIDATION OF FRAMEWORK

5.1 Introduction to chapter five

This chapter explains the development and validation process of the framework for evaluating the organisational learning in construction in specific to the process improvement perspective. The framework incorporates the key findings of the first three research objectives and defines the "meta" roles of provider, procurer and users. The first section outlines the key stages of framework development while justifying the significant need for developing such framework to explain how the process improvement can be undertaken in a construction context. The second section elaborates the data collection and analysis processes and how those data were filtered and fed into the framework. The third section explains the validation process of proposed framework and suggested improvement through validation. Finally it discusses the benefits and limitations of this framework.

5.2 Key steps of framework development process

Process improvement is widely accepted as a profit driven approach in manufacturing and services industries. However when compared to those industries, the application of process improvement tools and techniques in

construction products and processes is seemingly poor (Egan, 1998; Eriksson, 2013). As a result construction products produce high wastage in terms of labour, plant and materials and also lessen the ultimate value of the product and or business. In fact the appropriateness of process improvement typically varies across functions. For example, people in manufacturing, production, and operations, which emphasise consistency, reliability and efficiency, will generally relate easily to continuous improvement. In contrast, people in construction, which emphasise relationships and one-off product nature, are less likely to embrace it readily. There is no developed tool/technique available to evaluate the organisational learning in construction in particular to process improvement spectrum. Therefore, there is a necessity to develop such framework to understand the process improvement in construction organisations. Figure 5-1 illustrates the key stages that were undertaken in framework development.
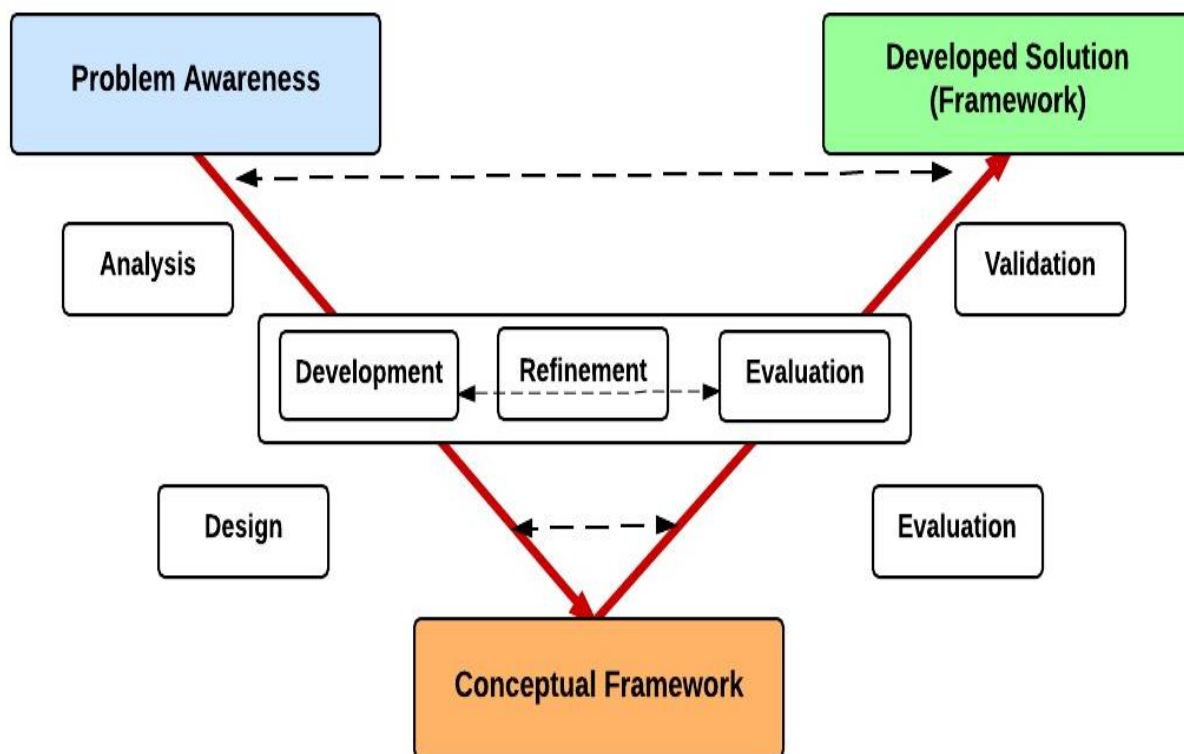
Figure 5-1: Key steps of framework development

To facilitate the design science approach in organisational learning V-model (V-shaped) was adopted within this research investigation. Literature reveals the frequent application of V-model in software industry (Burnstein, Suwanassart and Carlson, 1996; Vuković, 2013). This model identifies the interconnectedness of lifecycle phases that need to be considered throughout the product or process development. Each phase must be completed and feed forward/backward where appropriate before the next phase begins. Having identified that ability of the V-model it was adopted within this research to develop and validate the process improvement framework for construction organisations.

Design science approach was used to discover and identify opportunities and problems relevant to process improvement in construction organisations, which helps to creating a new or improved conceptual/empirical means to address those problems and thus to establish a link to the theoretical explanation at the end of the process. Simply, when the problem is identified a likely solution/s will be proposed. Then the problem and proposed solutions will be tested iteratively empirically, rationally or from both methods. A fine-tuned problem and close solutions can be expected as key outcome of the refining process. Three key stages, 'problem awareness', 'development of conceptual framework', 'developed solution' and associated processes were illustrated in Figure 5-1.

5.2.1 Problem awareness

This research study was initiated by identifying and representing opportunities and practical problems in a real world setting. An awareness of research problem is an important aspect in design science approach. It starts by looking into the existing knowledge, under the direction of theory is being carried out to generate proposals or hypothesised solution (establish practical problems). The information includes the contextual background of the research where existing theories are housed and acting as a precursor to the research process. Theory using at this stage is to formulate a hypothesis of a kind of approach to reduce the identified problem (Venable, Pries-Heje, and Baskerville, 2014) and also to understand and addressed the problem(s), i.e. the requirements for the research. In particular to this investigation the route problem arrived from SPICE 3 research project. Having studied the background information of the project, industry concerns and

informal discussions with expert in the fields of organisational learning and process improvement the researcher able to identify the existing gap in the current knowledge and then to articulate the research problem, which is to develop a framework for process improvement to facilitate organisational learning in construction context.

5.2.2 Conceptual framework

A conceptual framework was proposed in the centre of the final framework development process to map the core contextual issues relate to organisational learning in construction and also to establish the boundaries of process improvement from the literature and empirical evidences. In general, conceptual frameworks are proposed to support understanding of an issue or area of study, provide structure, communicate relationships within a system for a defined purpose, and support decision making and action (Phaal, Farrukh and Probert, 2004). Through the literature review and informal discussions twelve core contextual issues on organisational process improvements were identified and mapped on the conceptual framework. Then the findings of case studies will be used to tunnel through those contextual issues in detailed. The conceptual framework is illustrated in Figure 5-2.
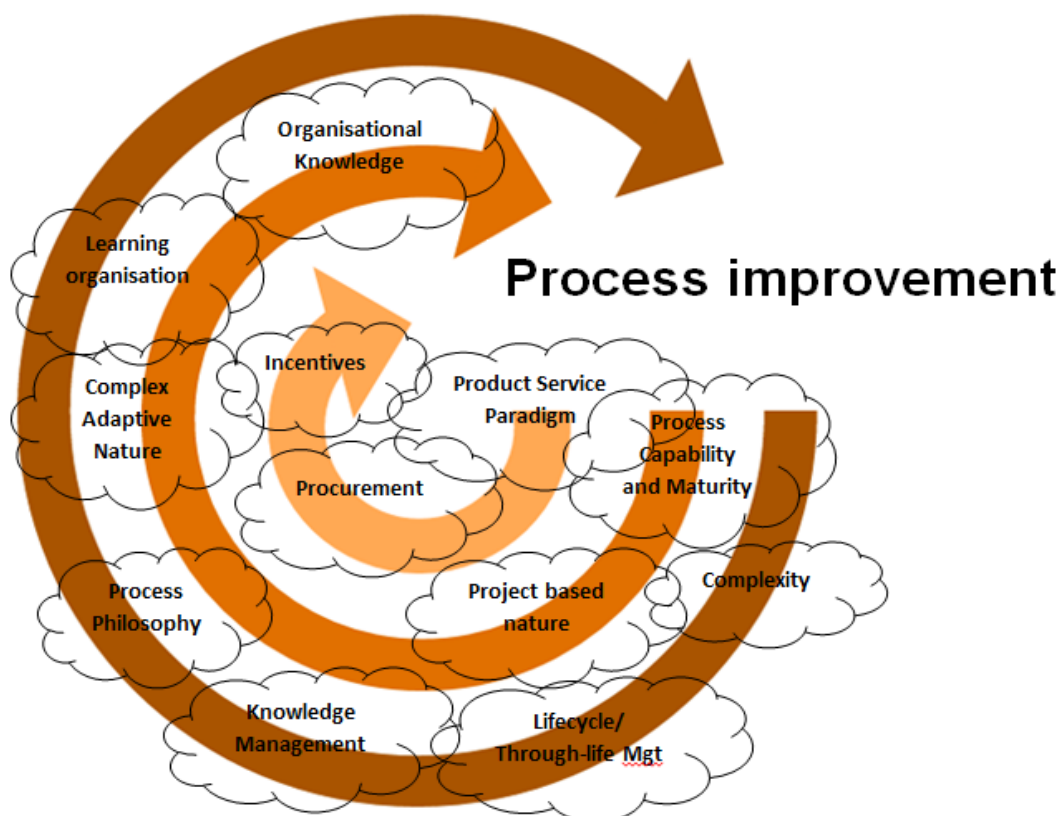
Figure 5-2: Conceptual framework

Having considered the organisational learning in construction context, twelve contextual issues were identified. Those contextual issues are highly likely influenced in the organisational process improvement either individually or collectively. However this research does not attempt to identify their interrelationships as because the main purpose of this conceptual framework is to identify and establish the contextual issues and then explain their behaviour in specific to construction organisation context. Three case studies were used to study how these contextual issues influence in organisational process improvement. Table 5-1 explains the key considerations of those contextual issues within the spectrum of construction organisations.

