DECISION MAKING SUPPORT THROUGH A KNOWLEDGE MANAGEMENT FRAMEWORK FOR COMPLEX IT SYSTEMS DEVELOPMENT PROJECTS IN THE KINGDOM OF SAUDI ARABIA

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ABSTRACT

Recent research reveals a narrow, rational model of problem- solving and decision-making in complex IT systems development projects. This creates problems that are identified in the thesis. The aim of this study is to develop a novel decision-making framework to support the decision-making process of managers of complex IT systems development projects by focusing on knowledge management frameworks. The objectives for the research were determined through a critical review of the existing research on decision-making in IT projects, primarily to discover how project managers' decision-making can be supported through project-specific knowledge management. A qualitative research approach was then designed to investigate the phenomenon in its context by conducting in-depth semi-structured interviews. This study used qualitative data, through expert participants' observations and opinions on IT systems development, particularly by understanding project management issues. The expert participants expressed their experiences through in-depth interviews. The collected data was then analysed using the thematic analysis technique and the findings were used to develop the IT Systems Development Decision-Making Support Framework. The Framework was then validated through focus group interviews. The main contribution of this research is based on the application of knowledge creation and knowledge management theories to decision-making frameworks for IT systems projects through the IT Systems Development Decision-Making Support Framework. The Framework is expected to enable decision evaluation and project-specific knowledge generation and sharing in IT systems development projects. This is vital for the type of contextual knowledge required for project-specific knowledge creation and management. Since IT systems development projects tend to be unique and their development process is complex, it is contended that an effective novel approach for modelling the expert decision-making process and assessing the defined model through project-specific knowledge activities is essential. This approach should help to deal with high level of complexity that is normally found in IT systems development projects.

Keywords: Complex IT systems development projects, knowledge management frameworks, decision-making, knowledge-creation theory, SECI model, Ba.

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DEDICATION

This Thesis is dedicated to:
My mother, Nadyah
My father, Hawailan
My wife, Alya
My daughters, Aseel, Joodi and Taraf

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GLOSSARY

AHP	Analytic Hierarchy Process
API	Application Programming Interfaces
BA	Business Analysis
BSCS	Business Support and Control System
CBR	Case Based Reasoning
CBIO	Charging and Billing in One
COCOMO	Constructive Cost Model
CCM	Critical Chain Method
CSF	Critical Success Factors
CRM	Customer Relationship Management
DB	Database
DMS	Document Management System
FPA	Function Point Analysis
IS	Information Systems
IT	Information Technology.
IDE	Integrated Development Environment
IEC	International Electrotechnical Commission
ISO	International Organization for Standardization
KM	Knowledge Management
KMLC	Knowledge Management Life Cycle
KMS	Knowledge Management Systems
MOP	Methods of Procedures
MCDM	Multi-criteria decision making
OODA	Observe, Orient, Decide, Act
PERT	Program Evaluation Review Technique
XP	Extreme Programming
PM	Project Management
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
Prince2	Projects In Controlled Environments
QA	Quality Assurance
RUP	Rational Unified Process
RASI	Responsibility, Authority, Support, Inform
SDLC	The systems development life cycle.
SECI	Socialization, Externalization, Combination, Internalization
SLIM	Software Lifecycle Management
SLOC	Source Lines of Code
SME	Small or medium enterprise
SR	Strategic Reconnaissance
SRS	Software Requirements Specification
SWOT	Strengths, Weaknesses, Opportunities and Threats.
SSADM	Structured Systems Analysis and Design Methodology
SDLC	The systems development life cycle.
VDCL	Value-Drive Change Leadership
VS	Visual Studio

CHAPTER 1 INTRODUCTION

1.1 Introduction

A project is defined as successful if it is delivered within budget, time and meets the required quality standard but may not meet clients' needs and requirements (Atkinson, 1999). Projects typically have predetermined budget, time and quality standards within which the system or set of interconnected systems need to be developed. This kind of project is normally used in organisations to develop complex information technology systems.

Since the term Information Technology (IT) was framed it has attracted the attention of researchers in computer science, computing, and management (Markus and Robey, 1988; Orlikowski and Baroudi, 1991; Lucas *et al.*, 2013). IT is the study of people, organisation and IT applied to purposeful action (Orlikowski *et al.*, 2016). It involves people, organisations, software, and IT and information artefacts, which are all referred to as an IT system. In this, several interfaces are needed between people, organisation, software, and information; where the problem of applying IT for organisational purpose arises. This problem is complex because of the 'people element' of IT systems. People attach meaning to their actions (Walsham, 1995), which makes the interfaces between people, organisation and IT problematical and gives rise to complex organisational settings in which IT is applied.

The issue that needs researching is how project managers of complex IT systems development formulate and produce project-specific knowledge (Chia, 2013) and how this knowledge can be used to support project managers decision-making processes. Projects that involve software engineering and IT are usually unique because they involve creating a new product - the IT system artefact - and usually this product has no previous example that the project manager can use to help make necessary resource, scheduling and especially system design decisions to deliver the current project. Moreover, project decisions are involved because the 'product' (i.e. the IT system artefact) is itself complex because of the interfaces between people and the organisational purpose that it has to serve and this makes it a product, service and interactive artefact simultaneously.

Project managers bring prior experience and knowledge that can be applied to a current project, but because it is unique the current project will require the formulation and production of new project-specific knowledge. It is this issue of knowledge creation, sharing and application that is problematical in complex IT systems development projects. The research literature does not cover how IT project managers acquire and manage project-specific knowledge for decision-

making. This prompted the research. Another reason for doing the research is the researcher's own experience and knowledge acquired from talking to project managers that they need systematic methods and techniques for managing project-specific knowledge.

As noted above, since IT systems involve people, organisation and the IT system artefact itself, the formulation and production of project-specific knowledge is across communities of practice, broadly across business people, IT and telecommunications people and expert outside consultants. It can be argued that project managers use implicit frameworks to help them manage project-specific knowledge for decision-making, based on their education, qualification, and previous experience of managing projects.

Better understanding and explanation of the complex interfaces between people, organisation, and IT, can improve IT systems development project management and enhance project managers decision-making. The combination of people, organisation and IT results in need for knowledge of all three by themselves and how they interconnect in an IT system artefact during systems development project. It is such interfaces and interconnectivity that produces systems developmental complexity, which requires project-specific knowledge to enable better project decisions to be made, decisions that uphold quality, integrity and economics of the systems development project. This research project aims to understand project-specific knowledge management to enable project managers to make better decisions during the development of such complex IT systems.

1.2 Background: IT Systems and Software Development

The general context of the research is described and the purpose of the research is explained in this section. The general issue of project management is covered first and then focus is placed on the specific issue of acquiring and managing project-specific knowledge to aid project manager's decision-making. This then identifies the research problem that is addressed.

IT systems development project management and software engineering project management are different kinds of projects. IT systems development project management is concerned with information technology; hardware, operating systems, networks, and software systems; systems processes, the integration of parts of systems and networks, the scope of the IT systems project, quality, human resources, communications, risk management, procurement, and stakeholders (Schwalbe, 2015). By contrast, a software development project is one where only software is developed according to user specifications. This research is focused on IT systems development

project management and seeks to understand and explain how IT systems development project-specific knowledge is managed.

Project management is recognised as an expertise in IT systems development (Nicholas and Steyn, 2017; Schwalbe, 2015; Lind and Culler 2013). This recognition has led to varied research in the topic including systems approaches (Kerzner, 2013); sociological explanations, socio-technical theories, and social theories (Pollack Adler, 2015). However, there is an absence of a knowledge management perspective in the field that this research adopted.

> "Project Management Research is primarily concerned with the selection, formulation and production of knowledge associated with the material practices of managing and organizing within pre-defined temporal and spatial contexts".
>
> (Chia, 2013: p.34).

The focus of this research is on this 'selection, formulation and production of knowledge' that is specific to a complex IT systems development project.

In general, a project has seven phases which can be defined as; (i) identification of the project parameters, (ii) preparation in which the project requirements and impact are assessed and determined, (iii) appraisal of time and budget available, usually achieved by negotiating with the project stakeholders, (iv) the presentation phase, in which the project leaders communication critical aspects to budget holders and stakeholders, such as the project need, goals and expected outcomes and impact, budget required and timeline to complete the project, (v) the implementation phase is the actual development of the project, including hiring project staff with the required expertise, identifying and sourcing the relevant IT technologies, coding, testing and trials, as well as documentation, (vi) monitoring the project happens during and after the project to monitor the agreed benchmarks, quality standards and user requirements, and finally (vii) the evaluation phase in which project leaders engage in critical self-evaluation, posing such questions as what practices succeeded, what did not go well and what are the take-away lessons for the next project (Kerzner, 2013; Pollack and Adler 2015; Müller, 2015)

These general phases are often referred to as the software 'waterfall' (Bassil, 2012) or project 'life cycle' (Dalcher, 2015). Bassil highlighted problems with the waterfall software development model. The five-phase model is also termed the Software Development Life Cycle (SDLC). It is used to design, build and maintain IT systems. The five phases of the SDLC must be completed sequentially for a successful software solution, but the use of the SDLC has resulted in budget overruns, delays, suspended delivery, and unsatisfied users. Bassil (2012) notes that project managers experience difficulties in assigning required technically competent staff to project

tasks, as well as estimate the required time and budget. This results in some SDLC phases being delayed and others delivered on time. This causes bottlenecks and even failure to deliver IT systems on time and within budget.

Consequently, IT systems development project management has attracted the attention of project management researchers and practitioners who have researched and developed various techniques, methods and information systems development methodologies. PRINCE is an IT systems development methodology used by governments and companies (Wideman, 2002). PRINCE stands for Projects in Controlled Environments and its constituents are processes, components, and techniques. A recent example of project management is Agile (Patwardhan, 2016). Agile systems development does not follow the SDLC phases. Neither does it follow the processes, components and techniques stipulated in PRINCE. This is because the agile systems development approach is based on regarding the application domain as dynamic and even 'emergent'. It is argued that in such a context it is not productive to follow a phased IT systems development methodology (Beck, 2001). Agile is also being transferred to non-IT applications and domains because of its focus on emergence of requirements and solutions (Conforto, 2014).

As IT is now applied in all types of organisations, especially in governments, companies, military, and healthcare, as well as in transportation management, the applications have become large, sophisticated, and complex. This increased magnitude of IT application in organisations means that the amount of data, information, and knowledge that is required to deliver a complex IT system has increased (Galliers and Leidner, 2014) and managing it has itself become an issue in large complex IT systems development and project management.

As applications of IT have become large, the idea of organisational knowledge, knowledge management, and knowledge management systems has developed (Bontis, 1999). Organisational knowledge was proposed as a way of understanding the purpose, goals, and operations of an organisation. The idea is that by creating and managing organisational knowledge the organisation can perform better in all key indicators (Fischer, 2001). This then extended to the notion of organisational knowledge management. In this view, organisational knowledge management was linked to company strategy and competition. Researchers suggested that an organisation's strategic objectives could be better fulfilled by managing organisational knowledge. This suggested that the focus should be placed on knowledge creation and this idea was linked with the innovativeness of an organisation (Fisher, 2001). At the same time,

computers and IT were being applied to manage knowledge, giving rise to the idea of knowledge management systems (Tiwana, 2000).

Knowledge creation takes place in a shared context or 'ba' according to Nonaka and Konno (1998). Knowledge is embedded in context or *ba* and where there is no context it is information. Consequently, information resides in media and networks but knowledge resides in *ba*, which is defined as a place or space for knowledge generation. In this space, knowledge is created and shared to innovate something new. This idea was then made into a dynamic theory of knowledge creation by Nonaka (1994). This theory of knowledge creation is adopted and applied in this research to investigate project-specific knowledge management in complex IT systems development projects. Such projects share the same characteristics as the innovation of products because each organisation where IT is applied is a new and different set of IT artefacts, organisational processes, and people with varying competencies. This include a new unique IT systems artefact, no previous knowledge that can be directly used for the IT system development, creating project-specific knowledge, sharing it, and applying it to deliver the IT systems artefact.

A complex IT systems development project is a place, a setting or *ba* in which a new IT system needs to be designed, developed, and delivered to the satisfaction of users. This unique setting is additionally impacted by the *actual* setting in which the IT system will be used. This usage setting consists of the people and organisation which are *soft* issues that make the IT system development even more complex; it creates the need for sophisticate interfaces between hardware, software, and people needs for meaningful information, as well as people involved in complex organisational processes. As well as making of use existing IT systems development knowledge, new knowledge needs to be created about how to develop the unique IT system, schedule and prioritise tasks, allocate limited resources, and the organisational setting in which it will be used.

Thus, the research problem is to explain the creation, sharing, and application of project-specific knowledge in unique and complex IT systems development projects. Teams of IT systems developers led by project managers collectively are expected to possess technical knowledge necessary to complete such projects successfully, yet surveys show that IT systems development projects fail (Willcocks, 2013). Current research on IT systems development project management is mainly focused on topics like project scoping and estimation techniques (Kerzner, 2013). Such a focus fails to acknowledge the importance of project-specific knowledge, knowledge possessed by project managers and the project team, and critically how new project knowledge is created and shared to enable and enhance project decision-making.

The theory of knowledge creation is recognised as providing direction and strategy for managing organisational knowledge (Nonaka and Konno, 1998). In this research, it forms the focal theory to investigate and explain project-specific knowledge management to support decision processes in complex IT systems development projects. Project managers need to make effective use of project-specific knowledge in order to deliver a quality and relevant IT system. As project managers and project teams collectively are expected to possess required technical knowledge to complete a project, the problem of how they use prior knowledge, create new knowledge, and share their knowledge and skills collectively needs to be explained. Often, both the use of prior project knowledge and creation of new project-specific knowledge and sharing it happens in unique IT systems development project situations. In the literature this problem is the knowledge management problem and it is explained by the theory of knowledge creation (Nonaka and Konno 1998) and organisational knowledge management (Wiig and Karl, 1997; Alavi and Leidner, 2001; Witherspoon, 2013). In the context of IT systems development project management, there is a need to explain theoretically how project managers and project teams collectively utilise their project knowledge to successfully deliver IT systems. How is project-specific knowledge created? How is it recorded? How is it managed by project managers? What communication methods are used to share project knowledge? How is it used to support project managers decision-making?

As indicated above, the focus of research in the literature on IT systems project management has been on budgeting, estimation, and scheduling tools and techniques (Shepperd and MacDonell, 2012; Nelson and Morris, 2014;), rather than project-specific knowledge creation, sharing, and application to decision-making. This type of research is better termed ‘project research’ (Söderlund, 2004) rather than project management research. In practice, project-specific knowledge is a problem because project managers need to achieve project gaols by managing restricted budget, equipment, and human resource available to the project. Since complex IT systems development is essentially knowledge work, it requires project managers to manage people’s knowledge of software, programming, IT hardware, telecommunications, networks, and systems to achieve required project outcomes.

The reason why KM approaches can help to reduce complex IT project failures concerns the need for technical knowledge and project knowledge that can be used for project decision-making. This is termed project-specific knowledge in this dissertation. Such knowledge can be created using knowledge creation and management techniques that are discussed in the literature review

Chapter 2. Knowledge that is created specifically for the IT project can be used directly to develop the required systems and manage the project.

Rather than project management techniques, KM approaches can be used to create project-specific knowledge. Project-specific knowledge addresses particular and unique problems of the systems development, and the knowledge generated can be applied directly. This kind of specific knowledge for a project's technical software design and coding, networking, and telecommunications is not available in traditional project management techniques. It can be created by using KM approaches.

The essential difficulty concerns adequate theoretical explanation about the creation and sharing of project-specific knowledge effectively. Unique and complex IT systems development projects, like the London Ambulance IT system (Finkelstein and Dowell, 1996; Beynon-Davies, 1999) require the creation of bespoke project knowledge. Also, sharing project knowledge in such complex projects is problematical because knowledge resides in people (Bhatt, 2001; Joe *et al.*, 2013), which makes it difficult to externalise when it is required in particular situations. When project-specific knowledge is externalised it requires appropriate concepts, processes, and techniques, which are as yet not part of the toolkit of project managers. Additionally, such knowledge management concepts, processes, and techniques need to be based on appropriate knowledge management theory.

Knowledge management fosters a unified approach to determining, representing, assessing, collecting, and distributing all of a business' knowledge resources (Nonaka *et al.*, 2000). These resources can compose of electronic information services, files, regulations, methods, and the expertise and experience of individual workers that was previously overlooked. Knowledge management systems are perceived as the way to help entities in making, distributing, and utilising knowledge. Organisations have invested numerous resources in such systems in order to produce a competitive value. Many times, the consequences of technology on the entity have not been given careful planning and thinking before the commencement of new systems (Bloch, 2011). There are two groups of information needed for the planning and execution of a knowledge management system (Newell *et al.*, 2000): skilled programming and design expertise and organizational expertise founded on the comprehension of information flows.

The issues and drawbacks that decision-makers encounter in complex IT systems development project management include domain knowledge, technical knowledge, and project management

knowledge. Employees basically do not possess the basic understanding of the intricacies of IT systems development project management (Newell *et al.*, 2000). In addition, a deficiency in organisational regulations, where organisations have not conformed to a strict policy for handling projects is another issue. Deficiency in the implementation of regulations and methods is also a drawback (Newell *et al.*, 2000). Moreover, deficiency exists in assessment for the degree and intricacies of IT systems development project management. For example, in IT systems development, project management includes clearly stating project partitioning framework and dependencies assist estimation, planning, reporting, and controlling. Estimating is a precondition to scheduling; time reporting affects project estimates and schedules; resource allocation is founded on accessibility of skilled workers (usually recorded in skills inventory) and present project schedules etc. (Kerzner, 2013). There are many computer programs on the market competing in several portions of IT systems project management, but very few aiming at a unified platform founded on a knowledge management perspective. Consequently, to cater for various IT systems development project stakeholders, limited budget, time constraints, and need for project-specific knowledge, this research has researched and developed an IT Systems Development Decision-Making Support Framework from a knowledge management perspective. The research sought to understand how the Framework can provide assistance in decision-making for complex IT systems development project management in order to curtail project management failure.

Though project management is an effective method that is used to deliver products and services within schedule, resource, and budget constraints (Kerzner, 2013), failure of IT systems development projects is common and is a major problem for many organisations and governments. There are many reasons that could contribute to the failure of IT systems projects (See Section 2.1.1 for root cause explanation). The team behind the project could be responsible for the failure. It could be the failure of the project manager to lead the team to success. It could especially be unclear requirements during the requirement gathering phase of the project. In IT systems development, the project managers should possess leadership skills and management characteristics in order to successfully manage the project from start to completion (Clarke, 2012). Project manager and the project team are tasked with identifying project requirements; managing the competing demands for quality, budget, scope, and time; and managing stakeholders with differing expectations.

The environment of today's IT systems development project management has changed compared to the traditional one. This is because, in today's project management, the project manager may be required to source for expertise from culturally and internationally diverse people from across the globe. The developed IT Systems Development Decision-Making Support Framework outlines the key areas to consider when designing project-specific knowledge management systems and processes. The Framework can be used to enable project managers to make better project decisions covering quality, resource, scheduling, and systems design decisions. These issues suggest the research problem that this research sought to investigate, which is the lack of supporting knowledge for decision-making processes in complex IT systems development projects. This problem is specified in detail in the research problem statement presented next.

1.3 Research Problem

Project managers' decision-making in complex IT systems development projects needs better understanding and support. The current research focus on better project tools and techniques or 'project research', fails to address the important aspect of project-specific knowledge creation, management, and application to decision-making. The issue of project-specific knowledge needs to be better understood in order to support decision processes. How do project managers generate project-specific knowledge? Where is such knowledge stored? And how is it used in project decision-making? Such questions need to be addressed because the current problems in complex IT systems development project management lead to poor decision-making and project failures, as noted in detail in Section 2.2.1.

Project managers and expert team members bring prior experience to a project. Such experience is relevant but not specific to the project. An IT systems development project has a particular context of development for which specific knowledge about the software to be developed, IT, telecommunications, networks, and system design decisions need to be made. Experts may have relevant prior knowledge that can be applied. However, the context of the development consists of a particular organisation and people working on organisational processes to which IT systems processes need to interface well. It is this application and interface of IT systems which requires project-specific knowledge.

Although project managers have access to well-developed project management techniques such project management techniques do not specifically and explicitly manage technical and project-specific knowledge. Currently, project managers use existing project management techniques to

support their decision-making process. But they need access to concepts, methods, and techniques for managing project-specific knowledge.

While there are many definitions of knowledge, in this thesis knowledge refers to 'true justified belief' (Nonaka, 2008). 'True' in this case refers to empirically verifiable knowledge. Justified refers to how the knowledge is created or the practical methods used to discover the knowledge and the relevance of the knowledge to the problem. Belief refers to an individual or groups' creation of such knowledge and held by them to be valid for the problem being addressed.

1.4 Research Question and Contribution

The issue that project managers encounter is creating and acquiring project-specific knowledge to make technical, design, and resource allocation decisions. Existing project management techniques are suitable for planning and scheduling project resources. Complex IT systems development requires project managers to make technical decisions about interfaces with organisational processes, users, IT components, design decisions concerning systems, and resource allocation systems. Such decision-making is problematical because of the innovation, uniqueness, and particular organisational context of IT system development, and it requires context-specific knowledge, as well as prior experience, information, and knowledge. IT systems development requires technical knowledge and knowledge about managing IT projects. For complex IT systems development such knowledge is varied and requires to be synthesized with an organisational context.

The research question is therefore:

Is it possible to improve decision-making process in complex IT systems development projects in the Kingdom of Saudi Arabia?

In order to address this research question, the research aim and objectives were formulated as explained in the next sections. The research aim suggests what the research expects to achieve and the major phases of the research project.

The main contribution of this research is based on the application of knowledge creation and management theories to IT systems development project management decision-making frameworks to develop the IT Systems Development Decision-Making Support Framework. The Framework is based on knowledge management concepts derived from existing knowledge creation theory and two rounds of interviews with project managers. The first round of interviews

was exploratory, and it provided directions that needed further investigation which was done in the second-round interviews. The concepts, elements, and relationships of the Framework were derived thematically from these two rounds of interviews. It was then validated using focus group interviews. Consequently, the Framework provides a theoretical basis for creating project-specific knowledge to support project managers' decision processes; it is based on the SECI model and knowledge-centric concepts based on empirical data to inform actual project knowledge activities based on Ba.

The Framework is expected to enable decision evaluation and knowledge sharing in complex IT systems development projects. This is vital with the type of knowledge considered for the respective domain. Project knowledge is critical for successful IT systems development; the combined knowledge of team members needs to be acquired, managed, and applied by project managers to make decisions. The IT Systems Development Decision-Making Support Framework explains how project managers acquire and use project-specific knowledge to make resource allocations decisions, technical decisions, and systems design decisions. Since it is based on the SECI model, it confirms the relevance of the theory of knowledge creation for complex IT systems development project management.

The SECI model was selected after reviewing other KM approaches. This included drawing on Heisig's (2009) quantitative and qualitative analysis using content analysis of 160 KM frameworks from different disciplines and applications worldwide. The applications ranged from science, practice, associations, and standardisation bodies worldwide. And the units of analysis consisted of the term 'knowledge', terms for knowledge process activities, and factors affecting the success of KM initiatives. The main criteria for selecting a relevant KM approach was its relevance to unique problems that is problems that could only minimally draw on prior experience. The required KM approach needed to be context-sensitive and generate knowledge for unique systems development and coding problems. Since the SECI model met both these criteria it was selected.

The main contribution of this research is expected to be a description and explanation of knowledge management practices in complex IT systems development projects, based on the application of knowledge creation and management theories to decision-making frameworks.

1.5 Research Aim

Initially, a decision-making perspective was adopted in order to explain IT projects and to examine how it can be improved for project success. However, the decision-making perspective was limiting because it did not consider the unique and specific contextual factors involved in IT systems development. The decision-making perspective contain models of decision-making that assume rational decision-making. As explained in the literature review Chapter 2, this is not a realistic assumption for complex IT systems development. Consequently, the KM approaches were considered as the alternative theoretical basis. Specifically, the SECI model is behavioural and more appropriate for the contextual factors and unique aspects of complex IT systems development, particularly concerning creating specific knowledge for the same.

The aim of the research is to investigate IT systems development projects to develop a framework for creating, managing, and applying project-specific knowledge for decision-making in complex IT systems development projects.

The framework is expected to contribute to successful project delivery through theoretical understanding of project knowledge management. Understanding better how project managers create, acquire, and apply project-specific knowledge during IT systems development will help to improve technical and project management decision processes.

The research investigated knowledge management practice in IT systems development projects in Saudi Arabia. Project managers involved in large and complex IT systems development need to synthesise specific technical knowledges from the various technical components of a project with the organisational context and needs of users, and to keep current with the project to acquire and apply project-specific knowledge to decisions. As explained above, there is a requirement to understand a project manager's need to manage technical knowledge and knowledge about the project to support decision processes.

Project managers encounter several project management problems. IT systems development projects are complex because they are composed of IT artefacts, organisations, and people. The interactional interfaces between these three elements are problematical to define and this needs to be done within a particular context. The main problem concerns communication between team members, clarity about their job roles, and systems requirements. A primary issue in this communication is establishing the requirements for the systems to be developed. Establishing requirements is not straightforward because of the interactional interfaces between the three

elements. Another issue is coordinating the project personnel and systems development technologies. The task of the project manager becomes even more complicated because available skills and competencies of team members have to be matched to the needs of the project, which itself is often vague. This suggests that complex IT systems development requires coordinated management of project-specific knowledge.

There is a need to understand how such project-specific knowledge is created, shared, stored, and managed for decision-making within a project. It is possible for a project manager to hold project knowledge in their head for small and straightforward projects but not for large amounts of project-specific knowledge involved in complex IT systems development projects. A better approach to manage project-specific knowledge is through knowledge management.

1.6 Objectives

A research aim is achieved by setting out the objectives. The objectives are the actual field work research activities needed to achieve the research aim and they need to specific, measurable – can be assessed to indicate result, achievable, relevant, and timely. It includes the review of the literature, which is done to get a comprehensive understanding of the research area and identify issues or controversies that need to be researched further. It is from such a review that the above research aim was identified. The objectives of the research are to:

1. Conduct a critical literature review in the domains of IT systems development project management, decision-making, knowledge management frameworks, focusing on existing examples of knowledge management, knowledge management techniques and underpinning project management and knowledge management theories.
2. Identify knowledge creation and knowledge flows in IT systems development project management.
3. Capture expert IT systems development project managers' decision-making processes.
4. Develop a novel IT systems development decision-making support framework based on knowledge management to enable IT systems development project managers to make more effective decisions to improve the success of projects.
5. Evaluate and validate the framework with expert IT systems development project managers.

As noted above, the first objective was to critically evaluate existing literature in order to identify a theoretical issue or controversy that needs further research. In order to do that, literature in the areas of IT systems development, project management and knowledge management, and

subtopics within these, was critically evaluated. The next four objectives were identified in order to undertake the empirical study. The second objective sought to collect data on how project-specific knowledge is created and communicated in a complex IT systems development projects by IT project manager in Saudi Arabia. A project manager and senior members of the systems development team would bring prior experience and knowledge to the project. But this is not sufficient because every project, especially large, complex IT systems development projects, is varies because of the different organizational context. Therefore, project managers, senior analysts, and programmers, would need to create new project-specific knowledge. They would need to apply their existing knowledge to the new context. Data needs to be collected to understand both these aspects in terms of project-specific knowledge management.

The third objective aimed to collect data on project managers' decision making. A project manager makes routine and critical design, development, and resource allocation decisions, as well as decisions concerning project budget and time. A project manager would draw on their experience, but as indicated above, in complex IT systems development projects they would need to consider the particular context of the IT application. Such contexts are unique because the IT and system is usually developed for a particular organization that has its own business processes and requirements. Therefore, it is necessary to collect data on how project manager make decisions using explicit project knowledge.

The fourth objective aimed to collect data to develop the framework for managing project-specific knowledge. Data needs to be collected on how project managers currently make project design, development, and resource allocation decisions and about the existing framework they use. It is assumed that they broadly use the SECI framework, though they may not be aware of doing so. The second part of the objective is to use the data collected from the second, third and first part of this fourth objective to develop the IT Systems Development Decision-Making Support Framework to support decision making in complex IT systems development projects.

The fifth and final objective is to validate the developed IT Systems Development Decision-Making Support Framework. Data was collected through focus group interviews from a group of expert IT systems development project managers. This was used to determine the relevance of the developed framework and its general applicability for decision-making in complex IT systems development projects.

1.7 Ethical statement

The researcher committed to Staffordshire University code. This statement follows the regulations of the University's Faculty Ethics Committee. Respondents were given the Research Information Sheet and the Research Participation Consent Form (See Appendices A and B). Respondents are given the choice to not add any of their private details that might affect their real responses. In addition, respondents' information is strictly kept anonymous. All respondents were aged 18 years or above.

1.8 Research Plan

The workplan is shown in Figure 2-1. It is associated with the research objectives to ensure that the objectives were completed. The actual tasks and times varied but the research objectives have been accomplished.

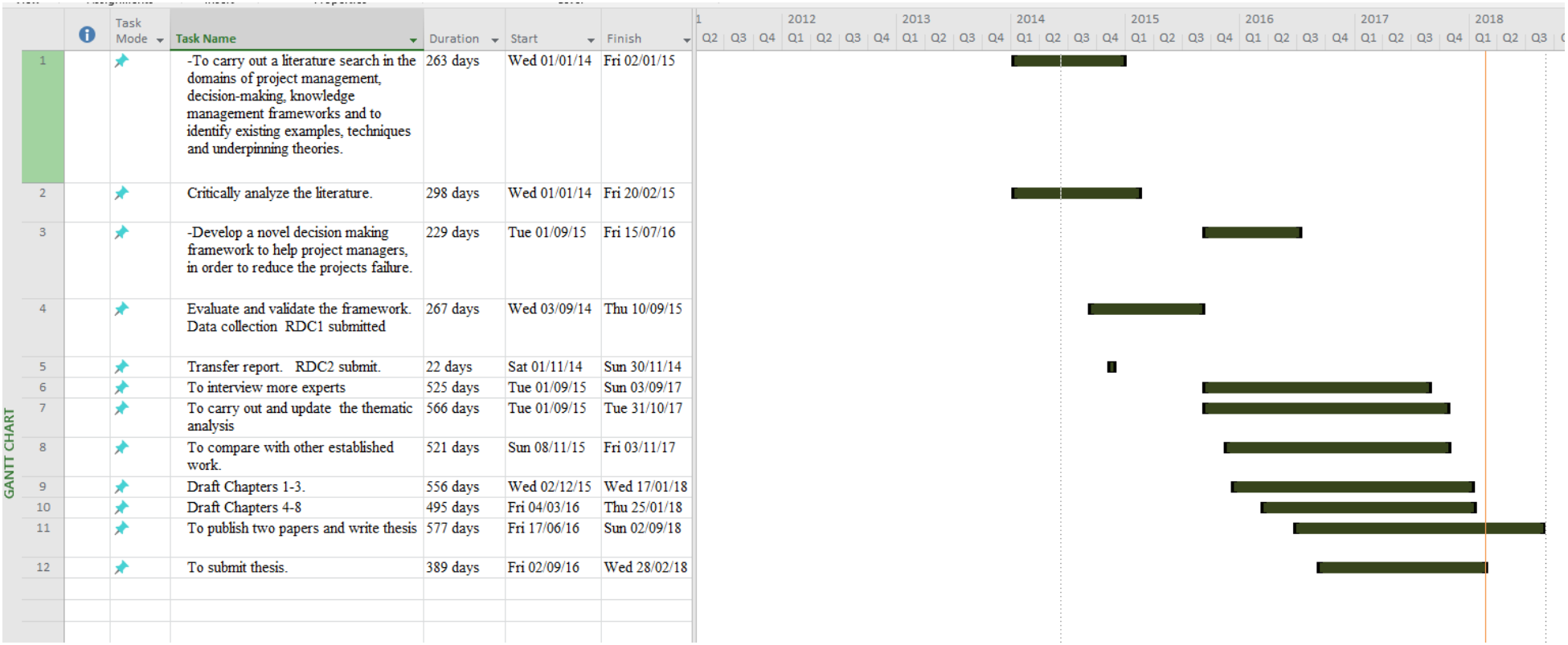

Figure 2-1 Workplan

1.9 Summary

This Chapter identified the research topic as project-specific knowledge management in IT project systems development to support project managers' decisions. IT project managers need relevant concepts and techniques to acquire, manage, and apply project-specific knowledge for decision-making. So the research question concerns improving the decision-making process in IT project management in Saudi Arabia. This suggested the research aim focus on developing the IT Systems Development Decision-Making Support Framework to aid project managers' decision-making. Accordingly, the research objectives were formulated to acquire data in the area. This leads to searching the existing knowledge in the research topic area in Chapter 2.

The contribution of the research is the validated IT Systems Development Decision-Making Support Framework. Evidence from project managers indicates that their project management activities include project-specific knowledge management activities, as described by the theory of knowledge creation or the SECI model. As current project management techniques focus on scheduling, resources, and budgeting for IT projects, it is necessary to understand the value of KM approaches to help generate project-specific knowledge. The Framework produced in this thesis can be applied by project managers to generate project-specific technical, design and development knowledge to support decision-making. Current project management techniques are not able to focus on generating such project-specific knowledge. Project-specific knowledge is needed to address systems design and coding problems that require multiple programming languages, interfaces, networking protocols. Often previous experience and knowledge can only be partially used in such unique systems design problems. This is a significant contribution because knowledge management in IT systems development projects needs a theoretical basis. This is because theory provides an explanation of the phenomenon. Consequently, basing action on theory produces a better practical result. Kurt Lewin stated that: 'There is nothing more practical than a good theory' (Burnes and Bargal, 2017). IT project management currently lacks a theoretical base. The theory of knowledge creation provides the necessary analytical framework for researchers to investigate how IT project managers actually manage project knowledge.

The IT Systems Development Decision-Making Support Framework has practical impact too. It has practical relevance because project managers can use it to reflect on their knowledge management activities during IT systems development in particular contexts. The framework provides them with a structured approach to identify the key types of knowledge creation and

knowledge sharing activities they need to undertake in their project management activities in order to make better technical and project management decisions.

1.10 Thesis Outline

Research literature on project management, IT systems development, and knowledge management is analytically reviewed in Chapters 2 and 3. The purpose of the critical review is to understand the current state of knowledge and theory in the area and to identify issues and controversies that require further research. In particular, the aim is to identify how project knowledge is created, stored, shared and applied for decision making. The focus was on theory that underpins frameworks for project knowledge management and then specifically for IT systems development project knowledge management. The review analysed the assumptions and research findings and considered coherency across different research. It also was critical of lack of theory used in project management and particularly project knowledge management. The outcome of this review provided the research topic with specific research aims and objectives.

Chapter 4: then sets out the pragmatist qualitative research methodology designed to investigate empirically the basis for the development of the theoretical framework. Pragmatism was chosen because IT systems development and project management are practical disciplines. This methodology needs to be able to collect relevant data for the defined research objectives. Therefore, the chosen data collection methods and data analysis methods are explained and justified.

Chapter 5: the data is collected and analysed. The analysis focuses on developing themes for construct development. In qualitative research a construct is an idea or concept that is verified by empirical data. The thematic data analysis technique that was used is explained and applied to the interview data to develop themes. These themes are then grouped into meta-themes that support the development of a theoretical perspective to enable the construction of the IT Systems Development Decision-Making Support Framework in Chapter 5.

Chapter 6: explains the construction of the conceptual IT Systems Development Decision-Making Support Framework. The conceptual framework is developed from knowledge creation theory and empirical data capable. It explains the creation and management of project-specific knowledge. It fulfils the research objectives concerning the explanation of knowledge

management in complex IT systems development projects. This conceptual explanation is based on the literature search and two rounds of interview data. The conceptual framework explains how project-specific knowledge is created, managed, and applied for decision making in complex IT systems development.

Chapter 7: the Framework is validated. This is done by relating the IT Systems Development Decision-Making Support Framework to the experiences of IT project managers through focus group interviews. Also, by relating the findings to the existing literature reviewed in Chapter 2 to identify consistencies, differences, and new contribution. This is done for both the data and the conceptual Framework. The discussion focuses on theory underpins the management of knowledge in complex IT systems development projects and the actual project knowledge activities that create project-specific knowledge to support decision-making.

Chapter 8: states the conclusions and provides the researcher self-evaluation of the research. It provides conclusions that can be drawn from the research and identifies further research arising from this research project. It also discusses the researcher's experiences of undertaking the research project and the lessons learnt for developing as a researcher.

CHAPTER 2 PROJECT MANAGEMENT AND KNOWLEDGE

2.1 Introduction

In the previous Chapter the research topic was identified, namely how IT project managers use project-specific knowledge management to acquire and apply technical and project knowledge to make decisions. This enables the literature search to be targeted to specific research areas. So, in this Chapter the existing literature on project management, IT systems development project management, knowledge creation, knowledge management, and decision-making is searched. The focus of the search is to understand what theory best describes project knowledge management for complex IT systems development and supports actual decision-making in context. And the aim is to identify a suitable knowledge creation and management theory to apply to complex IT systems development projects. However, the task is more involved because of the interdisciplinary area of IT systems development, projects management, knowledge management, and decision-making.

The literature search involved surveys and reports about IT project management to identify current issues and problems that project managers face. As explained in Section 2.2.1, such survey and reports help to describe current project management in terms of deliver delays, budget overruns, and, critically important, incomplete user requirements. This characterisation of the causes and effects of project failure will then be used to identify the root causes of the problems in order to develop a solution-based IT Systems Development Decision-Making Support Framework (See Section 6.2).

The domains of the literature search are related through the focal concept of knowledge management. Knowledge is present in IT systems development projects, theory of knowledge creation and management, and decision-making processes. This is shown in the diagram below in Figure 2-1. The main domains are IT, project management, knowledge management, and decision-making processes. Each domain has sub-topics for which the literature search was done. The spiral arrows indicate the intersection between the main domains.

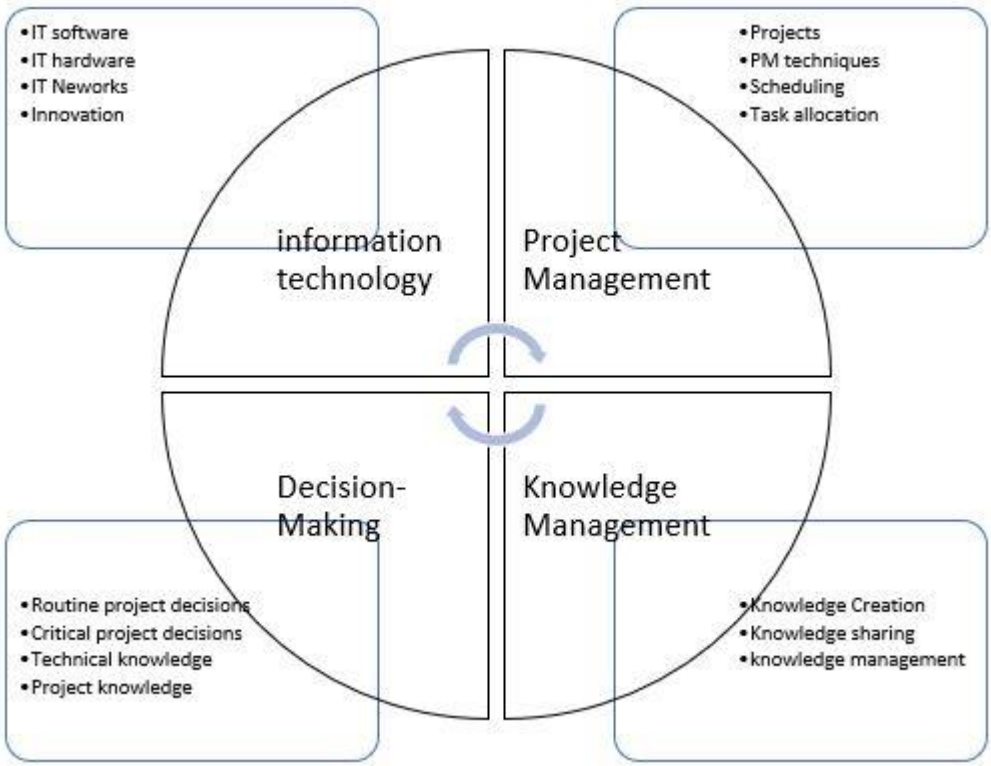

Figure 2-1 Literature Search Domains and their Interrelatedness

As mentioned in Chapter 1, projects feature in all types of organisations - business, government, and charitable. Management of projects is a research topic in management studies and has become a specialised research topic (Packendorff, 1995; Söderlund, 2004; Richardson, 2010; Shields and Rangarajan, 2013). Researchers investigate the role of project managers, composition of project teams and expert team members, techniques and tools for managing projects, and project management software. Softer aspects of project management are also researched like team building and trust among team members.

The secondary research sources used are recognised sources such as research journals and specialist subject textbooks. The research articles were sourced from University provided databases. The journals were selected because of their relevance for the research topic and consideration was given to their ranking, but this was not the main criteria for reading papers. The main criteria were to select papers that covered the areas of knowledge management, project management, and decision-making. Papers were selected to reflect the latest research covering the period from 2013 to 2017. However, papers earlier than this were also used because they contain original theory that is well-established in the field, for example knowledge creation theory and decision-making theory.

As mentioned earlier, the development of IT systems differs from software development because IT systems involve people, organisation, and IT artefacts. This combination makes IT systems development complex because each element differs and requires unique mix for different contexts of application. This makes each IT systems development project a new experience for project managers and the project team. For example, the same core information technologies are used to develop a customer database system and a patients' database system for patient records, but the context is unique. Complexity arises in the difference between the business organisation and the health organisation, covering differences in people's needs, different organisation structures, procedures and policies, and varying IT design, development and implementation for the different types of organisation.

Information is the key aspect of complex IT systems project management. IT systems development projects consist of project information. Project management records contain details about project requirements, team members, resources, and budget. Such information is used by project managers to plan, schedule, and organise IT systems development. But a key aspect emerging in the literature is the role of knowledge. The management of project knowledge is not well established. Consequently, it is necessary to review the literature on IT project management, knowledge management, knowledge creation and knowledge sharing.

In general project management, a project is a unique situation. It is a new situation that normally does not have previous specific, similar example that project managers can draw on. It is the uniqueness of a particular development that gives it the special properties of a project. The dimensions of a project are time, budget and skills required to complete Nelson and Morris, 2014). In IT systems, the creation of a national healthcare system, eGovernment, or global parcel tracking systems are examples of unique projects that have no previous examples to draw on. The research in this area focuses on the project management techniques, like budget, time, human resources etc. A search of the literature has not revealed the use of knowledge management techniques in such projects.

IT systems development projects are unique in other ways too. Research in this area focuses on the project management techniques, like budgeting, scheduling, team building etc. An IT project is complex because of the inter-related hardware, software systems, human resource, application domain (Sumner, 1999) compared to capability maturity models in software development projects (CMMI, 2016). In comparison, IT systems development projects are less formal, especially because they involve people and organisational processes. IT project structures tend

to be less ‘mature’ too. As indicated earlier, each IT project is original. IT projects tend to be done ‘as if for the first time’ (PMI, 2016). There is thus a lack of explicit knowledge for such projects – sources of information are often not reliable, or knowledge may not be recorded. Also, both project managers’ and team’s tacit knowledge often remains untapped, because of lack of concepts for project-specific knowledge management.

Consequently, the failure of IT systems development projects is common and is a major problem for many organisations (Willcocks, 2013). There are examples of high-profile IT systems development project failures. They include the development of ‘Socrates’ by the French Railways (Mitev, 1996), the Taurus at the London Stock Exchange (Currie, 1997) which failed dramatically, the system of the patient administration at the NSW Health in Australia (Sauer *et al.*, 1997) which also failed, and the Internal Revenue Service which attempted to develop a new US Tax Modernization System (Nelson and Ravichandran, 2001). Recent examples are BBC Digital Media (BBC, 2013), NHS Connecting for Health (BBC, 2013), eBoarders, and Siren Police IT project (BBC, 2014). The BBC (2013) abandoned the Digital Media Initiative which was meant to allow staff to share picture and video materials digitally. Between 2010 and 2012 the project cost £98.4 million pounds. The National Health Service (NHS) attempt to upgrade their computer systems in England ended up costing £9.8 billion pounds. The Universal Credit project in the UK was estimated to cost £2.2 billion pounds but the project cost grew to £12.8 billion pounds (TechTarget, 2013).

Many reasons contribute to IT system development projects failure. The project team could be responsible for the failure, it could be the failure of the project manager to lead the team to success, or it could be unclear requirements. According to (Dwived *et al.*, 2013), the fact that there has been a major occurrence IT systems project failure and without our ability to prevent, or even understand and clarify them, may indicate that the assumptions and approaches which already exist in IT systems research have not necessarily been the most beneficial. All such large and complex IT systems developments were undertaken as IT projects and depended on project management techniques suitable for small-scale projects. Significantly, it can be argued that they failed because they did not account for project-specific contextual knowledge necessary for developing complex IT systems. So, it is necessary to examine IT projects from a knowledge management perspective to identify issues for further research. But first the project management literature search is done that is most widely used in IT systems development.

As illustrated in Figure 2.8, the reasons for IT project failure include; the complexity of projects involving people, IT and organisation, a lack of understanding of non-functional and technical performance requirements, a lack of technical expertise and poor management. Technical expertise is closely related to the required project-specific knowledge. Other reasons include; unrealistic schedules, a failure to define, control and track change requirements, a lack of knowledge of the complex business processes and rules, an underestimate of risk, reliability, and unrealistic goals. Goals need to be realistic in terms of available expertise and knowledge and the lack of these needs to be factored into scheduling and resource requirements.

2.1.1 Project Management in Saudi Arabia

IT systems development projects in Saudi Arabia follows the same practices as in the UK, Europe and USA, based on project management. Studies reveal that they face similar issues as IT projects elsewhere and similar patterns of failure and causes of failure found in these countries.

Alfaadel *et al.*, (2012) found that around 53% of IT projects failed in Saudi Arabia, as reported by 308 project managers who had responded to their survey in Figure 2-2. They also conducted semi-structured interviews with eight project managers to understand deeper reasons. Consistent with the EPSRC (2007) report, Alfaadel *et al.* found culture characterized IT failure, as well as conflict of interest, instability, and lack of requirements clarity. For similar reasons, Saleh *et al.* (2013) found that over 90% of ERP projects became ‘run away projects’.

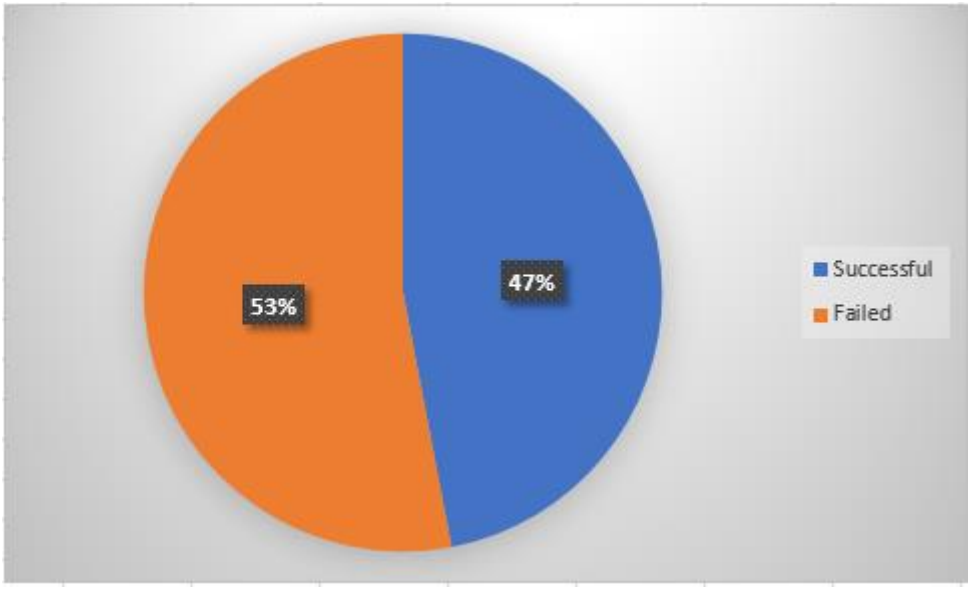

Figure 2-2 IT Project Failure Rate in Saudi Arabia

Such project failure is not uncommon generally. For similar reasons, Saleh *et al.* (2013) found that over 90% of ERP projects became 'run away projects' (see Figure 2-3). With ever more increasing requirement for complex IT systems development, the phenomenon of 'runaway' projects is more recognised in the literature. Runaway projects fail in all aspects of project management - quality, time, budget, and resources. As proposed, the focus on project management techniques and tools needs to change to focus on knowledge management, which could improve success of projects.

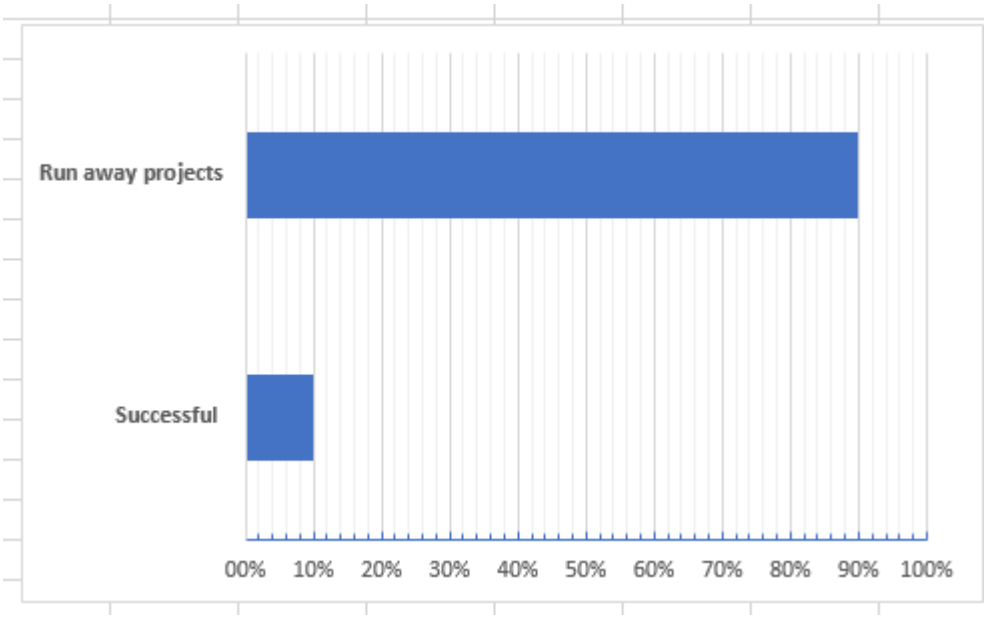

Figure 2-3 Runaway Project Failure

Ebad *et al.*, (2016) found a high lack of compliance in healthcare IT systems development. They examined two rights, four obligations, 22 constraints, and six rules to understand how project managers ensure compliance. They aimed to develop guidelines to aid requirements engineers, standards organisations, compliance officers, and stakeholders to conform to Saudi policy. In his recent doctoral study Sehele (2015) found quality, cost, and time as significant factors for project failure, and that these are related to individual, organisation and the environment.

Abouzahra's (2011) longitudinal 4 years study of 52 healthcare IT projects found that out of 52 projects, 41 did not meet the project objectives, accounting for over 78% failure of the 29 IT systems development projects studied, as shown in Figure 2-4. The IT systems ranged from 500,000 to 10 million US dollars. The causes of the failures included unclear scope, inability to manage risks, unclear stakeholders and their interest, and miscommunications. Abouzahra indicates that the high failure is significantly because of lack of understanding the nature of

healthcare IT systems. IT healthcare systems present their own unique regulatory and ethical standards that require special decision making by project managers.

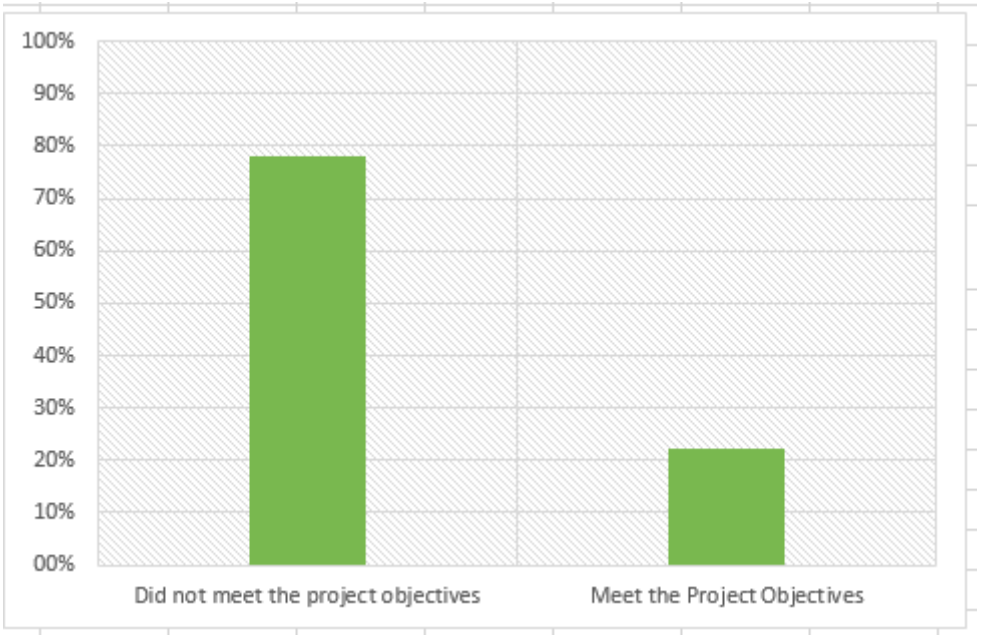

Figure 2-4 Failing Project Objectives in Healthcare IT Systems Development

Such studies focus on IT project management techniques to understand project success and failure. They suggest better standards and techniques for further research. However, doing so may not lead to better project management. As discussed later, such studies do not account for project-specific knowledge management that project managers need to make effective decisions.

The foundation of project management is to complete a project to satisfy users such that it meets the expected requirements. However, the problems arise because the project needs to be completed within certain constraints, as shown in Figure 2-5. The main challenge is to ensure that all the objectives are met while working within different constraints such as time, scope, quality, and budget while achieving the expected quality (Burke, 2003). This challenge becomes more problematical in complex projects like IT systems development, where people, organisation, and IT artefacts all generate interfaces that need to be aligned to achieve the organisational objectives.

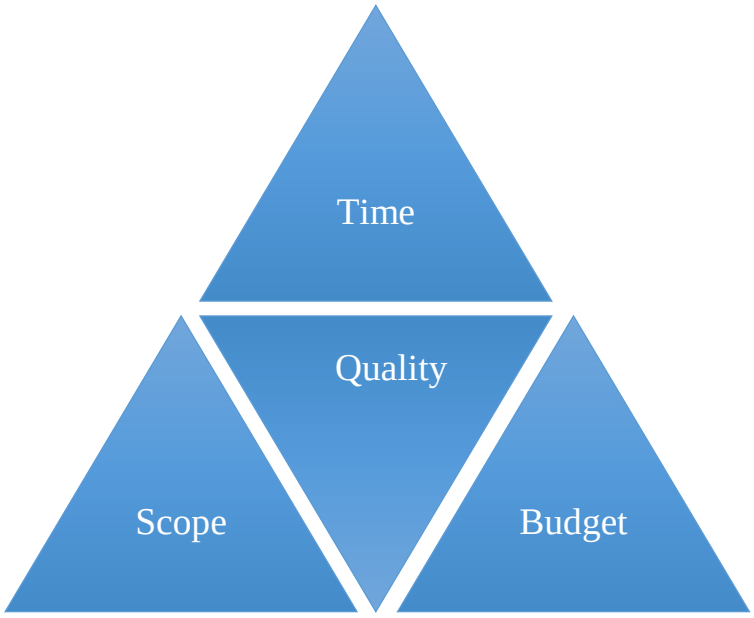

Figure 2-5 Project Management Goal and Constraints

2.2 Project Management

By understanding projects better the risk of IT systems failure as identified above can be reduced. This is the assumption underpinning project management research. In this Section, the literature search focused on assessing current knowledge about projects and project management techniques.

Project management involves planning, motivating, organizing, and controlling resources to achieve project goals (Nelson and Morris, 2014). A project involves temporary activities that are designed to realise a unique product or service within a given time. The main challenge in project management is ensuring that all project objectives are met, while working within constraints such as time, scope, quality, and budget (Burke, 2003). Project management processes can be classified into five categories: initiation, planning, monitoring, executing, and closing (PMI, 2016). In this section, existing literature on project management as a practice discipline is searched. All the research in this area is about improving project management practice by developing better tools and techniques or 'project research'. It does not focus on project managers decision-making.

2.2.1 Project Management for IT Systems Development

Project management is a method is used to deliver products and services within schedule, resource, and budget constraints. It includes defining the project goals and developing a plan to

achieve them (Burke, 2003; Kerzner, 2013; PMI, 2016). According to Meredith and Mantel Jr (2011, p. 107), the project manager is in charge of planning, implementing, and completing the project. The project manager should take responsibility for managing the team and the project resources throughout the life of the project. The project manager should possess different leadership and management characteristics in order to successfully manage the project from start to completion (Clarke, 2012). The project manager and project team are tasked with identifying project requirements; managing the competing demands for quality, budget, scope, and time; and managing stakeholders who have differing expectations.

The environment of today's project management has changed compared to the traditional one. In today's project management, the project manager may be required to source for expertise from people coming from different countries. This is especially common in projects involving IT systems development. In such projects, the project manager has to take into consideration the different cultures and languages of team members (Burke, 2003; PMI, 2016). A project manager should put different pieces of tasks completed by different team members together to form the entire coherent project. Unlike the functional manager, the project manager should be equipped with logical thinking, whereas the functional manager should be more versed in reasoning by elimination or abstract thinking (Meredith and Mantel Jr, 2011, p. 109).

Project management consists of concepts, tools, and techniques as agreed by professional project managers (Morris, 2011). There are different views about the scope of project management, its ontology, and epistemology. Garel (2013) adds that project management consists of a set of 'best practice' activities agreed by practitioners, but also states that there is 'project management theory' as articulated in such best practices. A project manager can be assigned to the project as soon as the project is selected for financing or at any earlier point that seems favourable to senior management. The project manager should have specific skills to have a reasonable chance of success. The project manager should understand that s/he is responsible for overseeing other team members in the project. For a project manager who does not have the required characteristics, it will be difficult for them to make the correct decision and thus not be able lead the development team to achieve the set objectives. Eventually, such a project manager may find it hard to complete the project within the required timeline and this may lead to project failure.