Table 5-1: Key contextual issues in construction process improvements

No	Contextual issue	Description
1	Complex adaptive nature	Ability of organisations to adapt in and evolve with a changing environment.
2	Complexity	Complicated nature of construction processes and products.
3	Incentives	There is nothing that motivates or encourages the construction industry stakeholders (especially for providers or users) for the sake of their engagement in project/service delivery.
4	Knowledge management	Efficient handling of information and resources within an organisational setting.
5	Learning organisation	Organisations which able to respond to the various pressures through individual and collective learning
6	Lifecycle/ through-life mgt	A functional/structural lifecycle of building or its associated element. The 'lifecycle' can be varied from 0 to 60+ years (componentry to building) in a typical building.
7	Organisational knowledge	Individual knowledge paired with that of other individuals in an organisation (synergy).
8	Process capability maturity	Technical and cross-discipline methodology used to facilitate and refine processes and process improvement.
9	Process philosophy	Dynamic sense of being as becoming or occurrence, the kinds of dynamic entities, the relationship between mind and world, and the realisation of values in action.
10	Procurement	Different procurement arrangements to procure the product or service. However majority of them are temporal and short-term.
11	Product-service paradigm	Designing and selling physical products, to sell a system of products and services, which are capable of fulfilling client demands.
12	Project based nature	Stakeholders are engaged to achieve specific (one-off) target (product/service) within a specified period of time.

The purpose of this chapter is to combine the outcomes of each of these endeavours to construct a practice-grounded conceptual framework in order to determine contextual issues and then to develop a process improvement framework for organisational learning in specific to construction context.

5.3 Framework development

In addition to conceptual framework, data were collected through three case studies to develop the final solution i.e framework. Those case study investigations were provided pertinent evidence to categorise and establish the key entities for organisational process improvement in construction context. Following sub sections overview three different case studies, their strengths, areas for further improvements and how that information was used to develop the solution through design science approach.

5.3.1 Adopted case studies

In order to ensure the applicability of SPICE Level 3 key processes and through-life knowledge information management for construction organisations, the field works were undertaken in real world settings. First two case studies (Case A and B) were conducted in close collaboration with two construction industry partners in the field of infrastructure. The third case (Case C) was a public owned building project, which was used to understand the through-life knowledge and information management in complex product-service settings. As discussed in Chapter 1, the nature of the construction industry and the behaviour of construction products and processes, it was decided to use cases (organisations) that deliver buildings and

infrastructure products. Having undertaken a preliminary study on each case, it was identified that the selected cases (A, B and C) represent the majority of contextual issues that were identified in the contextual framework. Therefore, the main reasons behind the selection of those three cases are to capture the different (if any) contextual issues related to organisational process improvement and their level of existence. Each individual case was analysed in detailed and further improvement areas of process improvement also identified. Figure 5-3 illustrates the case (Overall), reflective case (more specific to process improvement considerations) and the sequence of the study.
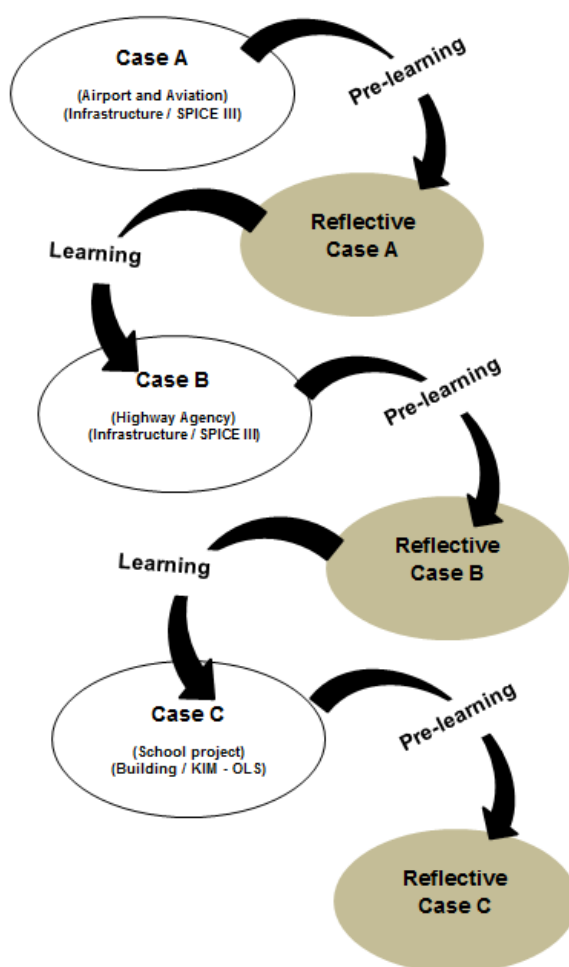
Figure 5-3: A sequence of data collection from selected cases

Consequently, Case study A, B and C were used to design, refine and validate the components of the final framework. The case study method is considered an all-encompassing method, as the data can be collected from multiple sources. However, difficulty in generalising the findings seems to be a critical issue in case study research. The findings of three case studies (even though they were categorised under different built environment settings) were used to explain the phenomenon of process improvement in construction organisations. In each case, the organisation was assessed against Level 3 of the SPICE framework, which was explained in Chapter 3. The following sections describe the data collection and analysis processes that were adopted in case studies.

5.3.2 Data collection and analysis

As noted in Table 1-1 and Figure 1-2 the data were collected through multi methods approach. Having identified the importance of process improvement in organisational learning and associated contextual issues through literature review, the organisations were used as the unit of analysis to scrutinise those issues in detailed and then to develop a framework to facilitate organisational learning within construction organisations. The managerial staff of the selected cases were volunteered to take a part in this study. Three levels of management staff (senior, middle and operative levels) were invited for the workshops and took part in the surveys.

- Invited and briefed management (senior, middle and operative level) and obtained their commitment to the SPICE Level 3 assessment;

- Managers who are directly or indirectly involved in organisation-wide process improvement were invited to compete a questionnaire (see Appendix B) and discuss key issues and concerns within their organisation. At this stage, discussions were open-ended in order to understand how they perceive their capability to share good practices at an organisational level and what mechanisms are used to facilitate the process improvement;

- A document review followed, to further understand current practices within the organisation's context;

- Potential participants were identified and their participation in the framework verification was confirmed. At this stage, the assessment focused on senior and middle management, as well as those staff members either responsible for or directly affected by the SPICE Level 3 key processes being assessed. The participants attended a short briefing at which they were explained about what the assessment was for and how the findings would be used. Workshops were used to examine current practices, perspective and a viewpoint of management staff;

- Data collected were analysed, highlighting the strengths and areas for further improvement against each case;

- A detailed feedback report was presented to key participants of each organisation, and their agreement was sought on findings.

5.3.2.1 Findings from the questionnaire survey

The questionnaire survey aimed to identify how the management perceive their capability to share good practices at an organisational level and what mechanisms are used to facilitate the process improvement. Twenty six (26) managers were specifically invited to take a part and 23 did so, which was given 88% response rate. The lengths of experience of the respondents varied from less than 10 years to more than 20 years, demonstrating a good spread of experience.
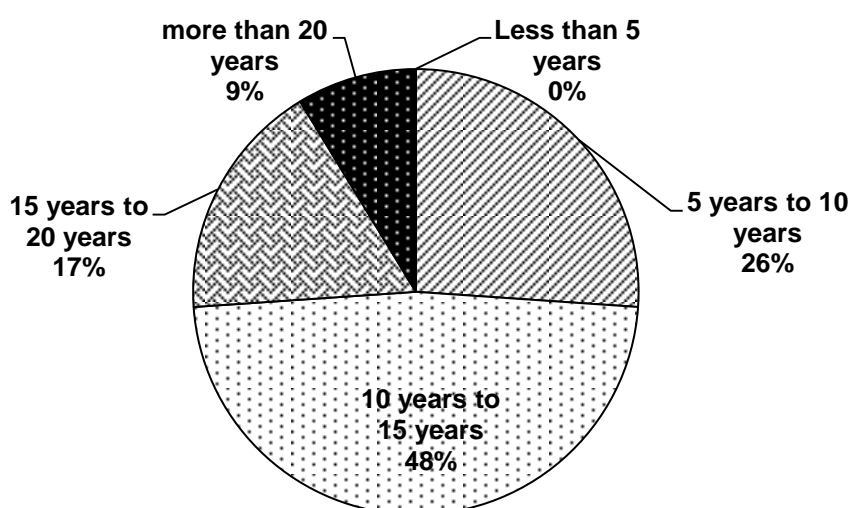
Figure 5-4: Respondents' experience

The respondents were specifically asked to state their perspectives on variety of issues which are directly or indirectly associated with the organisational process improvements. The X-axis represents the number of respondents and Y-axis determines their beliefs (see Figure 5-5. The significant results derived from the survey findings were identified and mapped in the framework. The first question was to identify the management commitment to planning and allocating

appropriate resources for developing individual, group, and organisational competencies to implement process successfully. The results are presented in Figure 5-5.
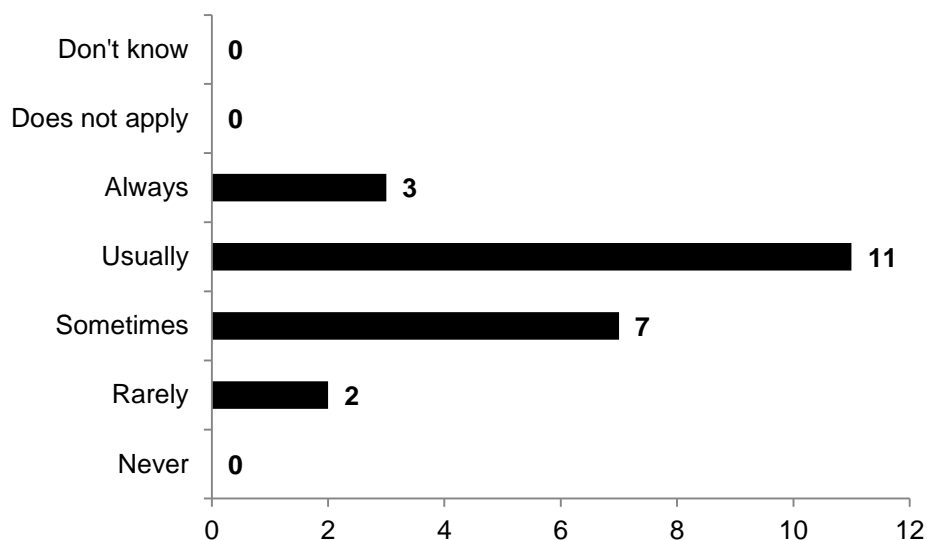
Figure 5-5: Respondents' perspectives on management commitment towards organisational process improvement

Majority of respondents (11/23) believe that they are usually committed on planning and allocating appropriate resources for developing individual, group, and organisational competencies to implement the organisational process successfully whilst (3/23) are always and (7/23) are committed sometimes. From this result it can be identified that the MANAGEMENT COMMITMENT towards organisational process improvement is highly significant and it is well-understood and practiced by the respondents.

The second question of this survey was focused on whether the organisation /management determined the specific needs and requirements of learning and

development of personal in prior to delivery of formal and informal training programmes. Their respondents' beliefs were illustrated in Figure 5-6.
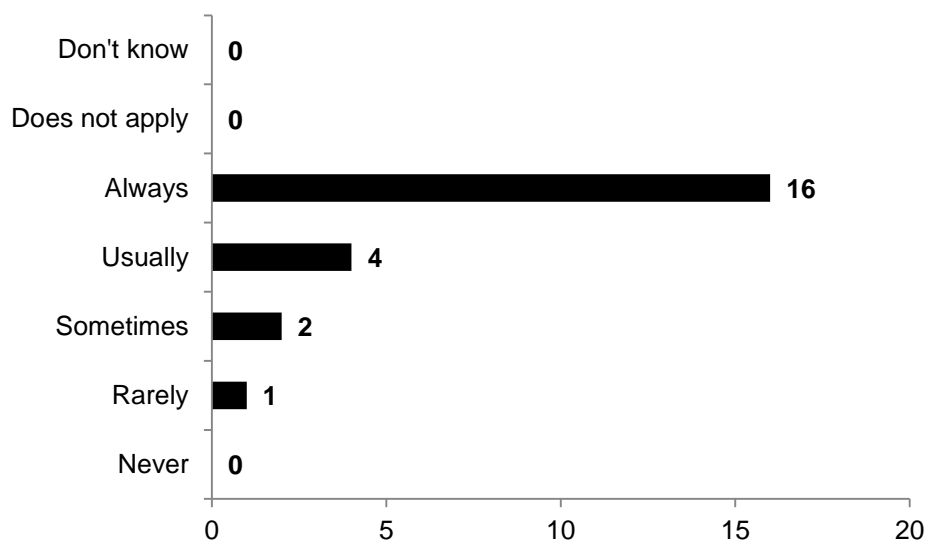
Figure 5-6: Respondents' beliefs on addressing specific requirements of learning in prior to training programmes

More than half of the respondents (16/23) believe that they always determined the specific needs and requirements of learning and development of personal in prior to delivery of formal and informal training programmes. However one manager said that they rarely establish the learning requirements at the start of the training. 4/23 believed they usually consider the learner requirements and 2/23 said sometimes. This issue was further discussed in the workshop session and participants were agreed that TRAINING is highly significant and it is a good practice (cost and time effective) to consider both the learner and organisational requirements before committed on any training.

The third question of the survey focused to identify whether organisations follow standard procedures/policies to meet its learning and development needs in enhancing the skills and competencies to perform individual and group roles in implementing processes. The results depicted in Figure 5-7.
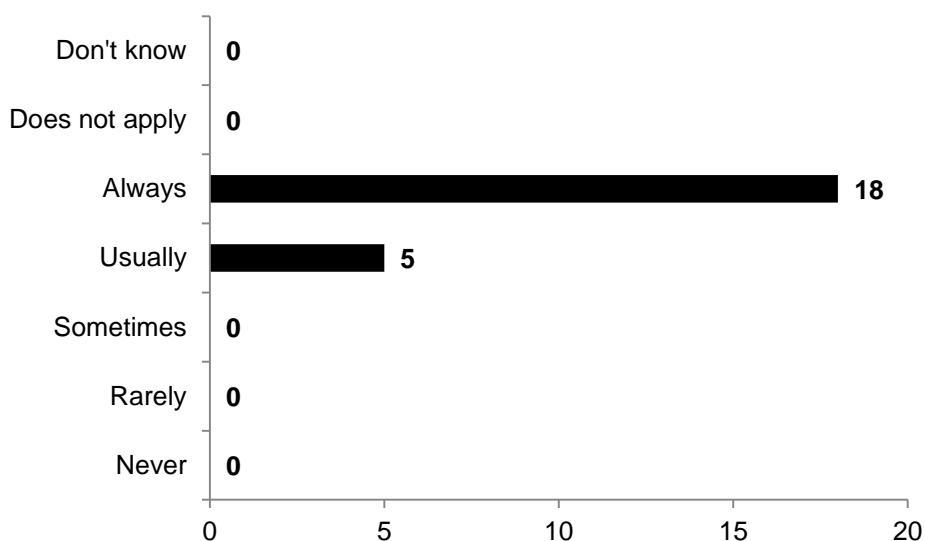
Figure 5-7: Respondents' beliefs on organisation policies towards learning and process improvement

The above result strongly highlighted that the selected organisations are used to follow standard guidelines and <u>POLICIES</u> towards learning and process improvement. 18/23 believed they always follow and policies and 5/23 said usually. The fourth question aimed to identify whether organisations provide adequate resources (i.e. funding, training, goods etc.) to implement the organisation's learning and development programmes. The managers beliefs illustrated in Figure 5-8.
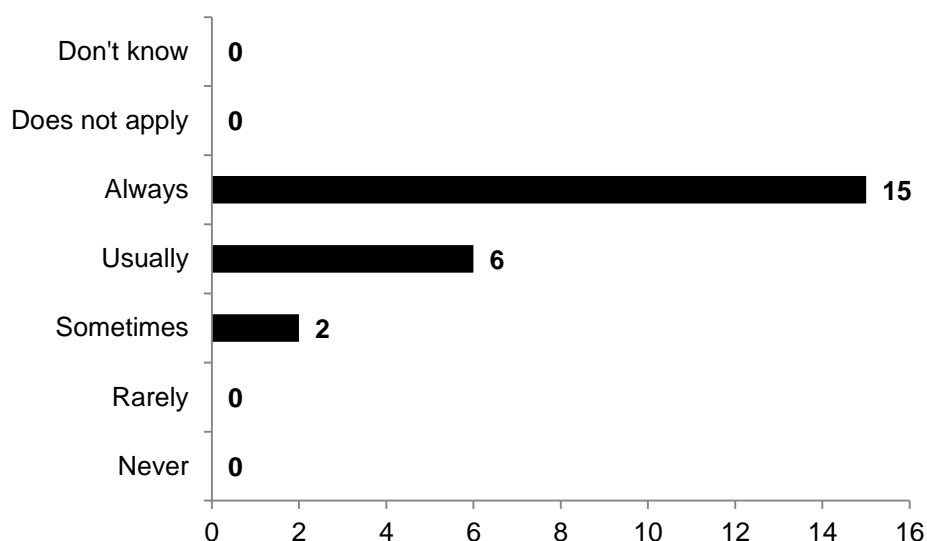
Figure 5-8: Respondents' beliefs on providing adequate resources for organisational learning and process improvement

The majority of the respondents (15/23) believed that their organisations provide

ADEQUATE RESOURCES to improve organisational learning and development.

However they said the evaluation of the appropriateness of particular resource will

be examined (in terms of cost, benefits and worth) before they committed to buy or

hire particular goods and/or service. 6 of them believed that their organisations

usually provide adequate resources to improve organisational learning and

development whilst two said sometimes.

The fifth question of this survey was to identify whether the organisations have any

SYSTEMS to ensure that individuals and groups understand the current and future

requirements of knowledge and skills required by the project and organisation. The

respondents' views on this are illustrated in Figure 5-9.
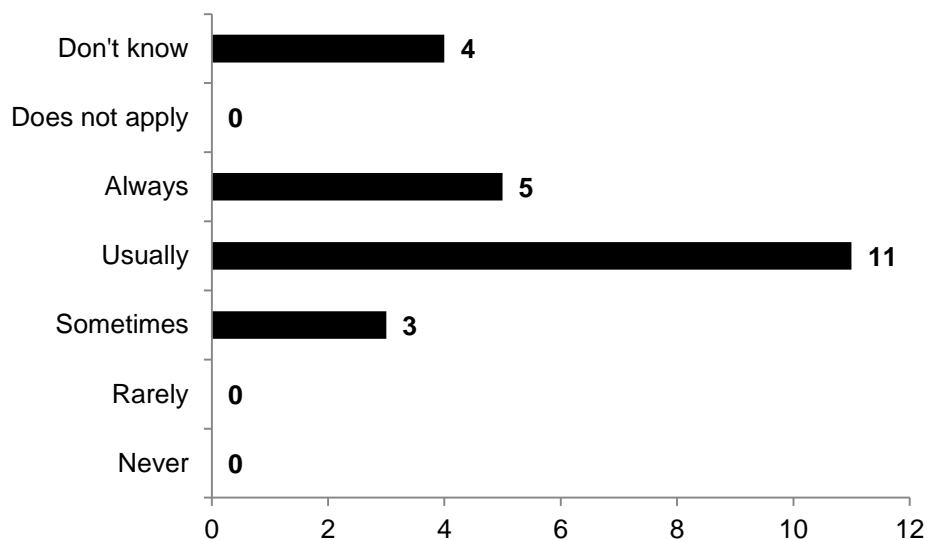
Figure 5-9: Respondents' beliefs on current organisational systems to capture required knowledge and skills requirements by the project and organisation

The majority of respondents (11/23) agreed that there are current systems relevant to managers who have responsibility to manage information, knowledge and communication systems across their organisation or area of responsibility. Moreover they said that those systems are capable enough to capture the required competencies/skills by the project and organisation and they used them usually. However 4 of them were unaware of those systems and 4 said 'always' and 3 said 'sometimes' their organisations adopt those systems to understand the current and future requirements of knowledge and skills required by the project and organisation.