Shenhar and Dvir (1996) developed a typology of project management consisting of two dimensions, technological uncertainty scaled into four magnitudes ('Low-Tech'; 'Medium-Tech', 'High-Tech' and 'Super High-Tech') and system scope scaled into three types (Assembly, System, Array), as shown in Figure 2-6. Uncertainty is the amount of information and knowledge available at the start of the project, which is either sufficient in the case of 'Low-Tech' familiar technologies or requires new knowledge in the case of 'Super High Tech' and design and building of new technologies. An example of 'High-Tech' is IBM's development of the personal computer, which used existing computer technologies. An example of 'Super High-Tech' is Lockheed's development of the SR-71 Blackbird Reconnaissance Aircraft, which used almost no previous technology.

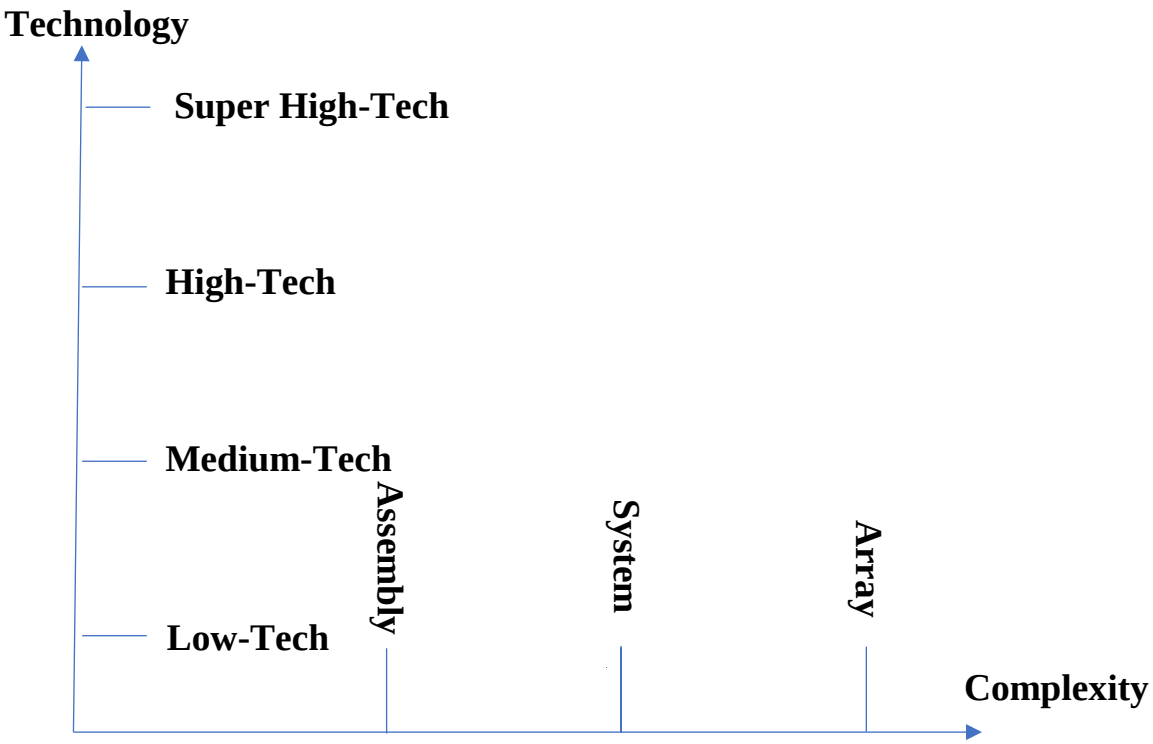

Figure 2-6 Typology of Project Management - Technology Uncertainty and System Scope

Using this typology, large, complex IT systems development projects are either 'High-Tech' or 'Super High-Tech'. The actual hardware already exists in most cases, for example the London Ambulance Service Computer Aided Dispatch system, but the software engineering often requires completely new configurations not found in the prior experience of project managers and team members. For example, as in the development of the NHS patient record system.

The software engineering has to consider the people and organisation aspects of such unique IT systems, which make it complex to design, develop and deploy to the satisfaction of users. Musick (2017) reports on the failure of the London Ambulance Service Computer Aided Dispatch system, noting that it failed on the first day of operation and the failure resulted in 46 people dying. Some immediate causes include imperfect data, interface issues and memory leak, in which memory was retained by code when it was no longer needed. The deeper causes include bad decisions by project managers. Charette (2005 p.47) suggests: "Bad decisions by project managers are probably the single greatest cause of software failure today" and provides the following examples of bad decisions:

- "Unrealistic or unarticulated project goals;
- Inaccurate estimates of needed resources;
- Badly defined system requirements;
- Poor reporting of the project's status;
- Unmanaged risks;
- Poor communication among customers, developers, and users;
- Use of immature technology;
- Inability to handle the project's complexity;
- Sloppy development practices;
- Poor project management;
- Stakeholder politics;
- Commercial pressures".

Charette (2005, p. 45)

Hardware, vendor selection, design, requirements and specifications, and flawed software processes were also aspects of the deeper causes of the failure (Musick 2017).

Project management tools include: Critical Path Analysis, Flow Analysis, Fishbone/Ishikawa Diagrams, PERT Chart, Product Breakdown Structure, and Work Breakdown Structure. Project managers make use of such techniques and tools. Murphy and Ledwith's (2007) findings indicated that SMEs tend not to make sophisticated use of project management tools. In comparison, in a more recent study Marcella and Rowley (2015) argue that in creative industries different challenges exist. They argue that these challenges determine the transferability of project management techniques and tools to the creative industry. These challenges include:

> "…a need to be flexible and reactive; the importance of reflecting on success and lessons learnt; and a tension between the creative and analytical mindsets."
> (Marcella and Rowley, 2015, p. 735).

Sufficient project management techniques and tools are available for IT systems development project managers. But as noted above some project managers may not be making the right

decisions or even making 'bad decisions' (Charette, 2005). Researchers claim there is a theory of project management (Shenhar and Dvir, 1996; Garel, 2013), but it may be that such theory as does exist is in need of better information and knowledge management framework. The PMI (2017) lists integration, scope, time, cost, quality, procurement, human resource, communications, risk management, and stakeholders as significant knowledge areas for project management. Though PMI lists these ten areas on which project management draws knowledge, this literature search found no published research directly linking knowledge management with project management. It is arguable that large, complex IT systems development projects, especially 'Super High-Tech' projects that require innovation, are in need of new knowledge and therefore need better knowledge management frameworks see Figure 2-7.

Figure 2-7 Knowledge Areas of Project Management

Various effects reported in surveys and reports on project management need to be noted, and it can be argued that such effects are not only because of poor project management techniques, but rather because of poor project-specific knowledge management. For example, Bassi *et al.*, (2017) comprehensive study of project management covering project time, project cost, project quality,

project scope, project communication etc. They reported on the relative weights that project managers gave to such factors and found that they varied in importance. They state that there are differences between the literature and actual experience of project managers, as reported in their survey. Project managers found it difficult to manage cost, time, and scope/quality. Fernando *et al.*, (2013) also report that cost, time, and quality are predominant considerations. The State of Project Management 2017 Annual Report (Wellington, 2017) reports that 55% of project managers create a scoping document, 66% of projects are baselined, and 50% of participating organisations were dissatisfied with the level of project management maturity. The challenges reported included poorly trained project managers and poor resource management. Another report found similar challenges: planning and resource management, communication with team and stakeholders, and process and documentation issues (Projectinabox, 2017). Such causes of poor project management and their effects, as well their overall effect on IT system delivery, is shown in the Fishbone diagram in Figure 2-8.

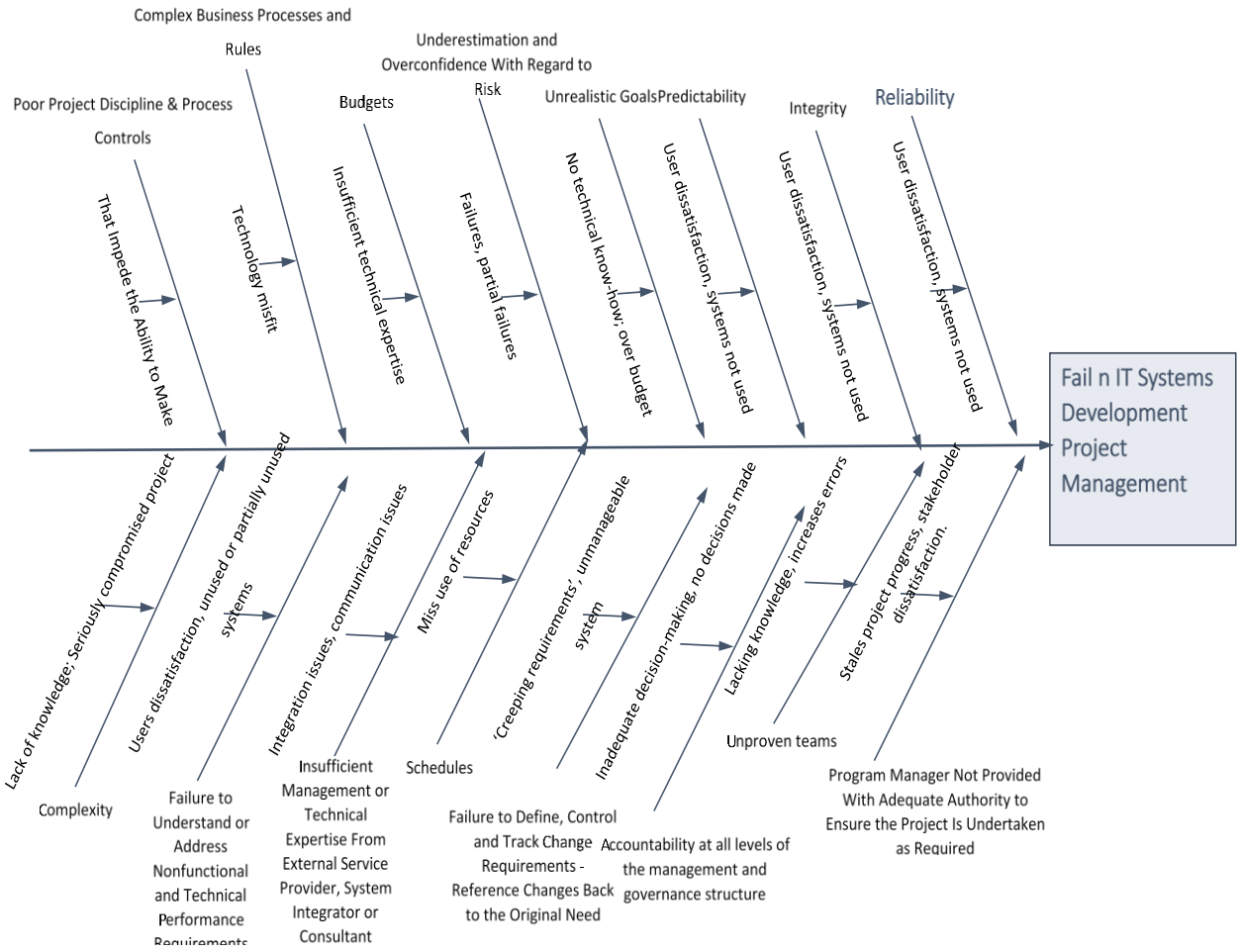

Figure 2-8 Root Cause Analysis

The Fishbone diagram lists the 16 causes found in various IT project management reports, including poor quality, budget over-runs, and user dissatisfaction and their effects on reliability, integrity, and predictability of project management. Also, issues such as unrealistic project goals and quality of scheduling which result in misuse of resources. As noted in the literature above, researchers have continued to address these issues by focusing on better project management tools and techniques, even though these problems have persisted. The literature search on project management and IT project management reveals that there is ongoing research on project management and project management techniques. However, as noted above, there was no published research found that linked knowledge management theory to project management, and even the project management theory reviewed in the next section is concerned with better techniques and tools. However, it is proposed in this research that a knowledge management perspective is needed to address the underlying cause of such issues. Hence, it is necessary to focus the literature search on project management theory to assess its application of knowledge management to complex IT systems development projects.

2.2.2 Project Management Theory

There is no obvious project management theory. Researchers have investigated project management from a practical perspective because it is a practical field. However, researchers have attempted to theorise about project management. Söderlund (2004) created a classification of project management contributions to analyse the state of art. He used published research on projects to propose a framework to analyse recent developments and perspectives. He notes that the research is better categorised as 'project research' rather than project management research. It is interesting that the analysis shows no research devoted to contexts of multiple-projects and multiple-firms, which is 'of great importance for the future of project studies' (Söderlund, 2004, p.655). This observation is important for complex IT systems development projects, because the context is highly significant and such projects involve multiple parties. Even more significant is that: 'The recent developments illustrate the need to better integrate project management with the general developments in management and organization' (Söderlund, 2004, p. 655). This describes accurately the nature of complex IT systems development projects, as they involve people, organisation and IT artefacts.

Project management is a practical field and the literature contain models, techniques, and tools for planning and controlling projects, as depicted in Figure 2-9, based on Morris (2011). Packendorff *et al.* (1987) note that research is needed on 'advice on organisational issues' related

to project management, suggesting that projects need to be seen as temporary organisations. They distinguish the 'project organisation' perspective, which focuses on plan, control and evaluate project activities from the 'project organising' perspective, which needs to focus on expectations, action, and learning. This leads to 'viewing projects as subjective realities, incessantly enacted by individual project members' (Packendorff *et al.*, 1987, p.21).

Project management processes can be classified into five categories which include initiation, planning, monitoring, executing, and closing (PMI, 2016). It is expected that project managers have the necessary knowledge and skills to be able to translate project aims and requirements into these discrete phases of project management. This is relatively straightforward for simple projects that have small budgets, but it is difficult to achieve successfully for complex IT systems development projects as discussed in Section 2.4.

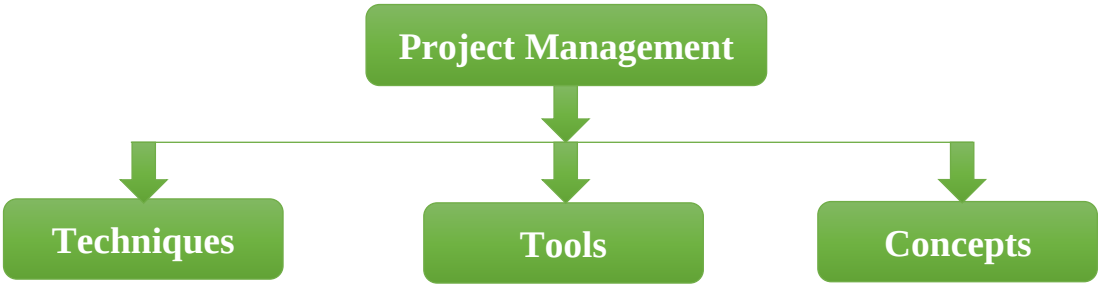

Figure 2-9 Project Management Techniques, Tools and Concepts

For complex IT projects a 'project organising' or planning perspective is relevant. Complex IT systems development projects are actually 'temporary organisations' consisting of the core project manager and expert project team. They need to work with other IT external experts or consultants providing hardware and software. All these parties, the project manager, project team members, business experts, and external consultants in turn need to cooperate and collaborate to establish the IT systems requirements, design, develop, and implement the system in the organisation. So, the project organising perspective is appropriate to investigate complex IT projects and coheres well with the knowledge management perspective adopted in this research.

Figure 2-10 The Project Management Process

A complex IT system is complex because of the interaction between these elements: organisation, IT, and people. Each of these elements itself is complex. Organisation involves purpose, objectives, processes, and resources. It involves digital artefacts. And people involves complex individuals seeking meaning, and their interactions with each other to organise to achieve purpose using IT. In the EPSRC Annual Report 2006-7, a complex IT system is defined as facing socio-technical issues stemming from the interaction between organisation, people, and systems in a 'high-integrity systems engineering' environment (ESPRC, 2007).

The literature search above reveals that different and disparate aspects of project management require integration information. The current focus is better described as 'project research' (Söderlund, 2004) rather than project management research. Project management techniques apply to different and separate aspects of an IT project, but the project manager has to coordinate all the different information in order to make project decisions. This requires more than information about the separate and different project activities. The project manager needs to acquire project-specific knowledge about the unique or innovative aspects of the project, knowledge about which decisions are critical, and knowledge to make such critical decisions. So, the literature search turns to knowledge management frameworks in order to assess their applicability to complex IT systems development project management.

2.3 Knowledge Management Frameworks

In this Section, the relevance of knowledge creation theory and knowledge management frameworks for complex IT systems development projects is assessed. Knowledge creation theory is normally applied to innovation studies, because innovation requires the creation of new knowledge. In complex IT systems development the IS being developed is often a new innovation – an IS embedded in a unique organisation, with people requiring different interpretation of the information provided by the system. Although existing information technologies are used, they are combined in a unique and new form which becomes an innovation challenge for IT systems developers.

The field of knowledge management contains theory about knowledge creation and knowledge management. Theory has been developed from studies of how organisations manage knowledge and how innovation is done in companies. In this section, this range of literature is searched to identify knowledge creation and management theory relevant for complex IT systems development project management.

For complex IT systems development project management, it is necessary to draw on a framework that can explain actual project management practice and be applied to project managers' decision-making. The knowledge creation model explains knowledge management for innovation decision-making. Knowledge management is concerned with individual human and organisational processes to create knowledge. This involves the Socialisation, Externalisation, Combination and Internalisation (SECI) of knowledge by individuals and the organisation (Nonaka, 2008).

This SECI model will be used in this research to provide the theoretical framework. It is also consistent with the 'organising' perspective recommended above for project management (Packendorff *et al.*, 1987). According to the organizational knowledge-creation theory, knowledge is created by repeated interactive process between tacit and explicit knowledge. Tacit knowledge is unseen knowledge that is not easily codified into any transmittable form. An example of the tacit knowledge is the skills that one acquires over time doing a specific job. Explicit knowledge is seen knowledge that is easily codified and transcribed (Nonaka *et al.*, 2000). Since this research focuses on project-specific knowledge in IT systems development project management, the SECI model is a relevant theoretical perspective, having four modes:

1. Tacit to Tacit: This mode is also known as "Socialisation" where the knowledge is transferred and share via social gathering and conversations.
2. Tacit to Explicit: This mode is also known as "Externalisation" where the knowledge is articulated and written down.
3. Explicit to Explicit: This mode is also known as "Combination" where different types of explicit knowledge are combined to form a new knowledge.
4. Explicit to Tacit: This mode is also known as "Internalisation" where the knowledge becomes a second nature and a part of an individual knowledge.

These four modes of knowledge creation are illustrated in Figure 2-11.

Since Nonaka and Nonno (1998) published their research on how Japanese firms innovate, the theory of knowledge creation and knowledge management has been applied to different fields (Allal-Chérif and Makhlouf, 2016; Tian, *et al.*, 2013; Chow, 2014). Nonaka and Nonno identified two types of knowledge, explicit and tacit knowledge.

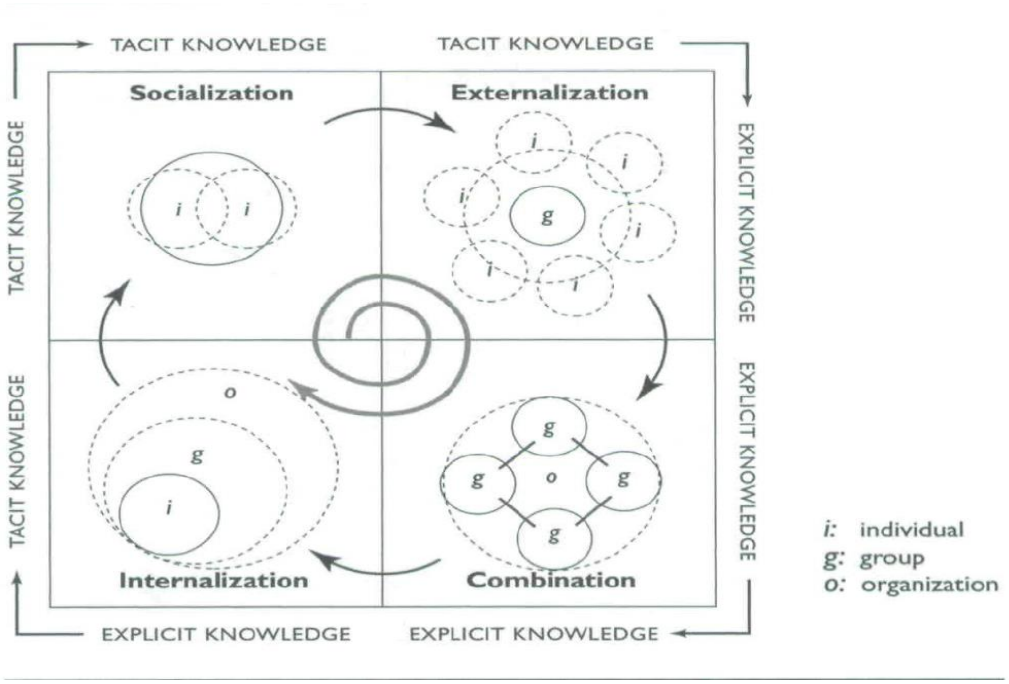

Figure 2-11 Four modes of knowledge creation by individual, group, and organisational processes

Source: Nonaka and Nonno (1998)

Explicit knowledge is shared in the form of numbers and words and is found in material items or artefacts. For example, scientific formulae, databases, documents, manuals and memos. This kind of knowledge can be transmitted among individuals without difficulty. People's intuition and insights is tacit knowledge. It is personal knowledge. This knowledge is difficult to share between individuals. 'Tacit knowledge is deeply rooted in an individual's actions and experience as well as in the ideas, values, or emotions he or she embraces.' (Nonaka and Nonno, 1998:42). Tacit knowledge is technical and cognitive. People's personal skills and 'know-how' is technical knowledge. People's ideals and values as well as their mental models is cognitive (Nonaka and Nonno, 1998).

There are four stages in the theory of knowledge creation Socialisation, Eternalisation, Combination and Integration, are processes that move in a 'spiral' between tacit and explicit knowledge. In socialisation tacit knowledge is shared among individuals. It is exchanged by 'being together', 'spending time' and 'living in the same environment.' This is called 'Ba', as shown in Figure 2-12.

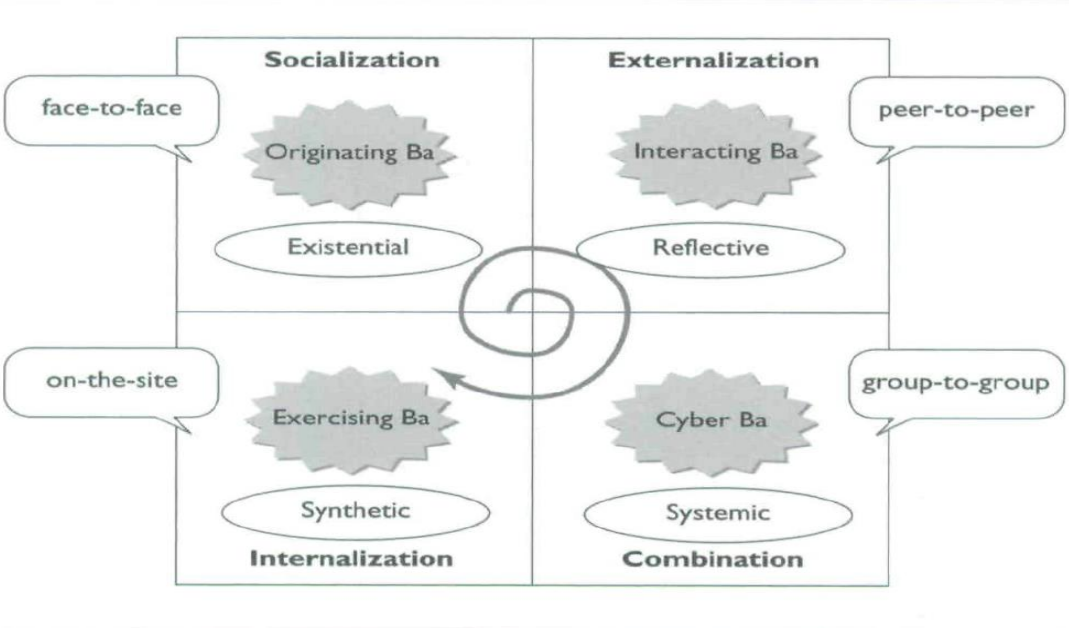

Figure 2-12 Types of Ba

Source: (Nonaka and Nonno, 1998)

In socialisation empathy is important as individuals 'capture' other people's tacit knowledge by being together. When tacit knowledge is expressed it is called externalisation. Knowledge is recorded for other people to comprehend. Individual start to become part of the group (Nonaka and Nonno, 1998:43). This way tacit knowledge is converted into explicit knowledge. When explicit knowledge is expanded it is called combination. 'In this stage, the key issues are communication and diffusion processes and the systemization of knowledge' (Nonaka and Nonno, 1998:44). Explicit knowledge is captured and disseminated. When explicit knowledge is converted into the organisation's tacit knowledge this is called internalisation. People learn by doing, training and exercises so that they access people's knowledge. Here, explicit knowledge is embodied in practices and actions. 'Thus, the process of internalising explicit knowledge actualizes concepts or methods about strategy, tactics, innovation, or improvement' (Nonaka and Nonno, 1998:45).

The benefits of the SECI model are that it takes into account the dynamic nature of knowledge and also knowledge creation. The model provides a framework that can manage relevant processes (Rice and Rice, 2005). The main disadvantage of SECI model is that it is mostly suitable for organisations in Japan, because they highly rely on tacit knowledge. In Japan, an employee can remain in one company for a lifetime. Another disadvantage is that the concepts are linear, and there is no flexibility of spiral jumping steps or going counter-clockwise (Rice and Rice, 2005).

An IT project features a wide number of activities and limited time is available to deliver the expected objectives within the budget. The field of project management unlike other areas of management has its own pool of knowledge that plays a significant role in project delivery (Pons, 2008). Decision-making is one of key aspects of project management. The project objectives would be defined in this process that makes it difficult to deal with this phase using the classic project management tools. The growing size of IT systems development projects has been challenging project managers with new concerns and issues (Hammouda *et al.*, 2011).

So, the main purpose of choosing the SECI model in this study is to serve this need of facilitating the process of decision-making via knowledge management. Other frameworks for organisational knowledge management were not suitable because they assumed an organisation (Goh, 2002; Hislop, 2013; Van den Berg, 2013), which a project can be argued is not. These other frameworks specifically assume many different departments, business strategy, and competition. In contrast, IT systems development is normally done as a project, which is not an organisation as such. The SECI model is sufficiently abstract to apply to groups, teams, and projects as conceptual entities rather than concrete entities like organisations.

Since the research aims to design a collaborative decision-making model based on knowledge management, the SECI model helps in developing a framework which would assist project managers via knowledge management and collaborative decision-making, capable of provided a global perspective of project progression and identifying the critical points for project success (Andreeva and Ikhilchik, 2011). With respect to IT systems projects, prior knowledge acquired in previous projects is not directly applicable to new projects; it can be argued that even the principles and knowledge vary between projects. Though, some knowledge and ideas acquired via one project can be applied in similar projects in a similar area. Thus, KM techniques like knowledge maintenance and transfer are important and relevant. This study intends to explore these aspects using the SECI model to suggest new ideas to facilitate better decision-making processes. So there is a need to consider knowledge creation theory and knowledge management in the context of IT systems development projects and to make a theory based research. This study will investigate the use of tacit knowledge in IT projects, as well as the process of Externalisation, where the knowledge is articulated and recorded in KM tools for use by project managers for decision-making.

The main purpose of choosing the SECI model in this study is to serve as a need of facilitating the process of decision-making via knowledge management. The study intends to design a

collaborative decision-making information model for structuring and organizing project management. The role of SECI model is crucial to this study because the model helps in developing a framework for managing less structured and more informal IT systems development projects, which would assist project managers via knowledge management and collaborative decision-making that provides a global project perspective towards project progression and identifying the critical points or critical success factors for the success of the project (Andreeva and Ikhilchik, 2011). With respect to IT, the principles and knowledge securing successful delivery of the project varies. Also, some knowledge and ideas acquired via one project can be applied in similar projects from similar area. Thus, KM techniques like knowledge maintenance and transfer are important and relevant for PM. This study intends to explore these aspects using the SECI model and suggest new ideas to facilitate the entire process. This study will be investigating the use of tacit knowledge, as well as the process of Externalisation, where the knowledge is articulated and written down or recorded for future reference. This means through the SECI process the knowledge is expressed and contribute to the experienced project managers by using codified results.

Knowledge sharing as in the SECI spiral model requires trust among team members. Park and Lee (2014) studied the role of trust and dependence in IT systems development projects. They measured four constructs -"environmental complexity, domain expertise, similarity of project value, and communication frequency". They conclude that trusting team members and feeling of dependency leads to more knowledge sharing. The more people communicate leads to feelings of dependence and trust, and team members begin to share project values. To increase knowledge sharing project managers can cultivate trust. This is because the primary tasks are critically knowledge intensive in IT projects. Also, Park and Lee (2013) argue that knowledge-creation and knowledge sharing can be more effective if the IT systems development project manager is a competent leader.

Similarly, Pee and Kim (2010) state that IT systems development is knowledge-intensive. It requires communication and coordinated application between business and IT professionals' expertise. But this is problematical, because of their different backgrounds and expertise domains. And this becomes more complex when external IT consultants are involved which creates organisational boundaries and blockages in communication and knowledge flow. Pee and Kim argued that perceived social interdependencies influence how much knowledge is shared among these different professional experts. The success rate of IT systems development projects

in addition to knowledge sharing could be related to perceived goal, task and reward interdependencies.

Chang *et al.*, (2013) found that knowledge contribution is critical for the success of IT systems development projects. By knowledge contribution they mean knowledge that is provided by team member which increases the project team's efficiency to achieve its goal. There are factors from a social cognitive perspective like relationship commitment, team relationship norms, and awareness of expertise location that are important. Critically, they found that a team's awareness is a mediating factor between affective commitment and relationship norms. A team's relationships determine how much knowledge contribution is made by individuals.

A knowledge management framework influences the knowledge management factors in a global setting. It outlines the key areas to consider when designing knowledge management systems and processes. And it may be used for different purposes which include guiding the development processes for the decision makers and implementers. Researchers have adopted a knowledge management framework as a reference model to compare research in the field by providing aspects that influence the success of knowledge management system and a common set of context descriptions (Sokolova and Fernández-Caballero, 2012). To understand what works and what does not work in an organizational or cultural context, it is necessary to map the findings to corresponding context information so as to make the research results and the project comparable and ensure transferability across different cultures and contexts.

It is thus necessary to capture the context of research projects and implementation, as well as adopting process in a clear way (Sokolova and Fernández-Caballero, 2012). Frameworks specify the important objects of interest as well as their coherence. A framework provides the aspects that must be considered when designing and implementing the project. Frameworks provide a solution to influence factors, mapping of the different contextual aspects, and the results. A framework should be seen as a conceptual model that may be used to develop knowledge management for projects by identifying interdependencies as well as influence factors (Sokolova and Fernández-Caballero, 2012). Frameworks outline, concepts such as systems or process, elements, and how they relate to a certain problem domain. This helps in ensuring to support better understanding of the intended purpose. Reference models serve the purpose of conceptual models and thus may be used in a similar manner.

Knowledge management frameworks examined above structure how knowledge can be created, shared and applied in different problem domains. They also emphasis context as being critical for effective knowledge management. Structuring knowledge and developing knowledge for a particular are activities that project managers do in complex IT systems development projects. Since project managers need to make decisions about the project team members' innovation aspects, identifying programming tasks, and project resource allocations, they acquire, structure and create new knowledge as the basis for such decision-making. So, in the next Section it is necessary to assess how IT project managers manage IT projects.

2.4 IT Systems Development Project Management

An IT systems development project is different from other kinds of engineering, business or civil projects. The fundamental difference is concerned with creating an active information system that is well aligned with the people and organisation it serves. This section analyses the literature on IT/IS projects by focusing on understanding complexity in IT systems development and the ontology of knowledge creation and sharing in such projects. It also discusses literature that distinguishes between data, information, and knowledge to better understand knowledge management in IT systems development projects.

A typical project consists of the following elements: business problem, constraints, schedule, contingency plans, risk mitigation, budget and project value (PMI, 2017). Project management is recognised as a 'strategic organisational competence' and viewed as a time- and budget-bound activity, a project is temporary. A project is also 'unique in that it is not a routine operation, but a specific set of operations designed to accomplish a singular goal.' (PMI, 2017). This concept of project has been used in business, government, health, and military organisations. It begins by considering the value that is expected to be derived from doing the project. This means the problem that needs to be resolved needs to be defined in terms of expected outcomes or the value it will add. This covers the project conception and definition.

One branch of explanations for complex IT systems project management has focused on IS development methodologies (Baskerville and Wood-Harper, 2016; Doolin, and McLeod, 2012). An alternative explanation is that the decisions made by project managers are based on the knowledge about the IT systems development. Many project decisions are guesses or estimates not based on sound information. Therefore, there is difficulty in monitoring progress. Some parts of IT projects (e.g. software) are invisible and therefore hard to schedule and track (Naedele *et. et*, 2015). Such dimensions of IT systems projects make for especially difficult decision-making

on the part of project managers. Therefore, the utilization of knowledge management techniques can support decision-making process.

Another perspective on complex IT systems development is project management. Framing an engineering problem and development as a project has been long established. Kwak (2005) traces it to 1950s for developing Polaris in the US. He identifies four periods of project management as: Prior to 1958 Craft System to Human Relations Administration; 1958-1979; Application of Management Science; 1980-1994 Production Center: Human Resources; and 1995 to the present, Creating New Environment. Each period is characterised by its own project management tools and practices and classic exemplar projects. This is in agreement with Morris (2011) who argues that project management is a socially constructed idea. As Kwak's periods show, understanding of project management has evolved and continues to evolve as the professional project management community learns from its experiences of managing complex projects.

2.4.1 IT Systems Development Project Team

The critical core of a project is the team. A team of experts with knowledge and skills required to execute the project is assembled, with the project manager having major influence on the composition of the team. The concept of teams can be traced to the idea of 'groups' (Benne and Sheats, 1948). But it attracted researchers with the work on teams by Belbin *et al.*, (1976). A modern team has experts capable of solving a problem and completing set objectives.

IT systems development project teams contain the project manager, programmers, database administrators, hardware specialists, and Internet and network experts, and mobile technologies experts. Their role in system development consists of defining, designing, coding, assembling, testing, and implementing an IT system. Project management teams are expected to perform expertly, work to schedule and project time scale, keep within the allocated resources and monetary budget, and deliver the IT system to the satisfaction of users.

2.4.2 IT Systems Development Project Knowledge

The theory of knowledge creation and specifically the SECI model can be applied to IT systems development project management to explain how such projects could be successfully managed by enabling enhanced decision-making processes.

IT systems development project management involves leading, planning, implementing, monitoring, and controlling IT systems development projects throughout the project lifecycle (Balaji and Murugaiyan, 2012). As the IT systems industry has continued to grow, there is a need

to manage new development through the use of methods that ensure that projects are completed within scheduled time and budget. Established project management methods may be used to manage IT systems development projects; however, there is a likelihood that the schedule will slip especially during the test runs (Mishra and Mahanty, 2014). This usually happens when there is disagreement between the delivered IT systems product and user specifications. In order to overcome these challenges, IT systems development project management techniques that are concerned with matching requirements of end-user to the IT systems product being developed need to be used (Wysocki, 2006).

In software engineering, many project management failures are a result of lack of sufficient involvement of the end user in the development process, poor communication among project manager and team members, between the project manager and the end user, and among the project team members who are developing the software (Beynon-Davies, 1999; Monteiro de Carvalho,. 2013; Abelein and Paech, 2015; Bano and Zowghi, 2015). Software project management failures also may be caused by a lack of articulated and realistic project goals, or lack of accurate estimates of the resources required for successful completion of the project (NHS 2013; BBC 2014). Incomplete system requirement specification may also be a major cause of software project management failure. If there is poor reporting of project status or poor management of risks involved, this may also cause project management failure (Wysocki, 2006). Appropriate and state of the art technology is also important to ensure the cost of the software project in terms of budget and time is kept at minimal. The project manager's inability to handle the complexity of the project may also lead to project failure. Lack of commitment by the different stakeholders will also lead to project failure; for example, if some stakeholders who are supposed to provide executive support do not attend meetings, or there is a lot of politics and conflicts between the end users, then the project management is likely to fail (Wysocki, 2006). Projects management tools are important to the success of IT systems development project. To succeed in IT systems development project management, it is necessary to apply the appropriate methods and use the appropriate tools to that will support these methods. Specific IT systems development methods and tools such as the waterfall model have been developing to support the process of IT systems development project management. Methods of IT systems development project management methods have continued to grow throughout the years; this trend will move away from the waterfall model to a model that involves cyclic project delivery; the new model is similar to the process of IT systems development (Chemuturi, and Cagley, 2010).

Knowledge sharing in complex IT systems development projects is critical to delivering a successful IT system. Park and Lee (2014) explained the role of dependence of projects members on each other's specialism and the trust necessary to share knowledge. A reason for complexity in large IT systems development is interconnectedness and the dependency that creates among the large development teams. With increases in micro services in companies' IT architecture there are an increasing number of smaller development teams which all need to cooperate and synchronise their development activity. Park and Lee's (2014) study showed that dependence and trust are significant in complex IT systems development projects. They proposed environmental complexity, domain similarity, similarity of project value, and communication frequency as critical antecedents of dependence and trust. Using a quantitative cross sectional survey research methodology involving partial least squares with data from 135 IT project teams in two companies, they conclude that team performance is determined by dependence and trust which has a strong impact on knowledge sharing. This means that team members share knowledge when they 'feel' dependence and trust their team members. They point out that such feelings of dependence and trust align with communication frequency, perceived similarity of project value, and perceived expertise. Their research leads them to advise projects managers to focus on communication frequency, perceived similarity of project value, and perceived expertise to improve the quality and level of knowledge sharing in project teams in intensive knowledge sharing projects, especially where the primary tasks are knowledge intensive.

This theme of dependence appears in the literature and Pee *et al.*, (2010) focus it on the social aspect, rather than only technical dependence. Project team members are dependent on each other's technical contribution to the project, which can be achieved through explicit information flows and knowledge bases such as the project database. But the focus on social dependence is critical in order to build a cohesive and trusting team. Knowledge sharing in complex IT systems development is more effective by building more social interdependence. Pee *et al.*, (2010) agree with Park and Lee (2014) that complex IT systems development is knowledge intensive and add that it requires coordinating business and IT professionals' expertise. They stress that complexity of knowledge sharing increases because of the different domains of business and IT professionals. As many complex IT systems development projects need external IT consultants, the issue of knowledge sharing is compounded because external experts and internal project team members need to acclimatise with each other. Pee *et al.* (2010) found that perceived social interdependence involving goal, task and reward determine the extent of knowledge sharing between IT project team members and external IT consultants. Their results show that consultant-

and-client matched pairs' perceive goal, task and reward interdependencies are significantly related to knowledge sharing and that this has an impact on the different phases of the project. So, they conclude that knowledge sharing mediates the relationship between interdependencies and ISD project phase performance. Pemsel and Wiewiora (2013) found little evidence of the brokering role of project management office. They examined the knowledge sharing function of project management office to determine whether it reflects the knowledge sharing needs of project managers. Project management office is regarded as a 'knowledge broker'. Their cross-case analysis of seven organisations reveal how project managers share knowledge.

This theme of social cohesiveness in projects in developed further by Lee *et al.*, (2015). They extend the construct to include social capital. They researched the raising of social capital with knowledge and communication in IT systems development. They acknowledge that systems development is knowledge intensive and social capital between business and technology experts is necessary. They conceptualised social capital as three sub-constructs: social ties, trust and shared vision. Similar to the Park and Lee (2014) study, they hypothesize that knowledge and communication by business and technology experts are critical antecedents of team social capital that improves team performance. Similar results are presented in Ding *et al.* (2014) study, in which they propose a model of knowledge sharing.

Agreeing with the research results reported above, Change *et al.*, (2013) state that the extent of knowledge contribution in systems development determines success of system development projects. They define knowledge contribution as knowledge provided to improve a project team's efficiency and achievement of its goal. They chose to look at the social cognitive perspective and examined the factors that influence social cognition. The factors they investigate include team relationship commitment, team relationship norms, and awareness of expertise location. They found that a team's awareness of expertise location mediates the effects of affective commitment and relations norms for knowledge contribution. They conclude that awareness of expertise location plays a crucial mediating role between socially prescribed motivations and knowledge contribution and that team relationship commitment has a significant impact on team established relational norms. It is this expertise location that is critical for knowledge sharing in complex IT systems development projects.

2.4.3 Knowledge Sharing, Expertise Location and Decision Making

The research reported above established that knowledge management is critical for complex IT systems development success. The proposition of this thesis is that knowledge management has

a critical role in complex IT system development projects and that it supports decision processes. As noted in Chapter 1 and above, knowledge management is established as critical for organizational and project success. A project manager is able to be more effective and make better project decisions involving resource allocations and technical issues with better project-specific knowledge, which means project knowledge needs to be created, gathered, managed and used for effective decision-making in IT systems development.

Project managers and the project team need to develop project-specific knowledge for better IT systems development. Knowledge management is effective and used to improve decision-making, productivity, creativity and profit (Edvardsson 2006, 2007) and (Petersen and Poulfelt 2002). Knowledge creation, deployment and management is critical in uncertain or new environments, as Nonaka (1994) stated. These are also the attributes of complex IT systems development projects. Such projects are unique. They are new in the sense that a project manager cannot draw on a similar previous context to make project decisions. Complex IT systems development happen in uncertain environment. This is because, though existing technology can be used, it is applied in unique context and also new combinations of IT are designed for such contexts. Consequently, a project manager has to deal with emerging information and knowledge to make project decisions. Nonaka (1994) states that such problem can be solved better through knowledge management, which is to help absorb knowledge into the company and contribute to success. According to this theory of knowledge management, a project manager needs to enable project team members to share their knowledge. This is not currently on project managers list of management practices.

The literature needs to build knowledge sharing in complex IT systems development projects on theory. Petersen and Poulfelt (2002) assert knowledge management enables knowledge gain and better performance through sharing, developing and applying knowledge. Knowledge sharing though it not explained in the IT system development literature. It is actually embedded in systems development project management tools in the form of project goals, packages, resources, tasks and timeline. This technological framing of IT systems development project is possibly a reason for project failure, because it assumes that project team members talk to each other to share knowledge. This is the finding of Greenes (cited in Petersen and Poulfelt, 2002: pp.5-6). Technological embedding of knowledge assumes that socialisation, through which knowledge is shared, happens too. Greenes questions this assumption and suggests it could be a reason for many knowledge management failures. It is argued by other researchers that the likelihood of

project failure is increased in the absence of organisational knowledge management strategy (Foote, Matson, and Rudd, 2001; Storey and Barnett, 2000).

Drawing on Nonaka (1994) and the theory of knowledge creation, knowledge management can have positive benefits and impact success as shown above. The issue for IT systems development concerns effective deployment of knowledge management in projects. Nonaka argues that individuals need to be developed for effective knowledge management in organisations. This requires them to interact with each other and know how to do that in order to create, share and manage information and knowledge to part in innovation. Complex IT systems development projects are innovative and require this kind of knowledge creation, sharing and management. A project manager needs to manage the IT system development knowledge in order to make decisions that lead to project phase success. It is proposed here that management of IT systems development project knowledge is key for its success. This requires creative ways of managing how project-specific knowledge is created and understand the process involved in knowledge creation, sharing and application. This means complex IT systems development project which are innovative need to be understood in terms of how to create and process information and knowledge in the unique people, organisation and IT context.

The literature agrees that knowledge management has an impact on IT systems development project success. Though the organisational knowledge management literature is clear that this requires competent individuals and effective knowledge management systems, the IT systems development literature is unclear and has not clearly defined the role of individuals in project knowledge creation, sharing and application for effective decision-making. Project success is dependent on competent project team members and effective decision-making by the project leader.

To be successful, complex IT systems development projects need better project knowledge management. The argument of this research is that project-specific knowledge management can be explained by the theory of knowledge creation proposed by Polanyi, (1966); Nonaka (1994); Nonaka and Takeuchi (1995); Nonaka and Nonno (1998:p.42); (Nonaka *et al.*, (2000); Nonaka, (2008) and other subsequent work based in it. Better and deeper understanding of complex IT systems development project knowledge management can be obtained through the theory of knowledge creation. The research aims to understand how complex IT systems development project-specific knowledge is created, shared and applied by project managers to deliver

successful systems that satisfy users. The ontology and epistemological dimensions of knowledge management according to the theory of knowledge creation is explained next.

2.4.4 The Ontological Dimension of Knowledge Management for IT Projects

To explain knowledge management in complex IT systems development projects, the theory of knowledge creation and model of knowledge management is explained in context. A complex IT systems development project is composed of project manager, expert software and IT people, external consultants, and expert business managers and process workers. They as individuals who possess the information and knowledge required to complete a project successfully. So, it is necessary to explain knowledge and the processes involved in creating, sharing and applying it. Nonaka (1994: p. 5) defines knowledge as: "a dynamic human process of justifying personal belief as part of an aspiration for the truth." Knowledge consists of explicit knowledge and tacit knowledge (Polanyi 1966).

A project manager needs to manage project-specific knowledge competently, which means managing the people because knowledge resides in the minds of expert project team members. Understanding what the nature of knowledge in complex IT projects and how is it managed by a project manager is ontology of knowledge. Since expert project team members analyse business, determine requirements, design, develop and implement an IT system, it is necessary to understand how they make sense of their responsibilities, their situation and expectations from project manager. Van Heijst *et al.* (1997: 192) define ontology as: "An ontology is an explicit knowledge-level specification of a conceptualization, i.e. the set of distinctions that are meaningful to an agent. The conceptualization - and therefore the ontology - may be affected by the particular domain and the particular task it is intended for." This is important because an appropriate conceptualisation of the nature of knowledge and process of creating, sharing and applying knowledge result in effective project-specific knowledge management. Poli (2002) identifies three types of ontology which apply to knowledge. Descriptive ontology is a collection of data and information relating to specific and general for the purpose of analysis. Formal ontology is the process of filtering, coding and organising the descriptive ontology collection. The result is the codified ontology.

This ontology can be related to knowledge required to successfully manage complex IT systems development projects. A feature of it is the process of knowledge creation. Knowledge creation begins at the individual level and then involves the team, with the final impact on the project manager's decision making. Individuals interacting is the core of the knowledge creation process

and the degree of social interaction (Nonaka, 1994) is key for sharing project knowledge. This raises interesting questions to pursue in the research investigation, including how willing are individuals to share knowledge, do they even want to interact socially? Are they committed to the project goals, budget and deadline?

2.4.5 Data, Information and Knowledge

Knowledge is the result of a process from data to information. Data are facts which exist by themselves, such as numbers, words, images and sounds and is gathered through observation (Firestone and McElroy, 2005). An IT systems development project consists of much data, including available programming and IT resources, budget, and available expertise and systems requirements. Such data becomes information when it is processed for a specific purpose. So, data becomes information for a specific context of use. Information consists of messages and meanings attached to such messages by people in receipt of the information (Machlup and Mansfield, 1984). Such meaning is associated with information becoming knowledge. Knowledge then is the application of information in a particular context (Hislop, 2013). Knowledge management consists of individual experience, context, interpretation and reflection (Davenport, *et al.*, 1998).

Both information and knowledge consist of syntax and semantics. Aspects with give grammatical structure to information and knowledge is syntax. Aspects that give meaning to information and knowledge is semantics. Nonaka (1994) argues that meaning is absent in information during the knowledge creation process. Knowledge becomes meaningful in the context of its use.

In this Section the key role of knowledge in IT systems development projects is clear. While project managers need projects information to monitor project resources, schedule and monitor tasks for example, in complex IT systems development because of their uniqueness and complexity, they also need to acquire project-specific knowledge and apply it to make decisions. Yet, project management literature does not make references to knowledge management theory. So, the next Section assess the relevance of the existing theory of knowledge management for IT project-specific knowledge management.

2.5 Conclusion

The literature on projects and project management was reviewed in this Chapter. It reveals that the focus of the current research is on tools and techniques for management projects and that such tools and techniques capture data and information about projects. This type of research is necessary

and provides information to project managers for decision-making. However, project failures still occur. It is argued in this thesis that project managers' decision-making can be enhanced by focusing on providing project-specific knowledge – as opposed to data and information. So, the literature on knowledge management is reviewed in the following chapter and its relevance for generating project-specific knowledge to aid project decision processes is evaluated.

CHAPTER 3 KNOWLEDGE MANAGEMENT AND DECISIONS

3.1 Introduction

The previous Chapter revealed that project management research is focused on tools and techniques that are designed to capture and process data and information. Also, that there is a need to consider research on knowledge and project management. This is because complex IT projects are uniquely bound to specific contexts and these contexts are composed on people, organisation and the IT artefacts required to provide information with specific meaning to users. Project managers need to gather specific knowledge about such contexts. Therefore, it is necessary to examine the relevance of knowledge management literature to IT systems development and project decision-making processes.

3.2 Theory of Knowledge Management

In this Section the relevance of knowledge management for IT project management is assessed from the perspective of IT project managers' decision-making. First, knowledge management frameworks are considered to determine which knowledge management perspective is appropriate for the research. Then the selected theoretical perspective is discussed. The theory of knowledge management focuses on a group or team's innovation activity, rather than a leader's need for knowledge in order to make decisions. An IT project usually has an allocated project manager responsible for the successful completion of the project. In very large IT project there may be several project departments and roles for integration specialists, but still the decisions are made by the project manager. In such complex IT projects it is necessary to acquire, structure and apply technical and project-specific knowledge. But the nature of such knowledge needs to be first understood.

3.2.1 Knowledge Management Frameworks

Heisig (2009) conducted the first quantitative and qualitative analysis using content analysis methods of 160 KM frameworks from different disciplines and applications worldwide. They ranged from science, practice, associations, and standardisation bodies worldwide. And the units of analysis consisted of the term 'knowledge', terms for knowledge process activities, and factors affecting the success of KM initiatives.

He suggests that as KM has entered into a new phase consolidation and harmonisation of concepts is required. The study aimed to analyse KM frameworks from practice and research to discover differences and correspondences regarding their model elements. Some first standards published in Europe and Australia were noted that fostered common understanding. He found

that despite the wide variety of terms used in these different KM frameworks they agreed on the 'basic categories' used to describe KM activities and the CSF of KM. However, the paper concludes that despite this consensus the core term 'knowledge' needs to be better understood in research and practice.

A framework is a:

> "Holistic and concise description of the major elements, concepts and principles, of a domain. It aims to explain and define a standardised schema of its core content as a reference for future design. A KM framework explains the world of KM by naming the major KM elements, their relationships and the principles of how these elements interact. It provides the reference for decisions about the implementation and application of KM."
>
> (Weber *et al.*, 2002 cited in Heisig, 2009).

Such KM frameworks can be prescriptive, descriptive, or hybrid combining both prescription and description. A prescriptive framework gives direction on the type of KM procedures to use for KM, but it does not provide specific details on how they should be used. It is a task-oriented framework. A descriptive framework characterised KM. It identifies attributes of KM that are important for successful KM. A prescriptive KM framework is needed for IT systems development, which contains the major elements, concepts, and principles relevant to IT systems development. This is important because as Heisig (2002) notes context of KM is significant because of the holistic nature of KM.

Heisig (2009) shows that knowledge dichotomies are used to describe knowledge, such as explicit and implicit, internal and external, and tacit and explicit. In total 29 dichotomies were found. As noted, there is also a distinction between data, information and knowledge. More important are the knowledge management activities which are explicit in 73 per cent of the frameworks examined. The activities range between two to nine KM activities per framework. There a six significant groups of KM activities, each containing multiple KM verbs such as 'create' 'acquire', 'store', and 'share', among others. The ranked order of KM activities are: Use (41), Identify (37), Create (36), Acquire (33), Share (31), and Store (24).

Holsapple and Joshi (1999) provided an earlier summary and comparative analysis of KM frameworks. In their smaller survey covering ten KM frameworks they found that none of the frameworks 'subsumes the others'. So, they suggest that the need for a unifying generic framework. They identified five types of KM frameworks: framework of KM pillars, framework of core capabilities and knowledge building, model of organisational knowledge management, framework of the knowing organisation, and framework of KM stages.

They compared such frameworks on five dimensions. Two context dimensions, focus and framework roots/origins. Three content dimensions, knowledge resources, knowledge manipulation activities, and influences on the conduct of KM. They found that little attention has been focused on the dimension of knowledge resources. There is no typical characterisation of knowledge manipulation activities. Similarly, there is no typical standard for influences on the conduct of KM. Finally, none of the frameworks subsumes the others. So they conclude that there is a need for a generic KM framework that characterises an organisation knowledge resources.

Holsapple and Joshi (1999) and Heisig's (2009) review shows that while there are many KM frameworks available and they cover a range of applications, there are none specifically for complex IT systems development. The spiral of knowledge creation model discussed in below is relevant for several reasons. It is more relevant for better theoretical understanding, the frameworks contained in the above studies do not develop a theory of KM for complex IT systems development. The generic spiral of knowledge creation proposed by Nonaka (1994) provides better theoretical definition of the term knowledge and understanding of how knowledge is created. Another reason for using the spiral of knowledge creation as explained in the next two sub-sections is that it was developed by studying innovation in Japanese firms. Such innovation can be compared to the innovation needed in developing complex IT systems.

Knowledge creation requires individuals to be competent knowledge creators and knowledge management needs them to be willing to learn and share their knowledge with others for a specific purpose. It is assumed by project managers and the literature on knowledge management that individuals are capable of creating and sharing knowledge. It is necessary to view knowledge management from the perspective of complex IT systems development knowledge management.

Earlier theory of organisational knowledge by Anderson (1996) was regarded as (a) declarative knowledge which cognitive and explicit knowledge and (b) tacit knowledge which is physically embodied in individuals, for example knowledge about riding a bicycle. But as noted earlier, the dominant theory of organisational knowledge creation is by Nonaka and Takeuchi (1995). Like Anderson (1996), Nonaka and Takeuchi use the existing concepts of explicit knowledge and tacit knowledge to explain how through combination of individuation and socialisation for a specific purpose, for example innovation, knowledge is created. Complex IT systems development projects are examples of digital innovation, for example creating an architecture for cloud computing.

The theory of knowledge creation focuses on individuals in organisations. It is the individual who possesses knowledge and shares it. The individual's knowledge is both tacit and explicit and has embedded 'beliefs' and 'commitment' that form the individual's value system. This is the case in IT systems development projects too. It is the individual project manager, systems analyst, requirements engineer, programmer, database administrator and systems tester, as individuals who possess tacit and explicit knowledge. Successful outcome for the project is what knowledge project members possess and how it is shared and managed. Knowledge management then involves project management processes that create and share their knowledge, which is detailed in the following sections.

3.2.2 Tacit and Explicit Knowledge

Polanyi (1966) sought to explain how scientists create knowledge. He distinguished two types of knowledge and explained that knowledge creation is a process involved these two types. An individual possesses the first type tacit knowledge is a way that cannot be verbalised. Tacit knowledge is embodied in an individual. For example, knowledge of how to ride a bicycle is tacit within the individual. When asked to teach a machine how to recognise and distinguish objects, a programmer may find it initially difficult to tell someone how to do it. They would rather demonstrate or show them how it can be done, as in a prototype system. The person learning would rather practice it to know how to do similar coding. So tacit knowledge is not easily formalised. When a programmer is asked to solve a problem, they can tell how they did it. This is explicit knowledge and explicit knowledge can be formalised. Explicit knowledge is recorded in print and in digital storage. Polanyi stated that individuals possess more tacit knowledge than they can communicate.

It can be argued that complex IT systems development consists of similar categories of knowledge. Individual experts possess both tacit and explicit knowledge about systems development. A complex IT systems development project like the NHS patients record possess IT and software problems. A systems analyst may be able to contribute to its design more based on tacit knowledge than explicit systems analysis. Similarly, a programmer might be able to solve a complicated sub-systems interface problem using deep tacit knowledge than explicit algorithms. In both cases, the experts possessing tacit knowledge need to communicate and share it with other project members. The processes involved in doing that is termed the spiral of knowledge creation model.

3.2.3 Spiral of Knowledge Creation Model

Nonaka and Takeuchi's (1995) model of knowledge creation draws on Polanyi's taxonomy of knowledge and combines it with processes for converting it from one type to the other. This they explain is the knowledge creation and application process, as shown in Figure 3-1.

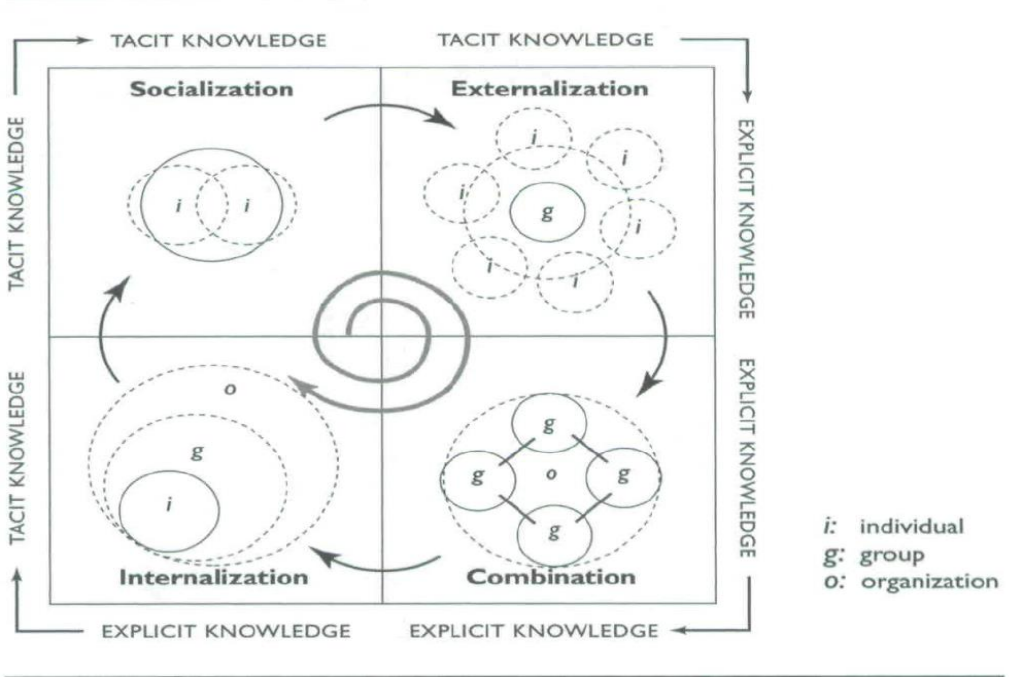

Figure 3-1 Spiral of Knowledge Creation through Tacit and Explict Knowledge

Source: Nonaka and Nonno (1998)

There are four modes of knowledge creation, Socialisation, Externalisation, Internalisation and Combination. These are explained in the context of complex IT systems development projects:

- **Socialisation** is the prime medium through tacit knowledge, which is transferred and shared between people. Socialisation is the process which results in converting the tacit knowledge of one person to tacit knowledge of others. Through socialising individuals convey their tacit knowledge to others. In a complex IT systems development project, an example is an expert API programmer talking to team members about an API problem and conveying experience to the other team members. Explicit knowledge however can be shared by observing, imitation and practice. Since IT systems development projects are unique, tacit knowledge can be brought to bear on particular problems through team meetings, demonstrations, colleagues chatting over lunch or coffee.
- **Combination** is the way explicit knowledge is shared. Combination involves meetings, emails, group chats etc. through which team members can communicate and share knowledge. As explicit is sorted and categorised the process leads to new explicit knowledge – or combination. Combination is more likely in complex IT systems development projects.