The sixth question of this survey used to identify whether managers and employees participate in reviewing and evaluating effectiveness and efficacy of process training programme. In other words it is about the obtaining a <u>FEEDBACK</u> on training and <u>FEEDFORWARD</u> how trainees will use their learning (through

training) in their current/future organisational activities/processes effectively. The respondents' views are illustrated in Figure 5-10.
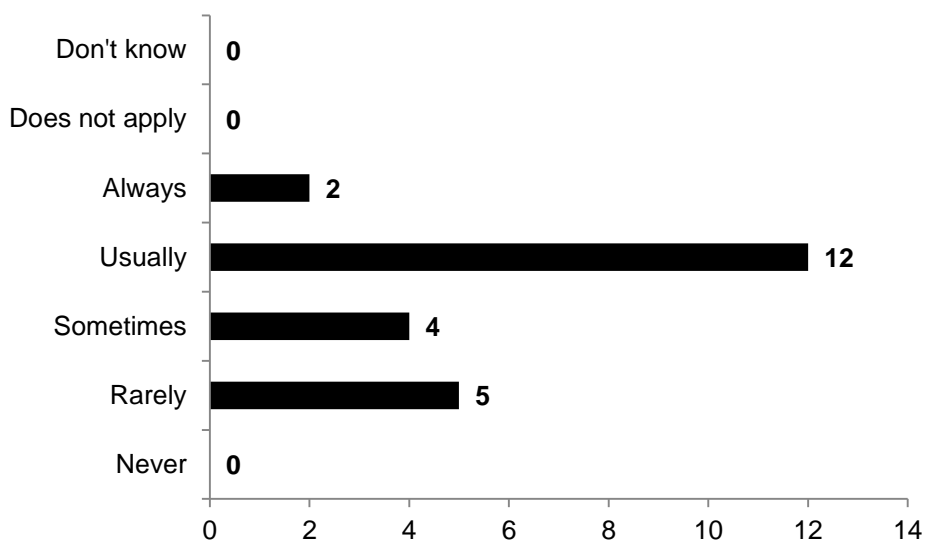
Figure 5-10: Respondents' beliefs on their participation in reviewing the process training

The majority of respondents (12/23) explained that they usually undertake a review after any process training programme. This process review able to establish the capability and capacity of existing systems (i.e. information, knowledge and communication) to meet current and likely future needs, and identify changes and enhancements required. 5 of 23 respondents believed they rarely undertake process reviews after training and 4 said sometimes.

The final question of this survey was to identify respondents' views on whether the activities for managing process training programmes are subjected to <u>QUALITY ASSURANCE</u> or other verifications. The results illustrated in Figure 5-11.
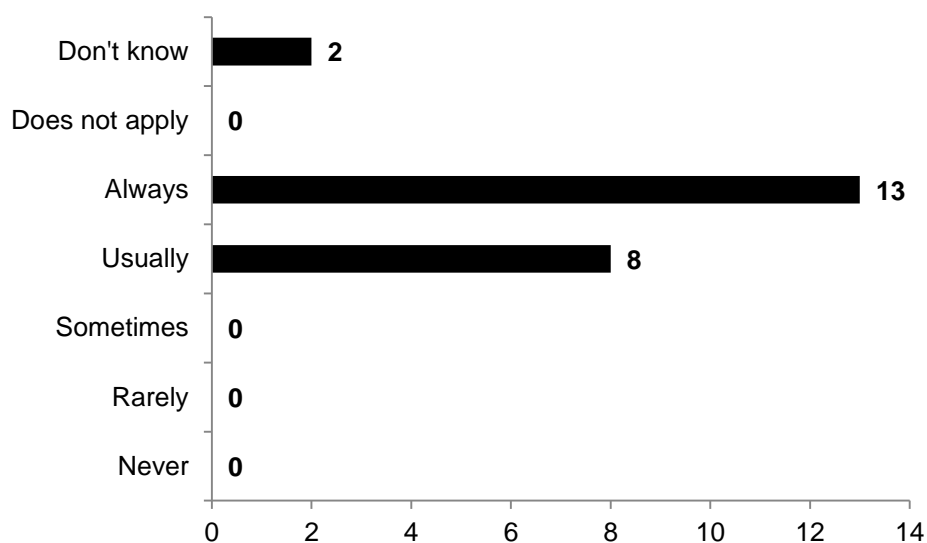
Figure 5-11: Respondents' beliefs on quality assured organisational process training

The majority of mangers (13/23) believed that their organisational process training activities are well monitored through quality assurance programme. 8 of 23 believed that they usually undertake quality assured process training programmes and 2 of 23 were not aware of it. The findings of above questionnaire survey identified significant elements for organisational process improvement, which the organisations are usually adopted. The management commitment, training, policies, adequate resources, systems, feedback, feed-forward, and quality assurance activities are seems as vital considerations for organisational process improvement. The section 5.3.2.2 explains the information derived from workshops on each case study and how the above elements of process improvements were addressed within each case. The attention was further extended to identify the areas for further improvements.

5.3.2.2 Case study A

The first case study was conducted with one of the UK's largest global airport operators, which manages all commercial facilities at its airports including shops, catering outlets, foreign currency exchange, car hire and car parks.

Strengths

The organisation has recognised that in order to achieve 'value for money', it is essential to adopt process approaches centred on products and revolutionary means to improve processes. The company has established its own dedicated team for process improvement that provides generic solutions for products and coordinates with local teams to tailor those solutions. Then, local teams are responsible for developing the generic solutions to fit the specific local circumstances and providing feedback to the process improvement team for further improvement on the solutions.

The integrated project team strived to integrate supply chain and utilise their expertise in an early project stage. This was enabled through a special contract type embracing the spirit of partnering. There were a significant number of learning mechanisms and supporting technology infrastructure (e.g. virtual learning, document management systems, mechanisms to facilitate and record lessons learnt during the project, open discussions on improvement) already in place. Process guidelines were well-established and key stages, processes, and milestones of project were clearly defined, whilst documented processes were executed with appropriate flexibility to accommodate local circumstances and

contingencies. There were also strong organisational drives for sustainability and value management.

The senior and middle managerial personnel shared that the importance and value of process management activities. The project team used generic high level and strategic, rather than operational level and detailed process maps. The process maps were not followed blindly, but were flexible and descriptive rather than normative. An emphasis was placed on objectives, inputs and outputs of each process, which is in turn linked up with previous, concurrent, or subsequent processes or sub-processes. The process maps included responsibility matrix for each process – who are responsible, accountable, to consult, or to be informed – which illustrated that the organisation's process maps were used as a platform for dialogues rather than a basis for auditing.

Areas for further improvement

However, this case revealed that not all project team members in the integrated team shared the same vision for the project. Even though the organisation is relatively adopt at facilitating learning at a management level, the absence of clear mechanisms to capture knowledge and experience at operative level meant that the lower echelon of the integrated project team became reactive to any change or development within the organisation. Despite the perceived value of post mortem project reviews, in actuality, reviews were taking place in an ad-hoc manner. Comments were also made that actions resulting from learning activities were not always visible to middle/lower managerial personnel and operatives. Some felt that they were isolated from the improvement initiatives, whereas others felt that they

were suffering from 'initiative fatigue'. Strategies and expectation of training to support learning and improvement initiatives were not also clear. Consequently, some corporate systems, e.g. electronic document management system and training programmes, were being under-utilised.

The most challenging task to the integrated project team appears to be generating consensus among the project team members on the vision and objectives of the project. Although, by and large, the organisation was successful and supportive at experimenting new ideas, the results were not quickly institutionalised across projects. Therefore, efforts on process improvement were isolated and practitioners felt that the organisation was operating numerous dispersed knowledge silos. There appears to be a lack of collective 'sense making' processes to share contexts and goals of process improvement.

5.3.2.3 Case study B

The case study B organisation is a major UK infrastructure provider working predominantly for the Highways Agency and Local Authorities. The commitment to process improvement is culminated in three areas: continuous improvement through training; capitalising on innovative technology; and partnering arrangements with its clients, business colleagues, subcontractors and suppliers.

Strengths

The organisation has a relatively short history of using process approach towards managing and improving site processes. The company aspired to have a high degree of strategic knowledge sharing and transfer good practices across their

dispersed sites. Some of the practices identified during the case study seemed to have established a good foundation for nurturing process improvement. The organisation has established a 'Process Improvement Team' and process owners were assigned to their respective process.

Overall process maps were developed with collaboration with process owners. Standard procedures, manuals, forms, etc. were codified and stored in the computer systems. There was a high level of team-centred culture fostering knowledge sharing among members within the same team. The organisation promoted a proactive approach to integrate key project participants in order to deliver better value to the client and achieve better bottom line results. Suggestion schemes and best practice dissemination workshops were in operation to encourage employees to take initiatives on process improvement. Attempts were made at mapping processes with downstream suppliers, who were evaluated periodically against various key performance indicators for encouraging continuous improvement.

Areas for further improvement

The major challenge appears to be a lack of visibility within process improvement activities. Although the organisation has established systems and assigned a dedicated process improvement team (PIT) to codify and store knowledge in the form of standards, documents, procedures, and rules, their existing systems were neither sophisticated enough nor user-friendly. It appears that it has placed too much emphasis on capturing good practices and documenting them in the form of standards and procedures. It has not yet developed a shared understanding,

among different levels of hierarchy, of how the organisation will improve processes and what would be the potential benefits.