Project data and information is normally stored in project management software, which can be used to process the data to produce new insights and information. The project manager would be primarily responsible for combination. Since knowledge is explicit, it is more likely to be shared, compared with tacit knowledge through socialisation.

- **Externalisation** is the process used to transfer tacit knowledge to explicit knowledge. This is done using metaphor. Since tacit knowledge is difficult to talk about, methods like using metaphor can help in externalising it. For example, the NHS IT systems can be described as turning around a large tanker. This conveys the many problems that NHS IT systems encounter. It requires holder of tacit knowledge to be able to talk in terms of metaphor and for others to understand the metaphors.
- **Internalisation** is the process used to transfer explicit knowledge into tacit knowledge. Internalisation is the process of knowing by doing. For example, a new programming technique like object orientation when it was introduced would be learnt by doing. For the individual, internalisation results in new knowledge and skills acquisition. For the project team it results in a skilled expert.

While each mode can itself result in converting knowledge, it is the complete 'cycle' (Nonaka and Takeuchi, 1995) of passing through each one in a process involving tacit to explicit and explicit to tacit knowledge. This is the 'spiral of knowledge creation'. This spiral of knowledge creation model can be interpreted in terms of complex IT systems development projects. IT systems development depend of available explicit knowledge. It is assumed that explicit knowledge is available to complete the project. However, since complex IT systems development project are unique, they necessarily involve creation of new knowledge, either as application of existing knowledge in the new context or creation of new knowledge by combining existing knowledge. In completely new IT systems development projects, it would be necessary to transfer tacit knowledge of an expert or group of experts to team members as explicit knowledge, and this would involve socialisation and externalisation knowledge transfer processes of the knowledge creation model.

Various issues for further research arise for complex IT systems development projects by applying the knowledge creation model. What socialisation channels exist for sharing tacit knowledge between the project manager and project team members? What socialisation are created by project managers? How is explicit knowledge about the systems development articulated? Is the explicit knowledge accessible for project team members? How does the project manager use the project-specific knowledge base? In particular, do project managers use

socialisation and externalisation to make the tacit knowledge of highly expert team members explicit? Even more critical is the question concerning is project-specific knowledge regarded as project knowledge management by project managers? Related to that question concerns the development of project team members for project-specific knowledge management. Finally, what project management techniques can be used to manage project-specific knowledge?

Such questions provide a theoretical framework to investigate knowledge management practices in complex IT systems development projects. The knowledge creation model forms the theoretical basis to understand knowledge management practice in the processes of complex IT systems development projects.

The focal concepts of the SECI model are explicit knowledge and tacit knowledge, and the process of the SECI model involves individuals' creation and possession of knowledge from one state to the other. These concepts and processes are applicable to the process of creating project-specific knowledge for complex IT systems development, as examined in the next Section.

3.3 The Process of IT Systems Development

The process of IT systems development is normally concerned with the production part of developing software and not the technical aspect, which may involve the software tools. The IT systems development process is meant to support the management of the software project. Software development processes are normally biased towards business concerns (Chemuturi, and Cagley, 2010). To increase the chances of IT systems development project management success, it is necessary to ensure appropriate trust management and interpersonal communication among the project manager and the team of developers, and also among the team developers themselves.

The IT systems development team should also seek the involvement of users in the development process. The input of the end user will be useful in making sure that the IT systems specifications are well communicated by the end user and understood by the software developers. If the end user is not involved in the development process, there is a risk of the IT systems developers misinterpreting the requirements and thus developing IT systems that the end user will consider as being unacceptable. Lack of end user involvement also will lead to insensitivity towards changing customer needs, it may also lead to the customer having unrealistic expectations and assuming that these expectations will be met whereas it is impossible to meet them (Chemuturi, and Cagley, 2010).

The communication between project managers, end-users, software developers, project sponsors and the customers are paramount towards the success of the IT systems development project.

Information gathered from this kind of communication ensures will allow the project manager and project stakeholders to conduct SWOT analysis for the IT systems development project. Information communicated early in the project life will be useful in avoiding many risks involved in the project. For risks that cannot be avoided, early communication will allow the project manager to effectively analyse the risks and develop appropriate strategies for mitigating the risks involved. For example, engaging the end-users, stakeholders, and team members in casual conversations can reveal potential problems early in the project life. Communication in project management process should be authentic and honest; it should be carried out regularly and frequently. Criticism is necessary in the ongoing project; however, it must be done in a calm, respectful, non-accusatory, and constructive manner (Ahmed, 2012). To keep the IT systems development project relevant, effective, and within the boundaries of what can be achieved given the existing constraints, there should be frequent communication between the developers and the end users, and among the client and the project manager (Ahmed, 2012).

The unsuccessful decisions made in these projects could be the main reason behind the failure. During the lifetime of the project, many critical decisions are made and if these decisions were based on an accurate and an unambiguous data, the project could be successful. To make a successful decision, the data, which the decision will be built upon, should be accurate and Knowledge management could play a vital role in this regard. Knowledge management is an important asset especially when it comes to software projects.

A similar report has not been done recently. But recent examples of failure are BBC Digital Media (BBC, 2013), NHS Connecting for Health (BBC, 2013), eBoarders and Siren Police IT project (BBC, 2014). The general pattern is one of IT systems development failure.

Table 3-1: The Standish Findings

	1994	1996	1998	2000	2002	2004	2009	2012	2015
Succeeded	16%	27%	26%	28%	34%	29%	32%	27%	13%
Failed	31%	40%	28%	23%	15%	18%	24%	56%	29%
Challenged “	53%	33%	46%	49%	51%	53%	44%	17%	58%

From Table 3-1 it is clear that projects are still failing and the causes of failure are different and not clear (Nasir and Sahibuddin, 2011). A paper (Kaur *et al.*, 2011) analysed several IT systems development projects and failure reasons and they identified several reasons that lead the projects

to failure. The requirements extraction, the lack of users' involvement, team size, time dimension, fixed controller, testing and poor quality management. All of these factors could be improved if they were built on top of a rigorous knowledge management framework. A survey of IT systems development project failures conducted by (El Emam and Koru, 2008) on information technology departments in 2005 and 2007 amid to gauge IT project's real dropping rates, the impact factors, the rate of successful projects and figure out if object size influences the cancellation and success of the project. Furthermore, the paper focuses on mid and senior-level IT project managers. Also, the paper found out that the projects fail without significant difference over time for two main reasons; firstly, the requirements and scope change and secondly there is little or no involvement of the senior management.

Reducing IT Project Management Failures by (Hidding and Nicholas, 2014) focused on early empirical results that can be applied to the failure or success of project management based on both Value-Drive Change Leadership VDCL and the traditional paradigm. In short, their gained result showed that both the traditional paradigm and VDCL produced several factors that are successful. Similar studies were carried out by (Jørgensen, 2014) where the focus was on providing a clearer view of the occurrence and the reasons of encountering failures for small-scale IT systems development projects in the global outsourcing marketplace. Therefore, (Jørgensen, 2014) came up with a model such that previous collaborations between the provider and the client are related to the factors that are connected in the failure's risk of the strongest reduction. Unlike the study of (Hidding and Nicholas, 2014) , The study showed that the failure factors' risks increased while both the project size and low price increased. The paper (McLeod and MacDonell, 2011) focused on a similar study where the factors affecting the development of IT systems and the outcomes of the deployment project were selected. Consequently, the researchers came up with a new classification framework such that a synthesised and abstracted view was represented based on the types and factors affecting the outcomes of the project. (Nasir and Sahibuddin, 2011) found that IT systems development projects comprise five most critical success factors, which can be summarised as:

- The realistic estimation of the budget and schedule;
- The factors of clear and frozen requirements, a competent project manager.

According to (Cecez-kecmanovic and Abrahall, 2014) The failure rate of the development of information systems (IS) has not altered in the last 30 years or so. The rate remains extremely high at 70%, according to Doherty *et al.*, (2012) , which troubles practitioners and puzzles researchers. The disappointment of the failure rates, as well as the imprecise project costing, through the use of the systems are also worrying practitioners and researchers (Urbach *et al.*,

2008; Remus and Wiener, 2010; Doherty *et al.*, 2012; Bloch *et al.*, 2011) . Even with a substantial body of literature on IS projects which proposes and tests a list of technological and organizational factors, which should be able to help the successful completion of the organisations projects (Sabherwal *et al.*, 2006; El Emam and Koru, 2008; Petter *et al.*, 2008) there is still a high, persistent failure rate. Therefore, the huge amount of given knowledge still does not make a difference in IS practice (Doherty *et al.*, 2012; Cobb, 1996). However, this position seems to contradict a recent survey conducted by McKinsey and Company (Cecez-kecmanovic and Abrahall, 2014) which claims that companies worldwide are growing their IS goals and investments for IS which support innovation and growth. According to (Savolainen *et al.*, 2012a) A question that has constantly been on the mind of practitioners and researchers is what is the main reasons behind IT systems development projects failures? Considering that software has successfully been applied in numerous areas, yet the software projects fail, it is thought to be puzzling. For this reason, it has been questioned by researchers whether enough has been learned in order to ensure that IT systems development projects are successful (Cerpa and Verner, 2009). In order to pronounce if any software project has succeeded or failed, the criteria must be agreed on, which is where the IEC (International Electrotechnical Commission) and ISO (International Organization for Standardization) play an important role. The IEC and ISO have settled their individual joint standards, in one of which a project is (Savolainen *et al.*, 2012b). Based on these standards, it has been found that the most commons combination of criteria, which measures the success or failure of the project, is meeting quality, functionality, cost and time goals (Yeo, 2002; Anda *et al.*, 2009; Sumner *et al.*, 2006; El Emam and Koru, 2008; Kappelman *et al.*, 2006; Lai, 1997; Atkinson, 1999). It is clear that more research should be done to study the reasons behind the failure of IT systems projects. The implication may be that the current methodologies and IT systems development processes do not support decision making adequately. Software development methodologies like Agile, Waterfall, Spiral and Software techniques like Planning Poker, wideband Delphi, Source Lines of Code (SLOC), Constructive Cost Model (COCOMO) and Function Point Analysis (Sinhal and Verma, 2013) do not protect the project from failing, and the implication may be that they do not provide enough information to support the decision making process.

The proposed Framework makes use of existing project management activities such as project meetings, technical seminars, brainstorming, etc. (see Sections 6.2 and 6.3) as explicit knowledge creation activities, and help project managers to recognise them as such. They can be used as knowledge creation Ba spaces to manage the knowledge required for handling complexity,

tackling systems integration problems, and specific knowledge of the actual context of the problem, meaning people, IT and organisation.

Every decision should be sustained by sufficient and correct information. Most of the IT systems projects are supported by project management techniques but they do not have a clear and rigorous framework to support the decision-making. For every stage of the project lifecycle, decisions should be taken and if the information is deficient, the decision will be affected. For example, decisions are made during the scheduling of the project, its cost could severely affect the project and its success in terms of project over-spends and over-runs.

This research will develop and validate a framework to support decision-making in IT systems projects through the use of knowledge management. The IT Systems Development Decision-Making Support Framework will provide the infrastructure that will support and guide the decision-making process.

3.3.1 Formulation and Production of Knowledge

Organisational learning is the idea that managers and the organisation need to continuously learn to solve problems and make better decisions, and become more effective (Argyris and Schon, 1974). This can be transferred to IT systems development in which project managers and team members jointly learn about a particular complex IT systems development project. The work of Boyd (2018) on Observe, Orient, Decide, Act (OODA) is in the same vein as Argyris and Schon but is better referenced in the context of decision-making (See Section 6.3).

The idea of knowledge creation and management arose from the notion of ‘knowledge society’ and study of organisation learning. The main paper in this field was by Nonaka (1994). He suggested a dynamic theory of organisational knowledge creation. As noted above, this theory consisted of knowledge creating processes that organisations use to create knowledge for innovation. The core constructs in this theory are that knowledge is created through processes involving tacit knowledge and explicit knowledge. Nonaka acknowledged that individuals create knowledge, but it is the organisation that play a vital role in articulating and amplifying that knowledge. Not too different from projects, these processes, articulating and amplification happens in teams. The main research interest in how organisations process knowledge but more importantly how organisations create knowledge.

Four years later Nonaka (1998) proposed the idea of ‘Ba’ or the space where knowledge is created. This is essentially the difference between information which has no specific context and knowledge which is applied in a specific context, as shown in Figure 3-2. In IT projects, this can

be viewed as the difference between explicit knowledge stored in project databases and project management software and the actual application of that explicit knowledge in the context of systems development, both the development of the system itself as a project and the deployment of the system in the organisational context. Ba is 'a shared space for emerging relationships' (Noanaka, 1998: 40). This space can be physical, such as a desk, office, emails and databases, or it can be mental, such as ideas, experiences, and ideals. In this way Ba provides the space for the advancement of individual and collective knowledge.

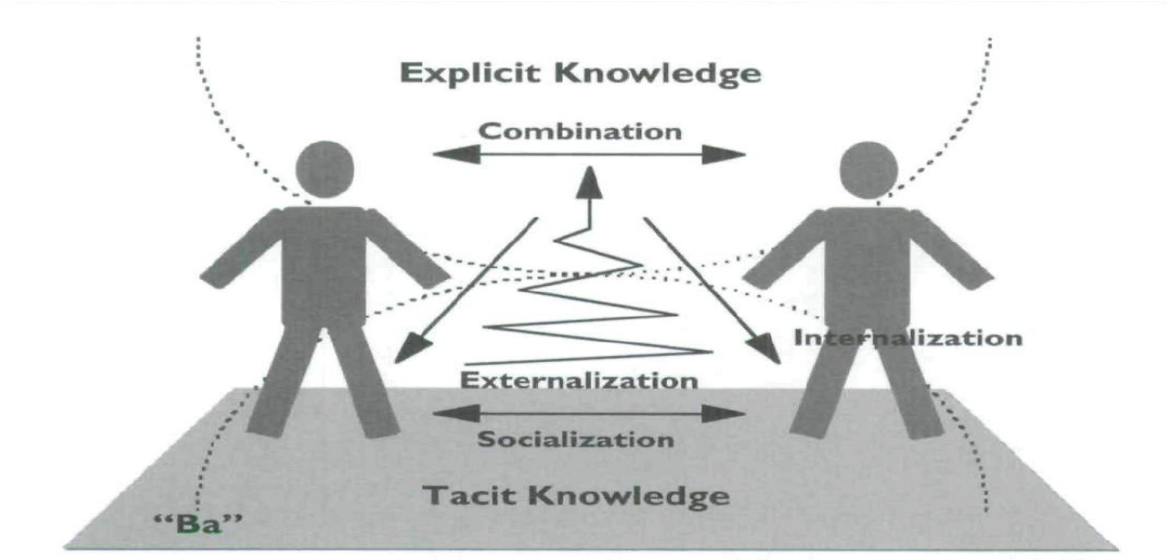

Figure 3-2 Ba as knowledge spaces

Source: (Nonaka and Nonno, 1998)

In the year 2000 Nonaka worked with colleagues to consolidate ideas about knowledge creations, and proposed the model of knowledge creation (Nonaka *et al.*, 2000). This model brought together the previous theories and empirical studies to provide a coherent view of organisational knowledge creation and management for the purpose of strategic advantage. The model of knowledge creation consisted of the SECI process, which is knowledge creation involving the conversion of tacit knowledge and explicit knowledge. It also included Ba or the shared context for knowledge creation. Critically, it added the third element, namely knowledge assets, the inputs, outputs and moderators of the knowledge-creating process. They suggested that the knowledge-creating process is a spiral of these three elements and the basis is dialectical thinking. The key role of top management is to articulate the organisation's knowledge vision and middle management need to act as knowledge producers by energising Ba.

The concept of Ba is confined to a space or place. Bathelt *et al.*, (2004) are critical of this idea of spatial location of tacit knowledge and codified knowledge. Codified knowledge is the same as Nonaka's (1998) explicit knowledge. Bathelt *et al.*, argue that both tacit knowledge and codified

knowledge can transcend local space and be transmitted globally. Their context is economic activity. They argue that knowledge creation happens in an interactive learning process. They argue that tacit knowledge is 'frictionless'.

Krogh (1998) put forward a five-stage process to describe the knowledge-creation process for companies seeking to create value. The initial stage is sharing knowledge, experience and practice in the team. This is making use of existing knowledge gained from previous experience and consists mainly of explicit or codified knowledge. The second stage if the creation of new service or product drawing on the initial stage. The next stage is justification of the concepts through evidence and data. Then a prototype stage seeks to produce the product as a demonstration. The final stage is to disseminate the knowledge and the product throughout the corporation. Krogh basis this model by considering the cognitivist perspective and constructivist perspective. He draws on the constructivist perspective because it incorporates tacit knowledge and explicit knowledge. He argues that 'care' is necessary in knowledge creation and associates care with learning.

3.3.2 Project Decision Making

Decisions about project resources, tasks, schedule, and job role allocation are made by project managers. A project manager is also involved in decisions concerning system analysis, system design, programming, system integration, testing, and implementation. Project managers draw on their training and prior experience to make such decisions. They are able to transfer much of their skills and knowledge across projects. But since complex IT systems development projects development projects are unique in terms of the combination of people, organisation, and IT, such projects require the creation of new project-specific knowledge and its application to decision-making in new contexts.

Knowledge is necessary for decision making. Information helps a project manager to know the parameters, people, and resources of development project, as well as the user requirements. Knowledge enables action to be taken. A project manager needs to make decisions about scheduling, allocating expert programmers, database administrators, API experts and more. Such decisions require actionable knowledge.

Park and Lee (2014) found that knowledge is essential for project management. They called for deeper study to explore how trust and dependence are actually formed among team members. This is critical for project managers because the resulting knowledge is used by project managers to make decisions. Similarly, Pee *et al.*, (2010) examined knowledge sharing in information

systems development. They found that goal interdependence is related to perceived task interdependence and forms the basis for knowledge sharing.

Decision-making theory needs to be considered in the context of complex IT systems development projects and knowledge creation. As noted above, people, organisation, and IT artefact are unique for each project. Also, that the actual context of IT system development involves a complicated mix of interfaces among these elements. Both of these points mean that traditional rational models of decision-making are not appropriate. Additionally, they would not be able to explain how project-specific knowledge creation and usage of knowledge would work in this complicated mix of interfaces.

For example, the Analytic Hierarchy Process (AHP) is a multi-criteria quantitative decision-making approach (Saaty, 1990). In AHP, the factors important for the decision are arranged in a hierarchy. The hierarchies need to include: a full description of the problem that allows for change; take into consideration the environment of the problem; identify issues and factors that contribute to the solution or decision; and, finally, identify critical and relevant people associated with the problem. A criticism of AHP is that it relies on people being able to make judgements based on expert knowledge to deal with uncertainty (Dağdeviren *et al.*, 2009). It is this uncertainty that is also a reason for criticising decision-making based on 'rational man'.

Decision-making models such as the AHP are based on the assumption of 'rational man'. Simon (1979) introduced a model of rational decision making in business. However, this assumption cannot be sustained because people do not always behave rationally and cannot always do so because of social and organisational factors. However, such quantitative decision-making approaches assume that the problem can be structured. There are problems like complex IT systems development that are 'messy problems' which happen in a 'fuzzy environment' that make identifying all the parameters of the problem very problematical.

Consequently, a behavioural perspective of decision making have been proposed. For example, Argyris (1976) proposed the double-loop model of decision-making. In contrast to the single-loop model, the double-loop model questions the assumptions underpinning decision-making. It is this kind of behavioural decision-making that IT project managers' face in complex IT systems development.

Project managers need to make critical decisions in complex IT project development. Such decision includes making decisions about new and innovative IT application, the combination of IT artefacts including software and hardware and it application in a new and unique context to

create an information system. That requires the project manager to become knowledgeable about the IT project, the team members, their collective skills and knowledges, and to harness that for the purpose of developing the IT system.

3.4 Conclusion

Most research in IT project management and project management is focused on tools and techniques specific to project management tasks. Project managers need for project-specific knowledge for decision-making is not well understood. Some research has been done on knowledge management in projects in general. It has examined knowledge has a factor in the success of projects and concluded that proper management of knowledge does contribute to the success of a project. Other research has been done specifically in IT systems development. This research too has concluded that knowledge management is essential for the success of a project. Consequently, this research sought to extend and develop the knowledge management perspective in IT systems development further.

The analytical review of the literature in this Chapter indicates that research is needed in the interdisciplinary area of IT systems development, projects management, knowledge management, and decision-making. This review suggests the need to construct a knowledge management framework for complex IT systems development project management which enhances project managers decision-making. As well as project management techniques, project managers need a framework for managing project-specific knowledge that they can then use to make better decisions. This research on project-specific knowledge management will contribute a framework that is theoretically based in the theory of knowledge creation and provide project managers with a way to structure project-specific knowledge to support their decision-making processes, which is expected to improve complex IT systems development project management success.

As noted earlier, complex IT systems development projects are unique and in essence can be considered entirely new projects with no prior experience. Though the project manager and project team members may have knowledge of and used systems development techniques and tools, skills and knowledge in other projects, their transfer to a new IT systems development project is not as straight forward. This is because the context of a new IT systems development project is unique in terms of the people, organisation and the IT artefact combination required to analyse, design, develop, integrate, test, and implement the system.

It is such unique and new contexts consisting of people, organisation and IT that compose a complex IT systems development project. The project manager and project team members bring their skills and knowledge to the unique project but the new combination of people, organisation and IT mean that it is necessary to consider project-specific knowledge management as an aspect of IT systems development project management.

The literature search shows that some research has been done in the area of project knowledge and that researchers call for further research and longitudinal research, especially in areas of trust and dependence among project team members. It is in this context that the theory of knowledge creation was adopted to investigate project-specific knowledge management in complex IT systems development projects. The spiral of knowledge creation model has individuals and teams as its unit of analysis and assumes that individuals and teams are willing to share knowledge. It explains that innovation, as in a complex IT systems development project, requires knowledge creation. This Chapter thus identified the relevant concepts and theoretical perspective of the research topic, namely knowledge creation, acquisition, sharing, and application for project decision-making by IT project managers. In the next Chapter the research methodology to investigate how this theoretical perspective and specifically the knowledge management constructs are detailed.

CHAPTER 4 RESEARCH METHODOLOGY

4.1 Introduction

In the previous Chapter the literature search revealed that project management research focuses on tools and techniques of project management, but that it neglects project-specific knowledge which is characteristic of complex IT systems development projects. This led to considering knowledge creation theory and knowledge management frameworks as a valuable perspective for IT systems development projects that could enhance project managers' decision-making. The theory of knowledge creation or the SECI model and its four phases for converting tacit knowledge into explicit knowledge and vice versa was determined as the appropriate theoretical framework to investigate how IT project managers manage project-specific knowledge in complex IT systems development projects. In this Chapter the research philosophy, research approach, data collection and analysis methods required to investigate knowledge management in IT systems development projects is explained. An academic inquiry like this research differs from ordinary inquiry because it is required to define the research methodology used to investigate the phenomenon of interest and draw conclusions from the collected data for theoretical contribution and impact on practice.

The research methodology enables the research question and objectives to be operationalised. The research methodology is important because the research design needs to be appropriate for the kind and volume of data needed to complete the research objectives. The choice of the research philosophy and approach, as well as the data collections and analysis techniques need to align well with the research aim and objectives. The research aim and objectives of this research can be achieved using a research methodology and they need to be related specifically to the data collection and analysis procedures used.

Saunders *et al.,* (2009) illustrate typical elements for research design, as shown in Figure 4-1. The elements are research philosophy, methodological approach, research strategy, choice methods, time scale, techniques and procedures. The appropriate decisions made regarding these methodological elements for this research are explained in this Chapter.

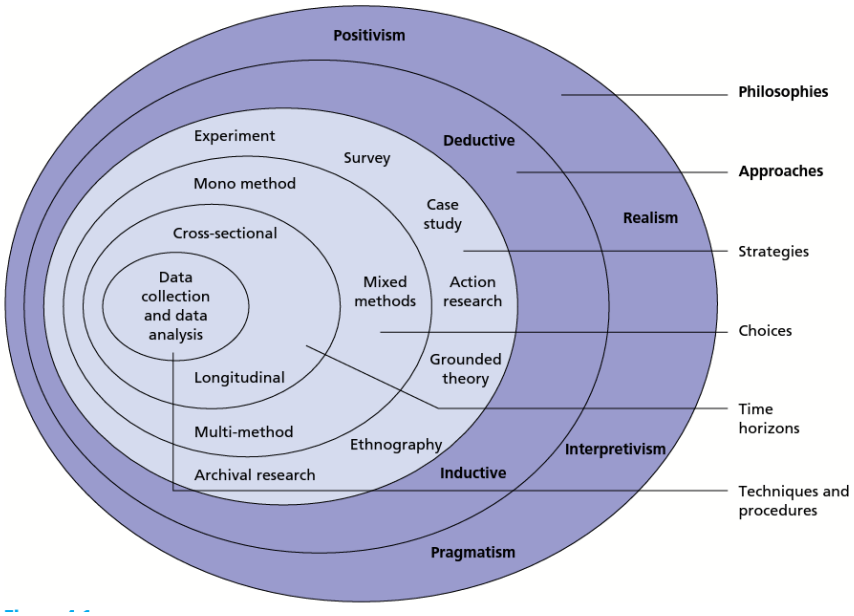

Figure 4-1 Research Onion

After Saunders *et al.* (2011)

Drawing on Saunders *et al.*, (2011), this research onion is interpreted and simplified in this research as shown in Figure 4-2. The adopted research philosophy is pragmatism, the research approach is inductive, the research strategy is qualitative, and the research methods are semis-structured interviews and focus groups. This methodology is appropriate to complete the research aim and objectives, which seek to conceptualise a knowledge management framework for project managers to support decision processes in complex IT systems development projects.

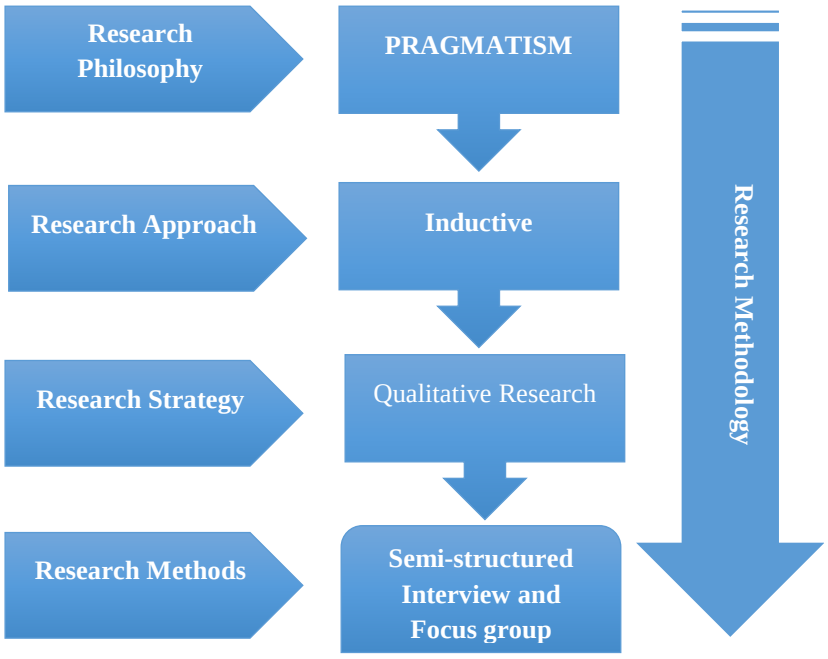

Figure 4-2: Research Onion applied to the Research Project

Bredillet (2010) argues that project management in general is ‘moving from an old paradigm—positivist - to a new one or to a more balanced one combining positivism, constructivism, and subjectivism, enabling us to address complexity, uncertainty, and ambiguity, because the old one is not working anymore’ (p.6). The use of qualitative interviews and focus group method for this research can be justified in this context. Bredillet ends by stating that: “As a young discipline, the theoretical foundation of the field is still in its early stages of development”.

4.2 Pragmatism Research Philosophy

The pragmatism research philosophy was adopted because it has a practical perspective. Pragmatists focus on research methods that result in a practical application of the research findings. So, they draw on all available research approaches and methods but orientate them for practical relevance. Since the research on IT systems development project management is concerned with developing a practical framework, the IT Systems Development Decision-Making Support Framework, to support the practice of IT systems development project management, the pragmatist philosophy is appropriate. As well as contributing theoretical knowledge, the intention is to enable IT project managers to apply the Framework in practice to enhance decision-making.

Pragmatism is concerned with the utility of action both scientific and practical (Corley and Gioia, 2011). Pragmatism also facilitates organisational adaptiveness and produces theory composed of statement of concepts which are interrelated and explains how and why they happen.

Pragmatism will be applied is this research to understand how IT project managers learn about and apply project-specific knowledge to enhance decision-making. It is argued that IT project managers produce beliefs or knowledge and generalisations that are pragmatic (Watson, 1996). They learn about the specific IT system development drawing on their values, but it is pragmatism that shapes their behaviour. However, it is the context which determines what they are actually capable of achieving.

Pragmatism can be synthesised with the qualitative research approach adopted for data collection. As noted above, IT project managers learn about the IT project drawing on their previous knowledge but aim to apply it to the particular situation and context of the IT system being developed. But critically they generate project-specific knowledge, which they learn through sharing with the team members, business people and external consultants. Perhaps IT project managers actually think as Peirce advocated: "Consider the practical effects of the objects of

your conception. Then, your conception of those effects is the whole of your conception of the object" (Peirce, 1905).

The chosen in-depth interview method and focus group research method can be used with the pragmatist research philosophy. The aim is to assess what is feasible and can work during data collection to achieve the research objectives. Since pragmatism is concerned with finding what works (Cresswell, 2003), the pragmatist research philosophy too needs to be consistent with the adopted research methods. And it needs to facilitate the investigation of the research problem and pursuit of the research questions.

4.3 Qualitative Research Approach

Qualitative research is concerned with interpreting the subjective views of the subjects involved in the research phenomenon and the researcher him or herself. It aims to develop tacit and reflexive skills (within the self) of the researcher. Then such a trained researcher is able to observe, listen and interpret psychosocial phenomena (Bryman and Bell, 201; Zikmund *et al.*, 2010; Punch, 2005).

Qualitative data explains the phenomenon from the point of view of the participants or 'actors' in involved in the phenomenon. Since there are not only many such actors but also many groups of actors, qualitative research uncovers multiple realities to develop a holistic understanding or picture of the phenomenon for the particular context under investigation (Frost *et al.*, 2010). Malakolunthu (2007) suggests qualitative data obtained through interviews and focus groups, allows the researcher to develop deeper and contextually rich understanding of the people, situation, and issues reflected in the phenomenon. Adopting the qualitative approach for this research will enable the researcher to collect data about project managers' psychosocial behaviour, meaning, and actions, as well as the same for team members. It will uncover their attitudes, skills, and knowledge they bring to a particular IT systems development project.

Research methodology aids the researcher to make decisions about the research approach, data collection, and data analysis methods (Merriam, 1998). The chosen research methodology needs to enable the research objectives to be completed. This research used two phases of qualitative data collection to design the decision support framework and focus group interviews to validate the developed framework. The qualitative research methods enable explanation of the theoretical constructs of the conceptual framework by reference to the attributes and quality of the phenomenon. In this research, the attributes and qualities refer to systems development project, people, organisation, project team members, and project manager, IT artefacts, as well as others

involved in the project. They also refer to linkages or relationships between these groups and the communication between them. In particular, to examine the quality concerning knowledge creation and knowledge sharing, and the meaning that people attribute to their actions in the unique context and situation of complex IT systems development project knowledge management.

The stages of the research design adopted are illustrated in Figure 4-3 below and explained further in the remainder of this Chapter. The first stage involved a search of the research literature on project management, tools, and techniques for project management, focusing on estimation techniques and work scheduling. The search revealed that current project management frameworks were lacking a theoretical knowledge management perspective. The main questions was how project managers manage project-specific knowledge for the successful delivery of projects. Data was collected to observe project managers' practice empirically.

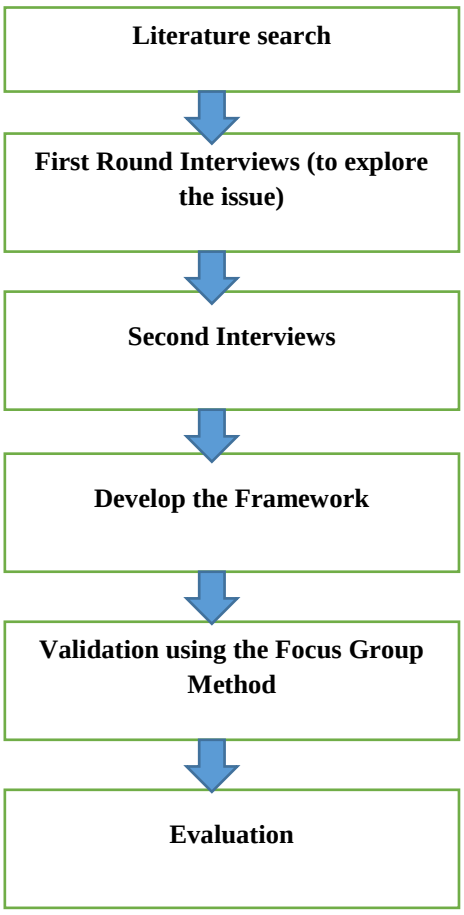

Figure 4-3: Research Methodology

The qualitative research methodology will be linked to the research objectives and the development of the conceptual framework. Qualitative research is used to determine, analyse, and

understand the processes involved in a phenomenon (Denzin and Lincoln, 1994). It aims to examine and explain how certain processes produce a phenomenon. In this research, this means identifying and analysing processes of project-specific knowledge creation and knowledge sharing in a complex IT systems development. That is the processes of knowledge management in IT systems development projects to facilitate decision-making.

Denzin and Lincoln (1994) state that the aim of qualitative research is to discover new factors and patterns from the collected data. This provides insight about how a phenomenon happens and works. Since each data set collected by different researchers is unique, the researcher may be led to fresh interpretation stemming from a different perspective. In this research the interest was on how complex IT systems development knowledge is managed within a specific project environment. What processes are involved to create project-specific knowledge from the existing knowledge possessed by project team members? And how such project-specific knowledge is managed to aid project managers' decision-making.

Researchers use either quantitative research or qualitative research. They are considered to be the two main research approaches. However, some researchers who use a third method. This third method is known as the mixed method which consists of the combination of qualitative and quantitative research. With this method it is much more accessible in exploiting the advantages of both methods; thus, making any argument in a study more accurate and persuasive. With this method, and the result of the statistical analysis, the hypotheses can either be supported or discredited (Creswell, 2013). The qualitative research approach will be used in this research.

Quantitative methodology is based on statistical and mathematical analysis. According (Saunders *et al.*, 2011), the data which is collected through the quantitative method is used to measure reality and to create meanings through the analysis of the data while keeping an open-minded and neutral stance. On the other hand, there is qualitative data which may involve numerous data collection techniques and consists of a procedure based on the analysis of the data which will contribute to the generation of non-numerical data. This type of data may include videos, clips, texts and pictures (Saunders *et al.*, 2011) . Therefore, qualitative data does not include statistics. Instead, it is a textual method and it consists of the research analysing the data, which has been collected, very thoroughly and coming to a conclusion. Qualitative data method is analysed the way that has been mentioned above (Saunders *et al.*, 2011).

Qualitative interview and focus group interview data is collected using self-reported data (Kuan *et al.*, 2014). Self-reported data is used in scientific research like medical research. It is data that is reported by the subject group. The researcher will derive interview questions from the literature search based on theories of knowledge creation and management to achieve the relevant research objectives. The questions for the focus group will be based on the analysis of the first and second round of interviews data analysis. Both sets of interviews will be trailed to check the robustness of the questions and the final interview and focus group questions amended accordingly.

4.3.1 Achieving Research Objectives

A qualitative research methodology was designed to enable the achievement of the research aim and objectives. The aim of this research is to investigate how project-specific knowledge is created and used to support decision processes and to develop a knowledge management framework based on the collected data. Qualitative research is inductive (Holyoak and Morrison, 2005). The research objectives were achieved using qualitative methods, two rounds of in-depth interviews to collect data to develop the framework and focus group to collect data to validate it. The purpose was to derive an explanation of knowledge management for decision support. The research objectives are:

- To conduct a critical literature search in the domains of IT systems development project management, decision-making, knowledge management frameworks, focusing on existing examples of knowledge management, knowledge management techniques and underpinning project management and knowledge management theories;
- To identify knowledge creation and knowledge flows in IT systems development project management;
- To capture expert IT systems development project managers' decision-making processes;
- To develop a novel IT systems development IT Systems Development Decision-Making Support Framework based on knowledge management to enable IT systems development project managers to make more effective decisions to improve the success of projects;
- To evaluate and validate the framework with expert IT systems development project managers.

In-depth interviews and focus group were determined to be suitable to achieve these objectives. This is because qualitative methods aims to explain how a phenomenon happens in context. The objectives cover the processes involved in creating, capturing and sharing project-specific knowledge, as well as capturing and sharing existing knowledge possessed by project team

members. Such processes happen in the context of complex IT systems development and in particular situations, usually involving identifying and solving systems analysis, design and implementation problems. Project managers do this in specific project contexts in order to gather information to make decisions. So qualitative methods focus on context and situation, as well as the meaning that actors attach to their actions, can be used to understand the IT systems development phenomenon in its context.

Qualitative research methods are used to uncover actors' meaning as indicated by their actions. Since social action happens in context, the meaning is linked to the context and qualitative methods result in data that is used to understand both the context and the action in context. Creswell (2013) states qualitative methods are used to explain how actors make sense of their action in context and the particular situation. This means uncovering the subjects involved and the processes. This is relevant for explaining knowledge management in complex IT systems development projects. The unique combination of people, organisation, IT and purposeful action results in actions designed to achieve the goal of developing IT systems. This combination itself is complex and the complexity of developing an IT solution is added to it. To understand this complexity, it is necessary to obtain data about peoples' actions in context.

- To identify knowledge creation and knowledge flows in IT systems development project management;
- To capture expert IT systems development project managers' decision-making processes.

The organisational context and IT systems development contexts included simple, routine, and complex IT systems development projects. Budgets ranged from below £50k to over £1m. Project teams ranged between 20 to over 50 members. The participants included programmers, business analysts, project managers, systems testers, database administrators and their experience ranged between 5 to over 21 years (See Appendix D).

Project managers involved in decision-making in complex project required better coordination of the project members and project sponsors. Information and knowledge to make involved systems design decisions, involved coding decisions, and integrations decisions was common among the participants. The organisational structure in the IT projects varied from being highly structured and coordinated to having loose structures, depending on the complexity of the development tasks. Some project managers used prescribed methodologies. Often, in the case of complex projects, all the communication and meetings were organised in the project office.

The organisational context varied from medium sized companies to large companies. The IT project teams worked alongside the business process owners. Some companies adhered to well defined organisational structure while others although they had a structure the actual operation was ad hoc. Also, the support that the IT project teams received varied from companies providing supportive assets such as access to business process owners to less supportive, meaning they could not identify relevant people to help inform decision-making. The limitation of organizational context could contribute to some projects to failing or become too expensive. Most IT project teams were accommodated well by business process owners and project managers reported that this helped then to follow the scope of the project definition. Some organisational issues impeded because of the necessity of adhering to business rules which sometimes do not fully comply with the IT project efficiency.

The organisational context is linked to the IT systems development context when both are aligned in terms of business processes, IT project managers noted. This contributes to achieving more efficiency. The project environment generally benefitted from such alignment. However, project managers noted 'the concrete limitations' in some of the IT systems due to the limited flexibilities of organisations which can produce some drawbacks in project environment. Most project teams used available recording and monitoring methods. For example, project cards based on PMI and also their Intranet based applications which support the PMI framework and policies. Because of the complexity SCRUM was popular. Scrum organized clustering of the teams was also used to create an osmotic environment. Also regular workshops and brainstorming session are recorded.

Data was collected about knowledge creation for unique systems development problems, including how it flows from tacit knowledge to explicit knowledge and back to tacit knowledge. Data was also collected about the decision-making processes of project managers and how specific project knowledge is used.

A common scenario for which data was gathered is resolving complex systems development and integration problems. This covered research objectives 2 and 3, which focus on understanding knowledge intensive aspects of complex IT systems development projects. So, data for these objectives was collected using in-depth interviews. The specific data to be collected was determined by the conceptual framework for complex IT systems development project knowledge management. The in-depth interview questions were initially formulated based on this contextual conceptual framework.

The first research objective was achieved by conducting a systematic search and analysis of project management, IT systems project management, knowledge management, and decision-making literature. This was done by using publications databases provided by the University and keyword searches were used. The questions for the first round interviews were developed from this systematic reading of the literature.

4.3.2 Implementation of the Methodology

As illustrated in Figure 4. 4, the implementation of the research methodology resulted in the KM framework. It shows the collection of the primary data and illustrating when the KM framework was developed. The research methodology was implemented leading to the KM framework in seven steps.

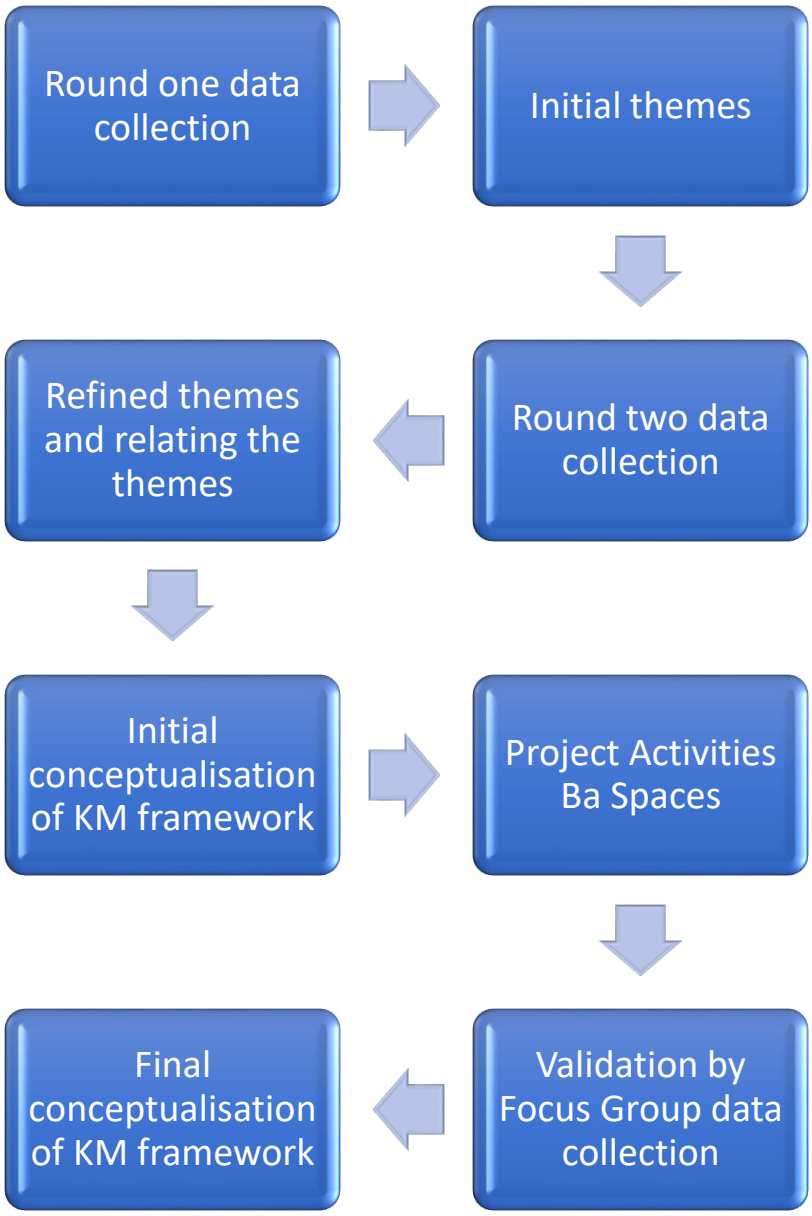

Figure 4-4 Implementation of the Methodology

In the first step initial data was collected about IT projects, project management, and participants. Forming themes relating to knowledge were drawn from it. This information was used to design the second round of interviews and the collected data was analysed in terms of the SECI model. This resulted in identifying meta-themes that exactly reflected the constituents of the SECI model, confirming the core knowledge creation activities in IT project management – Socialisation, Externalisation, Combination, and Integration. These refined themes and their interrelationships were then used to construct the initial conceptualisation of the KM framework with further development of the meta-themes and project activities that reflected the creative Ba spaces and the recording Ba spaces involved in IT projects. The resulting initial KM framework was used to

design questions for the focus group validation step. Data from this step was then used to refine the KM framework to propose the final conceptualisation.

4.4 Primary Research

For this study, qualitative data was collected using two rounds of in-depth interviews to design the IT Systems Development Decision-Making Support Framework. The qualitative data in the first round of interviews consisted of project managers' experiences, observations, and opinions about project management and on the reasons for project failures. The questions covered domains of project management and decision-making to identify existing techniques and tools used by project managers. These can be categorized under the qualitative method (Krishnaswami and Satyaprasad, 2010). Considering that the data collection techniques and analysis procedures took place one after the other, this approach can be categorized as inductive. The second round of interviews then further explored issues arising from the analysis of the data from the first-round interviews in order to identify potential knowledge management constructs for which to collect data.

The primary research collected data to develop the Framework. The first round of interviews revealed that project managers do try to externalise their own and other project members' project-specific knowledge by monitoring the project and build a knowledge base about the project. The second round of interviews then collected data to understand how tacit knowledge is externalised through Ba such as project meetings, emails and other forms of communication such as documentation and stored in repositories and KM tools. The other stages of knowledge creation spiral, Combination, Integration and Internalisation were also studied by collecting data through the in-depth interview rounds and validated through focus group.

To understand the role of project-specific knowledge in complex IT systems development projects qualitative approach is appropriate. Qualitative approach is recommended when a researcher wants to understand the important constructs of the situation through the contextual interactions of actors (Cresswell, 2003). It allows the researcher to use multiple ways to investigate the phenomenon. It is straightforward to describe, and report and the rich qualitative data is useful to define constructs better.

The qualitative approach helped to understand the required concepts, elements, and their relationship of the Framework. Data collection focused on the social context in which business people, project managers, team members, and consultants interact with each other. This creates a deep context of social settings and social interactions and actionable knowledge is created and

applied in such particular contexts. This social interaction needs to be explained in terms of creating project-specific knowledge and decision-making processes. As project-specific knowledge is used in the context of developing complex IT systems, the methodology needs to be able to investigate the context. Knowledge becomes clearer while dealing with the problem in the context. As the problem becomes clearer the need for particular knowledge becomes clearer. The context in the case of developing complex IT systems consists of people, organisation, and IT artefacts.

4.4.1 In-depth Interviews

The purpose of the first-round interviews with eight project managers was to explore their current practices. Questions of interest included: What issues do project managers encounter? How do they estimate programming time? How do they schedule tasks? What KM tools do they use? What knowledge management activities do they use?

The findings from this round were used to design the second round of in-depth interviews. The second-round semi-structured interviews with twenty-six project managers focused specifically on assessing the SECI model in practice. Questions on Socialisation, Externalisation, Combination and Internalisation of knowledge in IT systems development projects were formulated. The focus was on how project managers create and encourage sharing of project knowledge. What specific knowledge is created through Socialisation, Externalisation, Combination and Internalisation? And understand how it is shared among team members. Data was collected on sharing prior knowledge, gained through previous experience, education, and training, and sharing newly emerging project-specific knowledge will be studied. Another focus was on how project managers use their existing and newly generated project-specific knowledge to make project decisions. Complex IT systems development projects require unique problem-framing, as expressed by the user requirements, as well as problem-solving and resolution, all of which entails expert project-specific knowledge. The aim of the second round of interviews was thus to examine the Socialisation, Externalisation, Combination and Internalisation of unique project knowledge to deliver successful projects through effective decision-making.

The two sets of data from the first round and second round were then used to develop the IT Systems Development Decision-Making Support Framework. The datasets were analysed to reveal what actual project knowledge activities happen as Socialisation, Externalisation, Combination and Internalisation. And where such project-specific activities happen – the Ba or spaces for knowledge creation. Data on the decision-making processes used by project managers

to make project decisions was used to develop relevant decision-making constructs for the Framework focused on Ba. Both the data-content of the SECI modes of knowledge and the decision-making processes were thus used to develop the IT Systems Development Decision-Making Support Framework for complex IT systems development projects. The core of this Framework is the decision-making processes as informed by the SECI modes of knowledge creation and knowledge management.

Sampling is important because it gathers data from which generalisations can be made. If the sample is biased or not representative of the population, then the conclusions drawn from it cannot be generalised. Sampling is the data sources selection techniques used to identify objects of study or research participants from a population (Levy and Lemeshow, 2013).

The sampling technique chosen for the first round of interviews was the convenience sampling technique (Baker, 2013; Robinson, 2014). Convenience sampling is an 'uncontrolled convenience samples that produce estimates assuming that respondents are a random sample' (Baker, 2013). It was chosen because project managers have a network of professional connections which the researcher can use to get participants. Like other professionals, project managers usually draw on their network to deal with particular problems they encounter during a project. So, they would likely have close connections they can depend on to give advice and guidance. It is these people that the convenience sample aimed to attract. However, the sampling approach was constrained by reaching 'saturation' in the convenience sample (Gentles, 2015). Project managers with relevant experiences dried-up with each subsequent recommendation, which is when interview data collection stopped.

Robinson (2014) provides theoretical and practical guidelines for sampling in qualitative research. Sampling needs to consider the sample universe which states inclusion and exclusion criteria for research participants. It needs to define the sample size, which needs to consider the research methods used to make knowledge or epistemology and practical concerns. This enables the selection of a sampling strategy that could be random sampling, convenience sampling, stratified sampling, and quota sampling. Finally, sample sourcing which is finding the actual research participants and can be done by incentives, adverts, none-bias, and the ethical consideration to get informed consent.

The sample source for the interviews was through the professional networks of project managers. The researcher was able to draw on a convenience sample of 8 experienced project managers through their professional network for the first round and 26 project managers for the second

round. This was relevant because project managers look for advice and guidance from close professional network and this indicates knowledge sharing. The inclusion criteria used to select the convenience samples were:

- Must have 2 years' experience of IT systems development project management;
- Must have managed complex projects - as measured by complexity of requirements, uniqueness of project, different levels of people and departments involved, IT hardware;
- Must require high levels of project knowledge and skills/technical; analytical skills and new project knowledge that project managers have not experienced;
- Issues should have arisen about meeting project requirements by available project knowledge and expertise;
- Project managers must have high levels of knowledge and skills/technical; analytical skills; decision-making skills; social and communication skills;
- Project managers must have managed at least five people in a project;
- Project managers must have managed at least medium sized project $250,000;
- Project managers must have used project management techniques like PRINCE.

For the focus group interviews to validate the developed Framework 5 project managers from the second round were available and agreed to participate.

So, data was collected using two recognised qualitative methods, in-depth semi-structured interviews and focus groups. These are used by researchers who want to understand the meaning of peoples' actions as reported by themselves. This is normally done as interpretive research and Bredillet (2010) proposes that IT systems development project management is 'a complicated integrative knowledge fields', which needs to account for complexity, uncertainty, and ambiguity which arises in particular contexts. Interview questions were designed covering demographics, project management techniques used, especially time estimation, resource pool and knowledge base, and decision-making process. The focus was on project activities and decision-making concerned project-specific knowledge. Preliminary analysis of the collected data showed that expert IT project managers, as measured by their years of experience, tend to use their qualitative judgement, rather than formal metrics. Formal metrics are used more by novice IT project managers. Compared to experienced project managers, novice project managers tended to use formal metric to inform their decision-making. This and other findings were explored further in the second round of interviews.

The second set of interviews covered data collection to understand the theoretical underpinning of the Framework – the SECI model. To understand how Socialisation, Externalisation,

Combination and Internalisation of the creation and application of project-specific knowledge. This second set of interviews focused on the creation of knowledge and sharing of knowledge. Sharing of knowledge in a project context, which is done in the wider organisational context, is an issue because it is the key for the success of IT systems development projects. How well is the project-specific knowledge being shared was a key theme of the interview questions.

4.4.2 Focus Group Interviews

Focus group interviews were to determine consensus validation of the IT Systems Development Decision-Making Support Framework. The focus group method is used to establish a consensus among expert people. There is no defined way of conducting focus group interviews. Pitt *et al.* (1995) suggested how to design focus group, perform analysis, and report the results. This would produce better studies with validated results.

In focus groups, respondents differing knowledge is elicited and a consensus is formed on a specific topic or domain of expertise. The process begins by selecting domain experts and each one is asked to provide their knowledge about the domain topic. These inputs are collectively discussed for in-depth, focused understanding. The outcome is used to corroborate the existing themes and identify new emerging ones. This process was applied to validate the developed Framework. The Framework was presented to the 5 focus group participants and formed the basis for the focused discussion. Pitt *et al.* (1995) used the focus group method in their research. They used follow-up interviews to deepen the insights about the importance of the ranking.

The focus of the validation was on the relevance of the theory of knowledge management for creating and managing project-specific knowledge, and how such knowledge was applied to decision-making. Since, the Framework is based on theoretical knowledge creation constructs and evidenced by the empirical data, its practical use needed to be validated through the focus group method (See Chapter 7).

4.5 Thematic Data Analysis

The collected data was analysed using established data analysis methods for qualitative data. Such data analysis techniques are reliable (Creswell, 2013; Walsh, 2015). In this section the data analysis techniques used are explained. Data was analysed using thematic analysis technique. Thomas and Harden (2008) say that thematic analysis is used to develop knowledge for practice. This is significant because the aim of the developed Framework was to validate it for practice.

To identify emerging themes and theoretical constructs in the data the first round and second round interview data were thematically analysed. In the first round of data collected this resulted in identifying unexplored themes. In the second round of data collected this resulted in determining ideas, initial themes, codes, and cluster codes that became candidate constructs.

Data analysis followed the core methods in Miles and Huberman (1994). Qualitative data results in 'some lawful and reasonably stable relationships':

> "Human relationships and societies have peculiarities that make a realist approach to understanding them more complex – but not impossible. Unlike researchers in physics, we must contend with institutions, structures, practices, and conventions that people reproduce and transform. Human meanings and intentions are worked out within the framework of these structures – structures that are invisible but nonetheless real".
>
> (Miles and Huberman 1994 p.4)

Since the particular context and situation is significantly important in complex IT systems development projects, the data analysis focused understanding and accounting for context. Context is significant because each individual complex IT systems development is unique because of the variation in organisation, people and IT used. This unique context of variable organisation, people and IT requires its own contextual knowledge about applying IT.

The actual steps of the data analysis involved understanding and getting acquainted with the collected data, followed by initial open coding to explore comprehensively the available range of themes, the data was then sorted and similar themes were connected. This was for each of the rounds of data collection, two rounds of in-depth interviews and focus group.

Lapadat (2010) defines thematic analysis as:

> "…identifying themes or patterns of cultural meaning; coding and classifying data, usually textual, according to themes; and interpreting the resulting thematic structures by seeking commonalties, relationships, overarching patterns, theoretical constructs, or explanatory principles".
>
> (Lapadat 2010 pp. 925-926).

Thematic analysis follows the structural coding technique. Structural coding assumes that a theoretical framework is proposed to explain the phenomenon for which the data has been collected. Saladana explains that:

> "Structural coding applies a content based or conceptual phrase representing a topic of inquiry to a segment of data that relates to a specific research question used to frame the interview"
>
> (Saldana, 2013: p.84).

MacQueen links the transcript data analysis:

> "The result of structural coding is the identification of broad categories of the transcript text, which then enable in-depth analysis of the data within and across topics".
>
> (MacQueen, et. al., 2008: 125).

Each of the separate sets of data was analysed by identifying ideas, initial codes, themes, and cluster codes. This was focused further by identifying patterns of meaning that emerged given by the participants, such patterns were interpreted as potential constructs. Suitable codes were allocated to the emerging themes and the themes were classified, both in accordance with the development of the IT Systems Development Decision-Making Support Framework. Then the resulting thematic structure was interpreted by identifying commonalities, patterns, and theoretical constructs through the lens of the theory of knowledge creation and knowledge management.

4.6 Risk Management

The research project has risks associated with it. As it involves getting self-reported data from systems developers, their permission and availability needs to be ensured.

Access to the companies in which the ongoing complex IT systems development project management is to be studied has been obtained. Letters of introduction were written to the companies identified through the researcher's network and meetings arranged to introduce the research. For the first and second-round interviews the researcher had secured the participation of project managers for the interviews. In case any were not able to take part because of lack of availability, four more had been contacted for their potential participation and they had agreed. The same was done for the focus group interviews to gather the data to validate the conceptual framework.

4.7 Conclusion

In this Chapter the research methodology was detailed, consisting of the research philosophy, research approach, and research methods and techniques. A qualitative research approach was selected along with in-depth interview method to collect the data and focus group interviews to validate the IT Systems Development Decision-Making Support Framework. The qualitative approach is suitable because the context in which IT systems development project-specific knowledge is created, acquired, and applied to decision-making affects knowledge. By considering the context of complex IT systems development it is possible to identify sources of data and the data itself that will be most relevant. This enabled operationalisation of the conceptual framework to collect relevant data. In the next Chapter the data collection and analysis

process will be described. This will result in the concepts, elements, and constructs, and their relationships for the development of the IT Systems Development Decision-Making Support Framework in Chapter 5. The limitations of the research are covered in Section 5.2.6.

CHAPTER 5 DATA ANALYSIS

5.1 Introduction

The research methodology design was explained in Chapter 3. The pragmatist research philosophy was adopted because the aim is to contribute theoretical understanding and practical application of knowledge management for decision-making in complex IT systems development projects. Two rounds of qualitative in-depth interviews were chosen to collect data because they are compatible with the pragmatist research philosophy and the qualitative approach. And focus group method was chosen to validate the developed framework (See Section 7.2). In this Chapter the defined research methodology as implemented will be explained through the procedures used to analyse the data. The data analysis is to uncover ideas, themes, codes, and cluster codes, such cluster codes reveal patterns in the data that can be interpreted as potential constructs to use for the development of IT Systems Development Decision-Support Framework, as explained in Chapter 5.

The data was collected through in-depth, semi-structured interviews and focus group interviews. In the two rounds of interviews, the first round was exploratory, and its analysis informed the second-round interviews. The initial interview data was collected to obtain an overview of complex IT systems development projects, including user requirements, scheduling, resources, task allocation, and decision-making. Analysis of this data resulted in identifying areas for further exploration. So, a second round of interviews was designed. After thematically analysing the data from the second round, an initial framework for complex IT systems development project-specific knowledge management to support decision-making emerged. Analysis of the second round of interviews enabled the construction of the Framework (See Section 5.4). Focus group interviews were then used to verify and validate the Framework with experienced IT systems development project managers through focus group discussion (See Chapter 7).

Access to the research participants had been arranged through initial email contact and telephonic conversation. Those willing to take part were then sent the Research Information Sheet (See Appendix A) and the Participant Consent Form (Appendix B). On the day of the interviews the participants first signed the consent form and then the interview started. The interviews were conducted in the participants' workplace and each interview lasted on average 50-80 minutes. The same procedure was followed for the focus group interviews, which lasted approximately 180 minutes. Apart from travelling to Saudi Arabia to conduct the interviews no practical problems arose during the data collection. Example of the interview questions are in Appendices

C and D. Focus group questions are in Appendix E. The samples and sampling criteria were explained in Section 4.3.

5.2 Thematic Data Analysis Method

The thematic analysis data analysis technique was identified to be suitable for the collected data. As the data was collected based on the literature search, which identified relevant knowledge management concepts based on the theory of knowledge creation, it was necessary to identify the patterns and relationships present in the data. The thematic analysis technique is suitable for extracting such themes and their interrelationships. It is normally used to find emerging issues, unexplored factors, and interconnections between them. The actual data analysis used followed the core techniques found in Miles and Huberman (1994) and Saldana (2012). Miles and Huberman argue that generalisation is possible from qualitative data. They state that qualitative data produces 'some lawful and reasonably stable relationships' when rigorously analysed:

> "Human relationships and societies have peculiarities that make a realist approach to understanding them more complex – but not impossible. Unlike researchers in physics, we must contend with institutions, structures, practices, and conventions that people reproduce and transform. Human meanings and intentions are worked out within the framework of these structures – structures that are invisible but nonetheless real".
>
> (Miles and Huberman p.4).

As noted in the research aim and objectives, and identified in the literature search, context is significant in the creation, acquisition, sharing and application of project-specific knowledge. The thematic data analysis focused on accounting for the context in which project managers need to make decisions in order to deliver an IT. The questions of interest include: What issues concerning project development knowledge do project managers encounter? How do they estimate programming time? How do they solicit information from team members and synthesise it? Also, the emerging knowledge process themes need to be identified. So, the researcher proceeded by acquainting with the data. This consisted of carefully reading the interview transcriptions and making notes then, by starting initial open coding, to begin to identify patterns in the respondents' interview responses. Then followed the sorting and connecting of the identified themes and developing the thematic analysis for each round of the interviews. Finally, the results were synthesised in order to report lessons learnt.

Figure 5-1 illustrates the coding steps followed. This procedure is a synthesis of Miles and Huberman's (1994) and Saldana's (2012) guidance on coding, as explained in this section.

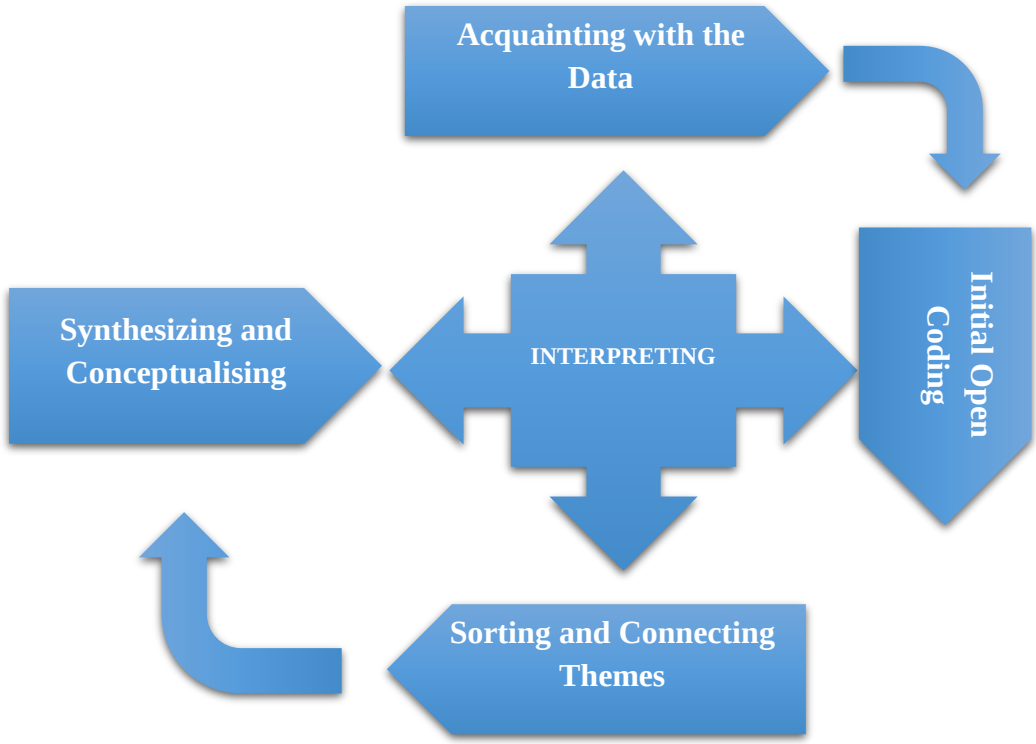

Figure 5-1 Coding Steps

5.2.1 Acquainting with the Data

The researcher looked at the actual words spoken by the respondents to become acquainted with the data. This was done without reference to the knowledge management theoretical perspective identified in Chapter 2. So, this phase was exploratory as the researcher sought to identify the content and its meaning as spoken by project managers. This was done using the transcribed audio recorded interviews and field notes. Each respondent's interview has related field notes which were taken as memos and reminders for later data analysis. The interview transcripts and field note memos were searched to identify key words, key phrases, new words, and connecting words. All these were recorded in list and notes added to interpret each one. This become the preliminary key words and phrases list.

These key words and phrases were subsequently then compared across each project manager's interview transcript. The comparison procedure consisted of sequentially running down the list to identify common occurrences of phrases and words across the interview transcripts. Some words appear different but conveyed the same meaning. For example, the respondents talked about 'information' and 'knowledge' as meaning knowledge to support the decision-making process. Verbs such as 'give', 'ask' and 'share' were interpreted to mean relationships between the project manager and the team or internally among the team.

Saladana (2012) states that the initial acquainting with the data is conceptually important. Identification of key words and phrases and the relationships among them provides the basic conceptual understanding from the empirical data. The researcher's ideas about the phenomenon become plausible through such evidence and it beings the process of rigorous data analysis, which enhances reliability and validity of the findings. The result is the discovery of the core themes and relationships of the conceptual understanding by rigorous data analysis.

5.2.2 Initial Open Coding

The funnel structure model was used to begin the initial open coding. It is intended to discover finer and focused analysis. This is done by step-wise fine tuning of the initial chunks of data identified in the acquainting with the data phase. It helps to find meaningful themes. Lapadat (2010) defines thematic analysis using such fine-tuning as requires: "identifying themes or patterns of cultural meaning; coding and classifying data, usually textual, according to themes; and interpreting the resulting thematic structures by seeking commonalties, relationships, overarching patterns, theoretical constructs, or explanatory principles" (p. 925-926). This distinguishes thematic analysis as essentially exploratory. The themes emerge from the data without presupposed structure.

Identifying key words, phrases, and relationships is the first step in data reduction (Cresswell, 2003). The large volume of textual data in the interview transcripts needs to be reduced or analysed to discover patterns and meanings. Then the next phase of identifying themes can begin. This initial theme discovery is the coding phase, a snippet is shown in Table 5-1 for Interview 1. (See Appendix C1 for the other Interviews). The coding at this stage was open coding, so it had no fixed codes and meanings only indicative ones. This open coding process involved several steps. First, the interview transcripts were marked to break down the data or the reduction of data. The 'chunks' of data were selected because relevant meaning relating to creation of knowledge, acquisition of knowledge, sharing of knowledge and application of knowledge for decision-making was clear.

These 'data chunks' reflecting the codes were meaningful and recurred across the interview transcripts, indicating that these were developing codes implying emerging themes. This initial open coding further enhanced the conceptual understanding gained from the first phase. Qualitative data analysis is inductive, data collection and analysis are interconnected so the in-depth interview data analysis informed and related to the focus group data analysis later. So, the interview transcripts were coded by using thematic analysis method using the funnel structure.

Table 5-1: Initial Open Coding Ideas/Themes Suggesting Initial Codes

I***Interview***	***Ideas/Themes***
1st Interview	Functional Point analysis technique and expert time estimated. Formal approach resolves project planning activities. Resource allocation dual approaches for programmer's skill. Projects cards, test documentation, capacity and test integration documentation contribute to manage project.

5.2.3 Sorting and Connecting Themes

The open codes as shown in Figure 4.1 above were then sorted and connected. The exploratory previous phases provided themes and relationships which needed connecting to provide a meaningful explanation. The sorting and connecting was based on the conceptual understanding gained from the first phase and further verified in the second phase. The themes found were related to the theory of knowledge management and project management and organised to make sense. The conceptual understanding was that project managers do create, acquire, share, and apply project-specific knowledge for decision-making. They use training, seminars, and meetings to do so, as Ba spaces to do so. An example of initial coding that suggests a cluster code in shown in Table 5-2. This example illustrates the use of project management techniques for system analysis and programming tasks. Project managers reported the use of 'Functional Point Analysis', 'formal approach', and 'project cards'. This suggests that 'Formal approach' is a key aspect of IT systems development.

Table 5-2: Initial Codes suggesting Cluster Codes

Initial Codes	***Cluster Code***
Functional Point Analysis Formal Approach Project cards	Formal Approach

The major data reduction phase is the sorting and connecting themes phase. To do this the codes were categorised into groups and connections between them were established (see Sub-sections 4.3 and 4.3). This was done using structural coding, which meant determining the ‘content’ or ‘conceptual phrase’ to apply to segments of data (Saladan, 2013. p.84). This structural coding then enabled in-depth analysis to identify patterns that can be interpreted as theoretical constructs, which resulted in a systematic view or explanation of the IT systems development knowledge management phenomenon. This in turn informed the emerging conceptual framework as the explanation.

5.2.4 Synthesizing and Conceptualising

In the final stage of the data analysis the codes, themes, and relationships were synthesized into the IT Systems Development Decision-Making Support Framework presented in Chapter 5. As explained in the next Section, this synthesis was done with reference to the theory of knowledge creation and the SECI model. This relating to the existing theory identified in the literature search Chapter 2 is critical for highlighting the key contribution to theory, by referencing similar, different and entirely new findings of this research. How the themes were related to the conceptual framework development is explained in Section 4.6. The conceptualisation also involved relating the themes to practice as one intention of the research is to deliver a practice framework for IT project managers.

5.2.5 Emerging Explanation from Thematic Analysis

The emerging conceptual framework required the major phases described above. It was a process requiring the development of thematic analysis by identifying patterns, relationships and meaningful themes. The coding consisted of exploring and then firming the codes based on conceptual understanding using structured codes. This meant interpreting the codes into meaningful themes, based on general patterns and relationships.

The emerging explanation, the conceptual IT Systems Development Decision-Making Support Framework for IT project management, was then related to the theory of knowledge creation and the SECI model. This was the theoretical phase of the thematic analysis. The commonalities, relationships, and general patterns discovered from the thematic analysis needed to be interpreted from a theoretical perspective. The SECI model thus provided further structure codes, meaning content and conceptual phrases that could be related to the discovered themes. So, phrases such as ‘explicit knowledge’, ‘tacit knowledge’, ‘socialisation’ etc. could be related to data items such

'database', 'programmers' knowledge', and 'meetings' or 'training' respectively. The SECI model provided the constructs and explanatory principles to theoretically interpret the results.

5.2.6 Limitations

Several limitations of the data analysis arise. The in-depth interview method and focus groups interviews are limited because they are data reported by the participants and there is no way to verify their self-reported data (Griffee, 2005). However, this was considered by collecting the data in two phases, the in-depth interviews and the focus group, which enabled cross-checking the interview transcripts to confirm the consistency of the self-reported data. The research avoids asking questions to the respondents that may seem to challenge their integrity for ethical reasons. As the self-reported data is consistent across the respondents it can be deemed reliable.

Another limitation is that in the presence of the researcher the respondents may have exaggerated their actual experience. They may want others to think that they have superior experience or want the researcher to give them better status. The focus group examined their experiences in a group, so any such exaggeration can be cancelled, as each respondent would be aware of peer presence.

There are other limitations of the interview method for data collection Griffee (2005). IT project managers may not have actually said what they think. This may be because they want others to believe that their projects were well-managed to avoid any repercussions from superiors. As they were assured anonymity and confidentiality this would have minimised this effect. Another limitation is the interviewer's interviewing skills. However, as mentioned in the research methodology chapter, the interviewer had attended research seminar on research methods to become familiar with interviewing methods and develop skills.

5.3 First Round Interviews Analysis

The purpose of the first-round interview was to discover the problems that project managers face in managing complex IT systems development and begin to understand IT systems development from the knowledge management perspective. Eight experienced project managers were interviewed. The interviews explored the current practice of project managers to define the problem. The initial questions arose from issues in the literature but mainly from Jorgensen (2004).

The first round of interviews focused on project management activities that could be interpreted as knowledge management activities. There were twenty-three questions. They collected basic demographic information, as well as information on project management activities such as

estimation and resource pool. Initial data was collected specifically on project managers' awareness of knowledge management. Questions of interest included: What issues concerning project development knowledge do project managers encounter? How to they estimate programming time? How do they solicit information from project team members and synthesise it? (See Appendix C for the Questions and C1 for sample transcripts, and codes).

The initial ideas arising from the interviews are shown in Table 5-3 below. As they need to make key decisions, project managers arrange meetings with key knowledgeable project team members to acquire information and knowledge and they use prior experience stored in knowledge bases. This is similar to Socialisation of the SECI model.

Table 5-3: First Interview Initial Ideas

Initial Themes	**Instances**	**Comment**
Techniques used	5	Techniques used varied included: Function Point Analysis, COCOMO, SLIM, Use Case Analysis
Techniques not used	4	Younger project managers tended not to use estimation techniques.
Mind/Spreadsheet	3	Project managers preferred to keep things simple.
Documentation	5	Most project managers kept some records about their previous experience. The younger project managers tended not to keep records.
Knowledge activities	5	Most project managers used project meetings, training sessions, brain storming, etc. as forums to gather knowledge. As well as formal records, they made personal noted too.
Knowledge base	5	Knowledge bases were used sparingly by project managers. It was expected that most project managers would keep some kind of experience knowledge base and add to it in their current project.
Decision-making	6	Project managers used project management activities to gather information for decision-making.

Project managers had an average of 10 years' experience. Experience related with the type of time estimation techniques they used. Also, experienced project managers tended to use estimation techniques. Experienced project managers also used some form of records or documentation of previous projects, as a knowledge base. For example, an experienced project manager said:

"Yes, I prefer to use formal estimation techniques like Use Case and SLIM. I like to see the resources and their use documented. That way I know what is being used and what I have available to allocate if needed." (SK PM1)

A project manager with over 35 years' experiences commented:

"We as company use the Functional Point Analysis, initially together with customers we prepare the SRS documentation and initially the statement of work. All these activities are conducted with detailed description of the requirements which are also related to the resource planning as well as time estimation. All FP are related to one or several functional units which are part of the increments in the agile project planning. We use usually combined methodology which is in routine work SCRUM based and in case of more complex activities where multiple vendors are involved we use the agile incremental based project approach". (YK PM3)

Project managers built up a knowledge base from their prior project management experience. They relied on this knowledge base for knowledge when faced with unique decisions for the particular context of the project they were involved in:

"Yes, during the development of every project, we insist on keeping a documentation record of every stage. The aim is to use the documentation to gather information for decisions that will be needed further along the project timeline. Many decision points arise in the specific project and I draw on my records for knowledge". (SK PM1)

Most project managers used company portals to build the project knowledge base:

"We have company portal where the knowledge base is maintained by the project office and the technical leaders. I am responsible for enterprise network knowledge base. All the documents are updated when some new technology is introduced. Also, in the ticketing system we maintain the short repository of conducted activities on the projects and troubleshooting activities. This small knowledge base is maintained by me and helps to trace the success of the employees and in the process of employee's evaluation processes". (SI PM4)

However, access to the knowledge base varied among the project managers, some knowledge bases are centrally controlled and others by the project manager. This has implications for knowledge flows and decision-making. A project in which the knowledge is centrally controlled commented:

"Project knowledge is explicit and dominantly resides in the existing systems used for document management as well code and test repositories. These platforms are managed by the project office and all access rights are controlled by them. Project officer controls the complete project repositories and also grants and approves the documentation changes." (MAK PM8).

Another project managers had control of the knowledge base himself, which facilitated decisions:

"We have company portal where the knowledge base is maintained by the project office and the technical leaders. I am responsible for enterprise network knowledge base. All the documents are updated when some new technology is introduced. Also, in the ticketing system we maintain the short repository of conducted activities on the projects and troubleshooting activities. This small knowledge base is maintained by me and helps to trace the success of the employees and in the process of employee's evaluation process". (SI PM4).

The knowledge bases used by project managers are related to the decision-making process. However, there was no consistency of awareness of 'knowledge management' among project managers as a framework for decision-making. A project manager who was aware of it shared how he relates the technology-based knowledge base with knowledge management for decision-making:

"I have several layers of utilizing the existing documentation of the projects like the project card, time plans, risk management, contingency planning. Project KPIs and all project card related documents are updated on regular bases. Weekly project follow-up meetings are practiced on regular basis and, we have morning scrum meetings where we define the future steps in the current day additionally we make short recap of the progress from the previous day. In spite of the scrum project structure we stick to documentation and the tacit knowledge is always externalized when needed in explicit knowledge". (SKP M1).

In contrast, another project manager seemed unaware explicitly about the phases of explicit and tacit knowledge for decision making:

"Depending on the project there are different approaches. Some customers are favouring the classical approach and we are approaching them with standard waterfall approach with classical documentation and PMI methodologies. On the other side there are some customers that have based their project on pure SCRUM teams and sprints. In that case we are complying with that approach. This is typical for service providers; which products are based on known technology and their SCRUM teams work together for relatively long time". (TP M5).

Another project manager with a large team of 50 team members did not mention 'knowledge' or 'knowledge management' as an aspect of decision-making. He based his decisions on heuristic approach, though involving gather information:

"I have fully autonomy in project decision making and very rare I need to ask for advice from the project office. In rare cases, it happens. Using available past project documentations and post mortem project questionnaire gives me fast access to some critical aspects in project decision making. According to me most of the failed projects had bad definition of the requirements and very aggressive time line which could not be met. I am always cautious when I manage the development of new modules that have not clear definition and tend to ask the headquarter departments to redefine some not very clear definitions in the requirements. I am always provided with sufficient information and the decision is made based on coordinated manner between the ordering party and the project office". (MKI PM7).

Similarly, there was no clear pattern on resource allocation. It's divided between project managers to use scheduling techniques rigorously and some who use it intermittently. Also, the level of software used varied. Several project managers used basic project techniques to allocate programmers:

According to the availability and capability of the programmer. I use available programmers, but I need to check their technical suitability. I use scheduling to details the tasks and technical programming skills require to complete it. And then I check the available programmers. (TP PM2)

It is based on the experience and qualifications of the programmers and as well as the availability in the resource allocation planning. The choice of the programmers as well as other resources is based exclusively on the competence as well as the time plan which should be compatible to the available resources, otherwise the change of the time plan can be applied. The project time planning may be changed in case we have multi fold estimations completed for different type of resource. And, the risk assessment as well as critical path can be created for different resources. The current allocation can be based on those factors and I usually use them. (MAK PM8).

A more sophisticated basic allocation technique was used too:

I use the resource allocation application and the feedback of the technical leads who participate in the mediation of the estimation process in creating of the time plan. Availability and competence is the crucial in assigning of the resources in the project. We have also sharing of resources since in the same time span multiple projects are conducted. We have tendency to use our own pool of engineers and only in specific cases, where some specific resources are needed, which are not present in our company, we sign specific contracts with external resources with stress to confidentiality and knowledge transfer. (SKPM1).

A more technological approach was used by another project manager, involving an outsourced software application:

I have small pool of programmers for which we use the application of the resource planning which is outsourced on the company group level. This process is highly automated, and I get the list of programmers which are available for the specific project duration. I have also the grade of the programmers available and know what their capabilities are. Based on that parameters and taking into consideration that we know each other the choice is not very complicated. More difficult is when we need some rare resource which is not available in our branch office. In such cases we consult the headquarters and they contribute with resources and project allocation as well as project planning finalization. (TP PM2).

A finding of the first-round interviews was that project managers with more experience do not follow the normal project management technique, such as estimation and scoping. Instead, they rely on experience to understand the parameters of the IT systems development challenge and organisational setting of the IT system. The actual ideas and themes and initial codes identified are shown in Table 5-4. These initial codes suggested preliminary cluster codes including formal knowledge, resources, task allocation, and tacit knowledge, as well as decision-making.

Table 5-4: First Interview Initial Codes and Preliminary Cluster Codes

Interview	***Ideas/Themes***	***Initial Codes***	***Preliminary Cluster Codes***

1st Interview	Functional Point analysis technique and expert time estimated. Formal approach resolves project planning activities. Resource allocation dual approaches for programmer's skill. Projects cards, test documentation, capacity and test integration documentation contribute to manage project.	Functional Point analysis Formal approach Project cards	Formal knowledge (explicit knowledge) Functional point analysis DELPHI methodology Context Intranet programme Resource allocation
2nd Interview	Functional analysis approach and DELPHI satisfies the time estimation. Small pool programmer is utilized as the resource planning. Intranet document knowledge is contributed with the application of RASIC diagram is used.	Functional analysis DELPI methodology Intranet programmer	
3rd Interview	Functional Point Analysis, SRS documentation and Delphi methodology with agile methodology is used. Consideration of previous project estimation is preferred. Repository documentation projects are utilized, and ticketing system keeps the record safe.	Functional Point analysis DELPHI methodology Respiratory documentation	
4th Interview	Functional Point Analysis and SCRUM methodology are used. Ticketing system is guided the assignment or project to conduct.	Functional Point analysis SCRUM methodology Ticketing system	

	Company portal and trouble shoot activities and SCRUM structure, time is utilised.		
5th Interview	FPA which is based on SRS is contribution and Delphi and Agile methodology is used. The knowledge of SECI dimensions and tacit knowledge is used.	Functional point analysis DELPHI methodology SECI dimension	Explicit knowledge
6th Interview	Software Size Unit and Delphi methodology is accessed for development of module. Resource administration planning application direct indications and preferred the exchange aspects of project.	Software Size Unit DELPHI methodology Planning application	Resources Poor quality
7th Interview	Software Size Units with planning poker are used and practicing scram project management technique. Estimation always relies on the programmer's skill and resource allocation application which is available on the company intranet. Full autonomy in project decision making and use the site by site programming technique, prefer project card, code repository, test scenarios and tests' results, integration tests' results.	Software size unit Planning poker Project card	Budget overruns Reliability Integrity Predictability Decision-making

8th Interview	Use Case Analysis. And provides precise project planning documentation. Choice of the programmers as well as other resources is based exclusively on the competence and shows interest involvement in telecommunication OSS project. SECI model and current project knowledge management is used. Side by side programming is preferred.	Case analysis Choice of programmer SECI model Side by side programming	Task allocation Tacit knowledge

According to the results of this round of interviews, it seems that there is a relation between the years of experience and the type of the time estimation technique used. The more experienced the project manager is more likely to use experiential expert time estimation. This suggest creation of project-specific knowledge, rather than simply drawing on prior experience. Another relevant finding is that the more experienced the project manager is more likely to keep some form of records or documentations of previous projects upon which they rely. This suggests explicit knowledge is relevant. A study by Jørgensen (2004) suggested similar findings.

Many decisions made in an IT systems development project require step by step logical analysis of the knowledge and information that is already available. Analysis of the available information helps in properly identifying and understanding the problem. Due to the continued sophistication and complexity of IT systems development, project managers have found that there is a need to try and find new ways of developing. One of the most crucial needs is determining how the project managers can be supported in the process of making decisions. Project managers are not always aware of what information they need; on the other hand, the project members providing the information may not understand well what is required and thus do not know what information they should give to the project managers. Project managers need both tacit as well as explicit knowledge. This was further explored in the second round of interviews and the results are presented next.

So these results suggest that project managers rely more on their personal knowledge rather than estimation techniques. They tend to create project-specific knowledge, even though keep formal records of prior experiences. This suggests that project-specific knowledge is significant in IT systems development projects and that knowledge management in the actual context of the IT system development is important. For this reason, the second-round semi-structured interviews analysed in the next Section focused on project-specific knowledge management in IT systems development projects.

5.4 Second-Round Interviews

The responses of the second round of interviewees comprised of 26 interviews. There were thirty-five questions (See Appendix D for the Questions and D1 for sample transcripts). Thematic data for 17 interviewees is reported in this section but the coding for all 26 interviewees is presented in Appendix D. As noted above, thematic analysis technique is defined as the way of highlighting, examining and treating patterns within information. The flexibility of this method makes its suitable choice for this study; Halverson *et al.* (2014) stated that thematic analysis is a simple technique that can easily be used by a new researcher because it fits with all kinds of theories and frameworks.

The analysis begins with coding, whereby codes are created after going through the transcripts of all interviews several times. After coding, eight themes were developed based on the repetition of each code, suggesting a pattern for a potential theoretical construct. Matthews and Ross (2014) state that identification of patterns help in theme development in the thematic analysis method. The example table below shows the initial open coding for a sample of interviews (See Appendix D1 for the full code table).

Table 5-5: Example Second Round Initial Open Coding

Interview	• Ideas/Themes	**Initial Codes**	**Emerging Codes**
#1	▪ Conducting infrastructure ▪ Application management ▪ Share the project content ▪ MS SharePoint portal ▪ Team bonding ▪ Supportive team leader	• MS SharePoint portal • Team bonding • Scrum methodology • Motivation	❖ ❖ Agile approach ❖ Motivation ❖ IT system ❖ ad hoc meeting ❖ Jira

	▪ Good relations ▪ Reward system ▪ Intranet network ▪ ad hoc meetings	• Team bonding	❖ Crystal methodology
#2	▪ Scrum project ▪ Micromanagement ▪ Knowledge exchange ▪ IT systems development ▪ Motivation	• Scrum project • IT systems development • SVN servers • Scrum • ITIL approach • Team building sessions	❖ Sharing ❖ Knowledge Reward ❖ Scrum methodology

5.5 Writing up

This is the last stage of the analysis whereby analysis of the responses was done in light of the literature as this cross examining helps in pointing out the similarities and differences between the responses of the interviewees and the available published data on the topic.

5.6 Emerging Themes

Theme 1: Sharing Tacit Knowledge by socialisation among project managers and members

Knowledge sharing was found significant from the analysis of the responses obtained from the interviewees, as all of seventeen interviewees clearly mentioned knowledge sharing as a project manager as PM4 mentioned:

"Sharable knowledge is basis for the project members to take initial understanding about the technical background and user requirements".

The literature also supports this, as Park and Lee (2014) posit that the procedure of knowledge sharing is of considerable importance within firms for the reason that it brings consumer satisfaction, cost cutback, quality in business activities and, ultimately, to gain competitive gains while keeping that gains. All interviewees reported sharing of tacit knowledge through socialisation with the project members and colleagues and the main channels for sharing their experiences related to past projects or current projects include; participation in workshops, organising teaching sessions for the junior PMs and newcomers, creating documents to state the

success and errors related to previous projects, arranging group verbal discussions, and using a brainstorming technique to share past experience and brief about the new;

"One of the approaches I used was a brainstorming session with all team members about half way through a particularly challenging project that was behind schedule. The approach worked well because it helped each team member take personal ownership of the project and feel as if their voice and ideas really mattered to the success of the project."

The responses are backed by the literature as Abu-Shanab *et al.* (2014) stated that project managers through interaction share knowledge both inside and outwardly and sometimes such interactions are formal, while some other time informal, depending upon the set of issues about the project and nature of tacit conversations.

Not only do the project managers share tacit knowledge but the project members also share their knowledge and experiences with the project managers with respect to previous and current projects, as PM10 reported:

"I ask them about past work in a formal way for example in a one to one meeting."

The responses of all interviewees were similar on sharing of knowledge with the project managers, and the channel of sharing mentioned by each interviewee was also the same, as all mentioned meetings with project managers for sharing knowledge, which is also found in light of the literature where Trusson *et al.* (2014) wrote that sharing and independent learning is likely to take place within the team for associates to be capable of satisfying the precondition performance targets within organisations as learning takes place by means of the conversations and information sharing among team associates as they accomplish the jobs and offer mutual benefit for the successful execution of new projects. The techniques used for the sharing of tacit knowledge by the interviewees include analogies with everyday memorable situations, paired programming, brainstorming sessions, coaching, informal exchanging information, processing documents, writing the ideas onto cards, and StoryBoarding techniques. This is supported by the literature as Chang *et al.* (2013) stated that the talk regarding the projects alongside varying standards and the examination of knowledge experiences are essential for a booming knowledge-based project manifestation. On the other hand, Keil *et al.* (2013) focus on communication, which plays an imperative part in knowledge sharing practices, as people share a substantial quantity of knowledge in discussions and in printed communication, for example documents, directives, and booklets as PM 8 reported in response to Q35 about communication:

"The principal technique is write a document with the important points and then a meeting to clarify any doubt."

Regarding the motivation of project managers to share knowledge with project members, the interviewees mentioned following motivations behind the knowledge sharing, breaking the influence of hierarchy, mutual trust building, exchange of opinions and clarification of points of the projects, project success, better understanding about the technical background and user requirements, team spirit, team coordination, quality improvement and reduction in committing mistakes, more problem solving, and different solution to issues. This shows that all interviewees recognised the significance of motivation behind knowledge sharing, which is quite in line with the literature, as Abu-Shanab *et al.* (2014) posit that the lack of a driving force to share knowledge, either from receiver or recipient it can bound the valuable knowledge to a particular individual, which, consecutively, can be challenging for the entire organisation.

Upon Q8 how organisation context affects the knowledge sharing process positively or negatively, all interviewees unanimously opined that organisational context does matter with respect to knowledge sharing and its effects on the process of knowledge sharing by making its contribution as PM1 stated:

"Organizational context is based on most of the conducted projects in the company and accommodates good environmental and supportive assets for most of the projects, but in some case, exceptions are required and for that purpose the top management should be aware".

This is supported by the literature as Keil *et al.* (2013) wrote that with the expansion of organisations the task of making tacit knowledge open for the efficient sharing knowledge has become challenging and it is obligatory for mature firms to facilitate knowledge sharing. Regarding the way trust affects knowledge sharing, the interviewees mentioned that the trust level works with respect to knowledge sharing by ensuring transparency and reducing dissatisfaction, facilitating team work, facilitate communication, mutual understanding among team members. However, the literature also supports the responses as Park and Lee (2014) stated that supporting an environment wherein workers have the chance to create equally ability and compassion-centred trust have to be a vital division of the knowledge administration programme of a firm as PM11 reported in response to Q10 that:

"The trust is fundamental to have good relations that help sharing ideas, situations, experiences and knowledge".

Except PM7, PM8, PM9, PM10, PM11, PM12, PM13, PM14, PM15, PM16, and PM17, all interviewees recognised the significance of reward system for facilitating knowledge sharing in the organisation. However, the monthly and quarterly evaluation system, competence areas for assessment, team appraisal, and rewarding system were the systems mentioned by the

interviewees to facilitate knowledge sharing. Trusson *et al.* (2014) supported the use of rewarding system for knowledge sharing by stating that it is imperative for team members to assess their performance and be stimulated to proceed on those appraisals for making change in their approaches.

Theme 2: Ways of Articulating Explicit Knowledge

Different questions were asked about the storage, and articulation of explicit knowledge from the interviewees and different responses were obtained, in the response. Upon asking the details of media used for recording explicit knowledge in firms, the interviewees mentioned following mediums, SharePoint portal, intranet portal, internal applications, internal wiki, JIRA, word templates, Team Foundation Server, and recorded video. However, out of all these mediums, SharePoint portal, intranet portal, JIRA and wiki were mentioned by more of interviewees, for example, SharePoint portal was mentioned by PM1, PM11,PM14, whereas intranet portal was mentioned by PM2,PM3, PM4, PM6. On the other hand, wiki was highlighted by PM7, PM12, PM15, and PM16 whilst Jira was mentioned by PM8, PM10, PM12, and PM13. The literature also supports these responses, as Ahern *et al.* (2014) wrote that the dynamic connections among the samples of learning communication in firms are based on different and broad types of media of exchange, which keep the co-reliance and co-development of every organisational structure and substructure with one another. This is asserted by PM17 who stated that:

"In complex project usually, we recorded video during knowledge sharing session, once new employee will join with that team, no need to spend same amount of time for knowledge sharing"

On the other side, Pemsel and Wiewiora (2013) posit that such media values and helps examining interactions between project members. According to Holzmann (2013), different software are used by firms to store and collaborate knowledge and the selection of appropriate medium is based on price, the benefits it offers, supporting tools and level of support.

On the use of metaphors and analogies while recording knowledge, the majority of the interviewees, PM1, PM2, PM3, PM4, PM5, PM6, PM8, PM9, PM10, PM12,PM14 reported not to use either of them, but the literature shows the significance of using metaphors and analogies during knowledge recording, as Eriksson (2013) wrote that the metaphor supported the initiative of sustaining the imitator as a casing, where the components that are more probable to collapse are assigned to the frequently replaced sealed unit as Apple endorsed their novel Apple computer as a bike for the brain in 1981. However, Keil *et al.* (2013) contradict this by positing that the metaphor emphasises more the design procedure on the working of what a manufactured good

does and conceal various other significant features, for example, how the client uses the interface. However, this contradiction was not supported by the interviewees as all including both who use it or not accepted the significance of using metaphors as PM 15 stated

"Yes, we use it often to describe situations that are complex to understand with words".

However, Park and Lee (2014) focused on the use of metaphors and analogies by stating that externalization has the solution to novel knowledge construction for the reason that it generates novel explicit ideas from implicit knowledge and the most proficient method to achieve this procedure is a chronological exercise of metaphor, similarity and representations as metaphors are lenses to understand all situations. Very few interviewees, PM7, PM11, PM13, PM15, PM16, and PM17 affirmed the use of metaphors and analogies as PM7 stated:

"In some cases, it helps to explain themes that are difficult to understand even using examples, one is the polymorphism".

Except three interviewees, PM11, PM14, PM15 all reported the use of different project management techniques, project cards, intranet-based applications, and PMI based templates, PMI Agile methodology, internal wiki, JIRA. The literature also supports the majority of the interviewees' opinion as Eriksson (2013) wrote that detaining, accumulating and sharing knowledge is important to any kind of knowledge management system as techniques like intranets, wikis are used for combined working and developed consensual perceptive about projects and developing glossaries, user handbooks, and others. On the other hand, Swift and Hwang (2013) mentioned the use of collaborative techniques for storing knowledge as a way of familiarising the new staff members with the old ones, which let them start work soon. All interviewees affirmed the organisation of knowledge in the project and for that purpose the method they mentioned they used were Agile methodology, templates, internal wiki, and JIRA as PM5 stated:

"There are several internal portals for that purpose as well as centralized repository for that purpose".

The literature support this as Ahern *et al.* (2014) stated that the knowledge should be accessible and put under proper material in a series, which facilitates others to find it in case of need and for this purpose the knowledge stored in a system needs to be displayed in a mode that helps alterations by the potential users, when required as PM 17 said:

"There lots of project management techniques like, RUP, SSADM, XP, SCRUM, Crystal Clear, Prince2 etc. We are using Agile, so we are following XP and Scrum. We are using JIRA to create our backlog, user story to record our knowledge or business domain of project wise".

Theme 3: Accessibility of Project Members To Project Knowledge

This is one of the most important themes derived from the responses as it highlights whether project knowledge is made accessible to the project members or not. There obtained mixed response regarding restrictive and complete access to project knowledge systems by project members as PM1, PM2, PM3, PM4, PM10, PM11, PM12, PM13, PM14 mentioned that they allow restrictive access according to the firm policy whereas the interviewees, PM5, PM6, PM7, PM8, PM9, PM15, PM16, PM17 stated that their company offers complete access to the project members as PM7 said:

"Full access, the can read and contribute with more information".

Regarding the restrictive access, the interviewees mentioned that the members are allowed access only to the information regarding technicalities of project and not to the financial details. However, all interviewees mentioned that members can add, edit and remove their comments from the record systems as PM5 stated:

"The project members have limited access to project knowledge. They can access code repository, test link platforms, JIRA ticketing application. They have no access to project cards, procurement documentation and financial reporting".

The literature supports the responses as according to Pemsel and Wiewiora (2013), the knowledge management procedure fluctuates between operational and project-centred firms as inside the area of operational firms, inventive and successful plans are stored on the structure for the management of knowledge and are accessible to the entire firm to take benefit of. However, Holzmann (2013) pinpointed that in case of project-centred firms, it is hard to store all plans, as they give preference to particular type of job, and because of the time constraints. Unlike this, Keil *et al.* (2013) pointed towards another possibility that the stored knowledge could be fixed in a particular project team, as the result of which, it is of very important for firms to task majority of their work in diverse projects to take on particular device to detain, amass and broaden knowledge all through the entire organization.

Regarding the nature of the restrictive access, PM11 stated:

"We cannot access to server if we need a change or addition is not allowed, we required and authorization for infrastructure".

Park and Lee (2014) also supported this view as he wrote that knowledge management as a method of protecting and nurturing the company asset firm knowledge, which in future could be utilised to improve the performance of firm by sharing knowledge, however, a good deal of the knowledge is possessed and handled by the people, which can be responsible for creating obstacles for administration to direct the knowledge, except in the condition that powerful sharing culture is not established in the firm as PM3 reported:

"They have selective access based on the user roles. Some project document is not accessible which due to confidentiality".

This view is supported by literature as Ahern *et al.* (2014) mentioned that the loss of intellectual property is one of the main issues, which is responsible for allowing project members to limited access to knowledge management systems as today, employees do not stay with a single company for his entire working career. Swift and Hwang (2013) support this view and elaborated that restrictive access to organisational knowledge management system is for the security of organisation as well as employees. Though academics oppose complete access but they have agreement over the significance of knowledge sharing as Pemsel and Wiewiora (2013) wrote that in projects, members are acquiring knowledge regarding the utilisation of their knowledge and understanding in a realistic framework, however, a good amount of the knowledge created in projects is difficult to formalize and include into the reconsideration activities or any kind of printed material so sharing procedure has to be backed by a setting that lets project members divulge errors and explicitly converse solutions to issues as reflected in the words of PM17:

"Knowledge gathering is nothing to just a lesion from previous experience. To make a project successful, experienced people can utilized their previous experience to identify the project risk, resource allocation, estimation, planning and deadline".

Conversely, PM10 emphasised the significance of trust for the facilitation of knowledge sharing and management as he said:

"If we do not trust with our team, it is very difficult to share the information even more knowledge. If we do not trust with our team, it is very difficult to share the information even more knowledge".

Theme 4: Use of knowledge base in decision making

Knowledge based decision making is the process that is followed by the organisations in order to get the efficient output at every stage of the project (Durus and Runar, 2012). In response to the question what knowledge base the managers use to draw to make the decisions related to the resource allocation, there were different responses came ahead. Except the respondents PM4, PM6, PM8, PM10, PM12, and PM20, the other respondents answered that they have a highly qualified an experienced team of managers who are working in the capacity of the resource

allocation department. If the team faces the mismatch of the demand with the allocated resources, then they adopt another methodology to allocate the resources. They use CCM methodology in order to analyse and allocate the resources according to the requirement. It is stated by PM1 that:

"We have the team of managers who analyse the situation and employee the methodology of resource allocation that suits best to the situation".

It is supported by the literature because according to Schwalbe (2015), since the resource allocation is a cruicial phenomenon in any organisation while working on the projects and meetig the demand is quuite neceassary. For this reason, the teams are developed in order to allocate the required resources to each stage of each task related to the project.

The respondents PM4, PM6, PM8, PM10, PM12, and PM20 do not have any particular team. As PM20 stated:

"We do not have any team for the knowledge-based resource allocation rather we prefer to select the activities by the employees themselves according to their skills".

The literature also supports that small firms that work on small-scale projects usually do not have the team for resource allocation, due to the reason of a small number of staff members. According to Liu *et al.* (2012), small firms mostly do not have the resource allocation team rather they have one manager or two who are responsible to allocate the required resources to different people according to their tasks.

In response to the question related to the management of complex projects, the respondents replied according to their scenarios. All the respondents considered the effective and fast communication in order to fulfil the requirements of complex projects and they prefer to use RASI methodology for the purpose of effective communication. As stated by PM3:

"RASI is used for more complex project to describe the communication plan and for smaller project we may use also RASI but not necessarily we can also use some simpler approach like SCRUM flipchart communication, mid sprint review and backlog reporting".

In support to these responses, Velasquez and Hester (2013) highlighted that usually the nature of projects in a big organisation is complex. The complex projects need more resources and more efficiency in terms of managing the project related tasks. Specially, complex projects require the effective channels of communication. Related information is needed on time in different departments because in the presence of poor communication channels, the effectiveness and efficiency would be affected.

Except PM16, 17, 18, and 19 because they consider handling the complex project by making its division into small tasks and then allocate these tasks to the team members. As stated by PM6: *Each member is excellent in one task; I try to give the correct task according to the abilities*.

This type of response is also supported by the existing literature. In the view of Chai *et al.* (2013), complex projects are needed to be handled very carefully. Each team member should be given that task in which he/she is proficient. This strategy would lessen the chance of errors and keep away from the wastage of time that is considered a very important resource.

The use of knowledge from other project experts seems a common trend. All the respondents responded to this question in the affirmative, since it is a good idea and prevents a company from future losses. As stated by PM 12:
"*Yes, when I need a second opinion about situations".*

In the view of Verhagen *et al.* (2012), the opinions from the other project experts are considered very facilitating. The project experts are highly experienced, and if they have already attempted the tasks that are related to the projects that are going on in the company, it would be cherry on the top. The opinions from the other project managers decline the confusions, make the tasks clear and the deliveries are on time without making any delay.

It was observed during the interviews that decision making during project management is dependent on the organizational structure. All the respondents highly considered this point and make decisions according to the organizational structure of whatever the organizational system is that they follow. According to PM1:

"Yes, organization structure influence in decision making. We always rely on participative decision making coming from some of the technical project leaders which rely on their team opinion".

Alhawari *et al.* (2012) highlighted that different organisations have different structures of decision making that affects the process of making decisions related to the projects.

The usage of the previous recorded information of explicit project knowledge for project decision-making is highly appreciated in the organisations in order to keep away from the losses and to minimise errors. All the respondents answered affirmatively that they always use the previous data in order to make new decisions for getting the maximum output and to minimise errors. As stated by PM 14:

"I used to clarify doubts and a starting guide for the new team members".

The literature also pointed out this fact. According to Sultan (2013), the usage of previous data is quite common while making decisions during the project. This activity provides the insights of the nature of related situations and how the particular action would affect the performance and outcomes of the projects. The use of previous information clears all the doubts of the selected methodology related to the ongoing project.

Theme 5: Knowledge Management for IT Systems Development

The system of knowledge management is greatly considered in the organisations since it facilitates the team in terms of developing the IT systems (Von Krogh, 2012). During the interviews it has been observed that different organisations have different types of knowledge management systems. In response to the question related to the type of management system of IT project whether they are fixed programming teams or interchanging programming teams. The responses were mix. Except PM9, PM10 and PM13, all the respondents responded that their organization has fixed programming system in order to develop the IT programs related to the particular project and when they need they add other members. As PM 4 stated that:

"*I use always till now fixed programming teams since my projects are smaller".*

It is highlighted by Von Krogh (2012), organisations that work on the small IT related projects they usually have the fixed team because the projects are quite simple, and the team is well versed on how to handle each step of the task that are given to them. In some projects, the fixed team faces difficulties in order to understand some features of the projects that can be understand by the other concerned people.

The respondents PM9, PM10 and PM13 respond that they have interchanging programming teams. As stated by PM 9:

"In complex project interchanging programming teams are inevitable practice. There are specialized technology related groups like integration specialist which are involved in the integration phase of the project".

It is supported by the existing literature. As explained by Reich *et al.* (2012), those organisations who follow the interchanging programming teams often leading the complex projects. The big organisations that cater the complex projects often need variations in the task that is needed to be up to the date. The complex projects require different types of specialists according to the added attributes timely. In order to resolve the issues, organisations have to hire different specialist as the project facilitator timely.

In response to the question of how the organisations manage the team members and what are the values followed by them in order to develop and manage the team. All of the respondents answered that they encourage their team members through various ways. The tasks are allocated in a way that each and every team member can take part in the activities related to the project. They build up the confidence level throughout providing them the different training sessions of the IT programming related to the requirements of the ongoing project. Organisations provide the competitive environment in order to enhance the abilities of the workers and provide those fringes and benefits accordingly. These rewards increase the level of confidence and they provide more productive output. As mentioned by PM 1:

"I encourage friendly competitive and trustworthy environment. Competition brings the progress and cooperation brings benefits on both individual and project plan. It is sometimes difficult to balance between these concepts".

According to Sung and Choi (2012), to develop and manage the team in a way that it can provide the beneficial output for the organization is quit challenging these days. In order to manage the team of IT program developers, the organization has to provide related training sessions that add new concepts in their knowledge in order to keep their knowledge up to date and make them more efficient for the organization. Hounkonnou *et al.* (2012) highlighted that in order to keep their motivation level sustained, the organisations provide perks and benefits to those employees who perform up to the mark. This gesture facilitates to improvise the performance of the other employees as well.

In response to the query on how the managers encourage the concept of Knowledge donating and knowledge collecting in the managing process of the team, there were various views came out. Except PM8, PM9, PM10, PM12, PM13 and PM16, all the respondents said that they use incentives for the team members those work under the concept of knowledge donating and knowledge collecting. It is the build in strategy of the human resource management of the organisations that give the perks and benefits to the compatible employees according to their performance. As mentioned by PM2:

"*I use the incentive methodology for senior IT staff who is willing to coach the juniors and to exchange knowledge on senior level."*

This is supported by the study of Ahern *et al.* (2014) that human resource managers often consider the incentives in order to encourage the employees' skills and knowledge. The practice of knowledge sharing, and knowledge gaining is quite favourable for the overall performance. As mentioned by PM8:

I give incentives to the team members who are most cooperative and exchange their knowledge with the other project members.

Theme 6: Project teams development for project knowledge management

The respondents did agree that High frequency communication must exist in all the types of projects. According to PM 9:

"Each team member is responsible to add the documentation about the system and business to wiki, project manager is responsible to add the minutes of meetings and sprint retrospective information".

High frequency communication can also have a significant impact on success and failure of a project. This fact was agreed upon by Hidding and Nicholas (2014) as they have emphasized on early empirical results that could be applied to the success and failure of project management that would be based on conventional paradigm as well as value-driven change leadership (VDCL). Within this regard, they have portrayed conventional paradigm and VDCL produced factors. According to Jorgensen (2014), the core emphasis lies on creating a vivid view towards reasons for encountering failures related to various development projects related to IT systems within the outsourcing marketplace. As a result, they have also arrived at a technique along with past collaborations that occurred among the client and the service provider would be directly integrated to the factors that would be connected with potential of risk reduction.

The importance of communication is agreed upon by Ahmed (2012). The research illustrates that engagement of stakeholders throughout casual conversations would illustrate potential issues within a project life. As a result, communication for the purpose of project management has to be honest and authentic. For maintaining the relevance and authenticity of the IT systems development project relevant, effective, and across the boundaries of what could be achieved within the constraints provided, there must be a consistent level of coordination and communication among all the associated stakeholders, including client and project manager.

Respondents were asked their expected level of communication frequency for complicated projects when compared with simple projects. All of the respondents, excluding PM3, did state that frequency communication is required to be high for every project. PM 3 stated that:

"*We use the RASI framework for complex projects and SCRUM for smaller projects*".

This fact was also agreed upon by Pee and Kim (2010). It is pivotal to have coordination and communication application among IT and business professionals' expertise. This process also becomes highly complicated when external IT consultants would be involved that would create

blockage and organizational for knowledge and communication flow. They have also perceived the fact that social interdependencies would influence how knowledge would be effectively shared among various professional experts. Within this regard, the rate of success and failure of IT systems development project within knowledge sharing would be interlinked to the perceived goals, objectives and reward interdependencies.

The respondents were also asked for explaining the use of ad hoc meetings for project management. According to PM 6:

"*Ad hoc meetings may be initiated by different parties (project members, project officer, project sponsors etc.) and are usually necessary since the reason for ad hoc meeting is crucial and if not resolved may affect the project timeline and outcome"*.

However, this fact is not agreed upon by Nasir and Sahibuddin (2011) who opined that even though Ad hoc meetings are being designed for project management, projects are still failing, and the causes of failure are different and not clear. Within this regard, there are several reasons that have lead towards failure of a project. Team size, requirements extraction, lack of users-involvement, fixed controller, time dimension, poor quality management and testing are some of the core reasons. A survey was developed by El Emam and Koru (2008) for the purpose of Information Technology (IT) departments in the year 2005. They have gauged the core dropping rates for IT Projects, impact factors and rate of successful projects. This would certainly influence success and cancellation of a project.

This view could be directly related in the light of literature by the study conducted by Cerpa and Verner (2009). The study illustrates on the question that constantly lies in the mind of practitioners and researchers is what would be core reasons behind IT systems development as well as projects failures. By evaluating the fact that software is applied successfully to various pivotal areas but still the software projects fail, it could have a detrimental impact. Due to this reason, it has been consistently questioned by the researchers whether they have adequate information for ensuring that development of IT systems development has been successful. For making sure if the notion of software project has either failed or succeeded, the criteria should be agreed upon. Within this regard, IEC (International Electro-technical Commission) and ISO ((International Organization for Standardization) play an essential role. Based primarily on such essential criterions, it is evident that the most essential factor that would gauge failure or success of a project focuses on meeting cost, quality and functionality.

However, Park and Lee (2014) have provided a contrasting viewpoint to that provided by the respondents. They have studied the significance of trust and dependence within the notion of IT systems development projects. As a result, they have measured four constructs that comprise of domain expertise, project value, environmental complexity and communication frequency. They had stated that feeling of dependency and trusting team member would lead towards knowledge sharing of individuals. The more people communicate leads towards feelings of dependence and trust, and team members would have project values. For improving the notion of knowledge sharing, project managers have to develop certain variables. This is due to the fact that core tasks would be primarily knowledge intensive. Moreover, knowledge-creation would be highly productive if the managers have an adequate level of competency.

Theme 7: Project Management technique to manage project knowledge

The respondents were asked what information systems development methodology/project management technique they had used. The responses by PM1, PM2, PM3, PM4, PM5, P6 and P8 had stated that they were using Agile PMI methodology for their project management technique. However, companies of respondents PM7, PM9, PM10, PM11, PM12, PM13, PM14, PM15, PM16 and PM17 were using different techniques for project management. PM 7 reported that:

"*We use scrum methodology; the knowledge is very important because teams must know the business to give high quality software at the end of the sprint. This business knowledge store in our wiki for future references and it is vital to our methodology"*.

In a similar scenario, PM 9 reported that:

"*We use RUP methodology; the knowledge is very fundamental at the beginning of the process; we need to understand complex business rules and describe it into a document"*.

According to Chemuturi, and Cagley (2010), specific IT systems as well as development tools and methods including waterfall model have developed for adequately supporting the method of IT systems development project management. Within this regard, methods of IT systems development as well as project management methods have continued to grow and develop throughout the years. Within this regard straying away from the system of waterfall model for a technique that would comprise of cyclical project delivery. Moreover, this new model would correlate to IT systems development.

However, the study of Meredith and Mantel Jr. (2011) provides a broader perspective when compared with the views of the respondents. Their research illustrates that the role of project

manager is of massive significance when designing project methodology. Technically, project manager is provided the responsibility of planning, implementing and completing a project. Moreover, a project manager would be responsible for team management along with the project resources across the project life. A project manager is required to posses highly distinguished management and leadership traits for designing and managing a project.

The respondents were also asked if they were using the method of information systems development methodology/project management technique for creating knowledge. The responses by PM1, PM2, PM3, PM4, PM5, P6, P7, P10 and PM14 did agree that they were using them as it was easier for managing in a single place. However, the responses by PM8, PM9, PM11, PM12, PM13, PM15, PM16 and PM17 were of the view that project knowledge as a whole could have dualistic implications. Within this regard, decision-making is directly integrated with this core aspect. The core objectives of the project could make it difficult for dealing with the tools of project management. PM 14 had reported that:

"It helps us to concentrate the knowledge in a central point".

This is also agreed upon by Sinhal and Verma (2013). It is essential for evaluating and assessing the core reasons behind the failure of IT systems and their projects. The core implication would be that IT systems and current methodologies would not support decision making adequately. Apart from that, the different systems of software development methodologies like Waterfall, Agile as well as different software techniques including wideband Delphi, Planning poker, Source Lines of Code (SLOC) and function point would not be protecting the project from failing as it would support the decision-making process.

The research by Chang *et al.* (2013) also agrees with the viewpoints of the respondents as the method of information systems could be highly productive for the success of IT systems development projects. Within the system of information systems development, a specific set of skills and level of competency is provided by each team member and this increases a project team's efficiency for attainment of their desired goals. They are highly essential factors from a social and cognitive perspective including relationship commitment, team relationship and having awareness of expertise location that are essential. Moreover, team awareness could also be a decisive factor when choosing between the most effective and efficient methodology. With regards to project management and IT, the principles and knowledge securing successful delivery

of the project varies. Moreover, some knowledge and ideas that have been attained through the project could be applied in similar projects.

The respondents were also asked what project processes they have used for managing responsibilities and tasks. All of the respondents stated that all team members are provided specific duties for managing their tasks. According to PM 9:

"*Team is responsible for documenting and designing documents along with adding useful comments within their code"*.

According to the research conducted by McLeod and MacDonnell (2011), every decision must be sustained through the means of correct and sufficient information. Almost all of the IT systems projects tend to be supported through the means of project management techniques. However, they don't possess a vivid and intense framework for supporting their notion of decision-making. Within each and every stage of a project's lifecycle, decisions related to information systems and project management has to be taken and the decision would be affected as a result. Within this regard, decisions would be made for project scheduling as the cost would affect a project severely and would influence its success in the long run.

However, the view of the respondents is contradicted by Sokolova and Fernaandez-Caballero (2012) as they emphasize on following frameworks. Frameworks could be highly beneficial when specifying the core business objectives along with their coherence. The framework would help in providing different aspects that have to be considered when implementing and designing a project. Frameworks can also help in providing a solution for influential factors that would map out the results and contextual aspects. A framework should be viewed as a conceptual model that could be used for creation of a global knowledge management through identification of influential factors. Various frameworks could be productive in outlining the concepts, aspects and systems and how they are integrated with a particular domain. Within this regard, reference models would fulfil the objectives of conceptual models.

Fifteen themes resulted from the analysis of the second round of interviews, as shown in the Table 5-6. These themes identify the role of knowledge in complex IT systems development projects and they reveal responsibilities, communication and decision-making needs of project managers. The central theme running across all the fifteen themes is project knowledge as mediated by sharing and trust between the project managers and project experts, as well as among the project members. The next phase of the research was to validate these themes as the

constructed IT Systems Development Decision-Making Support Framework and seek other emerging themes through focus, as presented in the next section.

Table 5-6: Table of Emerging Codes

	Codes	**Tally**
1	Sharing Tacit Knowledge	//// ///// ///
2	Techniques of sharing knowledge	//// //
3	Motivation for sharing knowledge	//// //// ////
4	Trust and knowledge sharing	//// //// ////
5	Reward system to encourage sharing	//// ////
6	Media for recording project knowledge	//// ///
7	Use of metaphors and analogies in knowledge storing	//// ////
8	Project management techniques for recording project knowledge	//// ////
9	Knowledge organization	///
10	Project members access to knowledge systems	///
11	Decision making in complex projects	////
12	Usage of project knowledge as a manager	//// ////
13	Project management structure	//// //// ////
14	Responsibilities to manage project	////
15	Communication in project management	////

5.6 Conceptualisation by relating the Themes

The IT Systems Development Decision-Making Support Framework developed in the next Chapter draws on the themes discovered from the analysis of the interview data. Three aspects of this data analysis can be used to inform the development of the Framework. First is the meta-themes which relate to the existing theory of knowledge creation. These meta-themes include knowledge creation, knowledge acquisition, knowledge sharing, and knowledge application or know-how. Such know-how relates directly to project managers decision-making process. The literature search in Chapter 2 revealed research mentioning these activities of knowledge management. The second are the themes themselves discovered from the interviews which indicate project-specific knowledge management procedures. These procedures are actual project

activities that project managers promote in order to gather technical and project knowledge to support decision-making. The third are actual project activities that directly reflect the SECI model in terms of Ba. This consists of project activities promoted by project managers to encourage Socialisation, Externalisation, Combination, and Internalisation to move between explicit knowledge and tacit knowledge and from tacit knowledge to explicit knowledge.

5.6.1 Meta-themes

During the synthesizing and conceptualisation phase of the thematic data analysis detailed in Section 4.2 above, the synthesizing resulted in further data reduction that identified four meta-themes shown in Table 5-7. They are meta-themes because they are analytically derived from and agree with (1) the literature search that identified the theory of knowledge management and the SECI models which are the reference theoretical perspective for this research and (2) as well as the themes identified from the interview data. The data analysis results confirm the same activities in IT systems development projects as reported in the theoretical perspective in the literature.