Even though a set of well-defined processes was being developed, there was little evidence that it was used as a learning tool. Evaluation of processes was sporadic and has not led to further improvements. Consequently, process owners or possible contributors to process improvement did not offer much more collaboration with the PIT than they could probably afford. Concerns were also raised that blindly enforcing processes recorded in the procedure document actually demoralised those who actually were implementing the process. There was an indication that relatively less attention had been paid to training people in comparison to building IT systems to store standard forms and procedures, etc.

5.3.2.4 Case study C

The case study C is a school building programme where a series of school building projects are planned. The central government's effort to invest in education resulted in a number of primary and secondary schools in UK either being extensively renovated or completely rebuilt. This case study was conducted within the primary capital programme of a major local authority in the UK. The study required the researchers to be embedded in the work setting, observe, and comment, with a view to incorporating the findings to future process improvement activities.

Strengths

Traditionally the provision of schools was mainly handled by the local education authority including the design, construction and maintenance aspects. However, the current school development programme involves a number of features that impact through-life management. The school head teachers are being significant amount of authority in terms of design decisions. They are also given the authority to decide the maintenance management of the schools. Central government imposes a number of key performance criteria (such as environmental sustainability, disability standards etc.), which the designers need to take into account. Where possible the use of Public-Private Partnerships was encouraged, although the benefit realisation of Public-Private Partnerships is constantly debated in both academia and industry.

The more integrated approach does provide enhanced opportunities for knowledge management and learning. The procurement approach and the procedures mandate the explicit identification and documentation of lessons learnt. The framework arrangements allow the transfer of lessons learnt from one project to the other due to the fact that the procurement, design and construction consortium remains largely the same.

Areas for further improvements

The local authority sees the reduction of the single point of responsibility it enjoyed for the whole life cycle of the building. Shifting of power to head teachers theoretically places the end user in a better position to contribute to the

requirements capture process. However, lack of prior experience of the head teachers in such activities is a hindrance. The obvious connection between funding and decision making power, has resulted in difficulties for preparing a maintenance strategy. Although the local authorities prefer to retain control of this process, the funding arrangements are not aligned to do so. This case also found evidence that the introduction of Public-Private Partnerships does not, in practice, necessarily contribute towards a single point of responsibility. Indeed, Public-Private Partnerships may be introduced as part of a package of other measures which result in a greater fragmentation of authority.

5.3.3 Overall reflections from the case studies

Having studied the three cases, participant observations, questionnaire survey and workshops the following themes were emerged as critical when facilitating organisational learning within construction environments.

- need to establish meta roles (project / organisational based) for stakeholders;
- identify the type/ level of knowledge/information flows between meta roles;
- explore the improvement areas that need organisational attention and efforts;
- prioritise activities to achieve continuous improvement;
- increase the awareness of processes/flows that will enhance organisational capability to explore and exploit organisational competencies by sharing good practice across projects; and
- facilitate discussions on process improvement throughout lessons learnt.

Moreover the identified contextual issues from the conceptual framework were re-examined in real case settings. The participants to the workshops from each organisation were asked to evaluate and rate the contextual issues (see Table 5-1) that are related to their organisational process improvement. The level of presence of each issue was scaled through 'High', 'Medium' and 'Low' scale. The Table 5-2 summarises the contextual issues, which are quite applicable with the selected case/organisation.

Table 5-2: Associated contextual issues and their level of presence in selected cases

	Contextual issue	Case A	Case B	Case C
1	Complex adaptive nature	M	M	M
2	Complexity	L	M	H
3	Incentives	M	L	M
4	Knowledge management	H	M	M
5	Learning organisation	H	L	M
6	Lifecycle/ through-life mgt	M	M	H
7	Organisational knowledge	H	L	M
8	Process capability maturity	H	M	N/A
9	Process philosophy	M	L	M
10	Procurement	H	H	H
11	Product-service paradigm	H	H	H
12	Project based nature	M	M	M

H – High; M – Medium; L - Low

The conceptual framework was used to determine the conceptual boundaries and critical issues of process improvements in construction context. The appropriate concepts/elements were identified through literature review and a series of

empirical investigations (informal discussions, questionnaire survey, focus group workshops). These empirical evidences from the previous stages were logically assembled together in a desk study to address the identified themes (Section 5.3.2) of each case and developed the intended framework. In addition, the researcher's intuition, the literature review and the informal discussions with the project SCRI research team members were used to design a logical and readable format for the framework.

5.3.4 Procurers, Providers and Users (PPU) framework

The importance of developing a strategic level framework for identifying the process improvements in construction organisations is highlighted in the previous chapters. A conceptual framework was developed as a first stage of framework development through the literature review and informal discussions to establish the boundary for the framework. Many of the inputs to the proposed framework were identified through the case studies and the findings from the questionnaire survey. Having collected all the information in a particular order, a desk study was used to interlink the most appropriate 'entities' and 'flows' for process improvement in construction organisations. The main aim of the framework is to encapsulate the changing roles of the entities (stakeholders) over time, and the resulting shifts of the flows between them. It is important to note that the roles (the type of vested interest) of those entities are likely to change with the time. Therefore, the terms Procurers, Providers and Users are considered as time dependent or 'meta' roles. Figure 5-12 illustrates the framework, which was developed to address the many

of issues (see section 5.3.2) identified through case studies/questionnaire survey and the verified framework is elucidates in Figure 5-13.
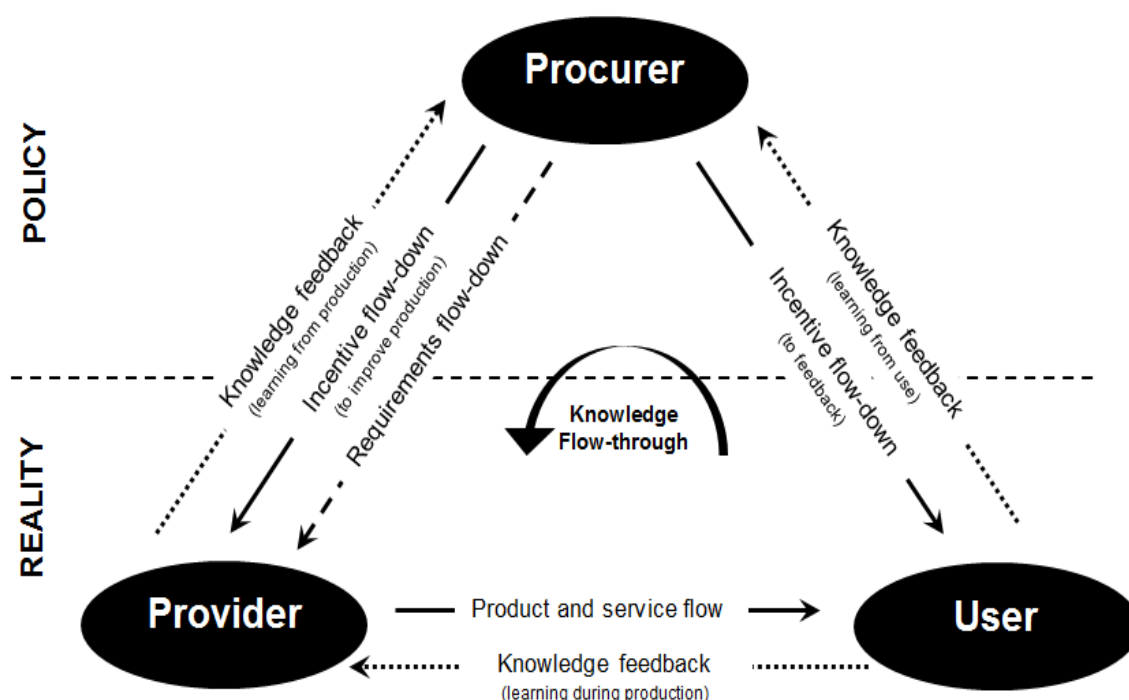
Figure 5-12: Proposed Procurer, Provider and User (PPU) framework

5.3.4.1 Meta roles and information flow

The most significant requirement raised through the reflection of case studies (see section 5.3.2) was a real need to establish Meta roles for stakeholders and then to identify the type/ level of knowledge/information flows between those Meta roles. Three Meta roles were identified and integrated within the framework, which are Procurer, Provider and the User.   The significant findings derived from the questionnaire survey on key considerations for organisational process improvement i.e. 'management commitment', 'training', 'policies', 'resource

requirement', 'systems', 'feedback and feedforward' and 'quality assurance' were considered within the information flows of the proposed framework. The sections 5.3.4.1.1 – 5.3.4.1.3 explain each Meta-role and their information in-out flows. An ideal example also provided to understand the changing nature of Meta roles when responding to different situations.

5.3.4.1.1 Procurer

A person who causes someone to do something or something to happen (Oxford Dictionary, 2011) is identified as a 'procurer'. This entity can be an individual or an organisation. The main information out-flows from procurer to provider are the requirement flow-down and the incentive flow-down. A clear briefing on required product/service is considered as requirement flow-down. In organisational or project settings procurers are responsible for funding the project. However in traditional settings their major concern is focused towards the low cost rather than the value enhancement. Therefore they are reluctant to offer such incentives to their stakeholders for giving knowledge feedback which emerge through 'learning from production' (providers concern) and learning from use (user concern). However from the workshop it was identified that the incentive flow-down from procures to other stakeholders is highly required for organisational process improvement within construction context.

5.3.4.1.2 Provider

An individual or organisation, which is responsible for providing such product or service, is identified as 'providers'. Providers play a core role in construction

project delivery. For example, they are responsible to design, procure resources and complete the end product/service. In providers perspective if they are receiving complete (more specific) requirement / brief from the procurer and also knowledge feedback from user on their final product / service, they could use them to improve their organisation processes.