The four meta-themes are knowledge creation, knowledge acquisition, knowledge sharing, knowledge application or know-how. It is because the themes discovered during the data analysis can be summarised as themes which relate to the literature search – theory of knowledge creation and SECI model – that they are termed meta-themes. This provides the theoretical basis for constructing the IT Systems Development Decision-Making Support Framework. So, the Framework is based on evidence in IT systems development projects of the theoretical knowledge management understanding.

The knowledge application or know-how theme relates to IT project decision-making processes. The theory of knowledge creation explains how knowledge is created in innovation activities in companies and the actual processes are then elaborated in the SECI model. As mentioned earlier, complex IT systems development projects are such innovative activities. They involve using existing IT artefacts and software, but these are assembled in novel way to meet user requirements. This creative effort requires innovative knowledge to make relevant design decisions, which is explained in the next sub-section.

5.6.2 Project knowledge management procedures

The emerging six themes form the data are explained next and shown in Table 5-8. These themes reflect project managers' actions and activities to create, acquire, share and apply knowledge for

decision-making. It is these indicative actions and activities, termed Ba in the theory of knowledge creation, combined with the meta-themes detailed in the previous section that underpin the development of the Framework in the next Chapter.

Table 5-7: Interpreting Themes as KM Meta-themes

Themes from Interview/Focus Group Data	Meta-themes	Comments
Use of metaphors and analogies in knowledge storing	Knowledge Creation	The themes that emerged from the interview and focus group data were interpreted to find commonalities. These themes collectively reflect 'knowledge creation' activities in an IT project.
Media for recording project knowledge		
Project management techniques for recording project knowledge		
Sharing Tacit Knowledge		
Responsibilities to manage project.	Knowledge Acquisition	These themes reflect project activities that structure channels for project knowledge. They can be interpreted as knowledge acquisition activities.
Project management structure		
Communication in project management.		
Knowledge organization.		
Motivation for sharing knowledge	Knowledge Sharing	These themes were considered to reflect knowledge sharing. The project managers communicated with team members to create an environment for knowledge sharing.
Trust and knowledge sharing		
Reward system to encourage sharing		
Techniques of sharing knowledge		
Project members access to knowledge systems		
Decision making in complex projects	Knowledge Application for Decision Making	These themes focus on applying the acquired knowledge. The use of project information and knowledge is interpreted as application for decision making.
Usage of project knowledge as a manager		

The first theme is channels for sharing tacit knowledge through Socialisation among project manager and project members. This is the Ba of IT systems project-specific knowledge creation. A key feature of knowledge creation is accessing the tacit knowledge possessed by project team members. Tacit knowledge needs to be transferred into explicit knowledge through the Externalisation of the SECI model. The externalised knowledge is captured as explicit knowledge in notes, on whiteboards, minutes of meetings, or directly in digital form. This Externalisation is achieved through socialisation. Socialisation consists of brainstorming sessions, meetings, and training delivered by experts to other team members.

The second theme is accessibility to the project knowledge by project team members. This concerns the knowledge sharing aspect of project knowledge. Project team members need to have

access to both the tacit knowledge, as mentioned above, and the explicit knowledge. While working on project tasks they need access to relevant information which is then applied. The project manager gains this knowledge for decision making through reports produced by senior project members.

Table 5-8: Project-Specific Knowledge Management Procedures and Ba

Knowledge Management Theme	Description
Channels for sharing tacit knowledge	Socialisation is used in the creative Ba to transfer tacit knowledge into explicit knowledge.
Accessibility of project-specific knowledge	The actual spaces for knowledge creation, such as meetings, seminars,
Application of project-specific knowledge for decision-making	Project managers access the externalised knowledge contained in the recording Ba for decision making.
Project team development for knowledge sharing	Project managers develop knowledge culture, sharing culture through appropriate reward schemes.
Project-specific knowledge management techniques	Knowledge management techniques are incorporated into project management. This is distinct from project management techniques that focus on routine project management responsibilities and tasks.

Both the previous two themes support the third theme, the use of the developing knowledge base for decision making processes. The developing knowledge base happens through the processes of Externalisation of project members' knowledge. This knowledge base consists of databases, word documents, emails, networked repositories, and conversations. Project managers then utilise this explicit knowledge for decision-making processes.

The fourth theme is knowledge management for IT systems development. This theme differs from the previous theme because it captured the aspect of innovative knowledge for IT systems development. The term 'complex' refers to the unique aspects of the IT systems development, the new Combination of existing information technologies required to meet use requirements, all of which needs knowledge creation. These knowledge creation activities are conducted through the project knowledge activities explained in the next Sub-section.

The fifth theme is project team development for project knowledge management. The project managers aimed to make team members aware of project knowledge. They developed the project team to become aware of the need to share knowledge for interdependent project tasks. The importance of project knowledge, recording knowledge and sharing it, were emphasised in training sessions. So, as well as managing the core IT system development, project managers aimed to develop the project team's awareness of the importance of project knowledge.

The final theme is project-specific knowledge management techniques to manage project knowledge. This consisted of activities that focused on creating, acquiring, sharing and applying knowledge for decision making. These are the core project knowledge management activities as explained next.

5.6.3 Project Knowledge Activities Ba

IT project activities consist of systems development activities such as systems design, programming, database development, and testing. The data analysis revealed other project activities specifically related to project-specific knowledge and knowledge management. In complex IT systems development projects managers depended on specific knowledge to support decision making processes. Consequently, as the themes above reveal, they instigated knowledge activities to create and share project-specific knowledge that would support their decision making processes.

Such knowledge activities are reflected the IT Systems Development Decision-Making Support Framework developed in the next Chapter. The actual activities reflect the Socialisation, Externalisation, Combination, and Internalisation knowledge activities of the SECI model. These activities included embedding knowledge awareness in brainstorming, training sessions, review meetings, and progress meetings. The training sessions to skill-up junior team members or provide advance skills to others, also focused on gathering and sharing knowledge. So, they were used as Ba spaces to transfer tacit knowledge. Some training for junior team members also included shadowing seasoned experts in order to benefit from tacit-to-explicit knowledge transfer.

Therefore, the usual project management techniques were supplemented with knowledge databases - stores of explicit knowledge that can be applied for decision-making purposes.

5.6.4 Themes That Reflect SECI

The data analysis results found patters in the interview data that directly indicate the embedded activities of the SECI model in IT systems development project. *Sharing tacit knowledge* was a key knowledge management activity. Project managers assessed and utilised senior and experienced project members' knowledge through the externalisation process – transferring tacit knowledge into explicit knowledge. They also identified existing project activities such as training and meetings as techniques of sharing knowledge. They introduced shadowing in which junior project members learn from senior ones. *Trust and knowledge sharing* was critical as the project managers were aware of their dependence on team members for critical information to make decisions. Another theme was *motivation for sharing knowledge*. Project members needed to be motivated to communicate their knowledge for the benefit of the project. The *decision making in complex projects* theme was key for the knowledge activities reflected in all these and other themes (The full list is in Appendix F). Project managers engaged in project knowledge management in order to collect explicit knowledge to make project decisions which were often critical decisions that determined the progress and success of the IT project.

5.7 Conclusion

In this Chapter the thematic data analysis was presented. The data analysis procedures and the thematic analysis technique used were explained, and limitations of the techniques were discussed. The thematic analysis of the in-depth interviews and focus groups was presented. The resulting themes which reflected project-specific knowledge management to support project manager's decision process were then conceptualised in terms of the theory of knowledge creations and the SECI model. Then these themes were related for the development of the conceptual framework in the next Chapter. The data analysis reveals clear patterns that suggest theoretical constructs or meta-themes consisting of knowledge creation, acquisition, sharing, and application to the decision-making process related to project knowledge. These meta-themes in turn relate the themes to the existing knowledge management literature. Project managers engaged in actual project-specific knowledge management activities, in addition to their normal project management activities to create knowledge for innovative design decisions and for critical project management decisions. How these themes can be constructed into a framework to support such decision-making process is presented in the next chapter.

CHAPTER 6 PROPOSED KM DECISION FRAMEWORK

6.1 Introduction

In the previous Chapter the data analysis resulted in identifying meta-themes related to the theory of knowledge creation and management; the SECI model and knowledge creation activities as Ba. They are constructs because they have been built on empirical data as opposed to concepts which are ideas that yet need to be verified. As noted in Chapter 4, the findings were summarised as the meta-themes that are in agreement with existing knowledge creation and application theory. These are important constructs because they confirm the findings of the research in relation to the existing theory of knowledge creation and the SECI model identified in the literature search in Chapter 2 as the theoretical perspective of this research. This Chapter now synthesises the constructs in terms of the SECI model from the perspective of knowledge management in IT projects to develop the IT Systems Development Decision-Making Framework.

These meta-themes form the foundation of the IT Systems Development Decision-Making Support Framework presented in this Chapter. It is normally assumed that project managers have the necessary knowledge to manage and deliver complex IT systems. As noted earlier, such systems development requires new creation of project-specific knowledge because of the novel combinations of existing organisation, people, IT artefacts, Internet and networks. So, this involves knowledge creation, knowledge acquisition, knowledge sharing, and knowledge application to make systems design and project management decisions. In this Chapter these core project-specific knowledge activities are assembled into the IT Systems Development Decision-Making Support Framework for complex IT systems development. The associated project activities were identified as the detailed themes (see Sections 4.6.3 and 4.6.4), which reflect actual project activities Ba or knowledge spaces composing the Framework. Together the meta-themes and project knowledge activity themes need to be interpreted in terms of the theory of knowledge creation and particularly the SECI model. This is done in this Chapter.

The construction of the Framework draws on the outcomes of the literature search which included identifying the problems and their effects on systems development (See Section 2.2.1). This identified the domains and the general problems of decision-making in complex IT systems development projects and the first round of interviews identified the specific problems for project managers of IT systems development in KSA. In Section 5.2 of this Chapter, the IT Systems Development Decision-Making Support Framework is constructed to address such problems and

their causes as detailed in the root cause analysis in Section 2.2.1. The expected outcome is that the Framework would be used by project managers to create, maintain, and update project management knowledgebase that could be a source for project managers to improve their decision-making and so overcome the problems identified in the root cause analysis.

The researcher began with the idea that IT systems development project managers require project-specific knowledge to make better decisions. This idea was referenced in existing theory in the literature search, where the theory of knowledge creation and the derived SECI model and decision-making framework were chosen as appropriate theoretical perspective to investigate the phenomenon further. The theoretical framework shows the theoretical ideas and thinking that framed the research investigation. Maxwell (2004) explains that:

> "The function of this theory is to inform the rest of the design—to help the researcher to assess and refine the goals, develop realistic and relevant research questions, select appropriate methods, and identify potential validity threats to your conclusions. It also helps you justify the research".
>
> (Maxwell 2004 pp. 33-34).

The IT Systems Development Decision-Making Support Framework is constructed from the literature review outcomes and empirical findings of the research. But as with all frameworks, it contains researcher's beliefs and assumptions (Miles and Huberman, 2002). The Framework reflects the research objectives and agrees with the findings. So, the coherency and consistency between the research aims and objectives and the conceptual framework is ensured. The aim is to explain how project-specific knowledge is managed to enable project manager's decision-making process. So the second, third, and fourth research objectives are fulfilled in the IT Systems Development Decision-Making Support Framework:

- To identify knowledge creation and knowledge flows in IT systems development project management;
- To capture expert IT systems development project managers' decision-making processes;
- To develop a novel management framework based on knowledge management to enable IT systems development project managers to make more effective decisions to improve the success of projects.

A conceptual framework can be regarded as a model of the findings of the investigation. However, the findings need to be explained in terms of a theoretical contribution. The findings in terms of project knowledge management agree with existing knowledge creation theory. In particular, the core and associated project-specific knowledge management activities as reflected

in the themes discovered can be interpreted in terms of the SECI model. The framework contains the researcher's interpretation of the findings in terms of this existing theory. It is an initial theoretical perspective of the phenomenon of knowledge management in complex IT systems development projects.

Thus, the IT Systems Development Decision-Making Support Framework is a conceptualisation of the IT systems development project-specific knowledge management phenomenon observed. A framework details the empirically observable phenomenon (Grant and Osanloo, 2014). Such a framework needs an underpinning theoretical perspective, which as noted is the SECI model. Grant and Osanloo state that it can be based on a single theory or various theories and it is used to explain the researcher's thinking about the phenomenon to be explained. So it sets out the concepts, definitions, elements and their interrelationships.

Melendez (2002) states there has been an increase in the use of conceptual framework in PhD research, because it provides a whole view of the proposed research. A conceptual framework deals with several aspects of the research process. It consists of the researcher's ideas about the subject of study and the explanation of how the phenomenon works. It contains the research problem that we addressed and accounts for the literature search. The conceptual framework is the basis for deriving an explanation of the phenomenon under investigation. The conceptual framework is the initial basis for constructing knowledge, as the conceptual aspect would need to be supported with empirical evidence. A central feature of the conceptual framework is the constructs it contains and their relationships, which the analysed data supports. In this Chapter the construction of the conceptual framework is explained and how it relates to the achievement of the research aim and objectives.

The conceptual IT Systems Development Decision-Making Support Framework is the structured explanation of the research findings. It addresses the research question and provides an explanation of the observed phenomenon. Critically, it sets out how the discovered themes are related to explain knowledge management to support decision process in complex IT systems development. After the data analysis, the conceptual framework is constructed to explain the phenomenon. The validity of the framework is then examined through focus group interviews in Chapter 6.

6.2 IT Systems Development Decision-Making Support Framework

The Framework is composed of two sets of knowledge activities, the doing set and the integration set. The SECI model and Ba respectively account for both these set of knowledge activities – components for doing and processes that integration knowledge creation and integration of knowledge for decision-making. The SECI model reflects the actual knowledge creation activities that create knowledge and Ba reflects the specific spaces in which this happens. The Framework makes use of the processes of Socialisation, Externalisation, Combination, and Internalisation to generate project-specific knowledge. This knowledge creation occurs in particular spaces such as conversations and brainstorming. The SECI model reflects strongly both the doing and integration set of knowledge activities and decision-making, as explained in this Chapter.

In the absence of a knowledge management framework, project managers in the first round of interviews reported that they use guesstimates about resources required for tasks for example, and often their guesstimate is incorrect. The developed Framework is expected to support project managers to allocate resources to tasks and make other system design decisions based on the root cause analysis (See Section 2.2.1). For example, a project manager has a lack of knowledge about resources required for particular task or is not sure about the risk level of a particular action. In such a scenario, the project manager would enable experts in the project team, those with relevant experience and knowledge, to meet to convert tacit knowledge into explicit knowledge, making use of the SECI element of Socialization and the meeting as the space or decision Ba. The resulting information, making use of the Externalization element of SECI, would then be entered into the project knowledge base as the recording Ba. For example, if the decision concerned allocation of resources, the resulting information would be entered into the resource database and the relevant information about the expertise into the expertise database.

The two layers of the IT Systems Development Decision-Making Support Framework are (1) the SECI elements that enable the creation of specific knowledge to resolve particular problems as indicated in the root cause analysis and (2) the Ba spaces to facilitate the knowledge creation and recording of the resultant information. The SECI layers are depicted as the oval elements in Figure 6.1 below and the Ba spaces as the rectangles. Linkages between elements are shown as arrows.

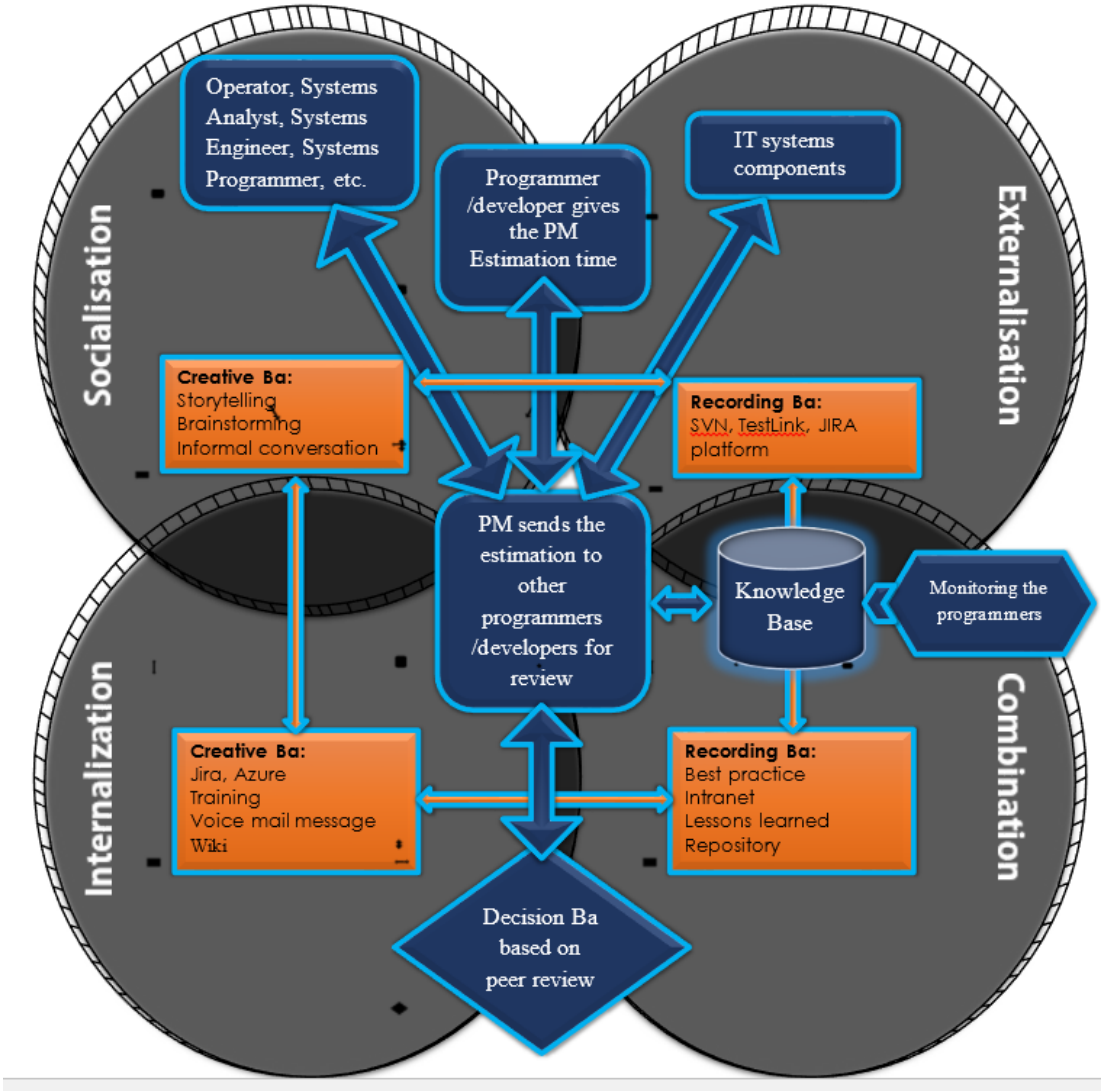

Figure 6-1 IT Systems Development Decision-Making Support Framework

Problems such as project complexity, budget overruns, or incomplete user requirements identified in the Root Cause Analysis (see Section 2.2.1) can be addressed by the two layers of the Framework: the SECI layer and the Ba layer. For example, risks and schedule were identified as root causes, and both of these concerned the project managers interviewed. In terms of the Framework, knowledge can be created through the Socialization element of the SECI model. Experienced project members can be freed to meet socially to share their stories about risk. Such meetings constitute the Ba space in which knowledge is created. This knowledge would then be stored in the knowledgebase for project managers to access when making decisions concerning the risk. Such knowledge storage reflected the Externalization element of SECI. Then the actual use of the knowledge by project managers reflects the combination and integration elements.

The Framework was constructed from empirical data as follows:

- Interview data was analysed to find codes/themes/patterns (Sections 5.3, 5.4, 5.5)
- The themes reflect the project-specific knowledge activities or Ba – like the normal activities; meetings, review meetings, estimation etc. (Section 5.6.3). These activities are the actual spaces - Ba in which project-specific knowledge is created and actioned for decision-making.
- These themes were then further analysed, and resulted in four patterns (meta-themes) – knowledge creation, knowledge acquisition, knowledge sharing, and knowledge application for decision-making (Section 5.6.1).
- Table 5.7 in Section 5.6.1 shows how the data analysis proceeded analytically from themes to meta-themes.

The first research objective, to conduct the literature search, was covered in Chapter 2. The fourth research objective to evaluate and validate the framework with expert IT systems development project managers is discussed in the next Chapter.

6.2.1 Ba spaces for Project-specific knowledge activities

The SECI model supports the Framework in terms of the creation of project-specific knowledge for decision-making, through the Socialization, Externalization, Combination, and Internalization activities. However, the actual 'Ba' or spaces in which such process occur is reflected in the actual project activities, such as meetings, review meetings, brainstorming, and conversations in which team members and experts share their experiences and stories. This is then stored in knowledge repositories and knowledge management systems such as JIRA and wikis and the Intranet. Ba is an important aspect of knowledge creation because it identifies the actual space in which project-specific knowledge is created.

Ba knowledge spaces are depicted in the Framework in Figure 6.1 as the rectangles connected by the bilateral connectors. Project knowledge activities such as brainstorming, and conversation produce relevant knowledge which stored in SVN, Testlink, or JIRA platform. It is recorded as best practice and drawn on by project managers to support decision-making. The data reveals that a knowledge culture was encouraged by rewarding team members who were willing to share their knowledge (See Section 5.4 Second-Round Interviews). Interviewees reported that they recognised the significance of reward systems to encourage knowledge sharing.

6.3 Improving Decision Making

Current decision-making theory discussed in Section 3.3.2 assumes 'rational man'. The assumption that individuals, groups, and organisations make decisions by rationally considering all the available options has been questioned in the literature. The findings of this research agree with the view that decision-making, like learning, is highly bound by the context in which decisions are made (SaiCebrian, 2018). A single model of knowledge creation and learning is not sufficient to explain the varied situations and settings of decision-making. The findings of this research reveal that although project managers and team members bring prior experience to a particular IT systems development project, it is not sufficient to completely address all the problems in the particular setting.

Rather than the 'rational man' models of decision-making, Boyd's (2018) 'organic' approach reflects better the findings of this research. Similar to the argument made in Chapter 2 about current research in project management, Boyd argues that failure leads researchers to focus on further and deeper researcher into the same topics. He argues that it is necessary to find a complete alternative focus, which he calls organic and its focus is on 'implicit nature of human beings.' Similar to the findings of this research and reflected in the IT Systems Development Decision-Making Framework, Boyd asserts that:

> "Without the implicit bonds or connections, associated with similar images or impressions, there can be neither harmony nor individual initiative within a collective entity, therefore, no way that such an organic whole can stay together and cope with a many-sided uncertain and ever-changing environment".
>
> (Boyd, 2018: Slide 21)

The meta-themes detailed above agree Boyd's conception of avoiding failure or more positively achieving survival organically. They also agree with the theory of knowledge creation (Nonaka 1994; Nonaka and Konno, 1998) in terms of creating context-specific knowledge, and they are used to build the IT Systems Development Decision-Making Support Framework. The Framework reflects Boyd's 'implicit nature of human beings'; project managers learn to cope with complex IT systems development settings by creating 'bonds or connections' to create 'harmony' in the 'collective' project, leading to 'organic' decision-making.

The meta-themes reflect the organizational knowledge-creation theory, which states that knowledge is created through an iterative process between tacit and explicit knowledge. Tacit knowledge is unseen knowledge that is not easily codified into any transmittable form. An

example of tacit knowledge is knowledge of how long a particular coding task takes. A programmer would know this tacitly but find it difficult to make the knowledge explicit. Explicit knowledge is seen knowledge that is easily codified and transcribed (Nonaka *et al.*, 2000). The project knowledge activities derived from the dataset (see Sub-section 4.6.3) shows evidence of this iterative process. The SECI, Socialization-Externalization-Combination-Internalization (SECI), model (Lewis, 2014) thus underpins the IT Systems Development Decision-Making Support Framework.

A critical aspect of the findings is the vital context of project-specific knowledge management. The research focused on complex IT systems development. This context is significant because knowledge is embedded in the complicated context consisting of people, organisation, and IT artefact development and the many complicated interfaces that this set of elements creates. As noted in the literature search, knowledge creation happens in a shared context or 'Ba', according to Nonaka and Konno (1998). Knowledge is embedded in context or Ba. Critically, where there is no context it is information, not knowledge. Consequently, information resides in media and networks, but knowledge resides in Ba, which is the complex IT systems development place. In this place knowledge is created and shared to innovate something new. This is the same experience of project managers. Though they have prior experience of IT systems development, in the particular cases they mentioned it was evident that they had to instigate core project-specific knowledge activities specially related to the particular setting of the IT systems development.

The focus of the research was on IT project manager's decision-making process. The Framework illustrated above is an explanation of how IT project managers create, acquire, share and apply technical systems and project management knowledge. It depicts the organisation and processes for managing project-specific knowledge. Essentially, it shows how tacit knowledge is transformed into explicit knowledge and how explicit knowledge is internalised into tacit knowledge.

The Framework is composed of meta-themes as the foundation (See Sub-section 5.6.1). Knowledge creation, acquisition, sharing, and applying underpin and explains how the framework works and is applied in practice. The actual knowledge activities in the project (See Sub-section 5.6.3) such as information on cost, time, scope and quality happened through the SECI spiral. Project knowledge management includes how a project is initiated, prepared, executed and controlled and evaluated. IT systems development project constructs include these

ideas but would need to include IT specific constructs like complexity, informality, originality, lack of explicit knowledge, reliance on tacit knowledge, and difficulty of monitoring progress.

As shown by the bi-directional arrows connecting the rectangles in Figure 5.1, programmers, developers, IT support components and other project entities communicate with the project manager to comply with information requests. However, this information is not final. It needs to be converted into project-specific knowledge that can be applied to make project decisions. This then happens in formal forums Ba spaces such as review meetings, progress meetings, training sessions and brainstorming, shown as the brown boxes with blue arrows rectangle – this is the project knowledge activities rectangle. The SECI process unfolds in these formal forums of project knowledge activities. That is knowledge is created through the social aspect of the formal meetings – Socialization. Specific tacit knowledge is externalized from experts – the Externalisation component. Existing explicit knowledge is combined with either tacit or explicit knowledge – Combination. Finally, knowledge is then integrated into the decision-making process – Internalization.

In the framework integrated knowledge becomes part of the project knowledgebase. So, the meta-themes and themes discovered through the data analysis are framed around the SECI model but in the specific context of project-specific knowledge management. Socialisation can include programming, procurement, work breakdown, and allocation. Externalisation can include the monitoring of progress and creation and use of explicit knowledge. Combination can include the integration of the project knowledge and various IT systems components like hardware, networks, software and people, and the Internalisation can include the understanding and use of the learnt knowledge about the IT systems development project, which can be used to make decisions.

Critical project decisions need to be made during IT systems development. A project that is in progress is considered to have zero value (Fleming and Koppelman, 2000) and the longer it continues in that state the more risky it becomes. In Information Technology, projects are only considered to have some value when they become operational. Once implemented and used, it has both utility as well as the cost of maintaining the functionality. This concept means that even though the project manager may have chosen the right project, the project manager must ensure that he/she can stop the project at any time (Jain and Nguyen, 2009). This ensures that one does not commit to invest time and money in a project that may end up being of less value than it was initially expected to be.

This phenomenon is referred to as the Sunk Cost Fallacy where one continues to invest over and above the cost benefit trade-off, and IT project managers constantly sought knowledge about critical decisions concerning the state and progress of the system development. Therefore, it is always necessary to ensure that one makes only small increments when investing in an Information Technology project. The investor should continually reassess the project and stop the investment in case the project proves to be of less value than initially expected (Jain and Nguyen, 2009). So IT project managers developed a formal knowledge management system, used to seize, record, and distribute knowledge. IT project managers learning was enabled through the SECI processes.

Often when making a decision, all the information that would be helpful in making that decision was not available to project managers. In most cases, decisions are made based on incomplete information or data. According to Amos (2001), to make an informed decision, it is essential to gather about 80 percent of the necessary information. It is often difficult to have all the information that is required in order to make a decision. In this case the project manager will only require to gather about 80 percent of the information and then make a decision in regard to the time the programmer should take in completing a specific task. The information was gathered through peer review and project meetings, which both reflect the socialisation phase of the SECI cycle.

The SECI model is combined with this Framework to understand the creation of knowledge for unique IT systems development projects. Its phases of knowledge creation reflect the environmental complexity, domain expertise, project values, and communication between different professionals, knowledge contribution, knowledge flows, and knowledge sharing. These four modes of knowledge creation reflect the critical decision-making process during IT systems development, as expected and discussed in the literature search (Lewis, 2014). So, the IT Systems Development Decision-Making Support Framework reflects the socialisation, externalisation, combination and integration aspects as expected. These are the core activities of knowledge work in IT systems development project.

This framework helps the decision maker to make the right decision about the time that a programmer takes on a given task, as well as other technical, design and project management decisions. For example, the programmer gives the project manager the expected time which is explicit knowledge. The project manager then sends the estimation to other programmers working on the project and requests them to review and making their own suggestions

anonymously – the Socialization and Externalization aspects. The project manager then evaluates all suggestions - decides the time as per the peer review, the internalisation aspect. Then through Combination, Peer Assistance Profits: A Peer Assist can support project teams accomplish clear deliverables such as:

- Shortened planning, Reduction of costs and execution time
- Management and identification of risks

6.3.1 Knowledge Sequence, Actions and Triggers

As mentioned in Section 2.6.2, though the dominant decision-making model assumes 'rational man', actual decision-making reflects lack of complete information and prevalence of uncertainty. Consequently, the two layers of the developed Framework, the SECI elements and the Ba creative and recording spaces are needed to generate and action project-specific knowledge.

The IT Systems Development Decision-Making Support Framework is about how the project-specific knowledge is created for decision-making. As the SECI model describes the creation of knowledge it is necessary to explain how the created knowledge would then be used in the context of IT systems development projects. So it is necessary to show elements of the Framework that store, update and make use of the created project-specific knowledge. This involves explaining the knowledge sequence to include knowledge actions and knowledge triggers.

Alhammadi *et al.*, (2015) conceptualised a knowledge-based model to support decision-making for cloud computing systems development combining the analytical hierarchical approach (AHP) with Case Based Reasoning (CBR), as shown in Figure 6.2. The Cloud Migration Decision Model consists of three phases: the CBR element, the AHP element, and the CBR element combined with the AHP element to enable decision making for cloud migration. This approach is Multi-criteria decision making (MCDM) which involves "the evaluation of the alternatives for the purpose of selection or ranking" (Özcan *et al.*, 2011).

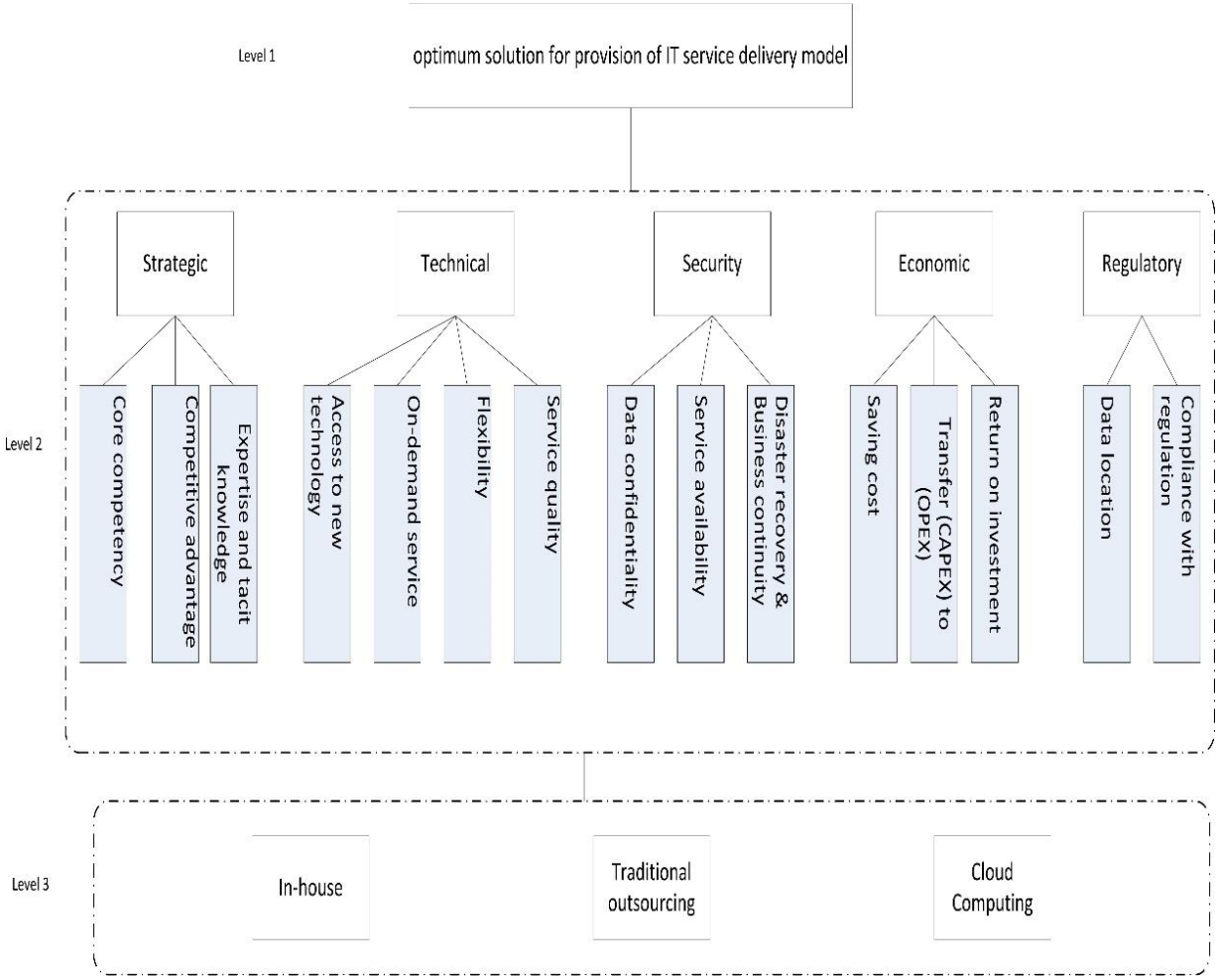

Figure 6-2 Cloud Migration Decision Model

Source: Alhammadi *et al.* (2015)

Sharp *et al.* (2003) propose the use of visual tools to help understand a problem situation. They explain the development of a visual tool in MaKE which is a KM method. Visual tools like Knowledge Targets Pyramid, Knowledge Tree, Knowledge Block, and the Linking are used to help present outcomes. The authors suggest that such tools can be used to understand and communicate information about complex phenomena. However, though such tools simplify or summarise complex phenomena and enhance communicability they also create misunderstanding and misrepresentation of the communicated subject. However, the MCDM and visual tools type of decision-making is uncharacteristic of complex IT systems development project. Consequently, the IT Systems Development Decision-Making Support Framework contains two layers to address the complexity of the deep context and the social interactions of experts during IT systems development. Projects normally require decisions to be made based on available resources and speicifc tasks and objectives to be achieved.

The foundation layer of the Framework is the theoretically based SECI model, shown as the elliptical elements. It addresses the issue of defining knowledge raised by Heisig (2009) in terms of tacit knowledge and explicit knowledge (See Section 3.2.2). The foundation layer is theoretically important because concepts and elements of the Framework are understood in terms of theory of knowledge creation.

The top layer is the knowledge sequence, knowledge actions, and knowledge triggers, as shown as the rectangles, squares, cylinders, bi-directional arrows and arrows of information and knowledge flows in the Framework in Figure 6.1. These are the project-specific knowledge activities explained in Sub-section 4.6.3 earlier. These knowledge activities are specific project activities initiated by project managers to understand a problem better in order to create relevant knowledge to make more informed decisions. The knowledge activities like brainstorming, conversation, JIRA etc. are initiated for the purpose of gathering information and knowledge, which is stored in the knowledge base. This knowledge can then be used to support project decision-making.

6.4 Causal and Contextual Understanding

Conceptual frameworks can be causal, contextual or a combination of both. The IT Systems Development Decision-Making Support Framework is not causal because it does not identify cause-effect. As Miles and Huberman (1994), as causal conceptual framework maps relevant concept and their relationships and trace the sequence of events to develop a model of the causality. So, a causal conceptual framework explains a cause-effect relationship of the phenomenon. Maxwell (2004) states that it needs to identify the variables and the expected relationships and indicates the measurement. This means one or more independent and dependent variables need to be identified. Similarly, actual decision-making by project managers does not reflect the cause-effect 'rational man' models of decision-making (See Section 2.6.2). Based on the gathered data, the developed Framework does not reflect any of these features.

Rather it reflects contextual understanding of project-specific knowledge management and decision-making. Complex IT systems development projects, being composed on people, organisation, and IT artefacts create *deep social context*s that do not fall into rational frameworks of explanation. So it is the second type of conceptual framework, contextual conceptual framework that better explains deep social contexts. A contextual conceptual framework depicts understanding of the context which is necessary to explain the phenomenon. This is because the

context is part of the explanation. In complex IT systems development projects, the context consists of people, organisation and the IT artefacts. This context is rich in the behaviours, interactions, and interrelationships of the project managers, expert programmers, database developers, and network specialists, as well as web designers and developers, and external consultants. Their actions and meanings they hold in their minds happen in the particular context of the IT system development. The IT Systems Development Decision-Making Support Framework through the SECI model and Ba reflects this rich contextual or deep social behaviour in order to create, acquire, share, and apply project-specific knowledge for decision-making.

The SECI model reviewed in Chapter 2 is concerned with the particular context of knowledge creation. So, as expected the research findings reflect the context in which project managers create, acquire, share, and apply knowledge. The context of complex IT systems development projects needs to be accounted for because complex IT systems require expert knowledge to be completed successfully. As noted in the literature search Chapter, knowledge resides in people and people interact to accomplish responsibilities. This is usually done through some organisation involving resources, responsibilities, tasks and time constraints. This rich context of knowledge creation and sharing is the basis of the proposed contextual conceptual framework of this research.

6.5 IT Systems Development Decision-Making Support Framework

In this section the design of the knowledge management is explained. The findings of the research were used to conceptualise knowledge management and decision-making process in complex IT systems development. The components of the framework, structure, elements, process, and relationships reflect the SECI model and the actual project-specific knowledge creation and usage activities observed.

The findings of the research as presented in Chapter 4, indicate that project managers engage with project-specific knowledge. The meta-themes indicate that project managers' decision-making process relies on managing project members' knowledge. These meta-themes, knowledge creation, knowledge acquisition, knowledge sharing, and application of knowledge for decision-making, in turn cohere well with the SECI model. Hence the base components of the IT Systems Development Decision-Making Support Framework are the same as the SECI model. Namely, Socialisation, Externalisation, Combination, and Internalisation, as explained in Sub-section 5.2. These components are reflected in actual project activities observed, as detailed

in Sub-section 4.6.3, and they explain the project-specific knowledge creation process aspect of the Framework.

The knowledge application aspect – decision-making – is explained by the overlaying components of the framework; the rectangles and bi-directional arrows. Namely, experts such as programmers and developers, IT systems components, and knowledge base and monitoring. These project personnel and result in explicit knowledge that is stored in the project knowledge base. The data analysis themes that emerged (See Section 5.5) described the overlaying components.

Project managers use the combination of the SECI and overlaying components of the Framework in order to support their decision-making process. In knowledge management, the place of the crucial decision-making process plays an important role depending on the capability of decision-makers. As per the Framework, regular discussions with practitioners helped project managers to gain understanding and transfer knowledge along with the evaluation of decisions. This also holds true for implicit knowledge that is applicable to the domain concerned. To support the process of project decision-making, framework has implemented an expert hybrid methodical system combining SECI and core project activities. The study throws light on SPM's decision process area. Both off-process and in-process aspects related to decision-making are included as elements (Sadabadi, n.d.).The role of knowledge management is changing in environments of IT systems development. It has an extended mode where the 5 SDLC phases are integrated along with Knowledge Management Life Cycle's 5 phases. The research revealed that project managers were greatly helped by gaining the know-how and perfect usage of critical knowledge in life cycle of software development. It also helped them in selecting the right phase of KMLC during its appropriate life cycle of software development. (Alawneh *et al.*, 2008).

A summary of the application of the KM framework is as follows. Project managers encounter a particular systems design problem, scheduling problem involving complex systems integration, or coding problem requiring API customisation, for example. They draw on their personal experience and consult available project knowledge bases. In order to contextualise the problem solution they consult with experts in the project team through project activities such as meetings, seminars or brainstorming. Such sessions are for creating project-specific knowledge and this involves making tacit knowledge into explicit knowledge, which requires going through the SECI steps. Then such externalised explicit knowledge is combined and stored in the project knowledge bases for the use of project managers when making project decisions.

An example illustration of the KM framework can be drawn from the focus group data. A project manager, with over twenty year's integration and customisation experience using the CBIO platform, related his experiences of needing project-specific knowledge. He first noted the evolution of the project management techniques but said that they lacked especially in knowledge transfer. In his work the KM framework would be used to formalise the socializing for externalising knowledge and for team building. In the socialisation phase the 'informal communication that happened to be more important in some cases then the formal communication' can be used to externalise project-specific knowledge. This would complement the assessment of the progress of the project through numerical KPIs which basically follows the formal part of the progress and financial KPIs. The socialisation phase can be used as social communication which creates valuable knowledge of the nontangible aspects of the projects as well as the evaluation of the knowledge transfer via coaching and team building sessions. He especially appreciated the informal communication which is sincerer and may create valuable information much earlier than the formal way of communication. He further illustrated one formal and one informal knowledge exchange with the BSCS specialists. The billing platform allows the BSCS specialists to do customization by changing the configuration aiming to satisfy the requirements of the product departments of the communal service providers. A formal trainng session was prepared. Since in most countries the requirements were similar it was very successful exchange of explicit knowledge among the international team members. When the formal training finished, the participants proceeded with tacit knowledge exchange conducting coaching sessions which covered the specifics which were not addressed during the generic training. This is one example how the knowledge transfer is conducted with concrete examples.

The KM framework can be used by project managers to support decision-making. In addition to using the project office formal paths in drawing more sensitive decisions, they can use the creative Ba to acquire project-specific knowledge. The decisions that affect the fine-tuning aspect of the project are made by project managers by drawing on the experience stored in the projects' repository. Decisions are discussed in the project meetings and follow up sessions – project activities that constitute creative Ba and decision Ba spaces. An example of making critical decision is a major upgrade program of the business support systems comprising the billing, customer relationship management, integration application interface, dunning system, prepaid billing platform, provisioning platform and document management platform. This process was initiated to make versions compatible with other companies in the group and at the same time to

check the new version of the billing platform in production. The project manager was finalising the end of the development and testing activities the final decision of the cutover date in the middle of the summer vacations. The baby sitting of the platform which is quite critical was to happen at the middle of the summer. It was risky decision since most of the expert will be on vacation and the resources from the vendors' side will be restricted. After several sessions of consultations including the program director, stake holders and other relevant parties, using the tacit knowledge exchange by exchanging informal opinions and experiences from the previous installations, as well as the written explicit documentation of the previous project and post mortem documentation, we decided to postpone the cut-off date in production after the summer holidays.

6.6 Knowledge Management and Decision Making

A discussion of the IT Systems Development Decision-Making Support Framework in relation to the literature review is presented in this Section. The IT Systems Development Decision-Making Support Framework is compared to the actual knowledge creation activities of project managers. The key is that the IT Systems Development Decision-Making Support Framework makes project knowledge management for decision making explicit. The framework conceptualises project managers' activities involving the project team to create knowledge to support decision-making process.

Knowledge management and decision making involve the generation of knowledge, a collection of raw materials of knowledge; for example, collection of data, or gathering information from individuals who pose experience. After gathering such information, then it is necessary to transform it into knowledge that will help increase the quality of decision making (Ferrell, *et al.* 2008).

Knowledge management requires tools that are concerned with accessibility and relevancy of information and the ability present the information to the stakeholders who need it. However, in the IT systems observed project managers had no explicit knowledge management tools. They used project activities such as estimating and budgeting to engage project members to create knowledge to support decision-making. A project is considered to have failed when either the budget that was set for the project has been exceeded, the project deadline is not met, when the scope of the project needs to be reduced in order to be completed within the budget as well as time schedule (Kerzner, 2013). So, for such critical decisions the current practice of relying on project management techniques - estimation, scheduling, etc. - can be supplemented with

knowledge management activities as explained in the IT Systems Development Decision-Making Support Framework.

In IT systems development, some steps may be taken to avoid the possibilities of the project failing. For example, the project manager should make sure that the project scope is accurately defined. The failure in most projects can be attributed to scope that was not initially well defined in terms of knowledge needed. A project that is realistic helps in eliminating exaggerated expectations for an IT systems development, this ensures completion of the project with the stated schedule (Ferrell, *et al.,* 2008). The project manager must also ensure that there are clear time and budget specifications. Realistic schedule and budget, and a well-defined project scope increases the likelihood of project success, which the IT Systems Development Decision-Making Support Framework evidenced.

Project managers ensured that they manage the project scope and do not try to control it (de Moraes *et al.*, 2014). To avoid project failure, the project developers must also ensure that they avoid software modification. In order to avoid developer's writing custom code that can lead to unexpected and often complicated development problems, project managers used the socialisation aspect of the IT Systems Development Decision-Making Support Framework to make their practices explicit. The resulting knowledge avoided unnecessary software modifications, that otherwise wold prevent easy downstream software upgrade can be carried out(de Moraes *et al.*, 2014).

To ensure that a project succeeds, it is essential for the developers to consider change management training of the end-user, as well as documentation indicating how the final software product operates. The project manager must communicate the status, goals, and impact of the final product on their way the user work. Currently, in many cases, the project manager does not pay adequate attention to the training and documentation, especially in cases where the budget of the project has been exceeded (de Moraes *et al.*, 2014). With the explicit IT Systems Development Decision-Making Support Framework, the resulting knowledgebase becomes useful for compiling the documentation. When documentation and training is not carried out, the productivity of the final product may be reduced. In other cases, the users may fail to use the product because they do not understand it. The project manager must ensure that all decisions are well made (de Moraes *et al.*, 2014).

6.7 Conclusion

Construction of the IT Systems Development Decision-Making Support Framework has been explained in this Chapter. It was developed using the derived meta-themes and themes from the data analysis Chapter and based on the SECI model. The SECI aspects form the base components as reflected in the meta-themes and the project-specific knowledge activities, as reflected in the data themes, form the actual knowledge creation and use activities. In this Chapter the actual project activities were compared with the structure, components, and process suggested by the IT Systems Development Decision-Making Support Framework.

Project managers engaged in project-specific knowledge creation and knowledge management activities without being aware of the SECI model and the use of normal project activities as knowledge management. They were able to reflect on their knowledge management practice with the aid of the IT Systems Development Decision-Making Support Framework. So, this developed framework was then validated with the project managers who participated in the focus group interviews, as explained in the next Chapter.

CHAPTER 7 VALIDATION

7.1 Introduction

In the previous chapter it was explained how the IT Systems Development Decision-Making Support Framework was developed. The IT Systems Development Decision-Making Support Framework is composed on several components in two layers, the foundational layer reflecting the SECI spiral and the top layer reflecting project-specific knowledge management activities. The aim then was to check its validity by assessing its practical value for IT systems project managers. So, this Chapter explains how the developed Framework was validated. The validation reflects the theoretical and practical contribution of the research.

The validation focused on two aspects of project knowledge management practice, theoretical validity and practical validity. The first concerns theoretical validity. Since theory is an explanation of an observed phenomenon, the IT Systems Development Decision-Making Support Framework needs to account for project managers observed project-specific knowledge management activities. Consequently, the focus was on whether project managers could relate their current knowledge management activities to the developed Framework. As the Framework was developed from the collected empirical data, it needs to explain or agree with existing practice in terms of project managers' actual project-specific knowledge creation and usage – for decision-making - activities. It should theoretically reflect the phenomenon.

The second concerns practical validity. It is expected that the research outcome should have practical impact. So, the Framework should be useful for project managers' project-specific knowledge management activities. Could they relate their behaviours, the behaviours of the team members, and project knowledge management activities to the SECI model embedded in the framework? And to the Ba spaces overlaying it? Could project managers use the developed Framework to articulate their knowledge management activities and enhance their practice of project-specific knowledge management to support decision-making processes?

The primary data from the first and second-round interviews was used to conceptualise the KM framework. The data from the focus group was used to validate it. The primary data analysis revealed themes called meta-themes (see Section 5.6.1) that explain how project-specific knowledge is created through normal project activities (see Section 5.6.3). These meta-themes and project activities for knowledge creation are illustrated in Figure 6.1. The data from the second-round interviews concerning specific systems design, coding, testing, and integration project activities shows that such activities required project-specific knowledge because of the complex and unique nature of the projects, they could not be done directly from existing explicit

knowledge bases. Therefore, project managers engaged various experts in meetings, seminars, brainstorming etc. to create such knowledge. This engagement reflects the Socialisation, Externalisation, Combination, and Integration of knowledge from tacit knowledge to explicit knowledge.

7.2 Validation Process

The validation of the Framework was done through focus group interviews. So, while designing the interview and focus group questions, based on the data it was assumed that the core Socialisation, Externalisation, Combination, and Internalisation knowledge activities were actually a part of a project managers' knowledge management activities. And the interview questions reflected this core aspect of the Framework. In deductive reasoning the premises are assumed to lead to evidence to support the conclusion – in this case, the premise being that the SECI model underpins project-specific knowledge management activity, and the conclusion is supported by the gathered empirical data. There were no problems in validating the IT Systems Development Decision-Making Support Framework. The validation design and plan were aspects of the research design (See Section 4.3.1). As such they were coherent with the designed research methodology and were implemented without any issues arising.

Therefore, the validation design consisted of seeking the theoretical and practical validity of the framework. During the focus group interviews project managers were asked questions that probed their views on the use of the IT Systems Development Decision-Making Support Framework, as underpinned by the SECI process and Ba knowledge spaces. The validation focused on project managers' project knowledge activities, such as determining tasks and responsibilities, estimating costs and time scales, as examples of Externalisation. Knowledge would be gathered through project meetings, seminars and group email communication, indicating the Socialisation aspect and knowledge spaces. They need to record the state of the project by gathering project information, indicating the Externalisation aspect. Information gathered would then be put into project repositories, indicating the Externalisation and Combination aspect. Finally, project managers would need to understand how to apply the knowledge about the project they have created for decision-making, the Internalisation aspect.

The validation is a fair test because the purpose was to assess the theoretical and practical contribution of the IT Systems Development Decision-Making Support Framework. Theoretical validation is normally done by testing whether the phenomenon agrees with the explanation represented in the Framework. This was done by gathering project managers' responses on the

explanation during the focus group interviews. Practical validation is normally done by testing the usability of the outcome of the research or its impact. This was done by discussing the results with project managers during the focus group interviews. Project managers' responses indicate that the theoretical explanation and the Framework utility are an appropriate reflection of their project-specific knowledge activities, and provide a practical framework for interpreting and structuring their project knowledge activities to support decision-making processes. So, the framework was studied in practice and the research data can help to validate the applicability of SECI theory in IT systems development project-specific knowledge management for decision support.

7.3 Focus Group Analysis

The focus group questions focused on understanding further about how project knowledge is managed, specifically how it is generated through sharing, as reflected in the developed IT Systems Development Decision-Making Support Framework. The questions probed project managers' and team's capability to solve complex and usually original IT systems development problems for particular organisational contexts in terms of their decision-making. In particular, the questions investigated project managers' ability to make critical project decisions to achieve a successful project. It was expected that the focus group data would contribute towards the aim of this study, namely to validate the IT Systems Development Decision-Making Support Framework that enables complex decision-making to reduce the failure of IT systems development projects. The underlying assumptions in formulating the focus group questions is to assess how project-specific knowledge is managed from the perspective of the SECI knowledge creation model, including the Ba knowledge spaces, and how project managers make complex IT systems development decisions using the created project-specific knowledge.

As the theory of knowledge creation assumes that knowledge moves through four stages of application of the SECI model, the management of complex IT systems development project means creating entirely original knowledge, knowledge that is unique to the complex IT systems development project. This may involve radically or new knowledge that combines existing know-how in new ways. So the questionnaire contained questions to model this SECI knowledge creation theory and investigate how complex IT systems development project knowledge is managed and project decisions are made.

The focus group questions sought to validate the Framework. They contain questions that were asked to gather data about the utility of the Framework and other questions that could be asked

as follow-up and probing questions if required. The group of IT project managers had an average of 25 years' experience of managing complex IT projects and were interested in knowledge management in such projects. (The focus group questions and sample responses are given in Appendix E.) Table 7.1 lists the meta-themes and the project activities themes of the KM framework in column one and a summary of the support data in column two, which also indicates the Sub-sections in this Chapter where data is elaborated. A summary of the validation results is presented in Table 7.1 and reflects the proposed KM framework illustrated in Figure 6.1.

Table 7-1 Focus Group Initial and Cluster Codes Embedded in Meta-themes

Framework Constructs	**Supporting Data**
Socialisation	Development methodologies like SCRUM draw on tacit knowledge which is harnessed through the Socialisation process. Knowledge transfer and sharing gains more focus in the newer systems development methodologies like SCRUM and agile systems development. Project managers emphasised that these development methodologies highlight the social context more because there is focus on sharing and transferring tacit knowledge. (See Sub-sections 7.3.1 and 7.3.2).
Externalisation	The recording of tacit knowledge as explicit knowledge through the Externalisation process. This issue was explored to understand whether explicit knowledge is as formal as assumed and how it is transferred and shared by project members. (See Sub-section 7.3.3).
Combination	The Socialisation and Externalisation process is used to transfer and share tacit knowledge and explicit knowledge, which is formally recorded in software tools (knowledgebases or recording Ba spaces). However, to be effective the externalised knowledge needs to be combined with existing explicit knowledge and be accessible to apply it to particular project management decisions and development tasks. (See Sub-sections 7.3.4)
Integration	The availability of project knowledgebase did not seem to make project managers' decisions easier. It had to be integrated into the project-specific issues that required project managers' attention to make critical decisions. The availability of the knowledgebase, through all the Socialisation, explicit recording, and enabling access does not in itself mean that the available knowledge can be immediately used directly by project managers to make critical decisions. Critical decisions are those that have a highly visible priority for stakeholders and can be used by them to judge the progress and success of the project. The complexity of decisions emerged as a theme across all the participants. (See Sub-section 7.3.5 and 7.3.6)
Project Activities as Ba Spaces	Normal project management activities such as project direction meetings, project steering meetings, training, seminars, brainstorming etc. were the actual Ba spaces. These Ba spaces were creative Ba, recording Ba, and decision-making Ba. (See Sub-section 7.3.7 and 7.4)
Decision-making	The availability of the knowledgebase, through all the Socialisation, explicit recording, and enabling access does not in itself mean that the available knowledge can be immediately used directly by project managers to make critical decisions. SECI aspects were used to contextualise stored knowledge before it could be applied for decision-making. Critical decisions are those that have a highly visible priority for stakeholders and can be used by them to judge the progress and success of the project. The complexity of decisions emerged as a theme across all the participants. The availability of project knowledgebase did not seem to make project managers' decisions easier. (See Sub-section 7.3.5, 7.5 and 7.6)
Impact	From the discussion above, it can be argued that the proposed complex IT Systems Development Decision-Making Support Framework has impact on conceptualising project knowledge management and supporting decision-making processes. The discussion shows that project managers currently use existing project management methodologies and associated project knowledge management tools. However, it is clear that they also use 'informal' practices that can be accurately described as reflecting the SECI knowledge management processes.

7.3.1 Social Context

The first question examined knowledge sharing by project managers with project members and by project managers with project managers. It sought to identify the deep social context of sharing personal experiential knowledge. The participants revealed that 'the social' aspect compliments the formal monitoring and reporting of the project. Project managers make use of the social context to gather specific information about certain aspects of the project, non-tangible aspects, and for progress reporting. As expected from the proposed IT Systems Development Decision-Making Support Framework, social processes are used to transfer and share both explicit and tacit project-specific knowledge.

7.3.2 Socialization

IT systems development projects are based on the assumption that all the required project knowledge is explicit knowledge, ready for executable action. However, this overlooks tacit knowledge. Knowledge transfer and sharing gained more focus in the newer systems development methodologies like SCRUM and agile systems development. Project managers emphasised that these development methodologies highlight the social context more because there is focus on sharing and transferring tacit knowledge. They related that transfer and sharing of tacit knowledge is necessary in SCRUM and agile methodologies, and that the SECI model's Socialisation and Internalisation processes describe well what they actually do in their projects to create project-specific development knowledge.

Participant 1, an experienced BSCS (Ericsson Billing platform – lately named CBIO) technical manager and project manager has experience in integration and customization programs and projects. He has over 10 years BSS project management experience. He said:

"… I witnessed the evolution of the project management techniques especially in the knowledge transfer. Related to the socializing approach always in the team work there is informal communication that happens to be more important in some cases then the formal communication. The assessment of the progress of the project always is based on both numerical KPIs which basically follows the formal part of the progress and financial KPIs."

The social context provides 'valuable knowledge' not covered by formal monitoring and reporting techniques of project management. The participant said:

"… Social communication … brings valuable knowledge of the nontangible aspects of the projects as well as the evaluation of the knowledge transfer via coaching and team building sessions. I appreciate the informal communication which is sincerer and may bring valuable information much earlier than the formal way of communication."

The social process is used to transfer and share both explicit and tacit IT systems development knowledge. The participant provided examples of formal and informal (social) sharing of knowledge:

"I will give one formal and one informal knowledge exchange that I have been using to exchange with the BSCS specialists. The billing platform allows the BSCS specialists to do customization by changing the configuration aiming to satisfy the demanding requirements of the product departments of the communal service providers. I prepared one tutorial for the project members which was used throughout the training program. Since in most countries the requirements were similar it was very successful exchange of explicit knowledge. When the training finished I proceed with tacit knowledge exchange conducting coaching sessions which covered the specifics which were not that much tackled during the generic training. This is one example of how the knowledge transfer is conducted."

Participant 2 also mentioned that the social context enables transfer and sharing of tacit knowledge. His view is that the social context is more 'dominant' for knowledge transfer and sharing than the formal project management reporting techniques, and that 'lose organisation' is better than a rigid formal project management structure:

"In the process of project management there is tendency of making the informal part of the knowledge or the tacit part as dominant part of the knowledge transfer. The new tendency of loose project organization which is very imminent in the SCRUM project structure rely on tacit knowledge and exchanging of informal knowledge. This is good for steady team structure and when the team members know each other for long time. I am always adjusting to the circumstances while managing projects. In some cases, lose organization with informal way of communication and knowledge transfer is more efficient with less overhead but in some cases strict organization is needed as well as explicit knowledge exchange. In one project the same phase is organized one way and in another differently, this is lately quite common."

Agreeing with Participant 1, he also provided an example of using the SCRUM project management technique:

"For example, for more routine work to be conducted by SCRUM lose project organization as the knowledge framework is suited, and in some cases the same module of the project is more formal where the uncertainties and the complexity emerges, and a new team structure is required."

As expected from the IT Systems Development Decision-Making Support Framework, Participant 2 noted that explicit knowledge is not dependent on the social context:

"In the complex project organization, the socializing is not always favourable for knowledge transfer and some combinations may be needed following the SECI spiral, where the transformation from one form of learning to another form of learning is used upon the circumstances and project phase needs."

Participant 3 has been leading customers' projects more than 10 years for telecommunication services providers. Consistent with Participant 1 and Participant 2, he related that the formal channels of communications 'strong hierarchy' remain in use, but there is more awareness of

informal or socialising 'lose hierarchy' especially in agile development as a means for transferring and sharing tacit knowledge:

Related to sharing tacit knowledge, I will explain my approach. Project can be conducted with strong hierarchy and with lose hierarchy. Traditional approach of strong hierarchy is still valid and actual but also there is new trend of using the socializing during the project management and sharing the informal knowledge during the progress of the project. I apply this in my agile project management which is quite suitable for the projects which are close to service delivery projects. In that case the customization and documentation for the knowledge management is not explicitly required but the informal transferring of experience and knowledge to the project members. This is common in agile projects and can deviate strongly in my case by the level of customization. If more customization is required than I use more formal approach and record some of the procedures and methodologies, if the work is pure deployment with some minor customizations then I use the socializing.

Participant 3 emphasised that the socialising aspect is valuable in complex IT systems development projects especially. These 'big projects' require customised integration of different components according to the unique organisational processes, as argued in the conceptual framework in Chapter 3:

The above-mentioned approach is also important in case of big projects… to manage the more complex or more difficult parts of integration in the project …. The easier modules, which do not need a lot of customization and development will be left to the scrum teams who will conduct the module installation and customization. The parallel engagement of project manager in multiple different projects is also something that contributes to achieve the goal with combined approach for better knowledge exchange.

Participant 4 is currently the Project Manager for a large telecommunications projects. He related that tacit knowledge is better communicated using agile development:

Most of the projects are conducted as SCRUM based project because these projects are product customization or service customization. … Agile approach is focused on the tacit knowledge and only fraction of the knowledge of agile projects involves explicate knowledge. Very often I am focused on conveying explicit knowledge to tacit using the approach of internalization. The spiral of the SECI model also may be used in more complex project where multiple products and services are bundled in the delivery.

The social context and socialising appears to have relevance in managing minor crisis during systems development. Participant 5 mentioned that tacit knowledge is often overlooked during problematical times when conflict is more likely to surface, but he generates conversation and discussion to transfer and share relevant tacit knowledge in order to manage the project better between other managers:

My approach to share the informal knowledge, or better said as the knowledge that seems difficult to make explicit, is by open and frank discussions among the project members involved in managing of the projects, like the technical managers, subproject leads, solution architects and QA leads from one side and members of the stakeholders from the other side. Good communication and positive approach to the defined project milestones and managing the crisis

with clear mind without panic means communicating tacit knowledge that I am trying to convey. The friendly atmosphere and avoiding conflicts as much as possible is my focus in project management.

7.3.3 Articulating Explicit Knowledge

IT systems development projects assume that explicit knowledge can be managed effectively to deliver successful projects. This issue was explored in the focus group to understand whether explicit knowledge is as formal as assumed and how it is transferred and shared by project members.

Participant 1 described well the formal processes for capturing, recording, transferring and sharing explicit knowledge, which involved rigorous formal processes tools like Bugzilla, SVN and GitHub:

"Explicit knowledge is recorded by using the project infrastructure environment which is basically based on intranet and the IDE and ticketing environments as well as QA environments which lately are aiming to be integrated in the IDE using the cloud (VS 2007 and Azure cloud). In my experience we used Bugzilla for ticketing and internal code repository based on SVN and GitHub which was more used in case of open source. I want to mention that the recording of the knowledge which is subject of training program is conducted from the beginning when the initial technical review sessions occur, during the initial introduction of the new features of the program. All the presentations are handed over by the vendor and are stored in the intranet environments. Afterwards the process of the generic training occurs where the details about specific product or feature are described and presented to the wider audience. This is also stored in the intranet knowledge-based portals also on manifold ways as documentation as wide material and if available also as interactive video tutorial. This process does not end with this, it continues further with the specific coaching sessions where the specifics about the products and features are learned through on hand development sessions. This is the final stage where we have exchange of tacit knowledge, usually not very often found in reference manuals but present as expertise of the experienced engineers and customization specialists. At the end, we prepare some records of this knowledge base and store it in the knowledge base portals. Another very useful feature is that the whole base of the knowledge is stored in common group knowledge portal and is available to all members of the group".

Participant 2 confirmed the use of such formal processes using IDE. He mentioned that multimedia with interactive tutorials is used to enable easy access to explicit knowledge, but he emphasised the need to transfer tacit knowledge into documented explicit knowledge:

"Another important part is the transfer of the tacit knowledge to the explicit documented knowledge. The process requires after the project management to consolidate the knowledge based on coaching and side by side programming in the form accessible for wider audience which can be used on workshops or similar technical review sessions by the technical teams. The project manager is responsible to collect all this documents from the developer and technical leads of the project and to organize to be documented and deployed on the intranet environment".

Like Participant 2, Participants 3 contributed to the discussion by confirming the use of IT tools to capture, transfer and share explicit knowledge to project members, but also mentioned transfer of tacit knowledge from senior managers to junior project members, which is 'very demanding':

"…There is also coaching which can be interactively formalized by transferring the tacit knowledge from the seniors to the juniors using the Method of Procedure Documentation, this process occurs after several coaching sessions where the tacit knowledge is documented. However, there is not always enough time to conduct the process of structuring the tacit knowledge, in such cases I tend to organize post mortem workshops among the technical staff and discuss the lessons learned from technical point of view. All parties will present some specifics about their engagement and this will at the end contribute to prepare video material about the project as technical review video. Although in most cases this do not comprise the externalization, this type of documenting can be helpful. I want to stress that the process of externalization is very demanding in respect of time and in some cases when the company is small and has not enough employees to prepare such kind of documentation we tend to have at least something then nothing".

Participant 3 confirmed methods for storing formal, explicit knowledge such as document management systems code SVN platform, TestLink platform, JIRA platform, and tickets raised. Interestingly, he added the idea of 'localisation' of the explicit knowledge:

"Also, all these platforms contribute to the localization of the explicate knowledge. For the sake of improvement, the delivery process, and reducing the time to market the explicit knowledge base is transferred as tacit knowledge to the team members of the project by implementing coaching sessions during the process of development, as well as the workshops and informal brainstorming".

The participant introduced learning during systems development, rather than assuming that project members already poses the required expert knowledge:

"This process is very helpful for the new project members like junior engineers and developers, to acquire the knowledge while working. Learning while working is the challenging practice for all participants in the project on one hand, but on the other hand can affect the quality of deliverables and mostly the project timeline. From this reason, it should be carefully conducted by using the soft management methods to override the stress and pressure which is produced for the juniors who are working in this tense project environment. Using the soft skills and friendly working environment may be good approach to avoid the possible risk of bad performance of the junior project members. For them the soft skills and the process of coaching and side by side programming is important to be conducted without obstacles and with strong discipline".

Participant 4 contributed the same DMS and QA formal methods for capturing and storing explicit knowledge. He added that for geographically spread teams 'multiple dislocated teams' cloud systems are used.

7.3.4 Access to Knowledge Base

As evidenced above, the Socialisation process is used to transfer and share tacit knowledge and explicit knowledge is formally recorded in software tools. However, to be effective both these need to be accessible to apply the knowledge to particular project management decisions and development tasks. So the next question focused on access to the knowledgebase by project managers and project members. Access to confidential financial information is restricted to project managers:

"*The financial part of the project is available to the managers of the company and the owner".* (Participant 4; but all the participants said the same.) As expected all the participants, as related by Participant 1, agreed and stated that the project manager has full access to all the knowledge bases established during the systems development.

"Project manager are always with highest access rights related to the read only and they can access but not change the knowledge located in the development and code repository. On the other side, based on the specifics of the project, the project managers have usually full access to the project repository including the sensitive information related to the financial and recruitment part. In some cases, the access rights are granted to the seniors in the project office who control the work of assigned project manager".

Participant 3 added:

"The new approach for the technical documentation is to unify it on one platform. This is possible by using the new IDE environments which have also multiple platforms residing on cloud environment. One example is Visual Studio 2017 and Azure cloud services. New technologies are enabling also to make the reports of the test results with minimal effort and to view the hints of refactoring and deployment of the code to the test environment with clicking and synchronizing the repositories residing on the Docker and Azure environments. This is one example how the new trends tend to unify the environments into one unified and integrated environment which will enable checking of the versions viewing the changes implementing regression tests, etc".

However, Participant 1 also mentioned the need for project managers not to be constrained by the available project knowledge bases especially for complex IT systems development projects:

"I want to mention that the work of project manager is not constrained only on the repositories of the past projects and the framework knowledge structure and guidelines of the project management methodologies. There is much broader knowledge base that is available and needed for the project manager who is involved in the project management of complex projects. Additionally, I have access to the ITILv3 directions, company processes workflows, company policies related to exchange of information and protection of information and wide range of company template documentation. All this is needed when we start a project, or better said when, we prepare to launch a new project".

Another aspect of complexity discussed by Participant 1 is speed of systems development. Systems need to be developed fast because of the changing business environment:

"Due to the dynamic nature of the current business environment the need for change in the business support systems is increasing, so the projects which in earlier years of the communal services providers were once in a year, now on average they are more than three times in a year. Due to dynamic environment, the need for fast introduction of the knowledge base in preparation and launching of a project is increased. We need to prepare the documentation with fast pace and use the tacit knowledge transfer in a speedy way whether by coaching the more experienced or specialized PMs or experts in the fields to use the knowledge base and stored documentation of the similar past projects".

Participant 4 commented on how knowledgebases can be accessed using cloud computing:

"Knowledge can be accessed from anywhere using the right profile credentials. I want to stress that since our company is medium and do not have big customer base, we have decided our documentation to be stored on the cloud which enables the availability of the documentation to be from various locations. The roles and access rights are also centrally controlled, and this enable access to the project documentation as well as to the legacy documentation from the previous projects. The layered hierarchy is applied, and everybody knows what is available to him".

On code base he commented:

"I want to stress that code base is very useful for the company like us. We use the special repositories and versioning software which enables us to follow up revisions, refactoring, changes of versions and platforms, upgrades due to HW change and SW updates. All this is enabled to us. I am project manager with technical background former developer, so all the techniques are accepted from my side. I can easily be a SCRUM master but also a full dedicated project manager. All the project documentation resides on the cloud and is available to all project members. …Decisions related to the changes and managing the project crisis and tackling of the risks, change management procedure always is subject of mutual tacit knowledge transfer. We are private company, so the cost control is involved in all aspects of the operation".

In terms of specialists' access, Participant 5 said:

"…The access rights are based on the project member roles and can vary from case to case. In general, the role of the architect is to have full access on all environments including refactoring. The developer can have restrictive access to those modules which are subjects of his engagement as well as the tester accordingly. Usually the technical managers have access to the full technical repositories. Access to the full documentation to tutorials and reference guides if they are not integrated in the IDE environment is usual open for all project members".

"The rolls enable different profiles of users to access the documentation related to their roles in the project which corresponds to the RASIC scheme. In case of SCRUM based projects, the explicit knowledge is in the sprint reports and backlogs, which may be lacking the full explicit knowledge base, but in case of such projects the knowledge is more informal. Visual Studio 2017 is one development environment that helps in that type of team works since it automates the documentation and reduce the formal reporting and explicit knowledge sharing is part of the team features of VS. It is one example where the technology helps in formalizing the explicit knowledge sharing".

7.3.5 Knowledgebase for Decision-making

The availability of the knowledgebase, through all the Socialisation, explicit recording, and enabling access does not in itself mean that the available knowledge can be immediately used directly used by project managers to make critical decisions. Critical decisions are those that have a highly visible priority for stakeholders and can be used by them to judge the progress and success of the project. The complexity of decisions emerged as a theme across all the participants. The availability of project knowledgebase did not seem to make project managers' decisions easier. Participant 1 provided an example of a critical decision that could not be simply made from the available knowledgebase. His voice is given in full to highlight the context which makes such decisions problematical:

"Based on the experience stored about the projects conducted in similar environment and similar scope the decisions which are made by me in the project are always based on the best practices knowledge base of the company. Additionally, I use the project office formal paths in drawing more sensitive decisions and also use the formal ways involving the steering committee members. The decisions which are affecting the fine-tuning aspect of the project are drawn by me and in that cases I use the experience stored in the projects' repository. Any decisions are discussed on the project meetings and follow up sessions, before formalizing them. I will mention one case by example to be clearer how we make critical decision as project managers in the company. We had one big upgrade program of the business support systems comprising the billing, customer relationship management, integration application interface, dunning system, prepaid billing platform, provisioning platform and document management platform. This process was initiated to make versions compatibility with other companies in the group and in the same time to check the new version of the billing platform in production. After we were closing the development and testing activities the final decision of the cut over date should be defined and we were at the middle of the summer vacations. The baby-sitting of the platform which is quite critical were to happen at the middle of the summer. It was risky decision since most of the experts will be on vacation and the resources from the vendors' side will be restricted. After several sessions of consultations including the program director, stake holders and other relevant parties, using the tacit knowledge exchange by exchanging of informal opinions and experiences from the previous installations as well as the written explicit documentation of the previous project and post mortem documentation, we decided to postpone the cut-off date in production after the summer holidays".

Similarly, Participant 2 contribution emphasised the context in shaping the nature of the decision in terms of its complexity. Knowledgebases and repository tools available in the methodologies used needed to be supplemented by more intangible knowledge sources, such as highly expert individuals. The actual situation determines the depth of consultation project managers need in order to make a decision:

"Project management decisions are made based on the existing experience with managing similar projects, the used methodology in the project framework, as well as the knowledge base of the existing projects. The influence in critical decisions is also very important from the side of

the project office. The project officers help me to understand the specifics of the situation and appropriately to conduct the right conclusion about the further steps and right decision".

Critical in this process of consultation is utilisation of tacit knowledge, which makes the consultation process itself as aspect of socialisation in terms of the SECI model:

"Here we have mix between the explicit and the tacit knowledge. The project risk assessments and contingency plans are essential during the project initiation phase. Also, it is one aspect of project management where the project manager's decision requires wide range of consultations on multiple tears in the change management process. This can also affect the project results and delivery as well as the project profitability. Due to the sensitivity of the subjects it is important to address the issues and raise a broader consultation base using the services of the project office, project officers, program managers, steering committee, project stakeholders etc. The outcome will be decision which will be justified and sustained".

Participant 3 also confirmed the need to tap further into tacit knowledge for critical decisions. He identified 'four areas' of knowledge, two that require explicit knowledge and two that draw on tacit knowledge:

"The knowledge in the decision making is basically divided in 4 areas. Two areas are focused on the explicate knowledge base residing in the central and local project management documentation. Both documentations are available to the project manager and he can rely on both in drawing his decision. Another part is informal or tacit knowledge that can be acquired during the process of consulting the central and local project office. The priority is always focused to draw the best decision which will contribute to the closing off the project with highest quality of deliverables, with expected profitability margin and on time. All decisions are in that respect viable if they achieve the project goals".

The need to draw on tacit knowledge in the form of explicit knowledge is heightened when there is a change in requirements, which is a feature of complex IT systems development projects:

"Most critical part is when there is change in the scope of the project raised by the customer. How these changes should be treated, should we rely on the statement of the work and also on the SRS documentation or should we be more flexible and accept the changes. All this is documented in the history documentation form, the previous projects and my decision is always in line with the directions and stored project experience from the previous projects which similar deliverables. The changes in the world of IT and telecommunication industries make some of these explicit knowledge based decisions obsolete and from that aspect some explicit knowledge coming from the central office is preferable because the specifications of the new versions of the platforms deviate from the previous version and some features enable off the shelf functionality without customization. On the other site, it may happen some legacy features not to be present and for them to spend more effort than in previous versions of the product".

Participant 5 shared similar experience of changing requirements and its impact on decision process:

"There are always surprises in the project coming from the side of the customer or more specifically by project stakeholders. The documentation helps to define whether these requirements are initially requested and are documented in the Statement of Work and SRS document, or are part of change management procedure. This approach is always useful to be

checked with the past project documentations related to the similar subjects. I check always the approach in case of deviations in the project costs, specifics related to the procurement procedures, hiring in case of specific and not very common project member profiles etc. The explicit project documents help a lot in such cases".

The next question focused on Internalisation aspects of knowledge sharing focusing on tacit knowledge for the particular systems development situations encountered by the participants. The aim was to explore the personal and experiential knowledge as applied in such situations.

Participant 1 provided an example of organising workshops to resolve issues with customisation and parametrization, this is because existing knowledge base did not provide the required knowledge. This indicates that the particular situation requires specific contextual knowledge:

"I mentioned one example of the customization and parametrization of some features of the billing platform for using it in specific products of the product portfolio of our company. This knowledge although available in the reference documentation was not available on one place and for novice billing specialist was very difficult to be acquired. I organized a special session of workshops which were based on the combination and internalisation of the knowledge base available as explicit and tacit knowledge. The systemized and recordable procedure was valuable resource for the next generation of billing specialists to come. So, this tacit knowledge based on long years of experience was transferred in explicit documented knowledge by transferring the coaching and training sessions, recordings into structured documentation".

Participant 3 identified culture and interrelationships as important issues in harnessing tacit knowledge. Transfer and sharing of personal knowledge is dependent on cultural traits and heuristics:

"This knowledge resides in the culture of project members interrelationships and is not formally recorded. As simple example, I will mention the behaviour of the project members on the team building events and their socializing. Most of the project members are young personalities and they want to joke and smile and positive attitude should be maintained. In case of coaching sessions, the same is valid for the interrelationship between the seniors and juniors. Always the informal transfer of knowledge can be less invasive and less offensive to the juniors in the project team if the working conditions are without tensions and pressure which is not always the case. The project management is always based partially on the informal knowledge exchange with the project office in form of advice and directions how to proceed in specific cases. The critical aspect within the project is to address the critical decisions and to consult with relevant parties like the stakeholders, product owner, business owners, project officers as well as project members. The decisions are not always based on strict methodologies but on more heuristic approach. I want to mention that the experimental knowledge can vary from case to case in respect to decision making and there is no pattern how to make the right decision".

Participant 2 added that:

"The compromise is always subject of tentative knowledge transfer and cannot be documented in the processes as explicate knowledge, although it can be somehow included as set of options what to do in case of specific project scope changes. Also, one part of the informal assessment is the assessment of the probability of risks in the risk management tables".

Participant 5 mentioned ‘soft management technique’ as means for harnessing tacit knowledge.

Participant 4 agreed that benefitting from tacit knowledge requires a coaching approach:

“The tacit knowledge in my opinion is the soft management technique that I am trying to spread among the project members. My soft management knowledge and emotional intelligence technique are the subject of my informal knowledge transfer to the project members and exchange of experience on peer level among the project managers on the forums, workshops and knowledge sharing sessions”.

“I want to mention one case where we have tacit knowledge transfer, and it is the moments, when we introduce new platforms and make installation of something that is not part of our expertise. In such cases we involve experts form the central office which come and conduct the installation by coaching our engineers and developers. This process of coaching is very common and is foundation for the future installation to be conducted by our staff. This valuable experience is documented and stored to the existing knowledge infrastructure and is used as basis for the newest installations. Usually it is stored as procedure documentation for the installation and direction, and general information for the customizations process. In this case externalization occurs”.

7.3.6 Project-specific knowledge combinations

As seen above, project managers work with explicit and tacit knowledge available on individual IT systems development projects. They do reflect the SECI model involving socialisation and externalisation, using both the tools and techniques from the systems development methodologies used and personal heuristics. The next question explored how the shared knowledge is combined for specific project tasks and problems. Participant 1 explained that combining knowledge depends on the actual task:

“Consulting the more experienced PMs and project officers contributes to learning in informal way. They have very substantial role in the ongoing experience that is exchanged during the project meetings and informal sessions of follow ups. I want to mention some examples where the new features are acquired by working together with the project members from the external resources. The new versions of the billing platform bring off the shelf features and help a lot to reduce the time needed for the customization. So, based on the gained information from the experts and freelancers involved in the project, I managed to reduce the duration of some of the project activities and extend the time needed for stabilization of the new version and bug fixing process which was unexpectedly longer than the projected time. So the knowledge coming from the project members by formal and mostly informal manner helped me to defend and retain the project delivery date”.

Participant 2 focused on risk management, noting that combining explicit knowledge, derived through the process of socialisation of tacit knowledge, is critical for managing risk:

“…informal knowledge transfer which can contribute in assessing the risk of the project as well as what is overlooked which often occur during the preparatory phase of the project, like the process of estimation. The estimation will bring the complete knowledge with informal and explicit or formal assessment close to the real parameters and cost and time estimations. One other part is in the process of assessing the risks and their probability and the possible cost if they occur. This part of the estimation of the probability of the risk and impact is also part of

collecting informal information and combining it with the explicit knowledge. This at the end will contribute to produce more accurate risk plan which will rely on real and accurate estimations. The concept of risk assessment is based on the experience in similar projects which are documented and on the informal knowledge about the customer, their organizational issues, may be financial issues if they exist etc. The risk management is also very complicated and is based on multiple parameters which influence to the project outcome and profitability. Usually talking about the projects, we talk about the quality of the deliverables, lead time and resources spent to achieve the project goals. The combination of different knowledge depositories and tacit knowledge contribute to good planning and execution of the project".

Participant 2 related the application of such knowledge to re-estimation and version upgrades, noting that such decision requires specific situational which is not available in the project knowledge base. This indicates that context is critical for combining knowledge:

"The project members may contribute in most cases where the need for re-estimation of the changed project time plan is needed, or for example decisions related to the change management procedure where the need for change requests is needed. Additional aspect in the socializing is the need to make re-evaluation of some changes in the releases of the new products in case the new versions already available solve some of the requirements with off the shelf functionalities. Such version upgrade which make savings in change requests but require new version which may be not part of the offer and quotation is subject of consultations with the customer and the project officers as well as owner of the company. This is specific and not documented but is not seldom part of the project management explicit knowledge".

Participants' responses above indicate that the SECI model is relevant to their practice. The specific issue of project managers decision-making is dependent on generating, collecting and applying both explicit and tacit knowledge. The knowledge generation processes described in the SECI model apply to these project managers' experiences. The following questions focused on the specifics of IT systems development knowledge management, in terms of actual examples that the participants could provide.

All the participants mentioned IDE environments, MOP (methods of procedures), SVN environments, Bugzilla, TestLink, Jira, Azure cloud, and GitHub. Two examples are Participant 1 and 3:

"In modern IDE environments, the technical knowledge is good documented in the repositories for development of applications. In case of IT systems deployment, most of the documents reside in MOP (methods of procedure) documentation where stepwise instructions are provided. I try to prepare documentation for any new steps and processes that are unique for the current project which will be beneficial for similar projects in the future. From technical perspective, the medium where the information is stored varies from the formal document management system where the documentation is indexed and searchable by keywords to the special repositories like SVN environments where the code base is stored and versioned. Also, there is system which keeps the ticketing information and bugs resolution information like Bugzilla platform. All these technical environments are located on the company intranet and are protected from external intrusions. Also, the platforms are role based and the access rights are different for the specific group of the

members of the project and company. Some have full access rights to the technical documentation with the right to change it with specific tags like the technical managers, on the other side there are some other project members that have restricted access rights and have access only to the specific part of the technical and project management documentation".

"Project management platforms in most cases are not centralized but distributed on several platforms. Project management documentation resides usually in document management platforms. Test and deployment platforms are in some cases integrated into one or can be different like TestLink, Jira, Azure cloud etc. In most cases virtualization in all forms is exploited to make the utilizations of the systems more effective regardless whether it resides on the local company platforms or use the cloud services. The code base is located on different platforms like SVN, or GitHub dependent where we have open source projects or specific customized code of our products. Based on the industries and supported technologies we have different approach in the exploited development repositories. I want to mention that the TestLink as platform collect all the test scenarios and results related to the conducted tests. This repository is used as open source platform but in professional use can be also licensed. In case of Microsoft and its latest development platform Visual Studio 2017 bundled with Mobile Centre, Docker platforms and Azure cloud, the integration and synchronization make the working on the projects quite efficient. This may be treated as one survey over the possibilities to use the SECI model by automation of the processes and logs into one converged repository and knowledge base".

Effective knowledge management depends on the coherence of the project team. Therefore, the next question focused on how project managers develop their project team. Participant 1 revealed that the project team is built to transfer formal knowledge:

"The team is trained at the start of the project in the initial phase where the necessary knowledge is transferred in a formal way, and in later stage by using the informal or coaching approach. The principle of side by side development process and pure coaching are crucial in the process of acquiring new experience and knowledge for the future projects. It is usually used when we have juniors in the team and need more time to spend on their preparation for independent work without coaching. …Another approach is to make the team to be coordinated and streamlined avoiding non-productive conflicts. Conflicts and competitive atmosphere can bring progress but only in controlled manner".

Participant 1 also described the actual process of starting the project, team familiarisation, training and engagement:

"After selecting the team members, we organize the technical review meetings, so every employee should know the new features which will be introduced by the upgrade of the platforms. In continuity, the mixed structure of the team is established, and the project documentation is defined and prepared. There is much documentation that need to be prepared and the formal and administrative part of the preparing the project may last for weeks. The team members, after the project kick off meeting, start to attend specialized trainings, since the number of training participants is relatively big, onsite training is organized. After the training the project starts, all project members grouped by technology and fields are coached by one external expert, then socializing (coaching) is practiced during the project duration. After project is completed the acquired knowledge is structured indexed by subjects and stored in the document management system. This is in short words the process of preparation of the team as well as transferring of the knowledge".

Participant 2 related that the project team is developed on the basis of 'experience and knowledge'. Rather than using formal training, informal workshops gel the team better and are more conducive to transfer and sharing knowledge:

"The critical part of every project team is the experience and knowledge and how the existing knowledge can be shared among the project members. In case the project members are experienced and seniors, the training part may be informal in small workshops and during the coaching sessions or with side by side organization of the development activities. The goals will be achieved without big overhead. … It is more challenging to manage such kind of inexperience team since the project milestones may not be met or may be partially met. In such cases the risks should be appropriately tackled".

Participant noted that a team with mixture of experienced and starter staff can still result in 'competence', but only after some learning and only with a 'friendly customer':

"The reason for involving mixed team is to train the team by working together which is the most effective way of achieving competence in the required areas. The risky part is the lack of competence at the beginning and if the project is short and the deliverables are phased then the risk may be with the first deliverables' timeline. This approach is good when there is friendly customer which will be used for pilot installation. The project management and project deliverables of such project is difficult, but the experience acquired is valuable, though the project office should follow the strategy and plans on board for using the knowledge and gained competence to spread the knowledge to new customers' projects and offering the project related deliverables to wider customer base. This type of project is often treated as investing project, or project for gaining competence and forming project teams for next customers' projects".

Sometimes project team composition is not appropriate for the technical aspects of the project. In such cases knowledge is acquired through training and sometimes external resources are brought into the project:

"Project team members are defined in the initial phase of the project and are engaged by the resource manager. In some cases, not always ideal team is created and can happen that the knowledge required for the project is deficient. In that case the training approach is of crucial importance. If the project is affected based on the performance of the team members, in most cases the initial training is not enough, and external resources are needed. In that case of external resources, the coaching approach is needed and may be not always streamlined smoothly. The process of caching is always good when we have local experts within the company to share the expert knowledge. If we have external experts involved in the coaching then we should count that the fee for the coaching expert is higher than the ordinary expert, and it raises the cost of the project delivery. The new versions of development IDE can help in that respect related to documenting the changes and logs. I have always been inclined to transfer the coaching knowledge to formal explicit by the end of the projects. Sometimes this step is forgotten due to the relief which occurs by the project members after closing of the project. But the moment is right to address the collection of valuable knowledge from the experts by organizing workshops or some other type of round table discussion when all collected knowledge is presented and recorded. At the end, this will contribute to have structured collection of information and documentation which will be used for the next team members for the specific subject. That information is one of the assets after the project and if properly organized in form of tutorial will

be one of the most valuable assets for the next juniors and skilled developers who want to be trained for specific competence".

Such training provides the basis for transferring tacit knowledge. Since it is not possible to compose a perfect project team, members of the team with expert knowledge need to be involved in the training to be able to transfer their tacit knowledge to other less experienced project members:

"The tacit knowledge transfer in this case is of crucial importance. In some cases, there is also reserve resources which are per call in case of excessive workload or some emergency situations in project development process. The strong and experience staff from the central office will come to help in case of emergency, this part of the project is covered with the contingency expenses incorporated in the financial part of the project".

Participants were then shown the proposed Framework in Figure 6.1 for knowledge management in complex IT systems development projects. This helped them to visualise the supposed origin and flow of knowledge within projects and relate their previous responses to a more structured approach.

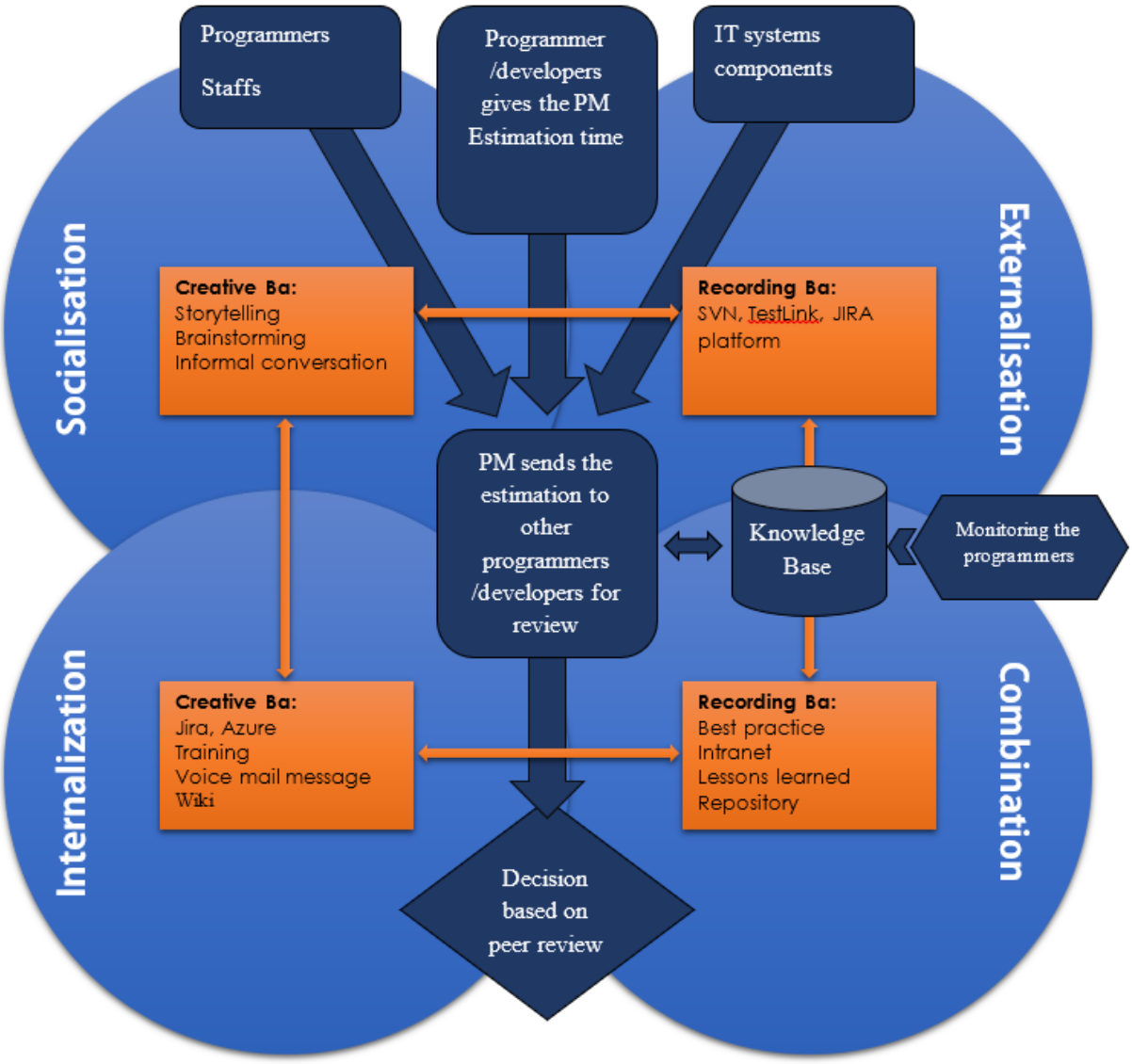

Figure 7-1 IT Systems Development Decision-Making Support Framework

The questions focused on using this IT Systems Development Decision-Making Support Framework for project management and participants were asked to refer to it when required. Participant provided a detailed response concerning process estimation of the person/hours and the lead time per activity. This scenario, based on the respondent's experience, is long but depicts the knowledge sharing well, involved estimation provided by a programmer/developer:

"The current example refers to the process of estimations of the man/hours as well as lead time per activities conducted by the developers. In one segment the developers in agile environment vote to assess the effort needed for specific chunk of the project, like activity which depends on one developer or team of developers or some subproject which is more complex and consist engagement of all participants. Let's simplify and assume that one programmer/developer will estimate the needed effort for specific project activity. The PM can revise the estimation with consulting some more experienced developer or technical lead or can give the same task/activity

to other developer. This is the formal part of estimation. Another is the agile approach where the estimation is conducted via voting and the defending of the estimation is provided by the participants after the voting. This concept is faster and does not have overhead produced by the necessary formalities in the process of collecting opinions from multiple parties. The concept of agile projects is actually based on removing documentation overhead, in its excessive forms it leaves the documentation only in repositories of the developers and testers and backlogs. I will now refer to the SECI model and the way how this process is organized in a concrete example. The initial big project is organized on more classical way following the PMI directions or better said the PMBOK documentation. In this way of organizing the projects the documentation provided from the training sessions is available together with the reference and user documentation of the product and is used as explicate knowledge transfer. The second part is related to the coaching which occurred during the process of product customization. In this respect, there is twofold benefit for the company, one is the benefit for the external resources which are offloaded from the routine work which is given to the practitioners which are subject of the coaching, and this on the other side is beneficial for the practitioners or the trainees since they gain valuable experience about the new systems. This process at the end of the project deliver the trained billing specialist with on hands experience and knowledge gained by training during work. This knowledge is documented at the end and is available for those who remained to operate the life systems. The process of externalization occurs. In the later stage when the new systems move to operation, further customizations and introducing of new products and services as well as tariffs for them will be conducted by agile approach since we have teams who are trained and are easily streamlined to the new requirements and the customization of the systems. This is depicting the SECI model and the spiral of knowledge exchange".

The other respondents too provided comments and examples involving experience, Socialisation, and the transfer of tacit knowledge as 'more common practice' because of their routine experience of certain types of projects.

"Even internalization or moving the explicit to tacit knowledge is common in that cases. This is typical with the SCRUM teams" commented participant two. And he added: "*I want to emphasize that this can be very common practice in service delivery and customization projects. In most cases the project deliverables are known and are subject of routine customization and development. This type of projects is very common in the service delivery companies. I want to emphasize that some of the informal knowledge exchange methodologies may fail if they are addressed to new team members that do not know each other and have lack of competence. For that purpose, introducing of new team members should be gradual alongside with the replacement of the older team members with new ones."*

Estimation of the man/hours of different profiles of the project produced much discussion. Different phases of the project can be addressed with knowledge management. The type of project determines the initial estimation of the man/hours of different profiles varying between development or customization project or integration project. A participant offered:

"The knowledge transfer can be informal in case of agile approach or strongly formal in waterfall approach. During the process of project management there are some moments where the project managers interact with multiple parties to formalize their decision and make them viable. For that purpose, the socializing concept prevails especially for the cases where there is no clear direction in management documentation how to make proper decision. For that purpose, the interrelations and collecting knowledge and information from various parties like the project

office, project members, project stakeholders and steering committee members are crucial for the decision making. The collected knowledge for specific case can be after the project documented in special document which will be presented to the other project managers. That way collection of the knowledge can be structured and documented so the tacit knowledge will be externalized."

The process management knowledge transfer framework based on SECI model is becoming popular by service delivery and platform/product delivery projects. This is especially useful when the teams are steady and are working together longer period. This is especially the case in complex, hybrid projects.

"The transferring and mixing the knowledge base from explicit to tacit and vice versa as well as tacit knowledge and combination of explicit knowledge bases are now achievable when having complex project environments. This contributes to the hybrid projects which are waterfall in one module development and agile in another module development. I will try to explain one long term team engagement in the process of knowledge transfer in the period of time covering several projects conducted by the same team members. First, we will start with the first project that is new for the team members and at the beginning the training is organized and several workshops including some covering the preparation for the certification of the project members. It starts like but continues to progress over the time with coaching and site by site working. The knowledge is collected as tacit knowledge and the team continues to conduct the projects with using the collected tacit knowledge and documented explicit knowledge. Now the team members are mature seniors and are working very coordinated, so the projects are conducted by the agile methodology with minimal explicate knowledge transfer. After certain time the team will need to be replicated in multipole teams since the number of projects has increased and the workload for the company requires increase in the employees and number of project members. In this stage documented knowledge is required and the collection of the tacit knowledge from the project members and transferring to explicit (externalization) will occur. This is the process of forming the teams, also the seniors will conduct the tacit knowledge transfer by coaching. All this processes of the SECI model spiral is common practice in fast growing companies-service and product integrators".

The project managers mentioned the variation of project knowledge management depending on the complexity of the project. It is important to understand that the techniques vary by the scope of the project as well as to the complexity of the projects/program.

"PMBOG based PM knowledge management is related to the interaction among time management, cost management, quality management, HR management, communication management, risk management and procurement management interacted by integration management. In agile project environments the product backlog, iterations, iteration backlogs, burndown charts are the core part of IT project sprint. All parts defined in PMBOG are also mapped to the SCRUM/AGILE projects and for that we need more detailed elaboration. Knowledge can be formally more utilized in case of classical project approach on agile projects knowledge is in the systems which are more advanced/automated as mentioned above and additionally tacit knowledge is retrieved on the SCRUM sessions and the close collaboration of the project members in the team. Which technique to be used strongly depend on the experience and team spirit of the project teams. If the teams are working together for a longer period they can easily be transformed in agile teams. Short precise and concise communication is the essence of scrum sessions".

The choice of the data-quotes above and below to analytically validate the Framework was based on the focus group coding table shown in Table 7-2. The Table shows the actual words and phrases used by the participants in the second column. These were then used to determine the initial codes shown in the third column. These initial codes were then clustered within the meta-themes. This process was used to relate the meta-themes which also reflect the theoretical literature with the empirical data and this was done to confirm the validity of the data, as well as the Framework.

Table 7-2: Focus Group Initial and Cluster Codes Embedded in Meta-themes

Participant	**Ideas/Themes** **Actual words and phrases from the focus group**	**Initial Code** **From actual words and phrases from the focus group**	**Cluster Code** **Emerging cluster codes embedded in meta-themes**
1	- Social communication - Transfer of knowledge by coaching and team building sessions - Informal association. - Utilisation of financial and non- financial approaches for project assessment. - Project infrastructure environment is used for externalisation - Intranet and the IDE and ticketing environments - Bugzilla for ticketing and internal code repository based on SVN and GitHub. - Internet knowledge-based portals - Coaching sessions for transferring knowledge - Experienced engineers and customization specialists. - Internet-based portal - Security of documentation and financial data - ITILv3 directions are used for the security of documentation. - Knowledge base resources for decision making. - Formulation of decision making is done based on meetings.	- Workshops, team building arrangement. - IDE, Bugzilla and GitHub approaches are used. - ITILv3 directions are used for the security of documentation. - The SECI model - PMI directions - PMBOK documentation	Knowledge Creation - Workshops for social integration. - Formulation of decision making is done based on meetings. Knowledge Acquisition - Training - PMBOK Knowledge Sharing - Agile approach - Transferring knowledge - Coaching sessions are focused on transferring knowledge.

	• Upgrade platforms for billing, customer relationship management, integration application interface, dunning system, prepaid billing, and provisioning and document management. • The special repositories like SVN • Team management for formalising the projects. • Formalised training is used for transferring information about projects. • The agile approach is preferred for decreasing the overhead. • Developers and testers and backlogs • The SECI model • PMI directions • PMBOK documentation		Knowledge Application for Decision-Making • Informal association • Explicit knowledge is gained by Agile projects • Knowledge base resources for decision making • Knowledge-based experiences are used for project decision making. • Decision making is based on the meetings with stakeholders, committees, program managers and project officers.
2	• SCRUM project • Transferring knowledge • IDE (Integrated Development Environment) is used for managing the internal organisation of billing and ticketing. • Company intranet portals • The multimedia environment enables easy accepting and learning of the new techniques in the IT and ICT (IT and Communication Technologies). • Project managers use IDE for unifying employees. • Knowledge-based experiences are used for project decision making. • Decision making is based on the meetings with stakeholders, committees, program managers and project officers. • All documents are present on company internet portal. • Project risk management is based on different parameters • IT system development environment is used for	• SCRUM model • IDE (Integrated Development Environment) • Decision making is based on the meetings with stakeholders, committees, program managers and project officers • VS 2017 is used for security of documentation.	Ba Project infrastructure environment • IDE, Bugzilla approaches • SCRUM model • VS 2017 for documentation. • JIRA platform • Special repositories and versioning software are used for reanalysing projects and other related documentation.

	managing multiple systems. - Development, deployment and testing are based on VS 2017. - Experienced-based knowledge and training will be used for project management. - Informal workshops are sued for transferring information about the projects. - SECI approach is used for efficient working and project management.		
3	- Hybrid approach projects are used. - Agile project management - **Scrum** - Training and workshops are being structured for - IDE is used for assessment of documentation - The privacy of documentation is handheld by IDE. - For relaying task description the layered hierarchy is applied is applied. - Special repositories and versioning software are used for reanalysing projects and other related documentation. - SCRUM is used for sharing information with all other project members and managers. - Change management framework helps the management for knowing about HW and SW update and change respectively. - Informal meetings are used for transferring knowledge and talks about clients and customer preferences. - The template is used for storing information that needs to be shared with the other project members. - Internships are used for socialising. - Coaching sessions are focused on transferring knowledge.	- Scrum - IDE - Coaching session and training - SVN, or GitHub dependent - SECI model - Agile approach	

	• Many parties are being focused on decision making such as stakeholders, products owner and officers and management. • Project managers are the important personality that helps the others for learning from the mistakes and depth of projects. • Re-evaluation and reassessment of all the tasks are done by project managers that help to increase socialising when are being shared with other employees and concerned people. • TestLink, Jira, Azure cloud are being used for testing projects and for analysing documentation. • Different platforms SVN, or GitHub dependent are being used for coding the opening sources of products. • For increasing the efficiency of projects Microsoft latest development platform Visual Studio 2017 bundled with Mobile Centre, Docker platforms and Azure cloud are being used. • SECI model by is used for automation. • Training is being used on the initial basis and for streamlining projects and related documentation and information. • Local expertise is concerned for further information. • Workshops and different trainers are arranged for sharing information and increasing knowledge. • The agile approach is used for transferring the knowledge with all the parties included in projects. • The detailed and description of the project is discussed with project		

	members by the agile approach.		
4	• Scrum based project has been used for product customisation. • Explicit knowledge is gained by Agile projects • For analysing and competing complex and multiple products spiral of SECI model is used. • HW and SW system along with MOP are basing used for preparing documentation. • TestLink platform for testing the documentation. • JIRA platform is used for handling the bug fixing process, tickets. • SVN platform codes are used for transferring of explicit knowledge. • Coaching sessions are used for transferring information. • Online tutorials, Method of Procedure documentation, micro-services platforms, ticketing systems and code repository platforms are being used for • For integration, IDE environment is usually open for all project members. • The training session is arranged for others. • The installation of new projects becomes very easy when the new and junior employees are being trained by external expertise and engineers for completing the task successfully. • The IDE environment, code repository, test repository and deployment repository are used for project integration. • Services delivery is done by SECI model. • The SECI model spiral is common practice in fast-growing companies-	• Scrum based project • Agile projects • JIRA platform • IDE environment • Training session • SVN platform codes • The IDE environment • Workshops	

	service and product integrators. - Workshops are important aspects of the organisation that helps the management and employees for understanding the study of projects.		
5	- Frank discussion within the project managers and employees for transferring the information is important. - Training and workshops - Company information is present on internet portal. - For RASIC scheme and SCRUM based Visual Studio 2017 is one development environment is used. - Statement of Work and SRS document are used for change management that includes the project cost, highlight specification of mistakes and hiring. - Informal knowledge transfer is done by soft management knowledge and emotional intelligence technique. - CRM, Billing and Integration Bus programmes are used for project assessment. - PMBOG based PM knowledge management is used for documentation. - The SCRUM is used for close collaboration.	- - Frank discussion - SCRUM based Visual Studio 2017 - PMBOG based PM knowledge - Training and workshops	

7.3.7 SECI and Ba Processes

Question ten focused specifically on the ‘socialisation’ process. The focus group members were asked how they use socialization among programmers to contribute to the project knowledge base and how they use that knowledge to make project decisions. They mentioned ‘speed’, ‘mutual understanding’, ‘mutual exchange of informal knowledge’ and ‘side by side developing,

among other socialisation techniques they used to transfer tacit knowledge among project members.

"The socialization process is bringing speed and mutual understanding among the older fellows in the project team but can bring frictions and misunderstandings even conflicts among new team members. So, the concept of mutual exchange of informal knowledge in modern ocean office environments is based on grouping the most communicative members of the team to be close to each other. This is like cluster organization and is one of the methodologies which facilitate the informal approach. The formal or explicit knowledge is on the other side maintained in the IDE repositories as well as deployment and test environments. The formal part of the project documentation resides on the document management servers".

The participant provided an example involving clusters of people working on specific modules:

"Let's give one example of socializing. I mentioned grouping of the project members into clusters of working places. They are exchanging oral information and are focused on resolving issues on the same subject, whether it is the project activity, module or some customization of the service. All these activities are related to the request which are coming from the product and tariffing department of the commercial division. The process of communication on the scrum meetings and managing the knowledge based on socializing contributes to the faster introduction of the products to market. All the tacit knowledge in most cases is internalized and already exists in the knowledge platforms. These concepts contribute to have high level of efficiency, avoiding unnecessary paper work and overhead of documentation".

A project manager mentioned coaching and side by side developing as a form of socialisation. This is used when the knowledge distribution among the developers is not uniform or the profiles for the project are not fully compatible for the required project activities. In such situations the 'method of informal knowledge interchange' is used because it contributes to the even distribution of the knowledge among the developers and other project members. More social activities were mentioned:

'Another approach is to have weekend team building sessions which apart of regular sport entertaining activities will include some informal technology related workshops which will bring the discussions on board. The possible contest in the area of developing some modules among several teams can also facilitate the informal transfer of knowledge. At the end of the contest all participants have to defend their solution. There are also other approaches in the informal transfer of the knowledge like the grouping if the working environments in clusters where those which communicate often can be close to each other'.

The methods of estimation with voting which is present in SCRUM approach was mentioned as a form of socialization and the results formalized based on experience.

"In the estimation process there are different methods, traditional one still used when the estimation is conducted by one experienced project member, usually is technical lead, the prepared document by him is given to another experienced developer to confirm or correct. This approach is more traditional and lasts relatively long in comparison to the simpler methodology of collecting the estimations in workshop session from the various parties who prepared the

estimations. On the session, everybody will defend his assessment and the most convincing will be accepted. This type of approach is close to the scrum-based voting concept. I want to emphasize that the process of estimation of the project activities by the developers in similar manner will be documented and used as explicate knowledge in more traditional projects where needed. In case of agile approach all the knowledge will be transferred to tacit by internalization which will be born in the project members. This concept of interchanging of the type of the knowledge is common when the team's members are maturing and are working together for the several similar projects in the row. The mature team can rely on tacit knowledge, since it contributes to the cost efficiency of the project. When the project is new, or the team is renewed than the switch to more traditional approach will be more beneficial and more efficient at least for the first projects in the row. This exchange of knowledge transfer methodology is repetitive and is coinciding with the spiral of SECI model".

Question eleven focused on the 'externalisation' process, with the 'knowledge base' overlapping with the 'combination processes. Participants were asked to describe the processes they used to externalize project knowledge and how they used that knowledge to make project decisions. The researcher sought specific examples relating to IT components. Techniques mentioned previously such as coaching and side by side development were discussed. Training was a key method:

"I would like to give one example by following the case from the previous provided answers. I have introduced one full flagged training session about bundling of services in the charging platform. The training was organized for all billing specialists in the group of companies associated with the mother company. Since all of companies were sharing the same billing platform with specific localized customization it was easy to organize generic training which will be organized for all participants in one session. After conducting this training, we proceed to organized coaching events working on the concrete tariffs and charging schemes specific for the local companies. There were on site workshops where the knowledge was transferred to the local billing specialist. This was a one-time session and after that the employees who were trained could do that activities independently from the experts who were conducting the training sessions".

This training was intended to be documented for every local company and be ready and documented like Method of Procedure documentation. This final step was conducted by the trainees and all of them prepared the document and stored it on the knowledge base platforms. Externalisation was regarded as 'easy' and using current repositories and logs. It involved coaching and tutorials:

"The process of formalizing the knowledge transfer while coaching and side by side programming can be easily conducted using the current repositories and logs which provide the new IDE environments. It is easy to formalize this type of knowledge transfer whether by the junior developer subject of coaching or by the technical lead who will use this repository to prepare examples and tutorials for the newcomers who want to specialize in the specific field. The externalization can be, initially, as document prepared by the junior developer and after that formalized and approved by the technical team leader. This approach is exploited in most of the technology service providers and IT development companies. The technology allows also

interactive tutorials which also can be completed and developed by specialized teams of the technology competence and training centre. That interactive knowledge can at the end be used for training sessions or for self-paced training".

The same process was used for the quality assurance teams. This process is of importance for the integration of teams and the application maintenance teams. Knowledge base from the quality assurance teams can easily be used as basis for the user manuals and also as user documentation for the customer.

For the purpose of decision making, as participant provided an example:

"I will give one example with the process of risk assessment which is based on the tacit knowledge transfer. This methodology of socializing is related to collecting all necessary information for determining the probability of the risk. It is based on making estimation using various knowledge and experiences from various parties as well as information and opinion from project members, customer's stakeholders etc. This informal information for specific subject which is repetitive may be documented and collected and prepared as explicit knowledge documented and structured in methodology for making calculation of the probability of the risk factors in certain project. Also, in the risk management process, we may include some additional processes which can be transferred to explicate knowledge. In my experience the process of tacit knowledge transfer for risk management, as specific knowledge areas of project management framework, is complicated and should be treated with caution".

Combination resulting from externalisation is easier with new technologies and can be integrated for tutorials and supporting workshops. The resulting documentation needed to be integrated and consistent with existing documentation. The importance of the team was emphasised by the participants:

"The new technologies enable the project results to be easily documented and transferred to modern tutorials. The process of using the IDE repositories and their adaptation can be used even by not very skilled administrators. Another aspect is the scope of the workshops organized after the project completion. Developers' workshops will contribute to the formal externalization of the gained experience and know how during the project coaching and site by site development sessions. As mentioned in the previous answer, I want to introduce that the recorded technical sessions are not enough for the process of externalization, we need to create more detailed documentation based on the recorded technical sessions, for that purpose there is need to establish a team who will participate in the process of creating the viable documentation based on the know how acquired by the team members using the tacit knowledge transfer methodologies. It is important to make documents that will be more detailed which will be complementary to the existing documentation and also will be useful to the new comers and also to those who already have experience in the subject. The documentation should be structured and be interactive to enable specific parts which are more specific and need advanced knowledge to be accessed directly by the seniors. Structured knowledge based on tacit knowledge is one aspect of preparing the documentation for the next projects".

Informal estimation sessions among evaluators is common in technology companies. This is to avoid wrong estimations resulting from just one developer or architect. As one participant said:

"The vanity in some cases may produce under estimated lead time for completion of the project which can jeopardize the critical path and the project milestones. If the company has less experience in the field it can lead to wrong estimations, for that reason involving of external resources is needed. The informal approach of consultations with the more experienced resources in evaluation bring the possibility to formalize the tacit into explicit knowledge documentation. This comes after several successful conducted projects and more often is routine in case of service delivery projects. (SaS)".

In question twelve the participants were asked about the 'combination' process in the framework. How do they use the knowledge base to combine with existing project knowledge to make project decisions? The process of combining explicit knowledge with explicit knowledge is common in complex projects. One respondent provided an example involving systems integration which involves formal exchange of knowledge and issues with the differing use of terminology:

"…I was project manager of the upgrade of the billing platform but was engaged in the migration program of multiple platforms. The explicit project knowledge for all the platforms part of the migration program was available but for the integration purposes the combination approach was necessary. We have prepared extensive documentation for the integration and this documentation was exchanged among the relevant project members in the program. The process was very demanding since the integration as always is the one of the final stages of the program and is subject of co-ordination among multiple groups of specialist and technologies. Often there is issue with the terminology which is not always the same for all participants, more and more formal exchange of information is needed as well as workshops with minutes of meeting to drawn decisions on technical and on organization level. This part of the program can be treated as separate project, like integration phase of the program and I am favouring written knowledge and information exchange. This is one of the examples of combination which I met during my experience".

Another project manager also talked about integrating knowledge across differing modules. He mentioned that while modules are treated as different competence areas they still need to be integrated or combined. The actual project management decisions are affected by various factors like migration of legacy systems, timing, determining master DB and when to conduct the integration.

"Explicit to explicit knowledge or combination process is used in more complex projects which consists of modules that belong to different fields and technologies. In that case the combination is necessary, for example CRM and Billing modules are always treated as different competence areas and these two knowledge bases are treated as combination of the two knowledge repositories. The decisions are dependent on the subject and in this cases, decisions are for example related to the migration of the legacy to the new platform, timing related to that, when to start which platform to be the master DB and when to conduct the integration, before or after the migration of the customer DB. Should the history be stored in the new systems or only the data after the cut-off date? Should first be conducted cold start tests and after that with full data set, worm tests. All these subjects are related to the knowledge provided, which is stored and is specific for the technologies and modules involved in the project delivery. But also, we have to bear in mind that also tacit knowledge transfer from the experienced PMs as well as project

officers and the project office should be taken into consideration. These processes are correlated and follow the SECI approach, which should bring more efficient work of the project members and more sustainable decisions".

Combination of knowledge is also required across phases of a complex IT systems development project. It involves multiple repositories of project knowledge:

"In case of multiple repositories of the project knowledge always based on the project phases and specific project requirements the combination of different project knowledge can be used to achieve the goal of the project and timely and successful completion. In one phase of the project we can use the explicit knowledge of development project in other phase the explicit knowledge of integration project. All the available knowledge base will be combined in specific project to achieve the project goal. I will give here one example from my company. We have very good order management platform for telecom providers. This platform has specific knowledge base and code base repositories. In case of telecommunication companies, we use additionally the BEA platform (owned by Oracle) for application integration which also has its own code base, customization as well as knowledge repository. Due to our long years of dedicated work in these two fields we have very good and structured explicate knowledge base, however we have also out tacit knowledge base due to the experienced team members. When new project is established for specific customer we have all the assets to conduct the combination process and conduct the merge of the two explicit knowledge bases into one relevant to the project".

The other participants agreed with this discussion. One project manager added that the process of preparing compound documentation based on several project modules development processes is very common and it is used to prepare new team for the similar project. The documents which are used for development of several different modules can be combined to complete the project. The knowledge base is integrated and bundled as one training package or tutorial. This tutorial will be stored in the knowledge base and will be used by the project members of the new projects as well of the current project. He added:

"Knowledge brings power to the team members and competence to handle the project requirements without risks. I mentioned how the process of externalization occurs after the sacksful completed projects where some of the team members were trained using the coaching methodology. The combination of this approach is crucial for the complex projects where different service customization should be used. The modules developed and integrated as standalone modules are maybe routine work for the team members and the project for them may be organized using the combination of the knowledge base. But at the end the integration of the modules will come, and the required knowledge is lacking in that case the expert will be involved from the head office in that case the expert will be involved in the integration process and the combination of tacit knowledge transfer and explicit knowledge transfer will be conducted. This process is very common in big vendors where the number of experts is geographically dislocated on multiple physical locations".

Question thirteen focused on the Internalisation process of the framework. Project managers were asked to discuss how they use the integrated knowledge to make project decisions. They shared the view that integrated knowledge is based on the use of all techniques of knowledge transfer

and based on the spiral of exchanging the documented knowledge and experienced exchanged by the socializing. However, they noted that in 'fast-changing' systems development environment this is not appropriate, especially where the staff turnover exceeds 10%. It also applies to fast-changing technologies, which requires 'tough decisions':

"This is dictated by the new technologies which are emerging in the core business and need also appropriate charging and billing platforms. The process of upgrades and convergence of multiple platforms brings tough decision in the project management, how to organize the phases of the projects which project phases to be organized in parallel and which to be organized in sequence. I was involved in making tough decisions and together with my fellow project managers from the project office were involved in the SECI model of decision spiral. This contributed to draw a proper and reasonable and achievable project plan. I used the available documentation, talks and workshops organized with the vendors, project management sessions from project managers who participated in previous integration projects, as well as informal discussions with the technical staff during the team building sessions etc.".

A participant noted the risk involved in making the project decisions. He stated that 'socialising' the decision helped him to evaluate whether his decision was right. This process of socialising' resulted in another period of bug fixes before proceeding to production.

"All the parties in the project were focused on my decision whether to proceed with the launch in production or to wait for another month to clean up the bugs in the repository of the ticketing system. The bugs were not many and not critical but where addressing restrictive product and customer base and the risk something to went wrong with the full production system were extremely high. I used multiple sources to evaluate the risks of going in production in such stage of the project deliverables and decided to follow the tacit knowledge acquired from the stakeholders and the key users. At the end, risks related concerns were stronger than the customer's management decision, and I made the right decision. So, I decided to proceed with another session of bug fixing before proceeding in production. This helped in the end the system to be clean from bugs and seamless in operation transition. This is one example when the Internalisation of the knowledge from multiple parties contribute to draw right decision and protect the business support systems from unstable operation which in the end can contribute to loss of revenue".