5.3.4.1.3 Users

Simply a person who uses any product or service is defined as a 'user'. With reference to PPU framework, users play a critical role in organisational process improvement. From the case studies and iterative workshops it was identified 'incentive flow-down' from procurer and 'product and service flow' from provider are the critical information inflows for users. In other words if procurer agrees to offer such incentives (monetary or non-monetary) to users for providing knowledge feedback (learning from use: either positive or negative) on their product or service that would of course help the procurer to improve his/her product/service performance. In fact the incentive flow-down approach provides a clear motivation of users to convey knowledge feedback (continuous, frequent, and one-off) to procurer. However none of the cases studied were used incentive flow-down scheme. Table 5-3 illustrates examples of Meta roles in a typical construction organisational setting.

Table 5-3: Meta roles of the PPU framework

Meta role	Responsibility	Example
Procures	Procures the products and services needed to provide main public services	Central Govt., Local Govt. National Health Service
Provider	Provides design, production, maintenance and refurbishment services	Designers, Builders, Facilities Managers, sub-contractors, suppliers
User	Uses the built facility as part of its resource base to deliver the business objectives	Individual or corporate clients

Moreover, Table 5-4 illustrates one of possible ways of which the Meta role can be likely to change in the primary education sector of the UK.

Table 5-4: Changing roles of stakeholders over project lifecycle

Meta role	New build	Periodic maintenance (5 years after)	Refurbishment (20 years after)	Demolition (60 years after)
Procures	Central Government and Local Govt.	Primary school	Local Govt.	Central Government and Local Govt.
Provider	Framework contractors	FM company	Contractors	Demolition contractors
User	Primary school	Staff and pupils of the school	Primary school	

The arrows in the diagram indicate the various types of flows that are considered as important for the sustaining effective product – service delivery in the built

environment. Most importantly the framework assists the stakeholders to establish their time dependant roles, requirements, incentives and flows within the organisational or project environments.

5.3.4.2 Policy and reality

The proposed PPU framework has been integrated 'policy' and 'reality' as major concerns in a real-world project settings. Policies (project objectives – time cost quality targets etc.) are determined by the procurer and both provider and user may indirectly support those policies. However reality/actuality is depend upon the actions and reactions of procurer and the users. These two entities (policy and reality) play a significant role in achieving project/organisational objectives especially when considering process improvements.

5.3.4.3 Improvement areas that require organisational attention

The second most important consideration derived from the case study analysis was the identification of areas that require organisational attention and efforts. The training, adequate resources, quality assurance and compliances, systems, policies and incentives are remarked as the significant areas that the stakeholders should pay their attention when focusing on organisational process improvements. The framework integrated two terminologies, which are 'incentive flow down (cascading of incentives beyond the first tier of the supply chain)' and 'requirements flow-down (communication of requirements to the appropriate tiers)' to reflect improvement areas that require organisational attention and efforts towards the process improvement. For example, if a requirement is realised to

follow quality assurance standards by the decision makers of the organisation, this message should flow in to the shop-floor level. However that is lacking in the current construction organisational settings and important to include within the developed framework.

5.3.4.4 Lessons learnt

Lessons learnt is identified as the next important area to be integrated within the process improvement framework, which is reflected through 'knowledge feedback'. Different types of feedbacks (i.e. learning from production, learning from use, learning during production) required to be flown in between Meta-roles, which assist the stakeholders to understand and evaluate the performance of their product/process. Section 5.4 explains the framework validation process.

5.4 Validation of PPU framework

This section explains the findings of the validation and the resulting improvements to the framework in its real case application. The focus group workshop to validate the framework was undertaken by the project collaborators. Focus groups can be easily combined with qualitative and quantitative methods, for example to develop a questionnaire or refine the key issues. Having studied the qualities of focus group workshops, the study adopted the method to fine-tune and validate the issues of the PPU framework. The strength of the workshop approach in assessing the usability of the framework is that it offers the possibility to look at many different facets of the system at the same time. The developed high level

framework for organisational process improvement considers Meta roles, information flows, areas to be improved and lessons learnt in specific to organisational process improvements (see Figure 5-12). Seven of senior management from the selected cases (2 from case A, 2 from case B and 3 from case C) were invited and engaged in the validation process.

This framework is an integration of the findings of the four research objectives (1-4) discussed in Chapter 1. The discussion elements of the workshop were treated like a focus group, with specific questions being asked and discussed by the participants. First, this framework, which was developed through the findings of case studies, was presented in this workshop through a PowerPoint presentation. Then each Meta role and their associated information in-out flows were enlarged to explain how these entities were integrated to develop the proposed framework. The workshop participants were asked the following questions and the responses to each question are noted below:

1. *Do you think this framework provides a formative guidance to its users (procurers/providers/users) about 'process improvement'?*

   This question was posed to get an overall idea about the presentation, the depth of information used and to identify the readability of proposed framework. Almost all the participants were agreed that the integrated Meta roles are significant in any organisational setting and the identified information flows also highly important towards the organisational process improvement. However, one important entity was missing in the original framework and they noted to include 'neighbour/community' and a new

entity to represent the individuals or organisations who does not play a direct role however they maybe or may not be engaged indirectly. Therefore, attention was paid to include 'neighbour' in the final framework however the information flow between main entities (PPU) and the neighbour didn't reveal as it becomes a complex issue which is out of this research objectives.

2. *How could this framework be implemented in the real case scenario?*

The purpose of this question was to identify the issues of practicability of implementing this framework for real-world projects. The design phase application was recommended because all of the Meta roles and their responsibilities (information flows) are required to be completed at the design phase of project lifecycle. In addition to above information, the framework clearly demonstrates the importance of considering areas to be improved and lessons learnt in specific to organisational process improvement.

3. *What further improvements are needed in the framework?*

Further improvements to this conceptual framework were discussed within the validation workshop. More than half of the participants at the validation workshop highlighted three critical points for future improvements in this framework.

- A clear identification and explanation of each meta roles and their responsibilities required to be documented at the project setting stage;

- There should be a correct mechanism to check whether the correct information is delivered / reached to the correct party; and

- Finally, there should be a good frame of reference throughout the project to identify which knowledge information would help them to improve their organisational processes.

Having considered those suggestions the final framework was developed and illustrates in the Figure 5-13.
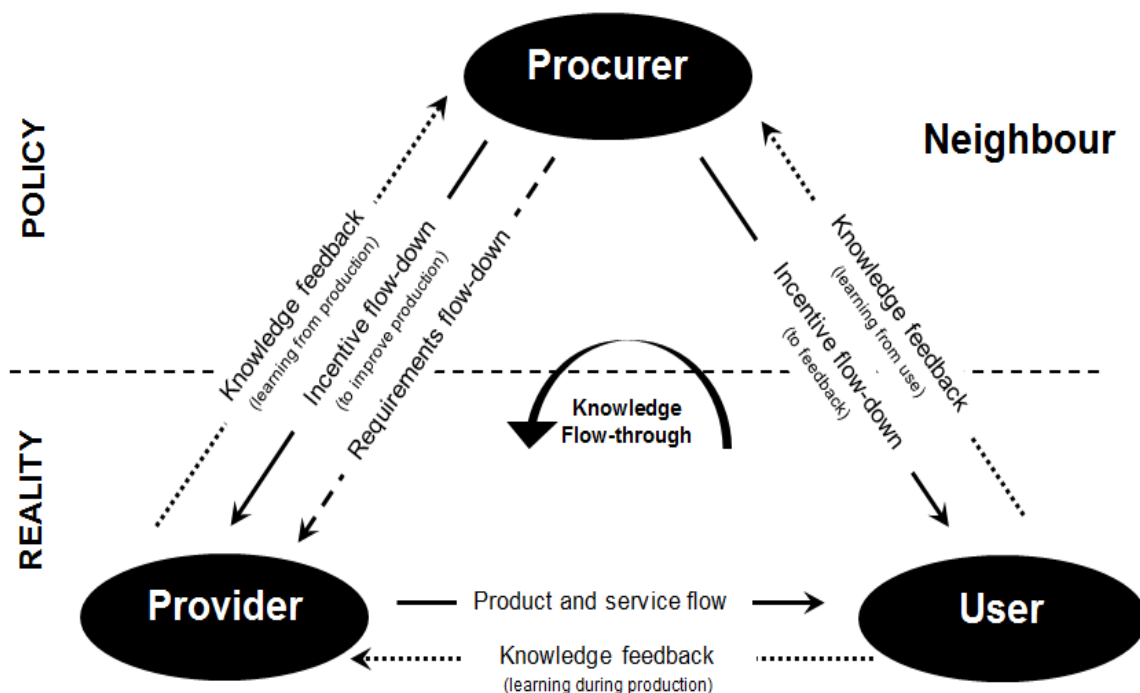
Figure 5-13: Developed procurer, provider and user (PPU) framework

The key difference between final framework (Figure 5-13) and original framework (Figure 5-12) is the insertion of 'neighbour' entity to represent all the other associated external bodies within a typical project setting.

5.5 Benefits and limitations of developed framework

Key benefits could be expected by adopting this framework in the design stage of the building lifecycle. The information flows (requirement, incentives, feedback) need to be determined at the very early stage of design and this certainly would lead to the identification of the specific Meta roles and responsibilities of project stakeholders for process improvements. Moreover the framework is able to identify the type / level of knowledge/information flows between Meta roles. It explores the improvement areas that need organisational attention and efforts and then prioritise activities to achieve continuous improvement. More importantly, the framework increases the stakeholders' awareness of processes/flows that would enhance organisational capability to explore and exploit organisational competencies by sharing good practices across projects and facilitate discussions on process improvement throughout lessons learnt. Therefore the framework provides formative guidance to the project stakeholders.

However, the framework was not tested in a real case scenario to identify the practical difficulties (if any) and to understand the further improvements to be required in practical application – this is one of the proposals for future work.