Internalisation process combines all methods for knowledge interchanging, using formal communication channels and informal communication channels. All the methods contribute to the goal of reaching the desired performance and results of the projects. The Internalisation of knowledge is not always formalized and is specific and dependent on the project methodology. A project manager noted:

"I will now continue with the previous answer and will mention the Internalisation in sense of integrating the two sets of knowledge basis from the order management platform and also the application integration platform. For both platforms, we specialized team members who are experts in the specific fields of competence. Additionally, we have involved juniors who contribute in the way that are coached by the experts and learn through work. All this means Internalisation since both parties are involved in explicit and tacit knowledge exchange. The

Internalisation process contributes the juniors to be completely motivated to learn and understand the project scope and be more efficient in the forthcoming projects".

A key aspect of internalisation knowledge, and of all the knowledge processes, is learning. While training, tutorials, and certification are useful, learning is effective while doing. One participant noted:

"Always, this approach of learning is more effective than normal ways of learning through tutorials, training sessions and certificate exams. Not always certification raises the employees to be senior and able to give high contribution of the project. Certification can only confirm that the employee has absorbed the relevant knowledge in systematic way and has a broad understanding about the development and customization of the platforms, but it does not add value to the project just like that".

The participants noted that integrated knowledge is one aspect of the proposed project management framework which contributed value to the decisions. Project managers draw on the tacit knowledge from the project offices and experienced project managers, as well as the knowledge stored in the project repositories of completed projects and the best practices of the project management. Project management techniques themselves now facilitate decision-making:

"Combination of knowledge from multiple knowledge sources is crucial in the project decisions. I want to stress that the project management techniques are evolving through the technology. The new and fast-moving progress of the technology makes the role of the project managers crucial in the dynamic environments. Now, the project managers should know the specifics of the new technology should not completely rely on the technical personal in drawing their own decisions, should be open to all communication channels, and conduct continuous improvement of the working environment and knowledge base".

The participants made the point that knowledge and code base are integrated in the IT project into the deliverables. This signifies the subtle aspect of project knowledge management, indicating that the code base itself reflects the knowledge of people, organisation and the implemented IT which constitutes the complex IT systems development project. A participant offered:

"The new approach is the micro-services which are residing in the containers and are used like Lego boxes in the process of integration into the deliverables. The knowledge can be integrated from the seniors to the juniors bringing the know-how in the initial project iterations or can be achieved during the coaching process. Micro-services approach defines the explicit part and coaching the tacit part of the knowledge transfer".

7.3.8 Project Managers' Responsibility

The final question then focused on the primary duty of the project manager to deliver the project specifications in budget and on time, and up to required quality. They were asked to discuss how they use knowledge management arising from the SECI process to monitor the project to this end. They were also asked to comment on the kind of project management decisions they make using the emerging knowledge base. One participant said that the process of collecting data from the project repositories and exchanging it and comparing with the past project documentations contributes to monitoring the project performance. He did not rely always on the project KPIs based on time and finances as good measures because in some cases the estimations are not accurate, and overestimation brings excessive savings but underestimation losses. As he commented:

"This is typical when we have unexperienced team dealing with new project which is not common for the project office portfolio. On the other side when the team is experienced and there is almost service based project or software as a service or platform as a service, the project leadership may decide to rely completely on SCRUM approach or tacit knowledge transfer. I will mention some of my approaches to evaluate and follow the project during the project execution. I use as always according to the good practices of project management a project card. The project card enables to have a high-level information about the project and have some tangible feeling in which direction the progress of the project is heading. For example, the bad values of the project KPIs will allow us to think that we have failed project and that the project should be stopped to avoid the excessive losses or to be reorganized. But it may not be the case, maybe we have underestimated the initial project activities, and overestimated the closing activities of the project. If we completely rely on the project cards, it is always the question, how to organize the project card to give a good overview of the project status. The opposite could also happen in case of good and favourable KPIs, the project at the end to be failed due to miscalculated let's say integration module which was miscalculated or wrongly planned. Due to this collecting information from the start and preparing the project plans should be based on SECI model using all possible knowledge resources to prepare the right project plan and organize the project card which will produce the right follow up KPIs".

The participants agreed that based on their experience and the project methodology, the SECI process can be used in different ways. This process relies on the postulates of having steady team and not very fluctuating employee base. In case of service delivery there are strong benefits of removing the formal part of the knowledge transfer and using the tacit knowledge as the basis in the project development lifecycles. The project managers said:

"I want to emphasize that project management is more complex when conducting projects which consists of multiple diversified modules. In that case, combined project methodology may be used and SECI spiral is the more appropriate, depending on the case, different methodology of knowledge transfer is used or a combination of them. I will give some example here related to that like delivering one module using the SCRUM project structure and methodology, while on the other side I will use in some other modules more conservative approach and implement waterfall methodology. This combined approach corresponds to the SECI spiral where the

processes are interchanged, and project methodology varies from module to module. This approach is lately more present and allows highly efficient utilization of the resources and knowledge base. Also, in the project management and reporting, as well as in updating of the project cards for the status of the progress and condition of the projects. We have to rely on multiple source of knowledge, where the SECI model is favourable".

Project managers also agreed that the project can be formally monitored using existing project tools like ticketing system, testing repository or it can be managed using the informal part like continuous project surveillance. One project manager preferred the combined approach of follow up activities. The SCRUM based projects use more the tacit approach and the backlogs not always are complete with all the details. This approach is allowed in most IT environments since the repositories collect the details that are not crucial for monitoring the progress of the project. However, in more complex project environments it is not possible to reply on tacit approach, and combination is used based on SECI model where all transformation of the knowledge base is used with the aim to facilitate and conduct the project to successful completion. One project manager described the situation as:

"The competence of the team member, the tacit knowledge exchange, can be used in the SCRUM based projects. And it can run for consecutive similar projects till a new project comes where the need for new competence arise. In that case we proceed with the training session which is combined methodology and will produce the first partial new competence of the project members. After that I will proceed with coaching session conducted by external experts as freelancers or from other companies. This will enable my staff to reach the level of competence to be independent in the next project and will conduct the activities in the project without external experts. Next step is converting the tacit knowledge into explicit and this is the process of externalization. This will be repetitive and will also be used when project team replication is conducted with the help of existing staff then we have internalization and combination and so on and so on. You see the spiral of the SECI model. This is the way how to grow the company portfolio and grow the company staff competence".

In case of project management in the IT industry, due to the improved and new technologies used in development, testing and deployment is moving toward more dynamic interchange of the knowledge based coming to and from the projects. This approach concurs with the SECI spiral which brings dynamic interchange of the two types of knowledge, their documentation, as well as transforming into the spoken word. All these processes are new and bring more changes in the mentality of project managers. The role of the project manager has become more technical and more dynamic, the decisions are founded on experience, spoken and recorded information. As one participant noted:

The project managers agreed that critical decisions must include all aspect of available knowledge and information and that the SECI processes are needed. It would also support better risk management to avoid requiring extra resources and time which brings the project in the red zone of profitability. Both complexity and duration of the project call for more SECI type processes of knowledge management.

The proposed SECI-based project management framework is a conceptualisation of knowledge management in complex IT systems development projects. The interview and focus group data support it. The first interviews reveal that project manager of complex IT systems need support in making effective project decisions. The second-round semi-structured interviews found evidence of the processes involved in the SECI model that is Socialisation, Externalisation, Combination and Internalisation. The project management framework was derived from this data and validated with project managers in a focus group.

The focus group discussions identified project management practices that reflect the proposed SECI-based project management framework. Though socialisation is not formally structured by project managers in their project knowledge management, it is used to exchange tacit knowledge. Some development methodologies like SCRUM are more tuned with socialisation. Externalisation of knowledge is an integral aspect of project management methodologies and newer development methodologies and platforms like BEA platform provide integral knowledge management tools. Combination process are also evident especially between senior and junior project members. In such cases both socialisation and externalisation are necessary in order to transfer tacit knowledge and learn explicit knowledge. Integration processes are evident during the integration of system modules and technologies. They are also evident across different projects as experienced by the project managers.

Project managers reply on externalised formal knowledge contained in project knowledge bases to make project decisions. Externalised formal knowledge is becoming increasingly available in newer project management methodologies. However, since project decision are unique because of the unique context of each project, project managers tend to draw on other sources of knowledge too to give them confidence in their decision making.

So, project decision making involves Socialisation, Externalisation, Combination, and Internalisation process of the proposed project management framework in situ. Project managers assess critical decision-making situations by drawing on these processes heuristically. They

assess the decision in the unique context and draw on externalised formal knowledge as well as socialisation to gather tacit knowledge from project members.

7.4 Knowledge Creation and Knowledge Flows

Thus theoretical validation is evidenced by the data. This is the foundation layer of the IT Systems Development Decision-Making Support Framework based on the SECI model, which explains knowledge creation and sharing. This research investigated IT systems development project management to develop the IT Systems Development Decision-Making Support Framework to aid project management decisions. Programmers and developers were involved in estimation of IT systems components development. Program managers used other expert programmers and systems developers for their views. Additionally, they used the SECI processes to finally make project decisions.

IT systems development projects are complex because they contain people, organisation, and the actual IT artefacts. The role of project managers is crucial for both the quality and effectiveness of IT systems. Understanding actual project knowledge management can lead to developing better understanding of project decision-making processes. The main issue concerns knowledge creation and sharing between expert team members in order to develop complex IT systems.

A primary issue in this knowledge creation and sharing concerns project managers' decision-making. This involves establishing systems requirements, coordinating the project personnel and systems development technologies. The task of the project manager becomes even more complicated because available programming skills and systems integration competencies have to be allocated, so project managers engage in the management of project knowledge. How this knowledge is established within a project and managed by project managers and shared with team members contributes to better complex IT systems project management.

The theory of knowledge creation was applied to understand project knowledge management and decision-making. While project managers can hold project knowledge in their head for small and straightforward projects, they depended on decision-making frameworks and supporting knowledge bases when developing large, complex IT systems. They agreed that a better approach to manage knowledge for such projects is to use knowledge management. This research found evidence for the spiral of knowledge management framework proposed by Nonaka (1994; 1998) in complex IT systems development. Project managers tended to go through the processes of converting tacit knowledge into explicit knowledge to inform project decisions. They also tended

to go through the processes of socialising, externalising, combining and integrating knowledge for the purpose of project decision making. In the following Sections the findings of the research are related to the research objectives and the existing literature to determine the contribution.

An objective of this research was to identify knowledge creation and knowledge flows in IT systems development project management. Evidence of such knowledge creation and knowledge flows would then support the SECI model and make the proposed complex IT Systems Development Decision-Making Support Framework feasible for practice. The evidence supports the proposition that project managers create knowledge specific to an IT systems development project and generate knowledge flows relevant for project tasks. One project manager stated: *"Sharable knowledge is basis for the project members to take initial understanding about the technical background and user requirements".*

It is necessary to manage knowledge for effective IT systems development. The evidence showed that project managers used various approaches and systems to manage project knowledge.

In modern IDE environments, the technical knowledge is documented in repositories for development of applications. In case of IT systems deployment, most of the documents reside in MOP (methods of procedure) documentation where stepwise instructions are provided. Project managers deal especially with new steps and processes that are unique for the current project.

Knowledge is generated in and flows from the formal document management system where the documentation is indexed and searchable by keywords to the special repositories like SVN environments where the code base is stored and versioned. Systems which keep the ticketing information and bugs resolution information like Bugzilla platform are used. To ensure effective knowledge flow, all these technical environments are located on the company intranet and are protected from external intrusions. Knowledge flow is directed as the platforms are role-based and the access rights are different for the specific group or members of the project and company. Some have full access rights to the technical documentation with the right to change it with specific tags like the technical managers, other project members have restricted access rights and have access only to the specific part of the technical and project management documentation.

Knowledge generation and flow is team-based in projects. Project managers stated that effective teams are critical for the success of the complex IT systems development project. Projects managers explained how they develop the project team in order to manage project knowledge. Project team development has multi-fold implications in the project outcome. The team is trained

at the start of the project where the necessary knowledge is transferred on formally and in later stages by using the informal or coaching approach. The principle of side by side development process and pure coaching are crucial in the process of acquiring new experience.

Knowledge flows was based heavily on the Socialisation process. Project managers described how they use socialization among programmers to contribute to the project knowledge base. The socialization process creates mutual understanding speedily among the experienced project team members but can bring friction and misunderstandings and even conflicts among new team members. So, the concept of mutual exchange of informal knowledge in modern ocean office environments is based on grouping the most communicative members of the team to be close to each other. This is like cluster organization and is one of the methodologies which facilitate the informal approach. The formal or explicit knowledge is maintained in the IDE repositories as well as deployment and test environments. The formal part of the project documentation resides on the document management servers.

Project managers related the Externalisation process, with the explicit knowledge base overlapping with the combination process. They described the processes used to externalize project knowledge and use it to make project decisions. ‘Coaching’ is used to transfer tacit knowledge to explicit knowledge. For example, a training session on bundling of services in the charging platform was used. The training was organized for all billing specialists in the group of companies associated with the holding company. Since all of companies were sharing the same billing platform with specific localized customization, generic training was organised for all participants in one session. There were on site workshops where the knowledge was transferred to the local billing specialist.

Project managers also used the Socialization process among programmers to contribute to the project knowledge base and they use the subsequent knowledge gained to make project decisions. Interestingly, the formal method of estimation with voting which is present in the SCRUM approach is treated as socialization and then formalized based on experience. The knowledge gained is used in coaching and scrum sessions and then automated using the available technology. In the estimation process there are different methods, the traditional one is still used when the estimation is conducted by one experienced project member, usually a technical lead and the prepared document by him is given to another experienced developer to confirm or correct. This approach is more traditional and lasts relatively long in comparison to the simpler methodology

of collecting the estimations in workshop session from the various parties who prepared the estimations. This kind of process of estimation of the project activities by the developers is then documented and used as explicit knowledge. In case of agile development all the knowledge is transferred to tacit knowledge through internalization by project teams. This concept of interchanging of the type of the knowledge is common when the team's members are maturing and are working together in several similar projects. The mature team can rely on tacit knowledge, since it contributes to the cost efficiency of the project. The traditional approach is used for new projects and new teams. So this exchange of knowledge transfer is repeated depending on the IT systems development project and reflects the spiral of SECI model.

Socialization for tacit knowledge transfer also occurs happens in brainstorming sessions organized by the architects and solution designers. Project managers related many examples where the tacit knowledge transfer is successful. This is achieved through an initial session of training to upgrade juniors to understand the platforms and environments and to achieve the level to cope with coaching and side by side programing, which is good for the peer to peer developer to exchange specific knowledge that is needed. This process is very common in the process of forming the team structure for the next projects and making the required skill set for the major team members. This approach is very common for the whole technical team members who exchange their opinion on a regular basis and try to learn the experience from the other members of the project. The sessions are documented and made available for the all technical staff. These repositories are treated as systemized transfer of tacit to explicate knowledge – externalization.

The practical validation is also evidenced by the data as the Ba creative and recording spaces. This is the decision-making layer of the IT Systems Development Decision-Making Support Framework, which is the application of project-specific knowledge to support decision-making processes. A central focus of the research was to capture expert IT systems development project managers' decision-making processes. The main finding of the first round interviews was that project managers with more experience do not follow the normal project management technique, such as estimation, scoping, Waterfall and Spiral software development techniques like Planning Poker, Wideband Delphi, Source Lines of Code (SLOC), Constructive Cost Model (COCOMO), and function point analysis. Instead, they rely on their experience to understand the broad parameters of the IT systems development challenge and organisational setting of the IT system. The research provides understanding of knowledge management for IT systems development in terms of project managers' decision making processes.

In the IDE environments, the technical knowledge is normally documented in the repositories for development of applications. In case of IT systems deployment, most of the documents reside in MOP (methods of procedure) documentation where stepwise instructions are provided. Project managers normally prepare documentation for any new steps and processes that are unique for the current project which will be beneficial for similar projects in the future. From a technical perspective, the medium where the information is stored varies from the formal document management system where the documentation is indexed and searchable by keywords to the special repositories like SVN environments where the code base is stored and versioned. They also use ticketing information and bugs resolution information systems like Bugzilla platform, available on the company intranet and are protected from external intrusions.

The IDE environment, which in later releases of VS 2017 are more integrated, provide integration of development, testing and deployment. It is more common to have SVN as code repository, intranet portals as project knowledge repositories, and local notes of the project managers to transfer the tacit knowledge to explicit. Project managers use the more sophisticated IDE to develop the new products, customize services already productized, or deliver customized products.

For complex IT systems development, project management platforms in most cases are not centralized but distributed on several platforms. Project management documentation resides usually in document management platforms. Test and deployment platforms are in some cases integrated into one or can be individual like TestLink, Jira, Azure cloud etc. In most cases virtualization in all forms is exploited to make the utilizations of the systems more effective regardless whether it resides on the local company platforms or use the cloud services. The code base is located on different platforms like SVN or GitHub depending on open source projects or specific customized code of existing products. TestLink collects all the test scenarios and results related tests. This repository is used as open source platform but in professional use can also be licensed. In the case of Microsoft and its latest development platform Visual Studio 2017 bundled with Mobile Centre, Docker platforms and Azure cloud, the integration and synchronization make working on projects quite efficient. This may be treated as one survey over the possibilities to use the SECI model by automation of the processes and logs into one converged repository and knowledge base.

Since project managers are charged with the deliver the project in time and budget, as well as required quality, they require relevant information. They were asked how they use knowledge management and whether it reflects the SECI process to monitor projects. They were also asked what kind of project management decisions they make using the emerging project knowledge base.

Project performance is monitored using project repositories. Project KPIs based on time and finances are not considered good measures. Since in some cases the estimations are not accurate and overestimation brings excessive savings but underestimation losses. This is typical with an inexperienced team dealing with a new project which is not common for the project office portfolio. When the team is experienced and there is almost service based project, or software as a service, or platform as a service, the project manager may decide to rely completely on SCRUM approach or tacit knowledge transfer.

As good practice project managers use a project card to manage projects. The project card provides high-level information about the project and gives indication of the progress of the project. For example, the unacceptable values of the project KPIs will allow project managers to consider halting a project or reorganising it. Decisions are made about underestimation of the initial project activities or overestimation of the closing activities of the project. So project managers use the project card as an indicator only.

The use of the SECI processes was determined by experience and the project methodology being used. These SECI processes relies on the postulates of having steady team and not very fluctuating employee base. In the case of service delivery there are strong benefits of removing the formal part of the knowledge transfer and using tacit knowledge as the basis in the project development lifecycles. Project management is more complex in conducting projects which consists of multiple diversified modules. In that case, combined project methodologies may be used and combined with some SECI processes. For example, delivering one module using the SCRUM project structure and methodology and for other modules more conservative approach and implement waterfall methodology. This combined approach corresponds to the SECI spiral where the processes are interchanged, and project methodology varies from module to module. This approach is lately more present and allows highly efficient utilization of the resources and knowledge base. Also, in project management and reporting, as well as in updating of the project cards for the status of the progress and condition of the projects, project managers rely on multiple source of knowledge, where the SECI model is well reflected.

Project managers formally monitor projects using the existing project tools like the ticketing system and testing repository. Informally they use continuous project surveillance. Most project managers prefer the combined approach of follow up activities. The SCRUM based projects used the tacit approach more. This approach is permitted in most IT environments, since the repositories collect the details that are not crucial for monitoring the progress of the project. In more complex project environments it is not always possible to follow the tacit approach, so combination is used based on SECI model where all transformation of the knowledge base is used with the aim to facilitate and conduct the project to successful completion.

Project managers emphasised competence of the team members. They linked it with tacit knowledge transfer potential in SCRUM based projects. They also related how it can be used across project until the need for new competence arises. In that case, project managers set up training session which is combined methodology and will produce the first partial new competence of the project members. Then a coaching session is conducted by external experts as freelancers or from other companies. Next step is the converting of the tacit knowledge into explicit and this is the process of externalization.

7.5 IT Systems Development Decision-Making Support Framework

The research sought to develop a novel IT Systems Development Decision-Making Support Framework based on knowledge management theory to enable IT systems development project managers to make more effective decisions to improve the success of projects. Project managers were asked about using the proposed IT Systems Development Decision-Making Support Framework for project management.

They recounted the current process of estimations of the man/hours as well as lead time per activities conducted by the developers. In one segment the developers in agile environment vote to assess the effort needed for specific chunk of the project, like activity which depends on one developer or team of developers or some subproject which is more complex and consist engagement of all participants. They also described the project manager’s role in revising estimation and the process of estimation in agile development.

The PM can revise the estimation by consulting experienced developers or technical lead or can give the same task/activity to other developers. This is the formal part of estimation. Another is the agile approach where the estimation is conducted via voting and defending of the estimation is provided by the participants after the voting.

Project managers interpreted their project activities in terms of the proposed IT Systems Development Decision-Making Support Framework. They said projects are organized using classical methodologies following the PMI directions or the PMBOK documentation. In this way of organizing the projects the documentation provided from the training sessions is available together with the reference and user documentation of the product and is used as explicate knowledge transfer. The second part is related to the coaching which occurs during the process of product customization. Knowledge is documented and is available for those who remain to operate the live systems. The process of externalization occurs. In the later stage, when the new systems move to operation, further customizations and introducing new products and services as well as tariffs for them is conducted by agile approach. This is depicting the SECI model and the spiral of knowledge exchange.

The process of interchanging the knowledge bases between certain project environments during the process of IT Systems development is common practice. In some cases where the project team members work for years and are delivering systems which are routine engagement in the project, the tacit knowledge exchange or socializing is the more common practice. Even internalization or moving the explicit to tacit knowledge is common in that cases. This is typical with the SCRUM teams. Important documentation resides in the repositories and is created automatically but the communication and exchange of knowledge is completely oral and informal in SCRUM projects. This is very common practice in service delivery and customization projects. In most cases the project deliverables are known and are subject of routine customization and development. Some of informal knowledge exchange methodologies may fail if they are addressed to new team members that do not know each other and have lack of competence. For that purpose, project managers stated that introducing new team members should be gradual alongside with the replacement of the older team members with new ones.

7.6 Actual Decision-Making Processes

An objective of the research was to validate the Framework with expert IT systems development project managers, focusing on their decision-making processes. This was to understand how the theory of knowledge creation, specifically the SECI model, can be applied to complex IT systems development projects to develop a decision-making framework. This was discussed in the focus group with the expert project managers in terms of how they use the knowledge base for decision-

making. They described situations and cases in which they drew on explicit knowledge to make project decisions. They also explained how this helps them to monitor IT systems development.

The researcher's search of the literature indicates that the knowledge management perspective has not been applied to IT systems development projects. It can be argued that much of the research on project management is not theory based, instead it develops and uses project management technical frameworks based on the idea of a project with limited budget, specific time period and specific tasks. This PhD research invokes the theory of knowledge creation and frameworks for managing organisation knowledge to explain how IT systems development project managers manage projects from the perspective of knowledge management.

Existing research topics on project management in the literature include project itself (Cresswell et. al, 2013), leadership of projects (Clarke, 2012).), techniques for managing projects (Shepperd and MacDonell, 2012) and tools (Nelson and Morris, 2014). It does not take a knowledge management perspective. This PhD research provides a new theoretical knowledge management perspective on IT systems development project management. The new unit of analysis is project knowledge and how it is created, shared and managed by project managers to accomplish projects successfully. The knowledge management perspective has the potential to contribute theoretical understanding about managing project knowledge in unique and complex IT systems development projects. This is important because such projects are essentially knowledge work and better theory can contribute to more effective IT systems development project management.

As noted earlier (Sub-section 2.6.2), decision-making can be characterised according to 'rational man' theories and behavioural theories. The data reveals that actual decision-making in complex IT systems development reflects behavioural theories more consistent with Boyd's notion of 'organic' situations. Project managers do use formal and visual tools to store data and information. But this is limited to systematic gathering and storing of data and information. The actual decision-making is bound by the context in which the decision needs to be made and this context composed of the project objectives, technical issues, problems, people, budget, and time-scales. In this context, project managers do not behave as 'rational man' (Simon 1979) or follow multicriteria quantitative decision-making approach (Saaty, 1990) when making decisions. Rather, they reply on heuristics and contextually-rich information which is not readily available but needs to be unearthed from the available knowledge sources among the team members.

So, project managers built up their knowledge based on similar projects, project scope, and project environments. This knowledge base was drawn on to create Office formal paths and shared with Steering Committee members. By sharing explicit knowledge from the knowledge base project managers engaged in externalising tacit knowledge. Project managers face critical decisions which they do not take without thorough consultation with stakeholders, product owner, business owners, project officers as well as project members. The decisions are not always based on strict methodologies but on more heuristic approach and experiential knowledge which varies from case to case in respect to decision-making and there is no pattern for making the right decision.

The explicit knowledge in the knowledge base was combined with the system development methodology. This indicates that systems development methodology knowledge itself is not sufficient to manage complex IT systems development. Critical project decisions especially drawn upon the knowledge base created through externalisation and internalisation knowledge processes. Like Steering Committee meetings, explicit knowledge from the knowledge base is combined with tacit knowledge arising from deploying a systems project methodology.

A critical aspect in which the explicit knowledge base is drawn upon is risk assessment and risk management. Similar to Steering Committee and project methodology situations, knowledge from the knowledge base is used in consultations with various project members to manage the change process. It is noteworthy that the explicit knowledge base is regarded at 'the change management framework'. It is used to determine what is within the scope of the project and how the new requirements should be treated by the project manager and Steering Committee.

The process of interchanging the knowledge base on certain project environment during the process of IT Systems development is common practice. In some cases where the project team members work for years and are delivering systems which are routine engagement in the project, the tacit knowledge exchange or socializing is the more common practice. Even internalization or moving from explicit to tacit knowledge is common in those cases.

7.7 Practical Impact

From the discussion above, it can be argued that the proposed complex IT Systems Development Decision-Making Support Framework has impact on conceptualising project knowledge management and supporting decision-making processes. The discussion shows that project managers currently use existing project management methodologies and associated project

knowledge management tools. However, it is clear that they also use ‘informal’ practices that can be accurately described as reflecting the SECI knowledge management processes.

Project managers need to create and manage specific project knowledge that matches the complexity of IT systems development. Whilst available project management methodologies are used, project managers draw on other aspects of teams and team membership that reflect the Socialisation, Externalisation, Combination and Internalisation aspects of the SECI model. These processes are also used for making critical project decisions such as considering new systems requirements.

Actual practice of managing project knowledge is not easily compartmentalised in the formally adopted systems development methodology. The complexity of the project, use of external expertise, competency of team members, their experience and other factors determine the extent to which SECI model processes are drawn upon by project managers. Where these aspects are lacking, the Socialisation, Externalisation, Combination, and Internalisation processes are evident in complex IT systems development projects.

7.8 Conclusion

Project managers of complex IT systems development projects make use of systems development methodologies alongside enacting the Socialisation, Externalisation, Combination, and Internalisation processes of the SECI model and Ba knowledge creation spaces. The proposed IT Systems Development Decision-Making Support Framework was evident. Programmers and developers were involved in estimation of IT systems components development. Program managers used other expert programmers and systems developers for their views. Additionally, they used the SECI processes to finally make project decisions. This Chapter thus confirms the validity of the IT Systems Development Decision-Making Support Framework. This then forms the basis for the conclusion and evaluation of the research in the next and final Chapter of the thesis.

CHAPTER 8 CONCLUSIONS, FUTURE WORK AND PERSONAL REFLECTION.

8.1 Introduction

In the previous Chapter the design, process, and results of the validation of the IT Systems Development Decision-Making Support Framework was presented. It was found that project managers' knowledge management activities do reflect the SECI model processes for project decision-making. This now enables the evaluation of the research in terms of reflection on the research process and the experience of the researcher. Research is both a personal journey, a formal process, and professional practice.

The formal process was explained in more detailed in the previous chapters of the thesis. This chapter will provide the conclusions of the research and evaluate the researcher experiences and what has been learnt as a developing researcher. Evaluation is concerned with appraising the effectiveness of a subject. In this case, it provides the researcher's reflection on the experience of undertaking the research project. In research evaluation or reflexivity is defined as: '…an attitude of attending systematically to the context of knowledge construction, especially to the effect of the researcher, at every step of the research process' (Qualres, 2018).

8.2 Research Aims and Objectives

The aim of this research was to investigate IT systems development project management in order to develop the IT Systems Development Decision-Making Support Framework to aid project management decisions. In order to achieve the research objectives, researcher first developed deep knowledge about knowledge management theory and IT project management. This was done as the critical literature review in the literature search. The domains of IT systems development project management, decision-making, knowledge management frameworks, focusing on existing examples of knowledge management, knowledge management techniques, and underpinning project management and knowledge management theories were studied. The researcher learnt the theoretical knowledge is debated rather than accepted by researchers and that different theories compete to be widely accepted. One such theory is the knowledge creations theory and its derivative the SECI model which the researcher adopted as the theoretical basis for the research.

Similarly, the objectives concerning knowledge creation and knowledge flows in IT projects, capturing expert project managers' decision-making processes, and development of the IT Systems Development Decision-Making Support Framework, were achieved as indicated in the

previous Chapter on validation. However, the researcher could have achieved these objectives differently and perhaps more richly. For example, the theoretical suppositions that the researcher made could have been better articulated and examined before accepting them and proceeding with the design and executing of the research methodology. Is it the case that knowledge is only of two types – explicit and tacit? This was accepted because it is the core assumption of the theory of knowledge (Nonaka, 1994). An alternative position could have been adopted, for example a more practical perspective involving 'know-what' and 'know-how'. Then assessing project manager's current knowledge levels with what knowledge, they believe they require in order to achieve system requirements, and how they expect to acquire this knowledge.

Another core assumption that was accepted was the project managers are rational actors, and as such they make decisions rationally. The researcher read alternatives this view such Simon's satisficing decision-making. He asserts that: argues: 'the artefacts do not exclusively emerge from a creator; rather, they evolve in response to a selective force' (Simon, 1988:p.52). IT systems artefacts could emerge from a 'selective force'. Accepting the satisficing perspective could have resulted in a different data set that could have informed the development of the IT Systems Development Decision-Making Support Framework differently.

A more practical issue is translating objectives two, there and four into practical research methodology. It is certain that the appropriate qualitative research methodology was selected. However, the issue of gather data on the nature of knowledge, such as tacit knowledge for instance, is not easily resolved. Although semi-structured interview does enable 'probing' where the researcher thinks more or different information can be obtained, it is not certain that this actually targeted tacit knowledge, which by definition is difficult to articulate and the reason for the very SECI model.

However, it is clear that the interaction between people and information technology in an organisation is problematical to model and translate into IT systems. The main problems concern communication between people and their job roles and information systems developers. Another issue is coordinating the project personnel and systems development technologies. The task of the project manager and project decisions become even more complicated because available skills and competencies have to be matched to the needs of the project. This suggest that complex IT systems development requires coordinated management of project knowledge.

This research investigated how this knowledge is established within a project and managed by the project manager and team members. For large, complex projects the amount of project knowledge involved is complex. The research objectives were (a) to identify knowledge creation and knowledge flows in IT systems development project management; (b) to capture expert IT systems development project managers' decision-making processes; (c) to develop a novel IT Systems Development Decision-Making Support Framework based on knowledge management to enable IT systems development project managers to make more effective decisions to improve the success of projects; and (d) to evaluate and validate the framework with expert IT systems development project managers.

These objectives were achieved by constructing a conceptual framework that explains knowledge management in complex IT systems development projects. This conceptual framework then operationalized to gather empirical data. The empirical data was gathered using an initial survey, in-depth interviews, and focus group interviews, and data was analysed using structured thematic analysis.

The findings reveal that complex IT systems development is a different class of project management. Non-complex IT systems development projects can be managed, and project decisions can be made drawing on mostly explicit knowledge. Complex IT systems development projects, however, require project managers to create and manage knowledge. This is because the constituent parts of a complex IT systems development project are people, organisations, and IT. Each is complicated in itself, but the interactions between them are many magnitudes more complex.

In terms of IT systems development, the many magnitudes of complexity concern the knowledge required to build such systems. Knowledge of disparate fields of expertise like people's organisational needs and various elements of IT need to be combined and synthesised. Project managers used the normal project management tools for gathering and storing project knowledge. Complex IT systems development though necessitated further knowledge creation and management processes as part of systems development. These processes were essentially concerned with creating and sharing knowledge specific to the unique complex IT systems development project.

Project managers needed to make routine and non-routine decisions. Routine project decisions were facilitated by prior project management experience and databases of explicit knowledge

and other project management repositories. For non-routine project decisions project managers drew on similar explicit sources, but they also drew on additional experiential knowledge of project members, which is of two types' explicit knowledge and tacit knowledge.

Project managers made decisions drawing on explicit knowledge and tacit knowledge. They organised the project resources, especially the human experts, so as to draw on both explicit and tacit knowledge to make project decisions. Since tacit knowledge resides in humans' bodily experiences, it was managed or made available to the project team as explicit knowledge through knowledge management processes. The knowledge management process found in complex IT system development projects are Socialisation, Externalisation, Combination, and Internalisation or SECI.

Complex IT systems development project management and project managers' decision making drew on knowledge management processes as modelled in the SECI spiral of knowledge. Since, complex IT systems development projects are by nature unique projects, they entailed innovation which composed re-combining existing elements in new and unique IT artefacts. Such innovation is catered for through project knowledge management that reflects the SECI spiral of knowledge management model.

The theoretical impact of the findings is that IT project management theory needs to classify projects into different classes of complexity. This complexity is measured with knowledge rather than other normal units used in IT project management like size, cost, and time. Complexity is reflected in the knowledge needed to develop a complex IT system. IT project management theory needs to account for creation of new knowledge and re-combination of existing knowledge in new ways in certain IT systems development. IT project management needs to recognise knowledge as a complexity inducing factor and cater for knowledge management as depicted in the spiral model of knowledge management.

The findings have an obvious practical impact. The development of the novel decision-making framework in this research can help to reduce failure of IT systems projects by facilitating better knowledge management. The findings reveal that project managers do manage project knowledge, especially in terms of eliciting tacit knowledge for non-routine project decisions. Project managers also confirmed practicing knowledge management during the validation of the IT Systems Development Decision-Making Support Framework. Currently, the framework is implicit in project managers' model of knowledge management. It can be used explicitly at the

start of complex IT projects to frame how project knowledge will be created through project members, shared with project members, and managed for effective project decision making. It can also be used to frame the training programmes that project managers mentioned during the interviews and focus group discussions.

For future research, the proposed IT Systems Development Decision-Making Support Framework can be used in an experiment to assess the following. Experimental results can identify more specific variables and their magnitudes, which would complement the qualitative findings of this research. To make an informed decision, do project managers gather about 20 percent of the necessary information? It is often difficult to have all the information and knowledge that is required in order to make a decision. What is the mix of explicit and tacit knowledge in project manager's gathering of about 20 percent of the information? Specifically, what is the knowledge gathering process involving peers? Does it reflect the spiral of knowledge creation and management? In terms of individual tasks, does the proposed IT Systems Development Decision-Making Support Framework support project managers' decisions in regard to the time a programmer should take in completing a specific task? This IT Systems Development Decision-Making Support Framework is proposed to support project managers make effective decisions.

8.3 Research Methodology

Looking back, the research design was highly appropriate. The study of knowledge deeply involves the context in which knowledge is created and used. The qualitative research approach is highly appropriate for studying phenomena like knowledge in context. The pragmatist research philosophy was appropriate for the same reason. Project managers acquired technical and project knowledge to apply to support the decision-making process. And the research aimed to develop both a theoretical perspective and practical impact as contributions, so the pragmatist philosophy guided the design of the research and interpretation of the results.

However, the actual research in the field would have benefitted with longer data collection period and further rounds of interviews to gather more data that would enable deeper patterns to be discovered. For instance, whilst project managers reported that they used the knowledge acquired through the SECI process, the research did not follow this up to see how and whether such knowledge improved the project outcomes. Another important point, mentioned in the research methodology Chapter, is that the research depended on self-reported data. To improve the validity of this dataset, shadowing could have been added – though for practical and

confidentiality reasons this was not possible. Shadowing would have provided an independent check on the self-reported data.

No unexpected issues that risked data collection arose. The researcher had secured the participation of the project managers and they obliged. The data analysis was conducted as expected too. Such critical aspects had been discussed with the research supervisor in order to help identify major risks.

8.4 Contribution

The research makes a theoretical and practical contribution. The theoretical contribution is to introduce the theory of knowledge to the project management literature in relation to the decision-making process. The knowledge creation theory provides an appropriate perspective to examine the need for knowledge in complex IT projects, which often involve creative, original design that requires unique knowledge. Decision –making in such projects cannot rely on only the prior experience of project managers or available project repositories and databases. The unique context of the projects, the newness of the systems, the new technical challenges, all require context-specific knowledge, as well as established project management knowledge. Such knowledge is an aspect of the theory of knowledge creation and it is well depicted in the SECI model which was used as the core assumption of the research. The SECI process were then actually observed in the practice of project managers.

The practical contribution is to articulate the IT Systems Development Decision-Making Support Framework for projects managers to reflect on their practice and to apply it in practice. The framework helps project managers to see project knowledge activities as reflecting the Socialisation, Externalisation, Combination, and Internalisation. These processes could be used by project managers to better crystallise their project knowledge activities to achieve more effective outcomes for decision-making. Also critically, project activities such meetings, training, brainstorming currently used for both project management and as knowledge activities, could be supplemented with more knowledge-centric activities suitable for their unique projects. Thus the top layer of the IT Systems Development Decision-Making Support Framework can be supplemented with knowledge-specific activities such as using knowledge management software, groupware, content management and document management systems, and more human focused activities such as establishing communities of practice and expert location to enhance the decision-making process.

8.5 Further Research

Need for further research that arises from this research, as noted above, is the need for deeper contextual data on project managers' project knowledge management activities. This would help to understand better the creative software aspects of project knowledge. Software is fundamental in complex IT systems such as the on-going Yesser e-Government program. The scale of such systems and the range of the health care activities they need to code requires creative use of software – which is knowledge creation and needs to be better understood to support the decision-making process.

Another area for further research is to investigate the use of knowledge-specific software and project activities to understand better the top layer of the IT Systems Development Decision-Making Support Framework. This top layer was depicted as consisting of programmers, other experts, and monitoring, knowledgebase and project managers. By understanding how for example groupware would be used to integrate knowledge management and decision making, the actual 'support' aspect of the decision-making process can be seen as an integrative activity rather than a separate activity.

This evaluation shows that the researcher's reflection has produced lessons that can be used for the next research project. As a 'research student' it is necessarily so. Research involves taking an idea and realising it through existing theory and appropriate research methodology. The idea needs to be examined by peers and related to the phenomenon studied in order to design an appropriate research methodology. The researcher learnt that this is the core of doctoral research. Specifically, in terms of contribution, in both these further research directions, this research has made a valuable contribution to complex IT systems project management by investigating it from the perspective of knowledge management to support decision-making process.

8.6 Evaluation

The researcher experienced the entire research process and learnt much throughout it. However, reflective practice suggests that experience is not sufficient for learning, reflection is necessary too. Reflective practice requires skills to reflect on experience in order to benefit from and engage in a continuous process of learning (Schon, 1983). So, in this section a formal reflection method is applied to my research experience in order to consolidate my learning as practice-based professional learning. From an adult education perspective Boud *et al.*, (1985) explain that:

> "Reflection is an important human activity in which people recapture their experience, think about it, mull it over and evaluate it. It is this working with experience that is important in learning" (p.19).

As well as learning professional knowledge better, reflection also needs to consider the practical values and theories used by the research. Bolton explains that:

> "…paying critical attention to the practical values and theories which inform everyday actions, by examining practice reflectively and reflexively. This leads to developmental insight" (p. 19).

Based on drawing elements from the above readings and talking to peers, the researcher used a formal learning approach to reflect consisting of the following: understanding the research experience by describing it; reflecting on my feelings and actions that I took; theorising to assess whether my preconceived ideas matched my actual experience and how my actions changed consequently; experimenting to understand what I could have done better that would change the outcome favourably.

The research experience was one of learning. This learning included acquiring knowledge and research skills. Learning about research and doing research was fascinating and interesting. I learnt that research requires a methodical approach. I learnt to be think systematically and logically. It was more interesting to learn how to define a practical problem in terms of research. This was dealt with by learning the formal process of doing research.

The formal process of defining a research problem meant learning to think logically and to reason about the problem. The actual practical problem that project managers faced is obtaining information for decision-making. I learnt that I had to first think systematically about the actual problem. Once I understood the problem in practical terms, I then had to relate it to an appropriate theoretical perspective. This two-step process was new, and I had to learn to think theoretically. I was used to thinking about only the actual practical problem. Relating the practical problem to theory was an intense learning process. The main aspect of this was understanding the unit of analysis – what exactly needed to be measured or understood. After identifying many variables including data and information, project and people, the variable 'knowledge' was decided to represent the actual problem of project decision process. Knowledge also related well to the theory of knowledge creation. This helped to understand how to think theoretically.

Managing my feelings was much more difficult. The initial excitement of being a PhD research student did not last long! I learnt about the gaps in my knowledge through supervisory meetings and feedback on my work. Understanding the need for formalism was the toughest lesson.

Research is about asking common sense questions, but these have to be formulated ‘rigorously’. Not fully comprehending this initially led to much frustration. Talking to peers about various topics and the process of research was useful because they too had similar experiences, so I was not alone. However, the learning process was toughest during the final months of the draft thesis. This is when supervisors provided close critical feedback which was difficult to deal with. Major areas of the dissertation needed to be changed and restructured. But I learnt from this to be systematic and do each task individually. This has taught me that written communication cannot be assumed. It must be clear and get my story across to the reader. But more importantly I learnt that formally writing down all my work needs careful planning and structuring.

Theorising about personal growth is very important. It about my prior expectations of being a research student and comparing it with my actual experiences to obtain professional learning. I had expected the PhD to be about actual IT systems development project management. But I learnt that it is not about management or practice; it’s not about being an IT project manager. I learnt that PhD research is about contributing to theoretical understand. This lesson was my most significant lesson during my PhD. In addition, I learnt that such theory has to be related with the phenomenon that I was investigating. I had no previous ideas about how to do research. But I learnt that contributing to theory is only acceptable through a formal research methodology. This lesson too was significant and made me aware of ‘rigour’ in my approach in order to minimise errors. So, theory and methodology lead to the final lesson of empirical data and logical reasoning. I finally learnt that research is about examining my ideas in relation to the actual phenomenon to assess whether they are true.

Such lessons have resulted in changing my values and behaviour as a researcher. I value research more than I did when I began. I believe that research is valuable for creating both theoretical knowledge and practical knowledge. Drawing on my adoption of pragmatism, I realised that research can be both theoretical and practical, thus meeting my original reason and expectation of doing PhD research. I now value practical knowledge that is established through rigorous research and which is theoretical. As an academic, I had valued others’ views but the PhD experience, through its seminars, conferences, presentations, etc. has made me value discussion and sharing knowledge even more.

Finally, changing my behaviour by actually doing things differently or experimenting has been an important lesson. Reading about research, watching others do research, discussing issues and problems with my supervisors, talking with peers, and thinking about research have all helped me

to reflect on my practice. If I were to do the research again, all the lessons I have learnt would help to create a better research project, where I would not have to deal with all the emotions which distracted me from the actual learning during the PhD research. I understand the value of the research aim and especially the research objectives in how they structure the research topic. I can better design a research methodology to gather the required data and interpret it conceptually to theorise better. All such lessons would produce a more enjoyable PhD experience! This suggest that perhaps I have experienced ‘double-loop learning’, in which I have questioned my assumptions about knowledge and how it is created. I have re-framed my ideas about knowledge and how I would acquire it.

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Appendix A: Research Information

RESEARCH INFORMATION SHEET

The aim of this research is to investigate IT systems development project management to develop a knowledge management framework to aid project management decisions.

Your participation in this research is appreciated. Your personal details will be kept confidential and shared only with the University supervisor and other related staff.

This is a study of enhancing knowledge management in project management to support project manger's decision-making processes. Groups and individuals' capability to solve complex IT systems development problem and project managers' ability to make project decisions important to achieve a successful project. The aim of this study is to develop a knowledge management framework that enables complex decision-making to reduce the failure of IT systems development projects. This empirical research, through this second round of interview questions, aims to assess how project knowledge is managed through the SECI knowledge creation model perspective, and how project managers make complex IT systems development decisions. The main contribution of this research is expected to be a description and explanation of knowledge management practices in complex IT systems development projects, based on the application of knowledge creation and management theories to decision-making frameworks.

Thank you.

Appendix B: Participant Consent Form

Research Ethics

Participant Consent Form

STAFFORDSHIRE UNIVERSITY

CONSENT FORM

Title of the Project:

Name of Researcher: Abdullah Almotilag
Email: abdullah.almotilag@research.staffs.ac.uk

please initial in last column for each one:

The researcher described the main procedures to me in advance, so that I am informed about what to expect.	
The researcher have informed me that my participation is voluntary.	
I understand I will have a copy of this consent form and the researcher will have another copy.	
I understand that I will be observed, the interview will be recorded, and notes will be written during the interview.	
I understand that I may withdraw from the research at any time and for any reason.	
I understand that I have the option of omitting questions that I do not want to answer.	
I understand that my data will be treated with confidentiality and that, if published, it will not be identifiable as mine or my organization.	
I understand that I have the opportunity to be debriefed i.e. to find out more about the study and its results.	
I understand that any interviews or focus groups will be recorded and transcribed, and I agree to the use of anonymised transcriptions for the researcher.	
I understand that Staffordshire University code of ethics will be followed during all the phases of this research.	
I agree to participate in this (interview, focus group)	

Name of Participant..... Signature ..... Date ...../.../.....

Researcher signature ..... Date ...../.../.....

* When completed, 1 copy for participant & 1 copy for researcher file

This form was given to all the participants to sign and the interviews were conducted after they consented.

Appendix C: First Round Interview Questions, Samples and Codes

The first round of interviews focused on project management activities that could be interpreted as knowledge management activities. The questions collected basic demographic information. It also collected information on project management activities such as estimation Initial data was collected specifically on project managers' awareness of knowledge management. This Appendix contains the questions asked, some sample responses, and codes.

Demographics:

1. How many employees do you have?
2. What is your business area?
3. What is the target customers?
4. What is the size of the software projects?
5. What is your role in the company?
6. What are your responsibilities?

Time estimation process:

1. Do you use any formal time estimation technique? And Why? (Function Point Analysis, COCOMO, SLIM, SEER-SEM, Use Case Analysis, Software Size Unit)
2. Do you use any expert time estimation technique? And Why? (Planning poker, Delphi)
3. Do you use other technique for time estimation?
4. Are you satisfied with the used technique? And Why?
5. Do you prefer the requirements of the project to be fixed at the beginning of the project or to be updated during the life-time of the project? Does that affect the time estimation process?
6. From your experience, what is the more accurate time estimation technique? Formal, expert, or other?

Resource pool:

1. How to assign a programmer to a certain task? Do you use any techniques?
2. Does the time estimation depend more on the programmer's skill or the task difficulty?

Knowledge base:

1. Please explain how you manage the project knowledge?
2. Do you use a formal knowledge management system?
3. How satisfied are you with your current project knowledge management?

4. Describe how you apply the knowledge for project decision-making?
5. Can you think about any instance where it was difficult to extract software developers or other IT experts' knowledge? Please describe the situation and what you did.
6. What project activities do you have for gathering knowledge from experts?
7. Do you keep a record of past project experiences?
8. What type of documents are kept after a project is finished?
9. What is the use of the documentation of past projects? (Quality assurance, time estimation, resource allocation, etc.)

Summary of Respondents Profile

Interviewee	Time estimation technique	Requirements type	Record keeping	Years of experience
1	**Expert**	**Fixed**	**Yes**	**15**
2	**Formal**	**Dynamic**	**No**	**2**
3	**Expert**	**Dynamic**	**Yes**	**13**
4	**Expert/Formal**	**Fixed**	**Yes**	**6**
5	**Expert**	**Fixed**	**Yes**	**9**
6	**Expert**	**Dynamic**	**Yes**	**11**
7	**Expert**	**Dynamic**	**Yes**	**9**
8	**Expert/Formal**	**Fixed**	**Yes**	**15**

Descriptive Statistics

	Mean	Std. Deviation	N
Years of experience	10.00	4.504	8

Interviewee: YK PM3

Interview Questions Structure

Demographics:

1. How many employees do you have?

   I have in my group 35 employees.

2. What is your business area?

   My area of activity is project management of projects in the field of Order Management, CRM, Service Provisioning related to customizations, maintenance and development.

3. What is the target customers?

   As company we are active in big enterprise projects basically in telecommunication industry as well as in the banking sector.

4. What is the size of the software projects?

   Our projects are ranging from 100K-1M Euros and involve up to 30 employees. Our main customers are telecommunication services providers in southeast Europe. Also, we have conducted several projects in the financial sector related to banking offices and posts.

5. What is your role in the company?

   I am dedicated project manager and responsible for managing multiple customer projects. Also, I manage programs and team of multiple project managers.

6. What are your responsibilities?

   I am responsible to conduct internal development projects as well as customer related projects. In some cases, I lead a program with multiple projects. Also, as senior project manager I am responsible to coach the junior project managers and project leads. I also participate in the financial reporting of my projects as well as on the resource management since I manage simultaneously multiple projects.

Time estimation process:

7. Do you use any formal time estimation technique? And Why? (Function Point Analysis, COCOMO, SLIM, SEER-SEM, Use Case Analysis, Software Size Unit)

   We as company use the Functional Point Analysis, initially together with customers we prepare the SRS documentation and initially the statement of work. All these activities are conducted with detailed description of the requirements which are also related to the resource planning as well as time estimation. All FP are related to one or several functional

units which are part of the increments in the agile project planning. We use usually combined methodology which is in routine work SCRUM based and in case of more complex activities where multiple vendors are involved we use the agile incremental based project approach.

8. Do you use any expert time estimation technique? And Why? (Planning poker, Delphi)

   We use Delphi methodology utilizing the experience of multiple experts involved in the project. The methodology helps us to achieve more precise estimations and avoid customer complaints in the early phase of the projects. 2 experts are involved in the process of the estimation they are contacted independently and provide concurrent estimation of the same functional units. The average value is exchanged to them in the second phase, which contribute to make second correction in achieving the final accepted estimation. Defending of the estimations is also required by elaboration of the resources needed as well as the specification of the lead time needed by involving of different resources. At the end, the process converges to the mutual agreed time estimation.

9. Do you use other technique for time estimation?

   We consult also the documentation provided from the previous projects as indicative to the current estimation. This approach cannot be replicated to the new projects due to the different conditions in the current project, due to the resource availability as well as due to the project specifics. We cannot also underestimate the customer involvement where in some cases it helps a lot but in some cases, can be big obstacle especially in the process where layoffs of the employees is involved by introducing of the new technology. That practice is often present in the post offices where the automation can contribute to significant cuts of the stuff.

10. Are you satisfied with the used technique? And Why?

    We are using the present methodology for quite a long time and in some smaller project we practice agile methodology. This approach is contributing to improve the flexibility and avoid long lasting ineffective projects. The increments should correspond to some stand-alone modules that can be efficiently tested and accepted by the customer. Using that approach we are avoiding bad surprises in the later stages of the project.

11. Do you prefer the requirements of the project to be fixed at the beginning of the project or to be updated during the life-time of the project? Does that affect the time estimation process?

    Initially we always aimed to fix the requirements at the beginning of the projects, but in some cases, it brings the dissatisfaction of the customers due to the missing functionality not well defined in the early phase of the requirements gathering. Due to this very common practice and the excessive and expensive change management process in the later stage it contributes our company strategy to move to agile project management. The increments

are standalone functionalities which are delivered in phases and tested and accepted by the customer. Changes are accepted but not drastic that can redefine all the increments.

12. From your experience, what is the more accurate time estimation technique? Formal, expert, or other?

We use the combined methodology. Using the past project estimations which are like the current one, but also, we consult the experts. Our aim is to earn from the project but in the same time to be competitive on the market since there is big competition. This approach is according to me optimal for our company. The methodology for time estimation basically strongly depends on the maturity of the project team. If the guys are experienced and are long time together, then there is no need to stick to the formal approach. We use in this case the brainstorming sessions and conclude the estimations and project plans in 2-3 sessions.

Resource pool:

13. How to assign a programmer to a certain task? Do you use any techniques?

We use resource planning application which provides us with the current resource availability as well as the future resource availability. This way we can see which resources are available and whether the available resources are competent to participate on the project. In case there is need to reassign more experienced programmers or experts which are already completely engaged then together with the project office we reassign the projects which are not more critical to some less experienced or junior resources. This approach is not very easy and produce conflicts, so this is the last step in the project resourcing. Alternatively, if the project is important and profitable we can assign some freelancer experts which are available in the market.

14. Does the time estimation depend more on the programmer's skill or the task difficulty?

Programmer's expertise is critical in assignment and it contributes to the project deliverables to be conducted according to the estimations. Also in some cases technical knowledge and competence of the programmers can not be enough in the project, where also domain knowledge is required. In such cases we need to engage specific experts and may be more efficient to use them in the coaching or side by side approach to make the socialization - tacit knowledge transfer.

Knowledge base:

15. Please explain how you manage the project knowledge?

We are using project documentation repository in the project office. The project officer controls the access rights of the project members. Also, we have code repository on our private git platform. We also use the project preparation workshops based on tacit knowledge transfer and exchange documentation between the project members based on explicit knowledge transfer. Transferring explicit knowledge to tacit is the last phase in the

agile projects when we have internalization. This helps in the agility of the team and is often practiced when the team members work long time together.

16. Do you use a formal knowledge management system?

We use the repository of the git for the code base and, we have knowledge portal where all the formal knowledge is collected. Additionally, we have ticketing system in which we keep the records of all projects. Related tickets from different faces of the SDLC (Software Development Life Cycle) are on one place. This also helps to allocate the most critical parts of the projects and also to address the difficult phases in the projects, address the project risks and also plan the cost of the resources as well as the contingencies.

17. How satisfied are you with your current project knowledge management?

There is always space for improvement especially in the project knowledge management. I would like to use all the multimedia resources in the preparation of the project management documentation and knowledge management. The indexing of the video files as well as all multimedia resources using the modern voice recognition techniques as well as recording most of the project activities can help in documenting the tacit knowledge and prepare the appropriate socialization mode in automated manner.

18. Describe how you apply the knowledge for project decision-making?

I consult the available project documentation as well as the repository of the past projects. All these together with the tacit knowledge exchange from the sessions with the project office as well as the meeting decisions on the project steering committee as well as the internal project meetings. The decisions are specific for every project and cannot be generalized based on the past decisions. In some cases, the customer is different, the methodology used tend to be more scrum and this brings new moments unique which prevent the synergies from the past project experience.

19. Can you think about any instance where it was difficult to extract software developers or other IT experts' knowledge? Please describe the situation and what you did.

There are multiple cases especially when external resources are involved in the project. The experts are avoiding transferring the know how or are hesitating, but using the modern technology it is possible to build the whole socialization - tacit knowledge transfer. Also, another approach is the utilization of the site by site programming or also coaching. This approach is proved to be very efficient especially in the scrum projects.

20. What project activities do you have for gathering knowledge from experts?

I rely on the brainstorming sessions which are fully recorded as well as coaching sessions. The approach to use two experts from different areas working side by side also contributes in the process of acquiring knowledge from the experts. In case of external resources, I tend to put the knowledge transfer in the contract. That's way I am pushing the cost a bit higher

but for sake of the future projects I collect documents and all multimedia material form the webinars, workshops etc.

21. Do you keep a record of past project experiences?

    Yes, our company keeps a complete code repository of the past projects. Since our company is involved in project maintenance activities, outsourcing as well in the full SDLC we must keep the complete project documentation of the past projects. Additionally, we have recently started to collect multimedia libraries which are indexed and can be accessed in different points in multimedia files. This helps to conduct tacit knowledge transfer more formally and to fuse the cycles in SECI.

22. What type of documents are kept after a project is finished?

    We keep all relevant documentation related to the project knowledge base, post mortem project documentation, evaluation of the performance as well as procurement documentation, project card, relevant documents supporting the project card and the full repository of the code base. There are 3 different platforms that are used, one is for the document management, another is related to the financial documentation and the last is the code repository.

23. What is the use of the documentation of past projects? (Quality assurance, time estimation, resource allocation, etc)

    All the past project documentation is available to the project managers. In case of not granted access rights the requirement is sent to the project officer who is authorized to grant the access rights to the project manager. The resource allocation documentation and the quality assurance test documentation are also asset in replication of some very similar project phases in project where the scopes are similar. In some cases, they are almost same when there is implementation of some products and services. All in all, documentation is also asset for the companies which contributes to have successful projects in the future.

Interviewee: YK PM6

Interview Questions Structure

Demographics:

1. How many employees do you have?

   I have in my group 20 highly skilled developers.

2. What is your business area?

   My area of activity are new technologies and research and development of new modules in the convergent billing and interconnect billing for telecommunication service providers.

3. What are the target customers?

   My target customer is internal company product department. I am developing and preparing upgrades of the billing modules for my company. Most of the initiatives are coming from the product and services department but also, I am engaged for specific key accounts of the company where tailored made billing is required.

4. What is the size of the software projects?

   My projects are ranging typically from 100K-3M. Since I am head of the special division I have also very big budget to realize my projects and have the freedom to engage the newest technologies including the deep learning services and intelligent service provisioning.

5. What is your role in the company?

   I am one of the key solution architects in the company and am involved in managing bigger team of key architects. Also, I am managing the internal development project where new technologies are introduced. Due to the confidentiality I cannot disclose the details about the new projects, but can say that are based on the newest artificial intelligence algorithms.

6. What are your responsibilities?

   I am responsible for introducing new technologies in the product and services of my company. I am part of larger team of developer hubs which are strongly coordinated by the program and product managers. In the telecommunication industry the introducing of the new technologies is a milestone which is part of survival and thriving policy of the business owners. The delay or inappropriate delivery of new technologies can cause big implications so my role as part of the bigger picture of the company innovations is critical for the success of the introduction of new products and services in the business support systems.

Time estimation process:

24. Do you use any formal time estimation technique? And Why? (Function Point Analysis, COCOMO, SLIM, SEER-SEM, Use Case Analysis, Software Size Unit)

    We use multiple customized techniques based on Software Size Unit. This technique enables us to make evaluation of the effort as well as to understand the object-oriented function points involved in the modules as the measure of difficulty. Also programming technique used in the process of developing complex models and libraries is fully monitored by the administrators of the project repositories.