5.6 Summary

This chapter discussed the process used to develop and validate a PPU framework for identifying process improvement capabilities of construction organisations. In short, the framework identifies the pertinent Meta roles, information flows, areas to be improved and lessons learnt that required towards achieving a set target (project / service development). The framework was tested for its usability and validity through a workshop by industry partners for the SPICE3/KIM projects. This validation provided an opportunity for retesting the findings of each research objective. The application of this framework at the design stage of the project lifecycle encourages the stakeholders to establish their roles and responsibilities.

Moreover, the product-service paradigm requires a shift in focus for many engineering disciplines, forcing them to change from providing products to providing products and associated services. Such a shift is likely to present several challenges to the built environment due to its inherent organisational fragmentations and through-life discontinuities. The chapter presented that the product-service paradigm as seen from a built environment perspective. Therefore the proposed PPU model represents the meta-roles and the information flows, considered as key to sustaining the product-service concept within the built environment.

Chapter Six

6. CONCLUSIONS AND RECOMMENDATIONS

6.1   Introduction to chapter six

The final chapter of this research endeavour is designed to encapsulate the findings, strengths, limitations, and recommendations of this research investigation. Section 6.2 provides an overview of the summary of the research and, the Section 6.3 explains the key findings of this research investigation. The priority is given in the Section 6.3 to explaining how the research objectives were achieved within the specified scope while comparing the similarities and differentiations of the research findings with the current state of knowledge. Section 6.4 expounds the original contributions made to research as part of this doctoral study. Moreover, Section 6.5 is used to explain the research implications in relevance to the industry/practice. Section 6.6 provides key recommendations while identifying the limitations of this study and the final section explains the considerations for future research studies.

6.2   An overview of the research

This study provides a clear backdrop for understanding the organisational learning in construction in particular to process improvement perspectives. Five interwoven

objectives were considered. Having studied the nature of the research question, the study adopted the theoretical position of constructivism and different empirical investigations were undertaken to collect, analyse and validate the data. A comprehensive literature review and a series of informal discussions with SPICE III (Structured Process Improvement of Construction Enterprises), KIM (Knowledge and Information Management) and OLS (Optimum Learning Spaces) project partners were preliminarily investigated to define the research aim and objectives. The study was guided by the 'constructivist knowledge claim' and categorised under the constructive research category. The dominant purpose was in the tradition of design science approach. However, some aspects of descriptive and explanatory research traditions were adopted in achieving the first three objectives.

The overall investigation followed the Hermeneutic learning spiral. The case study design exploited questionnaire survey, participant observations, document analysis, and several informal discussions with the project partners to collect data (see section 5.3.2). Three focused group workshops were organised with the project partners in different stages of the research to collect the required data and validate the findings of the three case studies. Those workshops were reinforced through Pre-learning – Learning concept. The overall research exploited a multi-method approach to collect the data, and descriptive statistics methods were used to analyse the collected data from the case studies. The concentration was further extended to develop a framework for articulating these findings in a logical sequence (establish Meta roles, knowledge - information flows etc.) through a

desk study and the framework was validated for its applicability in construction context and key implications for theory and practice were identified.

6.3 Research findings

In its wider context, 'organisational learning' means the capability of an organisation to respond to the "strategic – pull" and "individual – push" efforts to achieve organisational performances. Therefore the research investigated the concepts of organisational learning, knowledge management, process improvement, process philosophy and the complex adaptive nature of construction in detailed and attempt to identify their interrelationships (if any) towards achieving the organisation performance. The case study design was adopted to achieve the research objectives.

Having identified the importance of organisational learning in terms of its contribution to process improvement, the need for a framework to facilitate organisational learning was identified. The research used design science approach as the overarching methodology for the development and evaluation of the framework.

The framework features Meta-role actors with time and context dependent roles. The necessary data and action flows were identified. Through the verification process it was suggested to consider "neighbours" as an important entity that required to be considered in the framework. Therefore this new entity was introduced in the final framework.

The framework recognised the dynamic and complex (adaptive) nature of construction contexts. The dangers of being too prescriptive were also recognised. The one-of-a-kind nature of construction is a key factor in this regard. The framework recognises that in complex construction contexts such as highways and schools, there can be many roles contained within the same corporate organisation.

More importantly, the research recognises that contextual issues can sometimes set these sections/departments against each other. It also can lead to misunderstandings, especially when they compare with their previous work practices / routines. Therefore, it is necessary to 'unlearn' as part of the learning / adjustments that need to be performed. As such it is necessary for organisations and their respective business units to identify the position when they either enter or gets placed, in order to identify their time and context specific Meta-role, and identify their training needs / and knowledge management needs / organisational behaviour patterns.

6.3.1 Completion of the first objective

The first objective of this study was to identify the principal concepts of organisational learning within the context of construction industry. Through the findings of this study it was identified that 'learning' is an essential part for construction businesses that need to be considered and continued in the long term survival of the business. However, construction organisations generate relatively poor performance (i.e. health and safety, time, cost management etc.) when

compared to other business organisations. In fact, construction is a multifaceted industry and it is quite difficult to define the boundaries of its 'context'. People see construction organisation as a place for 'product development' and also a 'service provider'. Therefore the 'context' depends on the personal standpoints.

Construction organisation has relatively stable business entities (large to small scale). Project based organisations are to achieve a specific goal/target for a particular period of time. Depending on the time (i.e. duration) this relationship can be categorised as 'short-term', 'medium-term' or 'long-term' project organisations.

In the consideration of 'learning' within construction organisations the key considerations are:

Construction industry is an information intensive industry, and information intensive processes are commonplace. It is also rich of multidimensional information. As a result construction organisation faces the challenges of knowledge management and learning. Temporary / project based nature has advantages and disadvantages towards managing knowledge and learning. From this study it was identified there are clear opportunities to reflect and learn from project based organisations. However the drawback is that not many incentives exist to ensure that the above-mentioned learning takes place.

It was realised that 'construction organisations' need more enhanced understanding that they are in a continuous and adaptive context. Therefore the concepts of organisational learning such as single-loop, double loop and triple loop (see Chapter 2) required to be established within construction context. Therefore it

was identified the significant importance of recognising the 'Meta-roles' within construction organisation. These findings brought new insights to this study. Section 6.3.2 summarises the second objective, the methods used to complete the objective and the key findings.

6.3.2 Completion of the second objective

The second objective was to identify the role of process improvement perspective in facilitating organisational learning. The process view recognised the change as the norm rather than the exception. Simply when learning is facilitated in any organisation, the process view plays a vital role as learning is a change of status. As a result, intended performance may or may not be achieved. Given the fact that the intended outcome of process improvement is largely dependent on the Meta-roles, the Meta-role view of the organisation learning in construction contexts (as indicated in the framework developed) is a key necessity for effective facilitation of organisational learning.

6.3.3 Completion of the third objective

The third objective aimed to explore the contextual issues associated with organisational learning and process improvement within construction industry context. Twelve contextual issues were identified (see Table 5-1). Findings from the questionnaire survey further explained how the management perceive their capability to share good practices at an organisational level and what mechanisms are used to facilitate the process improvement. The result depicted management commitment, training, organisational policies, resource management, system,

feedback – feedforward and quality assurance are the as good practices towards facilitating organisational learning and process improvement.

Procurement – various procurement approaches (traditional, design and build, Project Finance Initiatives etc.) In fact the procurement methods affect the behaviour and relationships of stakeholders/parties. Therefore 'information-flow' seems inconstant due to the uncertainties and unpredictability of relationship.

Successful management of the product life cycle in the construction context requires long term engagement. In an ideal scenario this is needed for sustained learning. However the temporary project based nature of stakeholder engagement act as a barrier to this.

Due to the one-off nature of production in complex construction contexts, it is difficult to standardise many of the learning processes. Non-recognition of the time and context dependent meta-role adds further complexity and leads to development of unsustainable or ineffective learning processes.

A number of issues contribute to the complexity in construction context. In general construction does not behave as an 'industry' but more like a 'conglomerate of industries', an 'industry of industries' or a 'meta-industry' (Fernández-Solís, 2008). The dynamic socio-technical contexts delivering either a product, a service or product-service combination gives right to emergence of new order for which standards model of learning may not be compatible.

The absence of incentive flow-downs does not motivate the learning. This has resulted in lack of feed-up from the lower-tier supply chain members. The framework emphasised the necessity for the incentive flow-down to improve organisational learning.

6.3.4 Completion of the fourth and fifth objectives

The last two objectives of this research endeavour was to develop and validate a framework to facilitate organisational learning in complex construction contexts. Chapter 5 of this thesis described the development of the higher level framework comprising Meta-roles (procurer, provider and user), required information flows, areas to be improved and lessons learnt for organisational process improvement in detailed. It is essential to note that the development and the validation of the framework adopted the design science research approach. A key feature of the design science approach is that the continuous enhancing of the problem awareness, development of the solution and its validation are performed in iterative cycles (Koskela and Kagioglou, 2008). Therefore, the validation of this framework was an in-built feature of the overall research process, rather than a detached stand-alone effort. As such the framework recognises the fact that knowledge is both a "thing" and a "flow" as indicated in the literature and, attempts to facilitate it by indicating the meta-roles and the information flows. However, it should be noted that the case studies were conducted in sequential order, with case study A being the first and case study C being the last. As a result, this thesis admits the fact that Case study A made a significantly high contribution to the developmental phase of the framework, whilst case study C made a significantly

higher contribution to the validation phase of the framework. This higher/strategic level framework for organisational process improvement was tested for its usability in real case scenario and the introduction of 'neighbour/community' as an external entity is remarked to represent other external bodies associated with the construction project.

6.4 Contribution to the body of knowledge

The contribution to the body of knowledge from this investigation is threefold.

Firstly, the research developed a meta-role model framework to facilitate organisational learning in order to facilitate process improvement. The absence of such a framework in current literature makes this research outcome an original contribution to knowledge. Secondly, the research approach used was the design science approach (constructive research). This also adds to the novelty of this research as the field of construction management is identified as lacking in its use of such approaches (Koskela, 2008).