25. Do you use any expert time estimation technique? And Why? (Planning poker, Delphi)

    Due to the specifics of the code development techniques as well as part of the innovations involved in such projects we use the Delhi methodology to assess the time needed for developing of specific module. We also add as architects some additional contingency due to optimization efforts and code review approach in optimizing the product efficiency as well as avoiding flaws that are part of developing new modules as part of the final product. Also, we are dedicated to integration tests and optimizations of utilizations of the libraries to avoid excessive size of the modules.

26. Do you use other technique for time estimation?

    Due to the specifics of the project development and SDLC we have more flexible estimation of the time needed, giving more time to the repetitive iterations to achieve the robustness and code efficiency of the developed modules. We consult also the product departments to maintain the idea and not to reproduce already presented functionalities in the other modules. Coordination in the process of the development is strongly monitored by the program managers who communicate very closely with the product department. When there is big enterprise in question also the maintenance of the main repository of the projects and knowledge available in the central repository is critical for achieving time efficiency. Always we are looking to engage and utilize the existing developers which are currently available.

27. Are you satisfied with the used technique? And Why?

    I am always looking for improvements and this approach moves me further and further to achieving the company goals and my personal career path. I started to use Delphi but I am not excluding reuse of existing repositories of similar modules developments, also consult the post mortem project documentation of the already completed or failed projects. It is always possible some flaw to create big and unexpected standstill in the progress of the project. This ist the main concern in the development projects since they are unique and are not repetitive activities like service customization.

28. Do you prefer the requirements of the project to be fixed at the beginning of the project or to be updated during the life-time of the project? Does that affect the time estimation process?

    Requirements are not fixed and are always updateable in my development projects. This approach of RandD efforts to achieve something that will be of unique value on the market and will bring revenue and profit to the company. The strong coordination with the product department is of crucial importance to achieve the goal and to be competitive on the market. The approach is agile and is not strongly scrum based since we take care of the socializing aspect of the tacit knowledge. We want to keep the project well documented. Additionally, we are engaged in projects with fixed requirements when we make tailor made product for some of our key accounts of the company.

29. From your experience, what is the more accurate time estimation technique? Formal, expert, or other?

    I rely most of the time on expert knowledge in time estimation. Also, I used technique based on the code complexity and reusability as well as the possible implications of flaws in the critical modules. This aspect in development project tackles the risks of possible delays under control and bring more time in the process of code refactoring efforts and optimizations of the resources.

Resource pool:

30. How to assign a programmer to a certain task? Do you use any techniques?

    We always rely on the resource administration planning application which also gives us indication how long some resources may be available and whether they can be used during the whole project which is preferable or can be exchanged at the middle of the project which is not preferable. All this aspect as well as seniority of the resources are taken into consideration. In the same time, we are avoiding engagement of resources that are not part of our company since they can affect the confidentiality of the project. This is one aspect very important in RandD activities in the software industry.

31. Does the time estimation depend more on the programmer's skill or the task difficulty?

    In my time estimation process I use both aspects in time estimation. In these cases, the realization of the module can be strongly dependent on the skills and efforts of the developers as well as on the difficulty of the task. The task difficulty in most cases is not predictable since we are developing in most cases something that will be new on the market and may be treated as innovation.

Knowledge base:

32. Please explain how you manage the project knowledge?

We keep local code repository and also, we use the central knowledge base repository. Code repository is exchanged and replicated with the central repository servers on regular basis. Project documentation, MoM as well as all relevant decision documents and blueprints are all stored in the document management platform. As initially stressed we are in strong coordination with the business and product owners and this is the critical point for the success of the project.

33. Do you use a formal knowledge management system?

We have big company formal explicit documented knowledge and it is paramount for the success of the development projects. In very big enterprises the updating of explicit knowledge and conversion of the tacit to explicit knowledge is one of the main guidelines. Also, we tend to engage the junior staff in the process of internalization. The process of combination is also very common since the integration of different modules result in product that should be maintained and for that purpose the combination of explicit knowledge is necessary.

34. How satisfied are you with your current project knowledge management?

I am always looking for improvements. The coordination of my team is based on agile principles but also, we strongly tend to document the developed modules. This is important since it is not like service provisioning or customization but pure development. In that respect the documentation of the tacit knowledge is also part of our activities. Good documented SW is easier to be maintained and be modularized. We always tend to make modularization since the product portfolio of the company is very extensive and reusability is one of our ultimate goals.

35. Describe how you apply the knowledge for project decision-making?

I have relatively big freedom in project decision making and always tend to use the past knowledge base as well as rely on the unique requirements and project goals for the development of the required functionality. The technology and programming technique which will be implemented decides about the longevity of the product as well as the ROI. I always stay open during the duration of the project to new ideas or changes in requirements which will contribute to the project prolongation. Critical decisions are always result of strong coordination between the involved parties. Project knowledge repositories also are part of documentation used for risk assessment and decision making.

36. Can you think about any instance where it was difficult to extract software developers or other IT experts' knowledge? Please describe the situation and what you did.

It is rare practice to have issue with developer in preparation of application maintenance documentation, but since all the developers have different personalities and approach to preparing documentation which in most case some of them treat it as not very attractive

and not challenging activity I tend to motivate them at the end with some contest for the most comprehensive and documented SW modules.

37. What project activities do you have for gathering knowledge from experts?

We always prepare documentation at the closing and during the development phase, this is critical for our group. The tacit knowledge is always documented, and we do not save time with some improvised expert knowledge documenting. We have obligation to document all part of the code repository we use code refactoring and optimization of compactness to make the modules more compact and ready for capacity and integration tests.

38. Do you keep a record of past project experiences?

All our past projects and knowledge base which emerges from these projects are well documented in various repositories like the documentation of the project management, project structure, project card, development knowledge base, test knowledge base, test scenarios and test results from different test like final test, integration tests, capacity tests etc. All this is centralized in the main company repository and available according to the user roles.

39. What type of documents are kept after a project is finished?

At the end of the project we have fully documented project closure documents, project post mortem documentation, code repository, user documentation based on the test documentation, application maintenance documentation, interface documentation, module integration documentation etc.

40. What is the use of the documentation of past projects? (Quality assurance, time estimation, resource allocation, etc)

We reuse the similar documentation in new project which have sufficient degree of reusability from the previous project. Also, if the knowledge base and code are similar we may start from one extend in the code repository using the tagging. Also since most of reusable code is stored in library we use the libraries and appropriate documentation of those libraries. As I mentioned in the previous answers time estimation is based on interpolation of similar project time estimations and provided feedback from the DELPHI methodology of time planning.

Interviews Transcripts

Interview 1

Age: 55

Gender: Male

Years of experience as project manager: 15

Duration of the interview: 24 minutes

Demographics:

1. How many employees do you have?

   37 employees.

2. What is your business area?

   Government IT services.

3. What is the target customers?

   Government agencies and offices.

4. What is the size of the software projects?

   Large scale.

5. What is your role in the company and your responsibilities?

   I am a software project manager and my responsibilities include: Resource allocation, time estimation.

Time estimation process:

6. Do you use any formal time estimation technique? And Why? (Function Point Analysis, COCOMO, SLIM, SEER-SEM, Use Case Analysis, Software Size Unit**)**

   Yes, I prefer to use formal estimation techniques like Use Case and SLIM. I like to see the resources and their use documented. That way I know what is being used and what I have available to allocate if needed.

7. Do you use any expert time estimation technique? And why? (Planning poker, Delphi)

   Yes, we sometimes use Delphi only when we have conflicts between the project manager and the programmer regarding the time estimation for a certain task.

8. Do you use other technique for time estimation?

   Usually, the time estimation process is based on my assessment of the situation and on the available resource for that project at that time.

9 Are you satisfied with the used technique? And why?

   To a certain degree, yes. But there is a room for improvements.

10. Do you prefer the requirements of the project to be fixed at the beginning of the project or to be updated during the life-time of the project? Does that affect the time estimation process?

    I prefer the requirements to be fixed at the beginning of the project.

11. From your experience, what is the more accurate time estimation technique? Formal, expert, or other?

    I think there is a room for better time estimation techniques. I usually rely on my intuition and my assessment and judgment.

Resource pool:

12. How to assign a programmer to a certain task? Do you use any techniques?

    According to the availability and capability of the programmer. I use available programmers but I need to check their technical suitability. I use scheduling to details the tasks and technical programming skills require to complete it. And then I check the available programmers.

13. Does the time estimation depend more on the programmer's skill or the task difficulty?

    I think it is a combination of the two factors.

Knowledge base:

14. Do you keep a record of past project experiences?

    Yes, during the development of every project, we insist on keeping a documentation record of every stage. The aim is to use the documentation to gather information for decisions that will be needed further along the project timeline. Many decision points arise in the specific project and I draw on my records for knowledge.

15. What type of documents are kept after a project is finished?

    The task name and requirement, the programming language, the time spent.

16. What is the use of the documentation of past projects? (Quality assurance, time estimation, resource allocation, etc.)

    Usually for quality assurance purposes.

Interview 2

Age: 26

Gender: Male

Years of experience as project manager: 2

Duration of the interview: 20 minutes

Demographics:

1. How many employees do you have?

   11 employees.

2. What is your business area?

   Government IT services.

3. What is the target customers?

   Government and private agencies and offices.

4. What is the size of the software projects?

   Small.

5. What is your role in the company and your responsibilities?

   Project manager and my responsibilities to make sure the project deriver on time and Resource allocation.

Time estimation process:

6. Do you use any formal time estimation technique? And Why? (Function Point Analysis, COCOMO, SLIM, SEER-SEM, Use Case Analysis, Software Size Unit)

   Yes.

7. Do you use any expert time estimation technique? And Why? (Planning poker, Delphi)

   No.

8. Do you use other technique for time estimation?

   Usually, I use the formal technique.

9. Are you satisfied with the used technique? And Why?

Yes, it's more professional.

10. Do you prefer the requirements of the project to be fixed at the beginning of the project or to be updated during the life-time of the project? Does that affect the time estimation process?

    I prefer to be updated during the life-time of the project, of course it affect the time but not it keeps the quality.

11. From your experience, what is the more accurate time estimation technique? Formal, expert, or other?

    The time estimation technique is more accurate.

Resource pool:

12. How to assign a programmer to a certain task? Do you use any techniques?

    According to the availability and capability of the programmer. I use available programmers but I need to check their technical suitability. I use scheduling to details the tasks and technical programming skills require to complete it. And then I check the available programmers.

13. Does the time estimation depend more on the programmer's skill or the task difficulty?

    Both of the factors.

Knowledge base:

14. Do you keep a record of past project experiences?

    No, we only keep the business record.

15. What type of documents are kept after a project is finished?

    The business record.

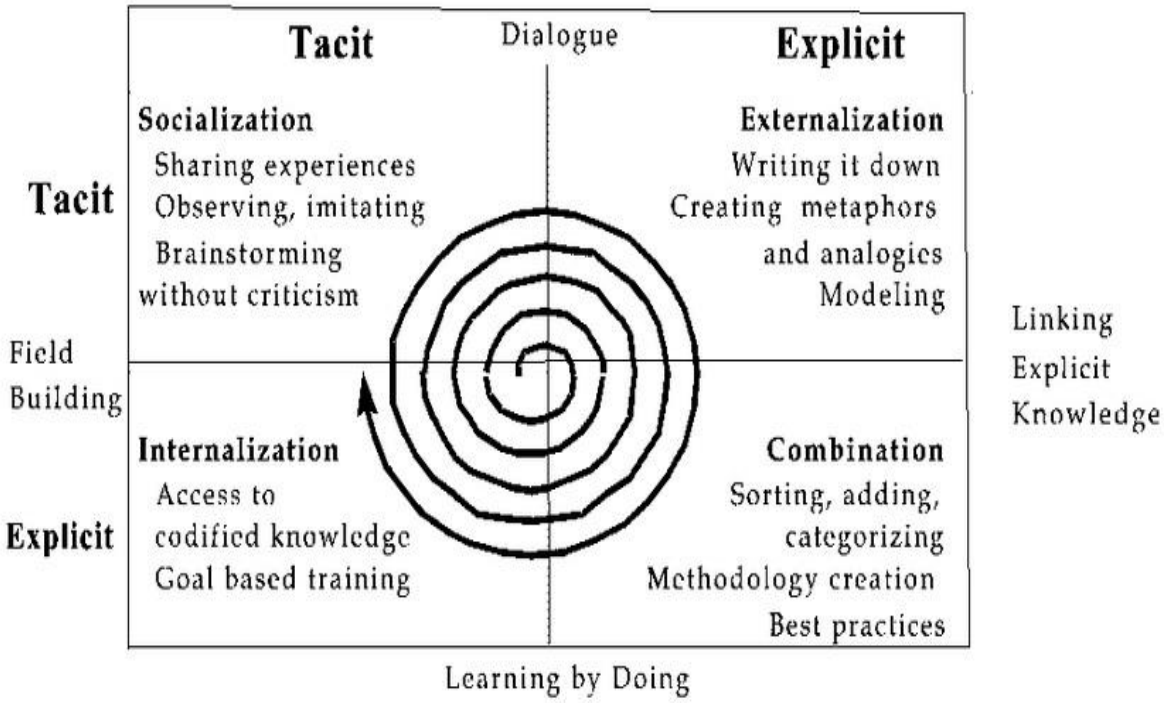
16. What is the use of the documentation of past projects? (Quality assurance, time estimation, resource allocation, etc.)

    For quality assurance.

First Interview Code Table

Code	Instances	Comment
Techniques used	6	Techniques used varied included: Function Point Analysis, COCOMO, SLIM, Use Case Analysis
Techniques not used	4	Younger project managers tended not to use estimation techniques.
Mind/Spreadsheet	3	Project managers preferred to keep things simple.
Documentation	8	Most project managers kept some records about their previous experience. The younger project managers tended not to keep records.
Knowledge activities	8	Most project managers used project meetings, training sessions, brain storming, etc. as forums to gather knowledge. As well as formal records, they made personal noted too.
Knowledge base	6	Knowledge bases were used sparingly by project managers. It was expected that most project managers would keep some kind of experience knowledge base and add to it in their current project.
Decision-making	9	Project managers used project management activities to gather information for decision-making.

The theory of knowledge creation assumes that knowledge moves through four stages of application, as seen this diagram. The management of complex IT systems development project often means creating entirely original knowledge because the particular system is radically or new knowledge that combines existing know-how in new ways. This questionnaire contains questions to model this SECI knowledge creation theory and investigate how complex IT systems development project knowledge is managed and project decisions are made.



INTERVIEW QUESTIONNAIRE

PROFESSIONAL INFORMATION	
Name:	
Title/Designation:	
Organisation:	

PERSONAL INFORMATION	
Gender	Male Female
Qualifications	Secondary School Degree PhD Professional Certification Other
Role/Position	Programmer Business Analyst Project Manager Systems Tester Database Administrator Other
Experience	1-5 Years 6- 10 Years 11-20 Years 21or More

Kind of Experience	Simple IT systems development projects Routine IT systems development projects Complex IT systems development projects
Project Budgets	Below £50000 £50001 - £100000 £100001-£250000 £250001-£500000 £500001-£1000000 Over £1000000
Project Team Size (People)	Below 5 6-10 11-20 21-30 31-40 41-50 Over 50

Appendix C1: Initial Open Coding and Suggested Cluster Codes

Interview	*Ideas/Themes*	*Initial Codes*	*Preliminary Cluster Codes*
1st Interview	Functional Point analysis technique and expert time estimated. Formal approach resolves project planning activities. Resource allocation dual approaches for programmer's skill. Projects cards, test documentation, capacity and test integration documentation contribute to manage project.	Functional Point analysis Formal approach Project cards	Function Point Analysis
2nd Interview	Functional analysis approach and DELPHI satisfies the time estimation. Small pool programmer is utilized as the resource planning. Intranet document knowledge is contributed with the application of RASIC diagram is used.	Functional analysis DELPI methodology Intranet programmer	DELPHI methodology
3rd Interview	Functional Point Analysis, SRS documentation and Delphi methodology with agile methodology is used. Consideration of previous project estimation is preferred. Repository documentation projects are utilized and ticketing system keeps the record safe.	Functional Point analysis DELPHI methodology Respiratory documentation	Context

4th Interview	Functional Point Analysis and SCRUM methodology are used. Ticketing system is guided the assignment or project to conduct. Company portal and trouble shoot activities and SCRUM structure, time is utilised..	Functional Point analysis SCRUM methodology Ticketing system	Intranet programme Resource allocation
5th Interview	FPA which is based on SRS is contribution and Delphi and Agile methodology is used. The knowledge of SECI dimensions and tacit knowledge is used.	Functional point analysis DELPHI methodology SECI dimension	Explicit knowledge
6th Interview	Software Size Unit and Delphi methodology is accessed for development of module. Resource administration planning application direct indications and preferred the exchange aspects of project.	Software Size Unit DELPHI methodology Planning application	Poor quality
7th Interview	Software Size Units with planning poker are used and practicing scram project management technique. Estimation always relies on the programmer's skill and resource allocation application which is available on the company intranet. Full autonomy in project decision making and use the site by site programming technique,	Software size unit Planning poker Project card	Budget overruns Reliability Integrity Predictability

	prefer project card, code repository, test scenarios and tests' results, integration tests' results.		
8th Interview	Use Case Analysis. And provides precise project planning documentation. Choice of the programmers as well as other resources is based exclusively on the competence and shows interest involvement in telecommunication OSS project. SECI model and current project knowledge management is used. side by side programming is preferred.	Case analysis Choice of programmer SECI model Side by side programming	Tacit knowledge

Appendix D: Second Round Interview Questions And Sample

INTERVIEW QUESTIONS		
Objective 2. To identify knowledge creation and knowledge flows in IT systems development project management.		
Tacit Knowledge (Feedback session) Tacit to Tacit: This mode is also known as "Socialisation" where the knowledge is transferred and shared via social gathering and conversations.		
1	How do you as a project manager share your experiences from your previous projects and within the current project with other project members? I am conducting infrastructure projects and application management and operation projects. I used to share the project content within my team.	
2	How do project members share their experiences with you as the project manager from previous projects and within the current project? We have one portal where we share the experience of the project management methodology used in our company.	
3	How do project members share their experiences with coworkers from previous projects and within the current project? There is **MS SharePoint** portal with project documentation from the previous projects and guidelines for project management.	
4	What techniques do you use to express and share tacit knowledge? (for example, metaphor, brainstorming) We in our team are like a family and resolve all the problems private and business together. We talk to each other.	
5	As a project manager, explain your motivation to share your knowledge with your project members. I am very close to the members of my project and help each other and support each other during the work hours.	
6	As a project member, explain your motivated to share your knowledge with the project manager and other project members? I do like to be useful and the people around me to trust me.	

7	Describe the social context of the project. For example, do you have lunch together as a rule or meet after work? Is this social context conducive for knowledge sharing? Yes, we have social life together and support each other out of the working hours.	
8	Explain how the organizational context of the IT systems development project facilitates or impedes knowledge sharing. Usually it facilitate the development project in our case of application maintenance project it helps us to follow the scope of the project definition and do not narrow or extend our scope of engagement. It impedes in the formal way due to the necessity of strong rules of work which sometimes do not fully comply with the efficiency.	
9	Does motivation to share knowledge vary between different types of knowledge required on projects? For example, creative knowledge for problem solving and routine knowledge for programming schedules. If there is close cooperation between the project members the motivation is coherent and belongs to the group and company goals.	
10	Describe how trust among project members affects knowledge sharing. Provide examples. I believe trust is crucial for good knowledge sharing and one of the drivers for good relations within the project team members.	
11	If you have made use of reward systems to encourage knowledge sharing in projects, explain the reward system, how it was used and its effectiveness for sharing knowledge. Reward system together with the assessment methodologies in project members upraise are motivating factors for closing the formal part of already practically closed project. The project is closed when the final document is prepared, approved and uploaded in portal library,	
Explicit Knowledge Tacit to Explicit: This mode is also known as "Externalisation" where the knowledge is articulated and written down.		
12	Detail the media in which project knowledge is recorded. In our case is intranet network and is also available to the employees and managers with specific user rights.	

13	Are metaphors and analogies used to create recordable knowledge? Provide examples. Through the informal documentation sharing and some more informal project documentation preparation, the formality is broken and association to funny moments in the projects bring the good spirit of the projects to those who read the documents.	
14	What project management techniques and modelling tools are used to record creative project knowledge? (For example, PRINCE tools, etc). Explain how they are populated with project knowledge? We follow the PMI methodology with full set of document templates.	
Combination Explicit to Explicit: This mode is also known as "Combination" where different types of explicit knowledge are combined to form a new knowledge.		
15	How is knowledge organized in the project? There are folders in the completed projects libraries as well as some indexing of the documents based in keywords.	
16	What methods are used to share best practice knowledge in the project? The good and profitable projects are shared among the company employees and project managers and some events are organized to support and stress the successful projects. Good projects are also available in success stories folder on the intranet portal.	
17	How is best practice knowledge used in the project? The experience is shared during the morning sessions on the management of the divisions and some problems are resolved using the previous knowledge referring to the resolution of the problems.	
18	What IT systems are used to manage project knowledge? (For example, ,project databases etc) DMS (document management systems)	
Internalisation		

Explicit to Tacit: This mode is also known as "Internalisation" where the knowledge becomes a second nature and a part of an individual knowledge.		
19	What access do project members have to project knowledge? There are user roles imposed to the project members and also to some company members during the life project. After the project is finished there is also possibility to extend the roles and access rights to the rest of company employees.	
20	What access do project members have to project knowledge stored on IT systems? They have read access to the project knowledge base. Only editor of the intranet site have the right to make editing according to the company rules.	
21	Explain how you, as a project manager, use explicit project knowledge. I consult the knowledge base whenever some formal templates should be used during the project lifecycle. Also some methods in specific critical stage of the project which were already used are available for reading.	
Objective 3 To capture expert IT systems development project managers' decision-making processes.		
Decision Making		
22	What knowledge base do you draw on to make resource allocation decisions? I use the documentation for project preparation phase and consult the company rules in resource allocation. For that purpose there is also available application with GUI environment.	
23	How do you approach decision-making in complex projects compared with simple projects? The decision-making in complex project requires stronger coordination of the project leaders and project sponsors as well as the project owners. In simple projects the team is normally smaller and the coordination can be organized with informal approach.	
24	Do you make use of other expert project manager's knowledge? Explain how?	

	I am concentrated to the portal where the project documentation and methodology resides. Also we have morning sessions every day where short coordination and consultation is conducted.	
25	Does your project decision making depend on certain aspects of organization structure – like participative decision making, ease of information flow, teams and communities of practice? The organization structure is crucial in decision making.	
26	As a project manager, how do you make use of explicit project knowledge stored in project databases and files for project decision-making? I use usually the templates and also use search based on keywords to find relevant information.	
Knowledge management		
Objective 4 To develop a novel IT systems development knowledge management framework based on knowledge management to enable IT systems development project		
27	Explain your use of fixed programing teams and interchanging programming teams as a structure for managing projects. There are benefits of having fixed dedicated programming teams. You can plan you resources and coordinate the activities based on the fixed capacity. In case of interchanging teams the problem is that you do not know exactly the current capacity and availability of the project team members. In some cases there is pros in one approach in some cases also cons in another approach. I prefer fixed programming teams to work with.	
28	Explain how you manage project members' values to create an effective project team. I intend to stress their positive values and try to decrease as much as possible the negative influence of their dominance in the project teams. Sometimes domination creates envy in other project members. There should be optimal approach.	
29	How do you encourage 'knowledge donating' and 'knowledge collecting' in the project teams you manage? Provide examples.	

	I organize sessions for exchanging information during the period of time when the workload is not so intense.	
Project Management		
30	What methods do you use to manage project knowledge? The project knowledge I intend to exchange on regular monthly workshops with my employees.	
31	What project processes do you use to manage responsibilities and tasks? For example, routine activities to affect knowledge sharing like daily meetings, retrospective reflection and pair programming. I use all the mentioned approaches in different stages in the project.	
32	What information systems development methodology/project management technique do you use? Describe how you use it to manage project knowledge? Some of the customers insist on using some of the PM methodologies. Lately the **agile** approach is more favored. In some cases also **scrum** methodology is used especially during application maintenance projects.	
33	Do you use an information systems development methodology/project management technique to create knowledge? Explain why? I use the techniques which are part of the company methodology for project management which strongly relies on **PMI** standard approach, lately **Scrum** methodology is also seen as more favored among the customers.	
34	Explain your use of ad hoc meetings to manage projects. Give examples of project tasks or issues that raised the need for ad hoc project meetings. I use ad hoc meetings to resolve some incidents and make resolution of problems that occurs in the everyday application lifecycle support activities.	
35	What is your expected level of communication frequency in complex projects compared to simple projects? Low, Medium or High. Give examples and explain why you labelled is Low, Medium or High In complex project which are usually with higher budget more people are involved and also higher managers of the company. In smaller projects there are only follow up activities.	

Appendix D1: Initial Open Coding And Suggested Cluster Codes

Interview	Ideas/Themes In this column are the ideas/themes from the 26 interviews that reflect the Initial Codes	Initial Codes	Emerging Cluster Codes
1	• conducting infrastructure • application management • share the project content • MS SharePoint portal • Team bonding • Supportive team leader • good relations • Reward system • intranet network • PMI methodology • good and profitable projects • document management systems • Editor right • GUI environment • Monthly workshops • agile approach • scrum methodology • ad hoc meetings	• MS SharePoint portal • Team bonding • GUI environment • agile approach • scrum methodology • motivation • Team bonding • document management systems	▪ agile approach ▪ motivation ▪ scrum methodology ▪ IT system ▪ ad hoc meeting ▪ Reward ▪ Jira ▪ Crystal methodology ▪ Sharing knowledge
2	• project postmortem documentation • leisure atmosphere	• scrum project	

	• scrum project • micromanagement • knowledge exchange • IT systems development • Motivation • system for evaluation • IT infrastructure • Confidential • CRM/BSS development • intranet portals • MS Sharepoint • Confidential information • PM methodologies • team leaders as pillars • project DBs • project KPIs • avoid micro management • organize presentation • pragmatic approach • agile methodology • standard waterfall methodology • Ad hoc project meetings	• IT systems development • leisure atmosphere • CRM/BSS development • PM methodologies • agile methodology	

3	• PMI methodology • share the experiences • workshops • brainstorming session • motivation • teambuilding sessions • knowledge sharing • standard approach • reward system • DMS platforms • PMI approach • agile project approach • collaborative environment • SVN servers • Data base • PMI knowledge • Scrum • coordination activities • flexible approached • reward • Jira for project • code the standards of SVN • ITIL approach • ad hoc meeting	• ad hoc meeting • PMI methodology • motivation • DMS platforms • PMI approach • agile project approach • SVN servers • Scrum • ITIL approach • team building sessions	
4	• BSS area • different portals and technologies • team building sessions	• Ad hoc project meetings • Motivation • Reward	

	• motivation • interpersonal relationship • trust • reward • intranet based projects' • agile methodologies • scrum • closing projects' sessions • document management environment • KPIs and financial reporting • On and off site dedicated team • RASIC matrix • Scrum • company portal • Fixed programming teams • collected project documentation • Knowledge sharing • PMI methodologies • Ad hoc project meetings	• Scrum • PMI methodologies • Knowledge sharing • agile methodologies • team building sessions	
5	• IT projects • regular meetings • project office employees • metaphors or analogies	• IT projects • Reward system • Agile methodology	

	• motivation • internal project communication • project communication • exchange opinions • Reward system • intranet portal • Prince2 methodology • Agile methodology • DMS portal • Workshops • document management systems • senior employees • regular session • project managers • interchanging programming teams • knowledge donating and knowledge collecting • workshops • retrospective meetings • daily reporting and meetings	• Prince2 methodology • DMS portal • Workshops • motivation • Ad hoc meetings • Crystal Agile • Scrum • Jira	
6	• BSCS platforms • mutual exchange of opinions • exchanging information • Crystal Agile		

	• Agile project methodologies • XP • Scrum • Virtual teams • project knowledge • Crystal methodology • PERT chart • SVN • Jira • intranet document management system • pair programming • collective code ownership • KM • DMS platform • explicit knowledge • exchange of knowledge • participative decision making • Fixed programming teams • Exchange knowledge • Crystal methodology • Ad hoc meetings	• Crystal methodology • DMS platform • Exchange knowledge	
7	• KM platform • Team building • daily stand up meetings • project advancing	• Ad hoc meetings • Crystal • Motivation	

	• XP • Crystal • Motivation • Trust • unified systems • KM system • Sharing knowledge • code repository • test cases • results repository • explicit knowledge • evaluation of the progress • workshop sessions • explicit project knowledge • fixed programming teams • soft skills • repository • Agile methodologies • waterfall methodology • Ad hoc meetings • Project manager	• Sharing knowledge • Agile methodologies • waterfall methodology • Team building • KM system	
8	• existing knowledge base • data base • post mortem documentation	• data base • post mortem documentation • sharing information	

	• DWH dispatch • strong dedication • sharing information • IT systems • pair programming • Creative knowledge • Trust • clear transparency • intranet • brainstorming sessions • DWH • Flipchart • code repository • projects' portals • project knowledge base • project allocation plan • intranet portals • Web portals • pair programming • incentives/rewards • agile approach • morning sessions • classical PMI approach • team leader	• Trust • Flipchart • intranet portals • classical PMI approach • agile approach • incentives/rewards	
9	• Pm workshops are used for communication. • Pair programming is used for knowledge sharing	• KM platforms • Trust • IT systems • code repository • Team working • Prince2	

	• KM platforms are used for internal documentation security. • Analogies and metaphors are used for training. • Smooth project environment • Creative knowledge • Trust • code repository • IT systems • critical path approach • opinion based decisions • Fixed programming teams • Exchanging knowledge • Team working • Prince2 • ad hoc meetings • Communication frequency	• ad hoc meetings • pair programming • Training and PM meetings • SharePoint application for documentation • PMI cards for PMI framework	
10	• Trainings and PM meetings are arranged for feedback. • Analogies are used for project scheduling. • Creative knowledge is important with the		

	employees for knowledge sharing. • SharePoint portal is used for information sharing and documentation. • PMI cards and internet support is used for PMI framework. • SVN and JIRA are used for resolving the issues. • Decision making is based on resource allocation and project management. • Fixed size team is used for project and performance is measured by assessment. • Adhoc meetings are arranged for complex projects. • Trustworthy environment is given importance		
11	• Project management is used for IT application Development • Workshops for organising teams. • Paired programming for training junior employees.	• SVN and JIRA are used for resolving issues. • Ad hoc meeting is held. • Trustworthy environment • Application of PM frameworks.	

	• Trustworthy environment is need of organisation. • Performance reporting is done by PMI based templates and project cards • PMI agile methodology is used for practising knowledge. • Resource allocation is done by critical chain methodology (CCM). • Fixed programming teams are used. • PMI agile methodology for project development. Level of projects is according to the critical level of project.	• Paired programming is used. • Trustworthy environment • PMI agile methodology has been used with critical chain methodology. • Communication level is high.	
12	• PM training • Workshops • Global success based on motivated employees. • Paired programming for coaching knowledge • trustworthy atmosphere for coaching and fulfilling aims • PMI framework is used for coaching	• Information sharing through experiences, workshops, meetings • Paired programming • PMI complaint box • KM platforms • Integration teamwork	

	• site programming, pair and osmotic working environments • IT management like ticketing program KM platforms on intranet environment is applied. • The CCM methodology is used for resource allocation. • RASI and SCRUM framework is used for resolving small issues	• SCRUM approach • Trustworthy environment	
13	• PM training • Workshops • Meetings • Brainstorming session • Sharable knowledge based management • Trustworthy environment • Management documentation is done by PMI Agile methodology • KM platform are used for organisation function • CCM methodology resource allocation. • RASI is used for decision making	• Workshops and meetings • Paired programming • PMI Agile methodology • CCM • SCRUM flipchart • Trustworthy environment	

	• fixed programming teams • pair programming for coaching approaches		

Appendix E: Focus Group Questions And Samples

Focus Group

KNOWLEDGE SHARING AND MANAGEMENT IN IT SYSTEMS DEVELOPMENT PROJECTS

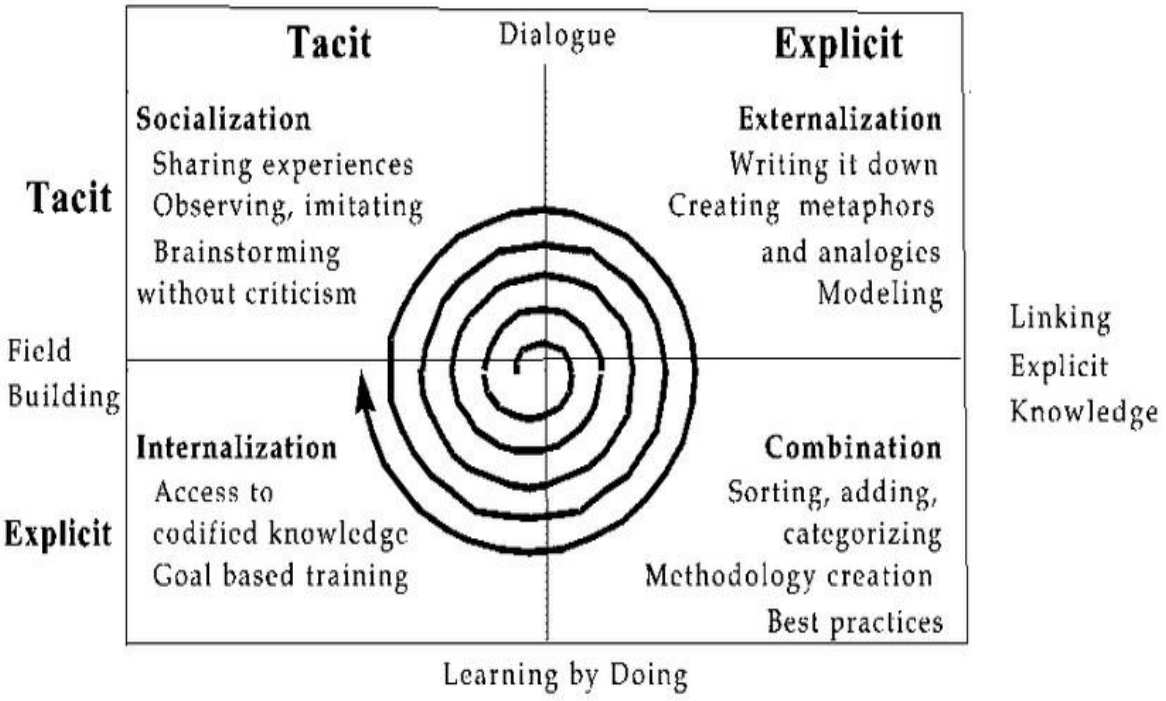
Research Aim

The aim of this research is to investigate IT systems development project management to develop a knowledge management framework to aid project management decisions.

This is a study of enhancing knowledge management in project management. Groups and individuals' capability to solve complex IT systems development problem and project managers' ability to make project decisions important to achieve a successful project. The aim of this study is to develop a knowledge management framework that enables complex decision-making to reduce the failure of IT systems development projects. This empirical research, through this second round of interview questions, aims to assess how project knowledge is managed through the SECI knowledge creation model perspective, and how project managers make complex IT systems development decisions. The main contribution of this research is expected to be a description and explanation of knowledge management practices in complex IT systems development projects, based on the application of knowledge creation and management theories to decision-making frameworks.

The theory of knowledge creation assumes that knowledge moves through four stages of application, as seen this diagram. The management of complex IT systems development project often means creating entirely original knowledge because the particular system is radically or new knowledge that combines existing know-how in new ways. This questionnaire contains questions to model this SECI knowledge creation theory and

investigate how complex IT systems development project knowledge is managed and project decisions are made.



Focus Group Setup

These focus group questions are to validate the proposed framework for knowledge management in complex IT projects. The focus group questions contain questions that will be asked to gather data on the proposed framework and other questions that could be asked as follow-up and probing questions if required. The design of the focus group questions draws on guidelines provided by specialist focus group facilitators and standard research textbooks.

Introduction by Facilitator

Hello, my name is Abdullah. I appreciate the time you have given to participate in this focus group on knowledge management in complex IT projects. This focus group is part of a larger empirical research consisting of two rounds of interviews and this focus group to understand how project managers manage knowledge for complex IT projects. IT projects consist of people, IT, IS and organisation which makes them complex projects to manage.

You are a group of IT project managers with an average of 12 years' experience of managing complex IT projects and you have an interest in knowledge management in such projects. Such complex projects require large amounts of information and knowledge which needs to be managed to help experts deliver the project on time and within budget.

In this focus group I will pose questions and facilitate a conversation by generating discussion on how knowledge is managed in complex IT projects. There are no "right" or "wrong" answers to any of the questions. The aim of the focus group is to gather you expert views and to stimulate and generate conversation around IT project knowledge management. Please feel comfortable and speak honestly to share your thoughts, ideas and knowledge.

The focus group is scheduled to last 90 minutes. It will be recorded to help me collect the data accurately and subsequently analyse it to produce useful knowledge. Your individual contribution to the focus group will be kept confidential and only thematic ideas will be used. Does anyone have questions before we begin?

The following focus group questions have been developed from the themes that emerged from the second round of interviews.

Focus Group Questions

1. Let's talk about how project managers and project members share personal knowledge (Tacit Knowledge). Sharing knowledge is a social process – meaning we share knowledge with others. How do you as project managers share your personal knowledge or experiential knowledge for the benefit of the project? How do you get project members to share their personal knowledge or experiential knowledge? [This question covers the socialisation construct of the proposed framework.]

2. Let's discuss the ways in which you as project managers articulate explicit knowledge. What media do you use to record explicit knowledge? How frequently is such recording done? Is this explicit knowledge validated in any way? [This question covers the externalisation construct of the proposed framework.]

3. I want to explore how project members access project knowledge in order to complete their projects responsibilities and specific tasks. How can project managers access project knowledge? [This question focuses on access to the knowledgebase by project manager and project members.]

4. Let's focus on how project managers use the knowledge base in decision making. Please detail situations and cases in which you have drawn on the explicit knowledge base to make decisions about the project. How does this help you to monitor the IT systems development? [This question explores the use of the knowledge base for decision making.]

5. I want to explore personal or experiential knowledge (tacit knowledge) in the situations you described. Please provide examples of such knowledge (knowledge that is not available

in the knowledge base or easily made explicit). [This question covers the integration aspects of sharing knowledge.]

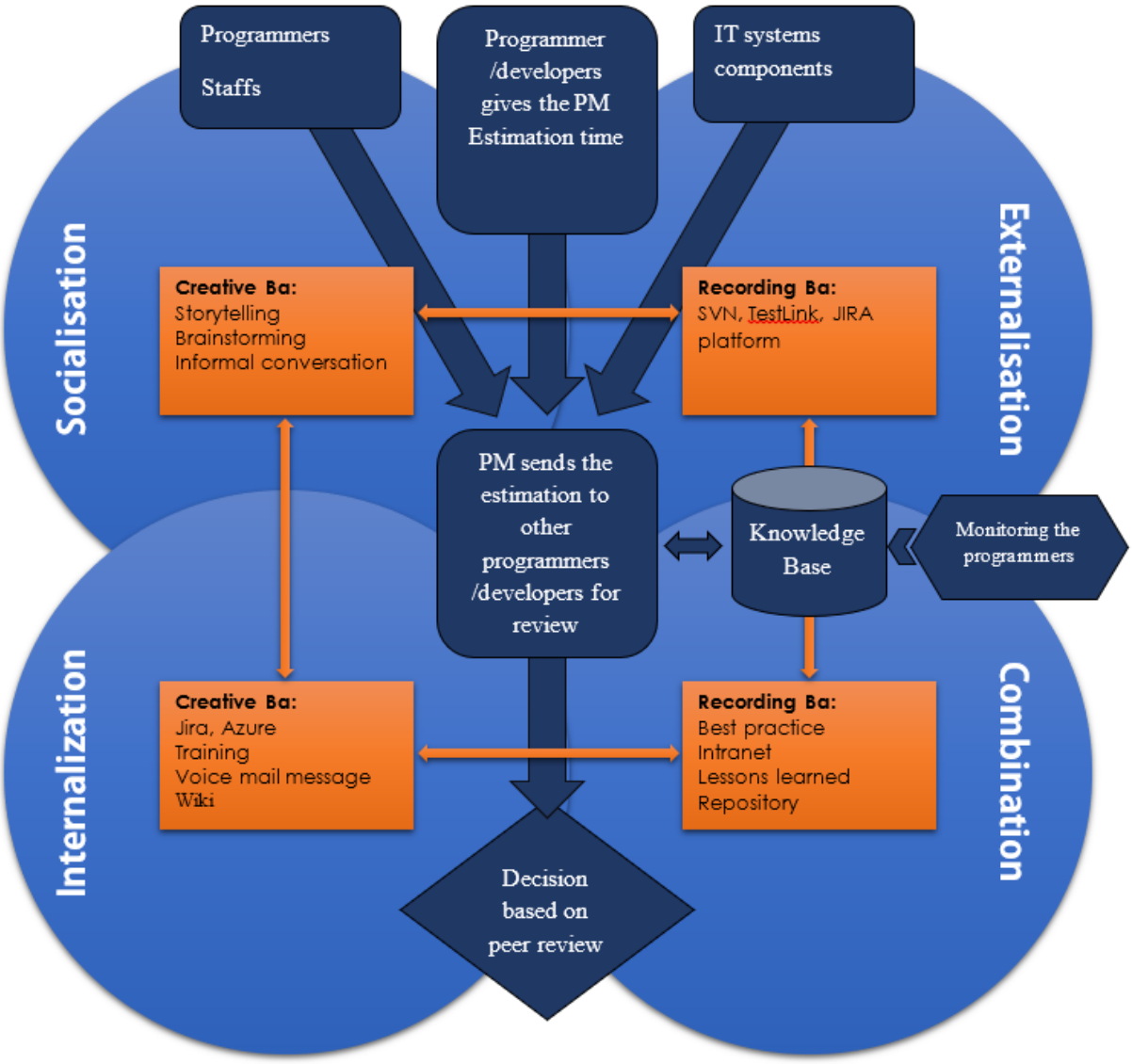
6. Let's explore how shared knowledge and explicit knowledge is combined. Please situations in which you existing knowledge has benefited from knowledge you received from project members. [This question covers the combination aspect of knowledge management.]

7. Now, I want to understand knowledge management for IT systems development. Please detail the approach and systems you use to manage project knowledge. Can you provide an example? What happened in the case of X?

8. The next point is critical for the success of the IT project. It concerns project team development for project knowledge management. Please explain how you develop the project team in order to manage project knowledge. In what situations do you need to train members of the project team? Please provide an example.

9. This next point is related to the previous one. It concerns project management techniques to manage project knowledge. What project management techniques are suitable for IT project knowledge management?

Now, I have a few questions about using this knowledge management framework for project management. Please study this IT project management knowledge management framework.



10. The framework shows the 'socialisation' process. Could we discuss how you use this socialization among programmers to contribute to the project knowledge base and how you use that knowledge to make project decisions? Please give specific examples.

11. The framework shows the 'externalisation' process, with the 'knowledge base' overlapping with the 'combination process. Could you describe the processes you use to externalize project knowledge and how you use that knowledge to make project decisions? Please give specific examples relating to IT components.

12. The framework shows the ‘combination’ process. How do you use the knowledge base to combine with existing project knowledge to make project decisions? Please give specific examples.

13. The framework shows the ‘integration’ process. How do you use the integrated knowledge to make project decisions? Please give specific examples.

14. A project manager’s primary duty is to deliver the project in time and budget, and up to required quality. How do you use knowledge management arising from the SECI process to monitor the project? What kind of project management decisions do you make using the emerging knowledge base?

-

Thank you for sharing your expert knowledge and your time!

SAMPLE FOCUS GROUP RESPONSES

PROFESSIONAL INFORMATION	
Name:	#####
Title/Designation:	#####
Organisation:	#####

PERSONAL INFORMATION	
Gender	Male Female
Qualifications	Secondary School Degree PhD Professional Certification Other
Role/Position	Programmer Business Analyst Project Manager Systems Tester Database Administrator Other
Experience	1-5 Years 6- 10 Years 11-20 Years 21or More

Kind of Experience	Simple IT systems development projects Routine IT systems development projects Complex IT systems development projects
Project Budgets	Below £50000 £50001 - £100000 £100001-£250000 £250001-£500000 £500001-£1000000 Over £1000000
Project Team Size (People)	Below 5 6-10 11-20 21-30 31-40 41-50 Over 50

INTERVIEW QUESTIONS		
Objective 2. To identify knowledge creation and knowledge flows in IT systems development project management.		
Tacit Knowledge (Feedback session) Tacit to Tacit: This mode is also known as "Socialisation" where the knowledge is transferred and shared via social gathering and conversations.		
1	How do you as a project manager share your experiences from your previous projects and within the current project with other project members? I have conducted numerous project in BSS for telecoms, In some cases I spent many months' even years as project manager or program manager. As expert in BSCS platforms I conducted several preparatory training sessions for the customers' members of the projects. It is usually at the start of the project but it is not necessary only at the start, it continues before every project iteration/increment.	
2	How do project members share their experiences with you as the project manager from previous projects and within the current project? We have mutual exchange of opinions at initial definition of the increments and brainstorming session which are used for converting the user stories to use cases. This initially is part of the scope of the statement of work before starting the project.	
3	How do project members share their experiences with coworkers from previous projects and within the current project? There are unformal and formal ways of exchanging information and knowledge between the project members. All the tacit knowledge is usually exchanged on morning stand up meetings, where the efficiency of the 5 min. sessions bring the people to be concise and up to the point of discussion.	
4	What techniques do you use to express and share tacit knowledge? (for example, metaphor, brainstorming) Tacit knowledge is not documented knowledge that comes up on the special occasions when there is unformal discussion in most of the cases. It is important to give space to the experienced team leaders and experts to	

	express themselves. This can be also in occasions of emergency when there is need for swift change.	
5	As a project manager, explain your motivation to share your knowledge with your project members. My role as project manager is not restrained to coordination and time planning as well as resource allocation planning, I am also coacher and business analyst. I also can coordinate the activities within stand up meetings and backlog review sessions. I am also experienced in risk assessment and integration activities.	
6	As a project member, explain your motivated to share your knowledge with the project manager and other project members? In case as a project member in cases when I am business analyst and in earlier days as BSCS designer, I tend to prepare all necessary information for the team members. I also have good cooperation with PM/.technical lead when I act as BA in case of creating the use cases for the test scenarios for the QA teams.	
7	Describe the social context of the project. For example, do you have lunch together as a rule or meet after work? Is this social context conducive for knowledge sharing? There are a lot of occasions where we have time together. As international team which is consisted of expatriates and customer's local staff we have a lot of to exchange apart from the project related information. The off hours bring us together in the crises project situations.	
8	Explain how the organizational context of the IT systems development project facilitates or impedes knowledge sharing. Organizational context is important and depends on the multiple factors. As newest methodology Crystal Agile which is tailorable according to the needs of the organization and project budgets is one of the most favored. The skeleton definition and the next increments to the final solution is one of my challenges when using this approach. Agile project methodologies are now whether XP, Scrum or Crystal are something that is used by most of the vendors due to the possibility to better use the resources and finances in the same time, and have something tangible for testing in the early stage of the projects.	
9	Does motivation to share knowledge vary between different types of knowledge required on projects? For example, creative knowledge for problem solving and routine knowledge for programming schedules.	

	The creative knowledge is usually located at the senior stuff of the project team. Unfortunately it is not easily shared with the other staff especially junior staff since there is big difference in competences. On the other hand the open and sharable code allows the juniors to look at the code and ideas behind. The more encouraging is the side by side coding or paring where the possibility to learn the new technique is easier achievable.	
10	Describe how trust among project members affects knowledge sharing. Provide examples. The good team spirit is crucial in agile methodologies. Virtual teams usually are more difficult for building trust. For that purpose the new video conference technologies bring the people together and make the trust to be built.	
11	If you have made use of reward systems to encourage knowledge sharing in projects, explain the reward system, how it was used and its effectiveness for sharing knowledge. In agile technologies there is possibility to evaluate everyday tasks of the stuff and make the incentives visible on daily basis. Point based system is important since it stress that the most important is to allow code review and refactoring since it will bring positive points and also to allow the seniors to be awarded when they make code review and refactoring. Also for QA team on the other site the reward will be in automation and efficiency of tests.	
Explicit Knowledge Tacit to Explicit: This mode is also known as "Externalisation" where the knowledge is articulated and written down.		
12	Detail the media in which project knowledge is recorded. The project knowledge is documented in company documentation and the methodology used. Knowledge of the project and documentation of project backlogs and all specifics to the projects are stored in the companies and vendors intranet. Project knowledge is desirable to be shared among project members.	
13	Are metaphors and analogies used to create recordable knowledge? Provide examples. This method of approach is important to make the project context easier to understand with vivid examples. In some cases the process of definition of the core functionalities which enable the system still to be functional with limitations is called as skeleton. This analogy is vivid and gives example	

	how the epic and user stories can be grouped to produce the skeleton with minimal use cases and on top of it to build the rest of the functionalities.	
14	What project management techniques and modelling tools are used to record creative project knowledge? (For example, PRINCE tools, etc). Explain how they are populated with project knowledge? We tend to use the Crystal methodology and use PERT chart.	
Combination Explicit to Explicit: This mode is also known as "Combination" where different types of explicit knowledge are combined to form a new knowledge.		
15	How is knowledge organized in the project? There are explicit and implicit knowledge. Explicit knowledge resides on the company infrastructure (SVN, Jira, intranet document management system). Second layer of knowledge exchange is the implicit part when with pair programing and side by side programming the developers learn from each other.	
16	What methods are used to share best practice knowledge in the project? I will stress collective code ownership and pair programming as one of the best methods for code sharing.	
17	How is best practice knowledge used in the project? There is built in platform for KM in the company where the explicit knowledge resides. The knowledge can also be acquired from external companies or even the user knowledge can be acquired as user stories and epic.	
18	What IT systems are used to manage project knowledge? (For example, project databases etc) There is DMS platform that is adopted for KM and also there are platforms for code repository, ticket repository, and test cases repository. Also the user documentation is part of the knowledge bad which is stored in DMS>	
Internalisation		

Explicit to Tacit: This mode is also known as "Internalisation" where the knowledge becomes a second nature and a part of an individual knowledge.		
19	What access do project members have to project knowledge? The KM systems have different access rights.	
20	What access do project members have to project knowledge stored on IT systems? They have access to the generic documentation related to similar projects and also project methodology as well to all infrastructure systems code repository, requirements repository, use cases repository, test scenarios, test results, project dashboard etc.	
21	Explain how you, as a project manager, use explicit project knowledge. I use the explicit knowledge on line if needed using the KM platform.	
Objective 3 To capture expert IT systems development project managers' decision-making processes.		
Decision Making		
22	What knowledge base do you draw on to make resource allocation decisions? Based on the increment scope and the planned time and resources to cope with the planning we implement the theory of constraints where special attention is given to bottlenecks and the allocation of the resources to tackle this issues.	
23	How do you approach decision-making in complex projects compared with simple projects? The complex projects have a lot of interaction and a lot of groups which work in pipeline mode. This approach is even more demanding taking into consideration that one iteration trigger the other and in same time the testing. Testing is reduced using special automation techniques.	
24	Do you make use of other expert project manager's knowledge? Explain how?	

	The exchange of knowledge and experience is very useful and coaching of experienced PMs in the field of expertise of theirs is crucial to resolution of some specific problems.	
25	Does your project decision making depend on certain aspects of organization structure – like participative decision making, ease of information flow, teams and communities of practice? I encourage participative decision making in the process of definition of the bottlenecks during the project planning. Also I encourage organizational change when there is possibility of improvements. All ideas are welcome. Communities of practice is popular in big organizations like enterprises with global daughter companies residing in many countries. They usually use synergies.	
26	As a project manager, how do you make use of explicit project knowledge stored in project databases and files for project decision-making? I consult the best practices from the known documentation and also use the documentation of the closed projects and lessons learned.	
Knowledge management		
Objective 4 To develop a novel IT systems development knowledge management framework based on knowledge management to enable IT systems development project		
27	Explain your use of fixed programing teams and interchanging programming teams as a structure for managing projects. Fixed programming teams are useful since they know each other and progress in the project with certain pace. They can be challenged when tackled the bottlenecks in the projects. My experience with interchanging programming teams is stronger since they are used in increments pipelines and exchange each other during the progress in the project. They are more favorable for complex projects.	
28	Explain how you manage project members' values to create an effective project team. I encourage the project members to exchange their knowledge and introduce system of evaluation which encourage the team work, like reviewing the	

	code of each other and refactoring of the junior code as well as for WA teams the incentive when they find a flow in the functionality.	
29	How do you encourage 'knowledge donating' and 'knowledge collecting' in the project teams you manage? Provide examples. This part is sensitive for all project members because they give up from their exclusivity sharing the knowledge and experience. The idea is that knowledge and experienced donating should be compensated with acquiring another knowledge from other group of developers or employees. Otherwise this will be treated as asymmetrical and unfair to donors.	
Project Management		
30	What methods do you use to manage project knowledge? I use the known explicit knowledge management and for the tacit knowledge I organize special sessions in the isolated environment where the employees stay together longer time and in friendly behavior they exchange their experiences. There should be symmetrical knowledge exchange. This knowledge that is treated as tacit or implicit should become after several sessions explicit.	
31	What project processes do you use to manage responsibilities and tasks? For example, routine activities to affect knowledge sharing like daily meetings, retrospective reflection and pair programming. We have regular daily stand up meetings, regular weekly meetings and steering monthly meetings.	
32	What information systems development methodology/project management technique do you use? Describe how you use it to manage project knowledge? I use the Crystal methodology. Knowledge is based on implicate and explicate. Implicate knowledge is used in the daily sessions with pair and side by side programming. All other methods are focused on collecting explicate knowledge in code and knowledge repositories as well as backlogs and user cases. test results, UAT and other documentation.	
33	Do you use an information systems development methodology/project management technique to create knowledge? Explain why?	

	The systems used to collect knowledge reside on different platform, from generic information to specific to the project as described in previous question.	
34	Explain your use of ad hoc meetings to manage projects. Give examples of project tasks or issues that raised the need for ad hoc project meetings. Ad hoc meetings occur always when there is need to change something in the project either organizational change or scope or project requirements change. In some case it is used to disclose some important information.	
35	What is your expected level of communication frequency in complex projects compared to simple projects? Low, Medium or High. Give examples and explain why you labelled is Low, Medium or High In complex projects there is structure of project leaders who coordinate the increments and also test leaders who coordinate the test teams, So the communication is maintained on higher level on a daily basis. In smaller teams it can be increased since the meetings even stand ups are attended by all team members.	

Appendix F: Themes List and SECI Model

This is the list of themes discovered from the in-depth interviews and focus group interviews. The data analysis results found themes that directly indicate the embedded activities of the SECI model. The coding technique and procedure for deriving the themes are explained in the research methodology Chapter 3 and data analysis Chapter 4.

THEMES

Sharing Tacit Knowledge

Techniques of sharing knowledge

Trust and knowledge sharing

Motivation for sharing knowledge

Reward system to encourage sharing

Media for recording project knowledge

Use of metaphors and analogies in knowledge storing

Project management techniques for recording project knowledge

Knowledge organization

Project members access to knowledge systems

Decision making in complex projects

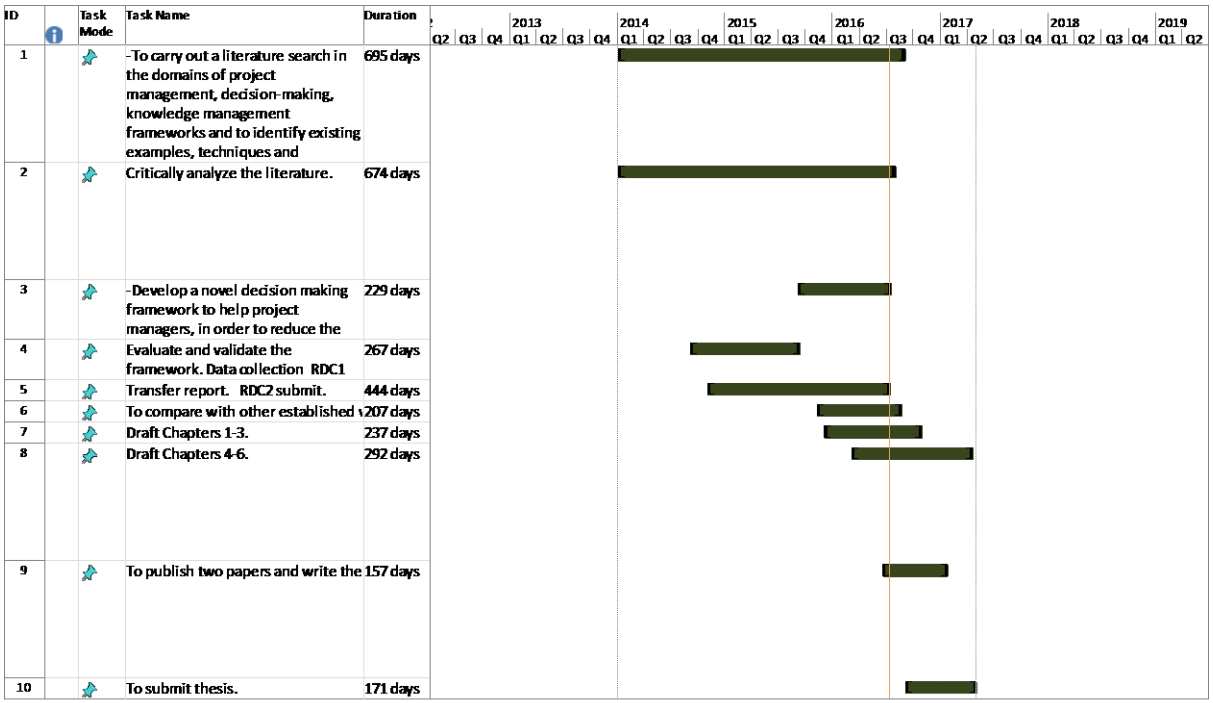
Usage of project knowledge as a manager

Project management structure

Responsibilities to manage project

Communication in project management

Appendix G: Research Plan



ID	Task Mode	Task Name	Duration
1		-To carry out a literature search in the domains of project management, decision-making, knowledge management frameworks and to identify existing examples, techniques and	695 days
2		Critically analyze the literature.	674 days
3		-Develop a novel decision making framework to help project managers, in order to reduce the	229 days
4		Evaluate and validate the framework. Data collection RDC1	267 days
5		Transfer report. RDC2 submit.	444 days
6		To compare with other established v	207 days
7		Draft Chapters 1-3.	237 days
8		Draft Chapters 4-6.	292 days
9		To publish two papers and write the	157 days
10		To submit thesis.	171 days