However, the current models of organisational learning disregard the dynamism that multi-organisational project based organisations that make-up the construction supply and value chain undergo. Therefore, the current prescriptive models do not sustain as they lack resilience to change. This framework brings out the dynamic nature through explicit recognition of organisations as time and stake dependant meta-roles, thereby, providing a much needed understanding of the complex

adaptive nature. As a result, it is expected that organisations in construction industry will develop much more realistic approaches to process improvement.

6.5 Research implications

The key implications from the findings of this research investigation in relevance to the industry are considered.

The developed framework could be adopted for any organisations, which are contracting, consultancy, client's organisations and/or regulatory bodies when they seek to improve their processes while facilitating organisational learning. The key feature is to identify their time-dependant roles as they position themselves in the framework. In addition to their roles the sustaining information flows (in and out) play a vital role in facilitating organisational learning. When designing procurement methods or managing projects within selected procurement approaches it is necessary to identify and understand where the specific organisations are positioned as per the framework. To facilitate sustained and continuous process improvement and learning the required incentives as indicated in the framework should either be introduced or maintained.

6.6 Recommendations

The following recommendations are offered for related research and the industry practices in the field of organisation learning in construction.

6.6.1 Recommendations for research

- Given the complex nature of construction project settings, a series of longitudinal studies, based on this higher level framework, would document trends and thereby increase the potential that decisions regarding the construction process improvement

- While the current spheres of process improvement framework considers the Meta roles and information flows between each role, it may be advantageous to conduct research which considers the distribution of the information across this model in the context of the different project settings (procurement methods, project type etc).

- Given that this study provides a basis for concluding that construction process improvement is a must needed requirement for achieving the organisational goals and set targets which needs to understand its attributes (i.e. meta roles, information flow) from a research base.

6.6.2 Recommendations for industry

The following recommendations are offered for practitioners in the field of construction process improvement.

- Figure 5-13 illustrated in chapter 5 of this thesis defines Meta roles and information flows relate to construction process improvement. It is recommended that industry practitioners / strategic level decision makers take consider their time and stake dependent meta-role and the resultant information flows as a basis for evaluating and updating their current organisational processes.

- Based on the results of this research investigation, it is recommended that organisational process improvement is a vital consideration in construction when achieving their project / organisational goals. Particular attention to this should be given by the industry professionals to monitor those Meta roles, responsibilities and type of information flows during the project life cycle.

6.7 Considerations for future research

The research identified four key themes based on which the literature on learning in organisations have developed. They were organisational learning, learning organisation, knowledge management and organisational knowledge. Given the fact this research adopted a constructivist approach; it was the researcher's biasness to organisational learning which made it the dominant theme in this

research. Extending this research by making the other themes especially knowledge management and organisational knowledge is a worthy effort.

The empirical data collection focused on complex project settings in the UK. Extending this research to other countries, especially non-commonwealth countries and, for projects which involves multi-national / across boarder collaboration is another suggested effort. The applicability and the validity of this framework can be further tested.

An increasing number of construction projects do now fall into the category of disaster management. Given the fact that such projects involve many stakeholders and are conducted under time, cost, quality and many other influencing factors, the applicability of this model in such complex contexts is also another further research suggestion.

The case study method was used in this study as the development of the framework and its validation required a rich understanding of the organisational settings. However, it is possible to use a survey method to judge the extent to which organisations recognise the time and contextual aspects, and the meta-roles. This is another further research. The above, ideally should be incorporated into the training programmes of organisations. Further research in this area is also needed.

The connection between the process philosophy, especially the cognitive and metaphysical elements, and that of learning and knowledge management in construction contexts should be studied.

Organisational learning in the construction contexts taking into account further the idea of product-service should be further researched.

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Appendices

Appendix – A: Research publications

Books:

- Jeong K. S., **Siriwardena M. L.**, Haigh R., Amaratunga D., Kagioglou M. and Sarshar M., (2004), *How to share good practice in your organisation*, Salford Centre for Research and Innovation (SCRI) in the built and human environment, ISBN 0-902896-75-X

Refereed Journal Papers

- Rooke J., Molley E., Sinclair M., Koskela L., **Siriwardena M.**, Kagioglou M., Siemieniuch K., (2008) Models and Metaphors: complexity theory and through-life management in the built environment, Architectural, Engineering and Design Management, Vol 4, pp 47-57

- Jeong K.S., Kagioglou M, Haigh R., Amaratunga D., and **Siriwardena M. L.,** (2006), "Embedding good practice sharing within process improvement", Engineering, Construction and Architectural Management, Vol 13(1), Emerald Group Publishing Limited, pp 62-81.

Refereed Conference Papers

- **Siriwardena, M** (2012), 'Process Capability Maturity Modelling in the Construction Industry ', Proceedings: Research Symposium of the Association of Professional Sri Lankans (APSL) in the UK. (Abstract) , Sheffield, November 2012

- Koskela L. Rooke J., and **Siriwardena M**., (2009), Position paper on theory in through-life management, SCRI Symposium proceedings, Salford

- Koskela L., **Siriwardena M**., and Rooke J., (2008), Through-life management of built facilities-towards a framework for analysis, International Group of Lean Construction Conference Proceedings, Manchester.

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- Rooke J., Molly E., Sinclair M., Koskela L., Kagioglou M., **Siriwardena M.,** and Siemieniuch C.., (2007), Models and Metaphors: some applications of complexity theory for design, construction and property management, Conference Proceedings CD: CIB World Building Congress, Cape Town.

- **Siriwardena M. L**. and Kagioglou M., (2006), Learning in organisations : towards an integrative framework, Conference Proceedings, 6th International Postgraduate Research Conference in the built and human environment, Delft University of Technology, Delft, The Netherlands

- Codinhoto R., Kagioglou M., Koskela L. Cooper R., and **Siriwardena M. L.**, (2006), Towards a framework to evaluate contributions to theory, Conference Proceedings, 6th International Postgraduate Research Conference in the built and human environment, Delft University of Technology, Delft, The Netherlands

- **Siriwardena M. L.**, Kagioglou M, Jeong K. S., Haigh R., Amaratunga D., (2006), Delivering public sector efficiencies: the potential role of capability

maturity models in construction, Conference Proceedings, 3rd SCRI research symposium, Delft University of Technology, Delft, The Netherlands.

- **Siriwardena M. L.**, Koskela L., Rooke J., McDermott P., Ruikar K., Kagioglou M., Sexton M., and Aouad G. (2006), Realising product-service paradigms: towards a foundation for researching 'incentive flowdown', Conference Proceedings: CIB W092 – Procurement Systems – Symposium on Sustainability and Value through Construction Procurement, Salford.

- Rooke J., Koskela L., **Siriwardena M.,** Ruikar K., Kagioglou M., Sexton M., McDermott P., Aouad G., (2006), Researching decision support: What do we need to know?, Conference Proceedings: CIB W092 – Procurement Systems – Symposium on Sustainability and Value through Construction Procurement, Salford.

- **Siriwardena, M**., and Kagioglou, M., (2005), Conceptual developments in organisational learning: an analytical review, in: 'Fifth International Postgraduate Research Conference in the Built and Human Environment', Research Institute for the Built and Human Environment, Salford, UK. Conference details: 5th International Postgraduate Research Conference, The University of Salford, UK.

- **Siriwardena, M.,** and Kagioglou, M., (2005), Knowledge sharing in the context of process improvement initiatives: opportunities and challenges for construction organisations, in: 'QUT International Research Week', Queensland University of Technology, Brisbane, Australia. Conference details: COBRA conference, QUT International Research Week, Brisbane.

- **Siriwardena, M**., and Kagioglou, M., (2005), An integrative review of organisational learning research in construction, in: 'QUT International Research Week', Queensland University of Technology, Brisbane, Australia. Conference details: COBRA conference - QUT International Research Week, Brisbane.

- **Siriwardena, M.**, and Kagioglou, M., (2004), Organisational Learning in Construction: a preliminary review of literature, in: 'Fourth International Postgraduate Research Conference in the Built and Human Environment', Research Institute for the Built and Human Environment, The University of Salford, Salford, UK. Conference details: Fourth International Postgraduate Research Conference in the Built and Human Environment.

Other research publications

- Koskela, L., Eckert, C., Jupp, J., Molloy, E., Rooke, J., Ruikar, K., Siemieniuch, C., Sinclair, M., and **Siriwardena, M.** (2007), Approaches to realising products and services over time, KIM project internal research conference, Loughborough.

Appendix – B: SPICE 3 questionnaire

SPICE III Questionnaire

1. Is there senior management commitment to planning and allocating appropriate resources for developing individual, group, and organisational competencies to implement processes successfully?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually

- ○ Always
- ○ Does not apply
- ○ Don't know

Comments

[   ]

2. Are the specific needs and requirements of learning and development of personnel determined prior to delivery of formal and informal training programmes?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually

- ○ Always
- ○ Does not apply
- ○ Don't know

Comments

[   ]

3. Does your organisation follow a written organisational policy to meet its learning and development needs in enhancing the skills and competencies to perform individual and group roles in implementing processes?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually

- ○ Always
- ○ Does not apply
- ○ Don't know

Comments

[   ]

4. Are adequate resources provided to implement the organisation's learning and development programmes (funding, personnel, and appropriate training facilities, etc.)?

- ○ Never
- ○ Rarely
- ○ Sometimes
- ○ Usually

- ○ Always
- ○ Does not apply
- ○ Don't know

Comments

[   ]

5. Are there systems to ensure that individuals and groups understand the current and future requirements of knowledge and skills required by the project and organisation?

○ Never   ○ Always

○ Rarely   ○ Does not apply

○ Sometimes   ○ Don't know

○ Usually

Comments

[   ]

6. Do managers and employees participate in reviewing and evaluating effectiveness and efficacy of process training programmes?

○ Never   ○ Always

○ Rarely   ○ Does not apply

○ Sometimes   ○ Don't know

○ Usually

Comments

[   ]

7. Are the activities for managing process training programmes subjected to QA or other verification?

○ Never   ○ Always

○ Rarely   ○ Does not apply

○ Sometimes   ○ Don't know

○ Usually

Comments

[   ]